Platte River Recovery Implementation Program

Michael Forsberg Photo

Final Environmental Impact Statement

Volume 1

U.S. Department of the Interior
Bureau of Reclamation

U.S. Department of the Interior
U.S. Fish and Wildlife Service

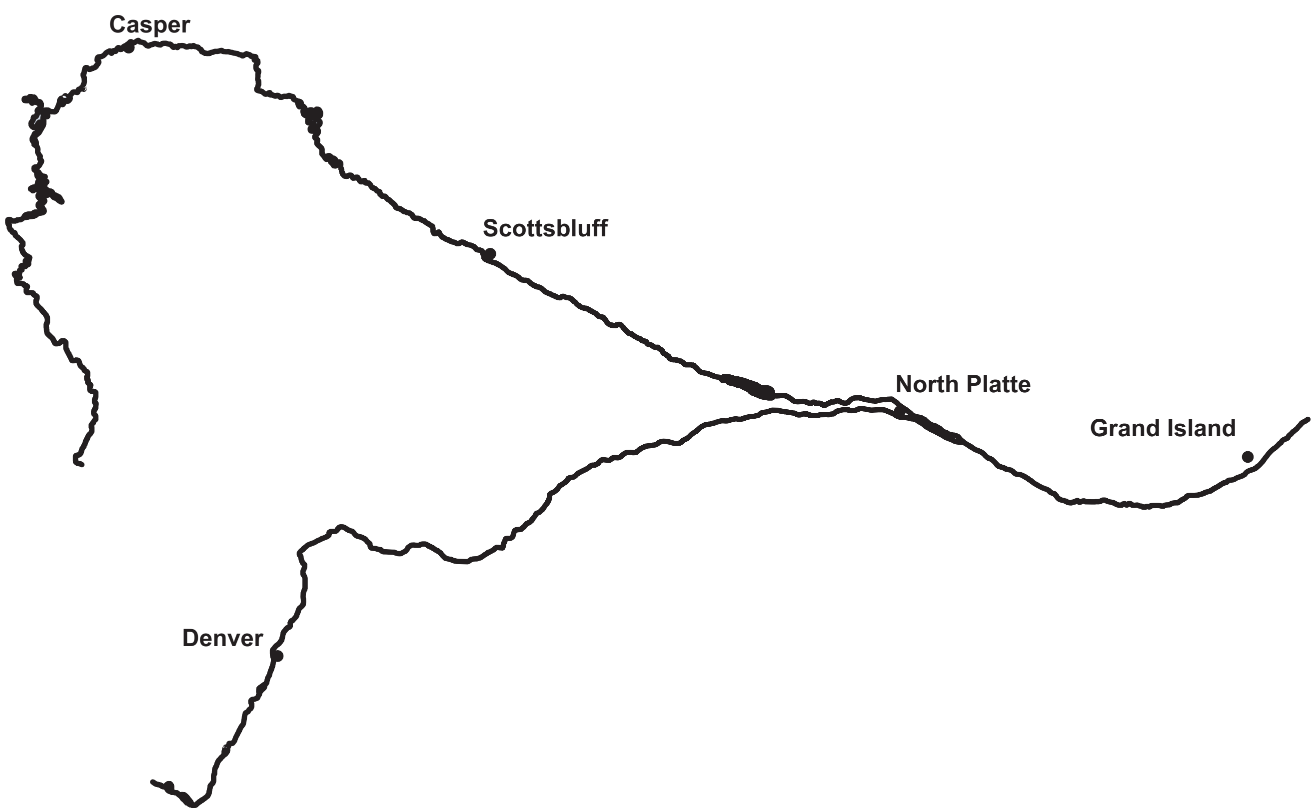
April 2006

Platte River Recovery Implementation Program Final Environmental Impact Statement

Volume 1

Assessing Alternatives for Implementation of a Basinwide, Cooperative, Endangered Species Recovery Program

April 2006



United States Department of the Interior
Bureau of Reclamation
U.S. Fish and Wildlife Service

COVER SHEET
Final Environmental Impact Statement
Platte River Recovery Implementation Program

Prepared by: Bureau of Reclamation and U.S. Fish and Wildlife Service.

National Environmental Policy Act Cooperating Agencies: U.S. Natural Resources Conservation Service, U.S. Environmental Protection Agency, Western Area Power Administration, U.S. Department of Agriculture-Forest Service, U.S. Geological Survey, U.S. Army Corps of Engineers, and Carbon County, Wyoming.

Action Area:
Nebraska Counties: Adams, Arthur, Banner, Buffalo, Cheyenne, Custer, Dawson, Deuel, Garden, Gosper, Hall, Hamilton, Kearney, Keith, Kimball, Lincoln, Merrick, McPherson, Morrill, Phelps, Scotts Bluff, and Sioux.
Colorado Counties: Adams, Arapahoe, Boulder, Clear Creek, Denver, Douglas, Elbert, Gilpin, Jackson, Jefferson, Larimer, Logan, Morgan, Park, Sedgwick, Teller, Washington, and Weld.
Wyoming Counties: Albany, Carbon, Converse, Fremont, Goshen, Laramie, Natrona, and Platte.

This Final Environmental Impact Statement (FEIS) is prepared to address requirements of the National Environmental Policy Act (NEPA). This FEIS also serves as the Biological Assessment for the Endangered Species Act (ESA) Section 7 consultation.

In 1997, the States of Nebraska, Wyoming, and Colorado and the U.S. Department of the Interior (Interior) signed a *Cooperative Agreement for Platte River Research and Other Efforts Relating to Endangered Species Habitats Along the Central Platte River, Nebraska (Cooperative Agreement*). In this document, the signatories agreed to pursue a Basinwide, cooperative approach to improve and maintain habitat for four threatened and endangered species—the whooping crane, interior least tern, piping plover, and pallid sturgeon in the Platte River.

Interior has prepared this FEIS to analyze the impacts of the first 13 years of implementation of the proposed Recovery Implementation Program (Program) (Program's First Increment) to benefit the target species and their habitat in the Platte River Basin and to provide compliance with the ESA for certain historic and future water uses in each state. The habitat objectives of the proposed Program include: improving flows in the Central Platte River through water re-regulation and conservation/ supply projects; and protecting, restoring, and maintaining at least 10,000 acres of habitat in the Central Platte River area between Lexington and Chapman, Nebraska. This FEIS analyzes the impacts of four alternatives to implement the Program. The Governance Committee Alternative is selected as Interior's preferred alternative.

The Programmatic FEIS focuses on impacts that the Program may have on hydrology, water quality, land, target species and their habitat, other species, hydropower, recreation, economics, social, and cultural resources. Subsequent NEPA and ESA documents required for implementation of specific Program actions will be tiered off of this document.

For further information regarding this FEIS, or to obtain additional copies of this FEIS, contact Joy Knipps at the Platte River EIS Office (PL-100), PO Box 25007, Denver, Colorado 80225-0007, telephone (303) 445-2096 or facsimile (303) 445-6331.

Copies of the *Platte River Recovery Implementation Program Document* may be obtained by contacting the office of the Executive Director, Governance Committee, 2003 Central Avenue, Cheyenne, Wyoming 82001, telephone (307) 634-1756 or toll-free (877) 634-1773. These documents are also available at <http://www.platteriver.org>.

ROADMAP TO THE FINAL ENVIRONMENTAL IMPACT STATEMENT

This FEIS is comprised of 3 volumes and a summary for easy reference and to provide a more thorough analytical background.

SUMMARY

The summary contains the basic information about the proposed Program and summarizes the alternatives, Present Condition, and potential impacts of each alternative.

FINAL ENVIRONMENTAL IMPACT STATEMENT, VOLUME 1

Chapter 1 introduces the purpose of and need for proposed Program and the approach to both National Environmental Policy Act (NEPA) and Endangered Species Act (ESA) analysis for the Program. The objectives and principles for the Program's First Increment, which guide the formulation of alternatives, are described. The chapter provides a sketch of the target species and the habitat they use in and along the Platte River in Nebraska, as well as the basic kinds of actions that would be taken to restore and protect habitat. Chapter 1 also describes briefly the significant changes that have been made in the EIS in response to public comments. The complete listing of public comments and responses from the EIS Team is in volume 2 of the FEIS (see below).

Chapter 2 gives a more detailed description of the target species and the key features of the Platte River habitat used by the species. This chapter also describes in detail the changes in the species habitat and trends in the species' population that provide the impetus and need for this Recovery Implementation Program.

Chapter 3 describes the action alternatives. A table summarizing the elements in each alternative, and a table summarizing the impacts of each alternative on the environment, is found at the end of chapter 3.

Chapter 4 describes the Present Condition for the affected resources, which serves as the baseline for comparing the action alternatives. The methods used for analysis are summarized in this chapter.

Chapter 5 analyzes impacts of the action alternatives for each indicator, as well as cumulative impacts. Chapter 5 also includes the biological assessments' determination of effects for the target species.

Chapter 6 describes the public involvement process and consultation and coordination efforts with other Federal, state, and local government agencies.

Chapter 7 is a list of environmental commitments that would be undertaken upon implementation of a Program.

Glossary
Bibliography
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Abbreviations and Acronyms
List of Preparers

FINAL ENVIRONMENTAL IMPACT STATEMENT, VOLUME 2

This volume contains documents that provide background information.

- Public Comments on the DEIS and Responses From the EIS Team
- Governance Committee Program Document Table of Contents
- The ESA Section 7 Consultation Process With and Without a Cooperative Program
- History of ESA Consultations on Platte River Target Species
- Platte River EIS Screening Report
- Lake McConaughy EA 2005 Operating Plan
- Major Water Facilities Likely to be Affected
- Service Draft Instream Flow Recommendations
- National Research Council Report on Endangered and Threatened Species for the Platte River[1]
- Fish and Wildlife Coordination Act Report: Platte River Recovery Implementation Program
- Financial Impacts to Pick-Sloan Firm Power Customers
- Volume 3 Table of Contents

FINAL ENVIRONMENTAL IMPACT STATEMENT, VOLUME 3 (ON REQUEST)

This volume is available by contacting the Platte River EIS Office <http://www.platteriver.org>. Platte River EIS Office, PL-100, PO Box 25007, Denver, Colorado 80225, USA. 303-445-2096. It contains:

A technical appendix for each resource discussed in chapters 4 and 5 to provide additional data including modeling results, methodology, and other analysis, on compact disk (CD).

Technical reports that support the data or describe methods.

[1]Reprinted with permission from the National Academies Press, Washington, D.C., Permission Number: 2248-10978.

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Sidebars

Chapter 1

Purpose of and Need for Action

INTRODUCTION AND OVERVIEW

The Platte River system has undergone extensive development for irrigation, power generation, and municipal water uses. The system today contains 15 major dams and reservoirs and provides water for about 3.5 million people. Existing facilities on the river provide hydroelectric power, irrigation water, flood control, recreation, and fish and wildlife habitat. Substantial portions of the economies of the Basin States—Wyoming, Colorado, and Nebraska—are based on water supplied by the Platte River.

Concerns have been building for years over the four threatened and endangered species that use the Platte River in Nebraska—the whooping crane, piping plover, interior least tern, and pallid sturgeon—as well as other wildlife in the Central Platte River in Nebraska. This habitat has been affected by the development of water projects throughout the Platte River Basin (Basin), and also by more local land use changes. In 1997, the States of Wyoming, Colorado, and Nebraska and the U.S. Department of the Interior (Interior) signed a *Cooperative Agreement for Platte River Research and Other Efforts Relating to Endangered Species Habitats Along the Central Platte River, Nebraska* (Cooperative Agreement).[1] In this agreement, the signatories agreed to pursue a Basinwide, cooperative Platte River Recovery Implementation Program (Program)[2] to improve and maintain habitat for the target species using the Central and Lower Platte Rivers in Nebraska.

To ensure compliance with the Endangered Species Act (ESA) and to allow water users throughout the Basin to continue their current use of Platte River water, the Program was developed to:

- **Provide additional or modified riverflows through the Central Platte River habitat**
- **Protect and restore areas of suitable land habitat between Lexington and Chapman, Nebraska**
- **Mitigate, or offset, impacts to the target species and their habitat resulting from new water development activities in the Basin**

Interior (Reclamation and the U.S. Fish and Wildlife Service [Service]) has prepared this Final Environmental Impact Statement (FEIS) to analyze and disclose the environmental consequences of the first 13 years of implementation of the proposed Program (Program First Increment)[3] to benefit the four

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[1]Available at <http://www.platteriver.org> or from the Office of the Executive Director, Governance Committee (see "Cover Sheet").

[2]A recovery implementation program is a set of actions to address aspects of the Service's recovery plan for a threatened or endangered species. A recovery implementation program aims to help recover the species, while not necessarily addressing all threats to a species throughout its range.

[3]The participants in the proposed Program selected 13 years as the expected duration in order to allow sufficient time to accomplish the actions proposed and enable initial monitoring of environmental effects.

threatened and endangered species (the four "target species") and their habitat in and along the Platte River in Nebraska:

- ➢ Whooping crane
- ➢ Interior least tern
- ➢ Northern Great Plains breeding population of the piping plover
- ➢ Pallid sturgeon

The FEIS assesses the effects of this Program when implemented in conjunction with ongoing operation of certain existing and future water-related activities[4] in the Platte River Basin.

The Program, when implemented, is intended to provide compliance with the ESA for certain existing water projects and water uses in the Basin upstream of the confluence of the Loup River, as well as for certain future water uses during the Program's First Increment of 13 years, as they affect the target species and their habitat in the Central and/or Lower Platte River. A listing of existing water projects that are subject to ESA consultation and water projects that are likely to use the Program to provide compliance for the effects of their historic and future water uses on the target species in Nebraska is in *The ESA Section 7 Consultation Process With and Without a Cooperative Program*, table 3-3, in volume 2.

The Cooperative Agreement established a Governance Committee, representing the three states, water users, environmental groups, and Federal agencies, to develop a proposal for the Program.[5] Pursuant to the Cooperative Agreement, the members of the Governance Committee formulated a draft proposal for the Program to be evaluated by Interior under the National Environmental Policy Act (NEPA) and ESA. The Governance Committee's draft proposal was evaluated along with three additional alternatives in a Draft Environmental Impact Statement (DEIS), released for public review in January 2004. Public comments were received until September 22, 2004.

The Governance Committee has since completed a final proposal for the Program, referred to in this FEIS as the "Governance Committee Alternative." It is described in detail in the *Governance Committee's Platte River Recovery Implementation Program Document*, 2005 (referred to in this FEIS as the "Governance Committee Program Document").[6] This FEIS assesses the impacts of that proposal, plus three additional action alternatives, through the Program's First Increment.

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[4]For purposes of the Cooperative Agreement and related documents, the term "water-related activities" means activities and aspects of activities which: (1) occur in the Platte River Basin upstream of the confluence of the Loup River with the Platte River; and (2) may affect Platte River flow quantity or timing, including, but not limited to, water diversion, storage and use activities, and land use activities. Changes in temperature and sediment transport will be considered impacts of a "water-related activity" to the extent that such changes are caused by activities affecting flow quantity or timing. Impacts of "water-related activities" do not include those components of land use activities or discharges of pollutants that do not affect flow quantity or timing. "Existing water-related activities" include surface water or hydrologically connected groundwater activities implemented on or before July 1, 1997. "New water-related activities" include new surface water or hydrologically connected groundwater activities including both new projects and expansion of existing projects, both those subject to and not subject to Section 7(a)(2) of the ESA, which may affect the quantity or timing of water reaching the associated habitats and which are implemented after July 1, 1997.

[5]A detailed history of the Cooperative Agreement process is presented in Freeman, 2003.

[6]Available in the attached CD or at <http://www.platteriver.org> or from the Office of the Executive Director, Governance Committee (see "Cover Sheet"). Note that this FEIS provides only a summary of the very detailed and lengthy proposal contained in the Governance Committee Program Document. This FEIS does not serve as the legal description of that proposal. Persons who wish to learn the details of this proposal should consult the Governance Committee Program Document.

NEED FOR THE PROGRAM

Various parts of the Platte River in Nebraska provide important habitat for the piping plover, whooping crane, interior least tern, and pallid sturgeon (Service, 1978 [whooping crane], 1988 [plover], 1990, 1993, 1994 [whooping crane], and 1994 [plover]; and National Research Council, 2005). Reasons cited by the Service for the listing of each species as threatened or endangered are summarized in sidebar 1-1. Parts of the Basin in Nebraska have been designated as critical habitat for the whooping crane as shown in chapter 2. Chapter 2 provides a detailed discussion of the development of water projects on the Platte River over the last 150 years which provide water for agricultural, municipal, and industrial activities, and how these projects, as well as other activities, have diminished river and related habitat for the target species.

As described later in this chapter, Federal agencies are responsible under the ESA for ensuring that their actions, or the actions for which they provide funding or permits, do not likely jeopardize the continued existence of endangered species or adversely modify or destroy designated critical habitat.

The *History of ESA Consultations on Platte River Target Species* in volume 2 provides a detailed history of the ESA consultations carried out between various Federal agencies and the Service regarding the effects of water projects and other water activities in the Basin on the target species. The Service has determined that, to avoid jeopardy to the target species, measures for restoration of habitat are needed.

The Platte River Management Joint Study (1990) was initiated by Reclamation and the Service, in cooperation with the States of Wyoming, Colorado, and Nebraska, to develop a fish and wildlife management plan for the Platte River system in central Nebraska that would offset adverse project-related impacts on the whooping crane and the species' federally designated critical habitat. The study recommended that 29,000 acres of habitat for the whooping crane, interior least tern, and piping plover be protected and/or restored along the Central Platte River from Lexington to Chapman, Nebraska.

The Service also determined objectives for the maintenance of riverflows in the Central Platte for the target species (see the "First Increment Goals and Objectives" section in chapter 3; Bowman, 1994; and Bowman and Carlson, 1994). Currently, riverflows fall short of these flow targets by roughly 417 kaf on an average annual basis. Achieving these flow targets would require significant increases in riverflows, especially during the spring and summer.[7]

Based on this information, Interior proposed a phased Program to address habitat restoration, with the Program's First Increment (13 years) that would achieve roughly one-third of these land and riverflow improvements (10,000 acres of habitat land; 130 to 150 kaf of flow improvements), while allowing for monitoring and research during this increment to increase our understanding of the species' needs and the most effective ways to provide habitat improvements.

[7] In 2003, Interior requested the National Academy of Sciences to review the science related to the target species use of the Platte River habitat and the Service's basis for development of the flow targets. The National Academy of Science's report, *Platte River Endangered Species* (National Research Council, 2005), confirmed the importance of this habitat for recovery of the species and that the Service's development of flow targets was based on the best information available at the time. Volume 2 provides the table of contents and conclusions from this report.

Sidebar 1-1.—Factors Cited as Reasons for Listing

Whooping Crane
Listed as an Endangered Species

- Major factors causing species population declines in the late 1800s were loss of large expanses of wetlands throughout most of the species range and shooting.
- Loss of specific areas that have been designated as critical habitat for the species would appreciably decrease and threaten the likelihood of survival and recovery. These areas include the following characteristics:

  Sufficient food (such as crayfish, frogs, small fish, insects, waste grain, etc.), water, and other nutrients to meet physiological needs.

  Adequate amounts and quality of roosting areas during migration, rearing, and wintering.

  Areas of open expanse required by whooping cranes for nightly roosting on sand or gravel bars in rivers and lakes.

  Habitat that is representative of the species' geographical distribution and includes areas for feeding and other normal behavior.

  Protection from human disturbances.

- 32 Federal Register, March 11, 1967; 43 Federal Register 20938, May 15, 1978.

Northern Great Plains Piping Plover
Listed as a Threatened Species

- Modification, curtailment, and destruction of the piping plover habitat (i.e., development of coastal beaches, channelization of rivers, encroachment of woody vegetation, drainage/alteration of wetlands) have led to its decline.
- Decline in population numbers, including those in Nebraska, based on Gulf of Mexico wintering ground and other independent counts.
- Elimination of nesting sandbar habitat along hundreds of miles of rivers due to dams and river channelization.
- Trampling of nests by cattle and an increase in the numbers of predators, which may contribute to the decrease in piping plover populations.
- Increased use of nesting areas by humans, which can disrupt incubation or interfere with fledging success by separating chicks from parents.
- 50 Federal Register 50726, December 11, 1985.

Interior Least Tern
Listed as an Endangered Species

- Permanent inundation or destruction of many nesting islands in rivers by reservoirs and channelization projects.
- Alteration of natural river dynamics has caused unfavorable vegetational succession on many remaining islands, curtailing nesting sites.
- Recreational use of sandbars has been a major threat to the reproductive success of the interior least tern.
- Delay of annual spring floods of the watershed past the onset of normal breeding, and many islands are not exposed as suitable sites in time for nesting.
- 50 Federal Register 21784, May 28, 1985.

Pallid Sturgeon
Listed as an Endangered Species

- A sharp decline in pallid sturgeon has been observed over its range.
- Construction of dams and related activities, particularly extensive in the 1950s and 1960s, changed water temperatures, flow patterns, and other factors that have contributed to declining pallid sturgeon observations.
- Lack of natural reproduction, for reasons that are yet unclear and under further study.
- Decline of the species, which appears to correspond with expanded commercial harvest; some states do not have regulations in place to prohibit keeping pallid sturgeons once they are caught.
- Declining pallid sturgeon observations occurred, in part, because of hybridization with a close species, the shovelnose sturgeon, in parts of its range.
- 55 Federal Register 36641, September 6, 1990.

PROGRAM PURPOSES

The purpose of the action is to implement the Program's First Increment to offset some of the impacts to the target species and their habitat located in the Central and Lower Platte River corridor caused by historic, current, and future water-related activities, through the implementation of land and water management actions which result in target species habitat restoration, creation, and/or enhancement.

The Program will:

- Assist in the conservation and recovery of the target species in the Basin and thereby provide ESA regulatory compliance for effects to the target species' river habitats from existing and certain new water-related activities that deplete water from the Platte River upstream of the Loup River confluence

- Provide a means to ensure that future water uses in the Basin do not undermine these habitat and species benefits and are in compliance with the ESA

- Help prevent the need to list more species under the ESA

SPECIFIC FEDERAL PURPOSES

Program purposes for the state, Federal, and private participants are similar. However, there are specific requirements which the Program must meet to address the responsibility of Federal agencies under the ESA. The Program must:

(1) **Serve as the ESA Reasonable and Prudent Alternative for Previously Completed Consultations:** Where the actions of Federal agencies have previously been the subject of ESA consultation and have received a jeopardy opinion from the Service under Section 7(a)(2) of the ESA, the Program is to serve as the Reasonable and Prudent Alternative (RPA) for those actions for the target species in the Central and Lower Platte River.

(2) **Provide ESA Offsetting Measures:** Where the ongoing operations of Federal water projects in the Basin have not yet completed ESA consultation, the Program is to provide sufficient benefits to the target species in and along the Platte River in Nebraska such that any impacts of those project's operations will be sufficiently offset to avoid the likelihood of jeopardizing the continued existence of the target species or adversely modifying or destroying designated critical habitat.

(3) In accomplishing these first two requirements, the Program will also provide for a much more streamlined and efficient process for completing hundreds of existing or pending consultations on water-related activities in the Platte River Basin.

(4) **Focus on Federal Project Impacts:** In serving as the ESA RPA, or in providing offsetting measures for project impacts to the target species, the Program must offset impacts on the target species' habitats that have been adversely affected by the Federal actions, in kind and in place, especially where designated critical habitat is involved.

(5) **Meet Obligations for Species Conservation:** The Program is to assist each Federal agency in meeting its obligations under Section 7(a)(1) of the ESA to help conserve the target species and other listed species.

(6) **Address Cumulative Impacts:** To ensure the effectiveness of the Program in meeting these Federal objectives, the Program must address cumulative impacts on species habitat due to existing and future private water depletions. The Program must further ensure that contributions of water to the Program by individual water projects are not diverted or subverted by the actions of others in the Basin.

CREATING AN EFFECTIVE RECOVERY IMPLEMENTATION PROGRAM

Interior believes that a Basinwide, cooperative effort to improve and maintain habitat for the target species is essential to meeting these purposes and needs, for the following reasons:

(1) **Effectiveness for the Species:** The coordinated approach will be more effective than a project-by-project approach. A key purpose of the Program is to provide improved riverflows at the Central Platte Habitat Area to offset depletions caused by upstream reservoirs and irrigation projects that are, in some cases, hundreds of miles away. Water moved from those projects to the Central Platte Habitat Area often must cross state lines and always must pass many diversion points. Without the cooperation and assistance of the states and other water users, much of the water being moved to the Central Platte Habitat Area could be diverted or stored by other projects. Similarly, improvement of land habitat for the species will be more effective if all participants can pool resources and acquire and manage land in a coordinated fashion. Without a cooperative approach, many projects and many agencies will literally compete for both water and land to improve habitat. This will lead to a less effective and substantially more costly effort.

(2) **Managing Cumulative Effects:** A cooperative Program is able to address effects on the habitat in a more comprehensive fashion than would individual project compliance with the ESA. Under the Cooperative Agreement, the states and the Federal Government have each committed to undertaking a Depletion Management Plan. These plans will address the cumulative effect of Federal and non-Federal actions on species target flows, protecting those flows from future depletions–even depletions from actions not subject to Section 7 consultation. This effort by the states would not occur under individual project compliance with the ESA.

(3) **Coordination of Program Operations:** Effectively improving flows for the target species requires coordinating operations of many water facilities throughout the Basin. A cooperative approach, that brings together all of the major system operators, can employ Program resources much more efficiently and effectively.

(4) **Monitoring and Adaptive Management:** A coordinated Program also enables comprehensive monitoring of habitat restoration efforts. This, in turn, allows for scientific evaluation of actions and improvement of those actions through an adaptive management approach. The commitment of all parties to an adaptive management approach means that the Program's effectiveness can be increased as more knowledge and experience is gained. This coordinated effort would not occur under individual consultations.

(5) **Equitable Distribution of Effort:** A collaborative effort among all major water users in the Basin allows for a more equitable distribution of effort than might occur under individual project consultation. Individual consultations tend not to focus on issues of equity and fair share but, rather, focus only on offsetting the effects of the project currently in consultation.

Whether or not a Basinwide, cooperative Program is implemented, Federal agencies and the projects they operate, fund, or authorize (which include many state and private water projects) must comply with the ESA. The alternative to a Basinwide approach to ESA compliance would be for each water project to undergo separate ESA review and develop separate measures to offset loss of habitat for the target species without relying upon the Program. This process is very costly for all parties and usually takes many years to accomplish.

The ESA Section 7 Consultation Process With and Without a Cooperative Program in volume 2 explains why a separate, project-by-project approach to ESA compliance is likely to be significantly more costly for water users and less effective for offsetting impacts to the species habitat.

PROPOSED FEDERAL ACTION

To address the Program needs and purposes, Interior, working with the states and other partners, has proposed a Basinwide, cooperative Program to meet its obligations under the ESA. Four alternatives for such an approach are described and evaluated in this FEIS. Each alternative focuses on restoring habitat in the Central and Lower Platte for the four target species through a combination of riverflow improvements and land restoration.

PREFERRED ALTERNATIVE

Based upon the DEIS and associated public review process, and the analysis presented in this FEIS, Interior has selected the Governance Committee Alternative as its preferred alternative.

SCOPE AND INTENT OF NEPA AND ESA ANALYSIS

The Program's intent is to serve as the ESA RPA or offsetting measures for all Basin water-related activities for the target species, when consultation for those activities occurs. Therefore, this FEIS analyzes the effect of the proposed Program in combination with all existing water-related activities in the Basin. Thus, it can serve as the programmatic biological assessment for the effects of Reclamation and Service activities on the target species (the proposed Federal action) and also may serve as the same for other Basin activities (Federal and non-Federal) which require ESA consultation on their species effects. This includes numerous Federal and private water projects which have already completed ESA Section 7 consultation for impacts to one or more of the target species in the Central and Lower Platte River and have a biological opinion that depends on implementing a Platte River recovery implementation program, as well as other projects with a Federal nexus which have not yet consulted for impacts to the target species. (See the *History of ESA Consultations on Platte River Target Species* in volume 2 for a listing of both kinds of projects). More discussion of this topic is found in the "Endangered Species Act Consultation" section in this chapter.

The proposed Federal action is the funding and implementation of the preferred alternative for a recovery implementation program for the four target species together with the continued operation of Reclamation and Service water-related activities in the Basin as they affect riverflows and habitat for the target and other listed species in the Central and Lower Platte River in Nebraska. These water activities include the Reclamation projects on the North Platte and the South Platte Rivers, and the Service projects throughout the Basin. (Major Reclamation, Service, and private water projects in the North and Central Platte River Basins which are likely to be affected by Program actions are described in more detail in *Major Water Facilities Likely to be Affected* in volume 2.

STUDY AREA

The study area[8] and the affected environment for this FEIS are those areas in the Basin which might be affected by Program actions. This includes the main stem, tributaries and associated water projects of the North Platte River, in Wyoming, Colorado, and Nebraska; South Platte River in Colorado, downstream of Greeley, Colorado, and in Nebraska; and the Platte River in Nebraska. See map of the Basin (figure 1-1) or the subbasin maps in the "History of Land and Water Development" section in chapter 2.

BASINS

When discussing river operations in this FEIS, the subbasins are defined to encompass river reaches which are operated as functional units:

- **Platte River Basin:** Refers to the sum of all the subbasins.

- **North Platte River Basin:** Refers to the river from its headwaters in northern Colorado through Wyoming, and through Nebraska to Lake McConaughy.

- **South Platte River Basin:** Refers to the river from its headwaters in Colorado to its junction with the North Platte River in Nebraska.

- **Central Platte River Basin:** Refers to the river from Lake McConaughy to Chapman, Nebraska (this includes part of the North Platte River).

- **Lower Platte River Basin:** Refers to the Platte River from Chapman, Nebraska, to its confluence with the Missouri River near Omaha, Nebraska.

HABITAT AREAS

While elements of the action alternatives are located throughout the Basin, the intent of all elements is to improve habitat conditions in two habitat areas along the Platte River in Nebraska:

- **Central Platte Habitat Area** (Lexington, Nebraska, to Chapman, Nebraska) for the whooping crane, piping plover, and interior least tern.

- **Lower Platte Habitat Area** (from the mouth of the Elkhorn River to the Platte's confluence with the Missouri River) for the pallid sturgeon.

Maps in chapter 2 delineate these habitat areas.

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[8]"Study area" and "action area" are terms used under the NEPA and the ESA, respectively, to refer to the geographic area in which the alternatives may have an effect on the environment or on federally listed species. For this FEIS, these terms and areas are equivalent.

AREAS OF POTENTIAL IMPACT

Within these parts of the Basin, the study area also includes lands irrigated with Platte River water, generally located within a few miles of the river, where water may be leased or sold to the Program or other changes in water use may occur. For economic impacts, the affected environment includes the counties in which these irrigated lands occur, and in which the regional impacts of changes in agricultural and related economic operations may result. Some minor effects may occur in the Missouri River close to the mouth of the Platte River.

The study area and affected environment also include the lands along the Central Platte River in Nebraska where habitat restoration will occur. Potentially significant impacts are examined wherever they occur.

Subbasins of the Platte River as Defined in the EIS

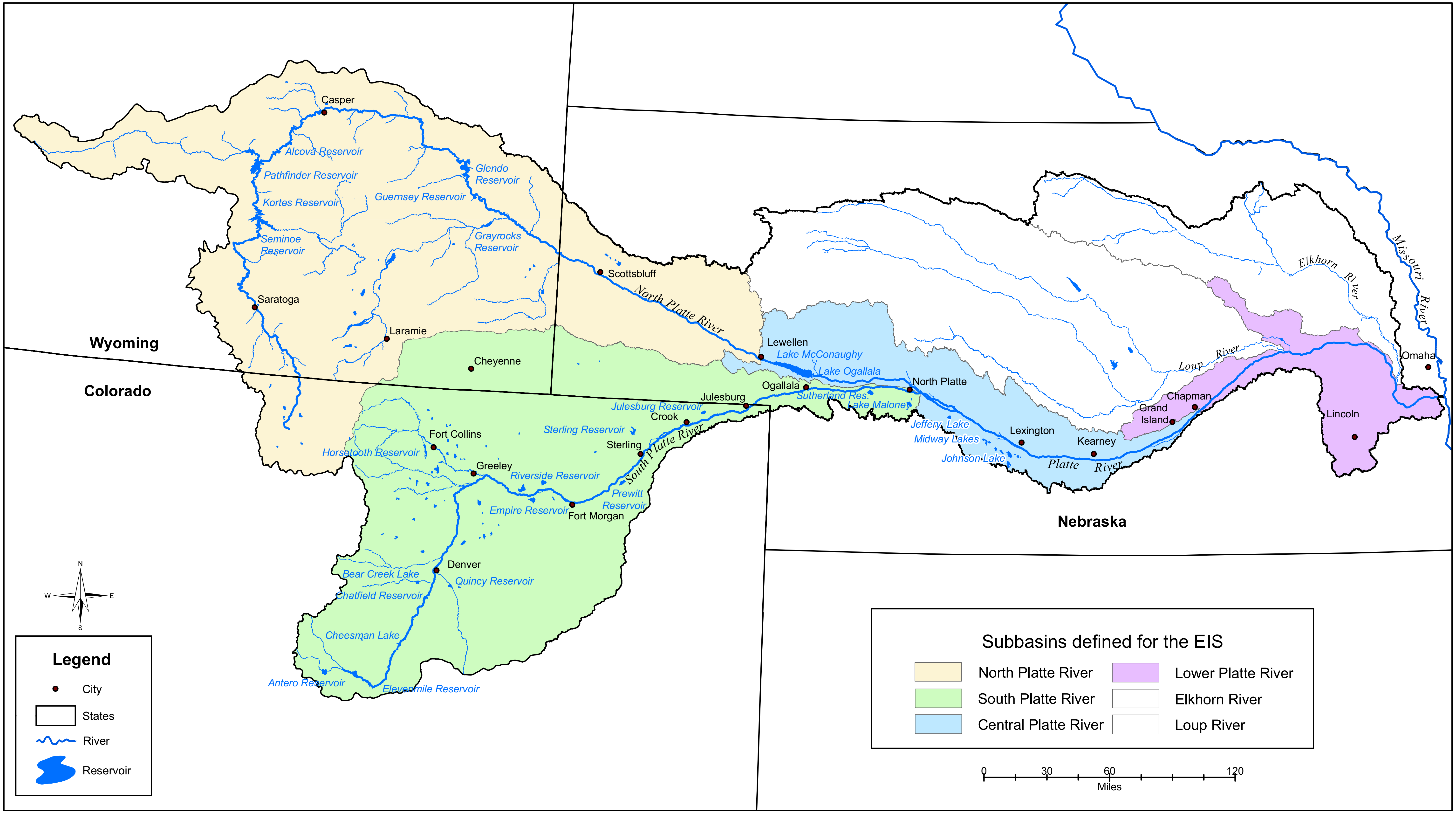

Figure 1-1. — Platte tri-basin map with each subbasin colored (no designation of habitat areas).

BACKGROUND

TARGET SPECIES

The target species for the Program are described briefly below. Photographs of the species and more detailed descriptions are found in chapter 2, "History of Habitat Use and Habitat Trends for Target Species."

Whooping Crane

The whooping crane is found only in North America and is this continent's tallest bird. It is the rarest crane and one of the rarest bird species in the world. Historically, its range extended from the Arctic coast south to central Mexico and from the Rocky Mountain region in Utah eastward to the Atlantic coast. The Aransas-Wood Buffalo flock of whooping cranes, which migrate from Texas to Canada, use the Central Platte River area in Nebraska as a stopover for roosting and foraging. The species was listed as endangered in 1967.

Several areas along the crane's migrational route have been designated as critical habitat. Included in these habitat areas is an area of land, water, and air-space in Dawson, Buffalo, Hall, Phelps, Kearney, and Adams Counties in Nebraska with the following boundaries: Platte River bottoms—a strip of river bottom with a north-south width 3 miles, a south boundary paralleling Interstate 80, beginning at the junction of U.S. Highway 283 and Interstate 80 near Lexington, and extending eastward along Interstate 80 to the interchange for Shelton and Denman, Nebraska, near the Buffalo-Hall County line (FR, 1978 [43:20938]).

Interior Least Tern

The interior least tern is one of the smallest tern species in North America. The interior population of the least tern breeds along the Missouri, Mississippi, Ohio, Red, and Rio Grande river systems, mostly on bare sandbars. The species was listed as endangered in 1985.

Piping Plover (Northern Great Plains Breeding Population)

The piping plover is a small shore bird related to the more common killdeer. Three North American breeding populations of piping plovers are recognized. The greatest number of piping plovers breed in the Northern Great Plains in Canada and the United States. In the United States, this breeding population occurs on the Missouri River and its tributaries in North and South Dakota, Nebraska, Kansas, and Montana. The piping plover nests on sandbars in these rivers, including the Platte River in Nebraska. The species was listed as threatened in 1985.

Pallid Sturgeon

The pallid sturgeon is one of the largest fishes found in the Missouri-Mississippi River drainage, with specimens weighing up to 85 pounds. The species is a bottom dweller, found in areas of strong current and sandy or gravel bottom in the main channel of large turbid rivers, such as the Missouri River and the Lower Platte River. The species was listed as endangered in 1990.

HABITAT FEATURES USED BY THE TARGET SPECIES

In subsequent chapters, the following aspects of river-related habitat used by the target species are described in detail:

- Wide, shallow river areas for roosting by whooping cranes and bare sandbars for nesting of the piping plover and interior least tern
- Riverflows conducive to whooping crane roosting in spring and fall
- Sufficient supply of medium-grained riverbed sediment to build and maintain sandbars
- Spring riverflows which build sandbars for plover and tern nesting which are high enough above summer water levels to avoid subsequent sandbar and nest inundation during summer rainfall events
- Riverflows that support healthy fish and macroinvertebrate communities that interior least terns and piping plovers eat
- Lowland grasslands and wetlands near the Platte River for whooping crane foraging
- Lower Platte River flows and channel characteristics that provide habitat for the pallid sturgeon

POTENTIAL APPROACHES TO HABITAT RESTORATION

Remedies for the loss of habitat involve reversing or minimizing habitat changes that have reduced the value of the Central and Lower Platte Habitat Areas for the target species. The Service has assessed the needs of the three bird species and the pallid sturgeon for Platte River channel and adjacent habitat in the Central Platte River valley and Lower Platte River and has identified various potential habitat changes to improve conditions for the target species. These changes include:

- Restoring some areas of the narrow river channel to wide, open river channel with unvegetated sandbars and open views
- Improving flows in the river during the crane migration seasons and the tern and plover nesting season, and maintaining fish and macroinvertebrate populations used as forage by interior least terns and piping plovers
- Protecting and restoring wet meadows for crane foraging
- Offsetting the ongoing erosion and downcutting of the riverbed in the Central Platte Habitat Area

- Reducing disturbance to target species while roosting, nesting, and foraging
- Increasing sediment transport to the Lower Platte River for pallid sturgeon habitat and increasing the occurrence of significant spring rise in the river to provide spawning cues, nutrient cycling, and reproductive habitat for the pallid sturgeon and its food base

THE PROPOSED RECOVERY IMPLEMENTATION PROGRAM

The goals and objectives of the proposed Program are described below. These goals and objectives were used to guide formulation of all action alternatives. (Boxed text provides direct excerpts from the Governance Committee Program Document.) Note that excerpts used in this FEIS are based on the Governance Committee Program Document as of September 6, 2005, and may vary slightly from the Governance Committee's final document.

I. Program Purposes

A. The purpose of this Program is to implement certain aspects of the U.S. Fish and Wildlife Service's [Service] recovery plans for the target species that relate to their associated habitats by providing for the following:

1. securing defined benefits for the target species and their associated habitats to assist in their conservation and recovery through a Basinwide, cooperative approach agreed to by the three states and the Department of the Interior [Interior];

2. providing ESA compliance* for existing and new water related activities** in the Platte River Basin;

3. helping prevent the need to list more basin associated species pursuant to the ESA;

4. mitigating the adverse impacts of new water related activities on (1) the occurrence of Service target flows (as described in Section E.1.a [of the Program Document]) and (2) the effectiveness of the Program in reducing shortages to those flows, such mitigation to occur in the manner and to the extent described in Section E.3. [of the Program Document] and in the approved depletion management plans; and

*"ESA compliance" means**:** (1) serving as the reasonable and prudent alternative to offset the effects of water related activities that the Service found were likely to cause jeopardy to one or more of the target species or to adversely modify critical habitat before the Program was in place; (2) providing offsetting measures to avoid the likelihood of jeopardy to one or more of the target species or adverse modification of the critical habitat for new or existing water related activities evaluated under the ESA after the Program was in place; and (3) avoiding any prohibited take of target species.

**For purposes of this Program Document and its attachments,[9] the term "water related activities" means activities and aspects of activities which (1) occur in the Platte River basin upstream of the confluence of the Loup River with the Platte River, and (2) may affect Platte River flow quantity and timing, including, but not limited to, water diversion, storage and use activities and land use activities. Changes in temperature and sediment transport will be considered impacts of a "water related activity" to the extent that such changes are caused by activities affecting flow quantity or timing. Impacts of "water related activities" do not include those components of land-use activities or discharges of pollutants that do not affect flow quantity or timing. Existing water related activities include surface water or hydrologically connected groundwater activities implemented on or before July 1, 1997. "New water related activities" include new surface water or hydrologically connected groundwater activities including both new projects and expansions of existing projects, both those subject to and not subject to Section 7(a)(2) of the ESA, which may affect the quantity or timing or water reaching the associated habitats and which are implemented after July 1, 1997.

[9]This Programmatic FEIS adopts the same definition.

5. establishing and maintaining an organizational structure that will ensure appropriate state and federal government and stakeholder involvement in the implementation of the Program.

B. When doing so will not reduce resources available to target species, the Program will also manage Program lands to benefit non-target listed species and non-listed species of concern and to reduce the likelihood of future listing. When feasible, the Program will provide regulatory certainty with respect to those non-target, listed species.

II. Program Goals

The Program's long-term goal is to improve and maintain the associated habitats. This goal includes: (1) improving and maintaining migrational habitat for whooping cranes, and reproductive habitat for least terns and piping plovers; (2) reducing the likelihood of future listings of other species found in this area; and (3) testing the assumption that managing flow in the Central Platte River also improves the pallid sturgeon's lower Platte River habitat.***

III. Program Elements

A. General Description

1. Elements—The Program has three elements: (1) increasing streamflows in the central Platte River during relevant time periods through re-regulation and water conservation/supply projects; (2) enhancing, restoring, and protecting habitat lands for the target species; and (3) accommodating new water related activities in a manner consistent with long-term Program goals.

2. Increments—The Program will be implemented in increments. The First Increment of the Program begins with the signing of the Program Agreement by Interior and the three states, and shall continue for thirteen years from that date or until any later date agreed upon by the Governance Committee in approval of an extension, subject to appropriations as described in Section II.H. of the Program Agreement. Subsequent increments, if agreed to by the Secretary of the Interior and Governors of the three states, will be implemented for such periods of time as may be set forth in a replacement or extended cooperative agreement.

3. Objectives—

(a) Long-term Objectives. The long-term objectives of the Program are:

(1) to provide sufficient water to and through the central Platte habitat area to meet the general goal set forth in Paragraph II above by re-regulation and water conservation/supply projects;

***The Integrated Monitoring and Research Plan (Attachment 3, Section V) [of the Program Document] addresses how the assumption is to be tested, including steps that will be taken to determine habitat needs of the pallid sturgeon.

(2) to perpetually protect, restore where appropriate, and maintain approximately 29,000[10] acres of suitable habitat primarily in habitat complexes in the Central Platte River area located between Lexington and Chapman, Nebraska.****

(b) First Increment Objectives. Interior and the states commit to achieving the following objectives by the end of the First Increment of the Program:

(1) improving the occurrence of Platte River flows in the central Platte associated habitats relative to the present occurrence of species and annual pulse target flows (hereinafter referred to as “reducing shortages to the target flows”) by an average of 130,000 to 150,000 acre-feet per year at Grand Island, through reregulation and water conservation/supply projects. Interior and the states agree that the Service’s target flows will be examined through the Adaptive Management Plan and peer review and may be modified by the Service accordingly. Interior and the states have agreed, however, that during the First Increment, species and annual pulse target flows serve as an initial reference point for determining periods of excess and shortage in the operation of Program re-regulation and water conservation/supply projects.

(2) protecting, restoring where appropriate, and maintaining at least 10,000 acres of habitat in the central Platte River area between Lexington and Chapman, Nebraska. The Governance Committee may agree to undertake, fund or give credit for land activities outside this area to provide biological benefits to the target species.

****Non-complex habitat approved for acquisition by the Governance Committee will count toward the 29,000-acre objective because it will provide demonstrable benefits to target species. The definitions of complex and non-complex habitat may be changed by the Governance Committee, but are initially set forth in the Governance Committee Program Document: Attachment 4, Land Plan.

KEY PROGRAM PRINCIPLES

The Cooperative Agreement established important parameters for the proposed Program, including willing seller/lessor, incremental approach, adaptive management, and payment of taxes (or equivalent amount) on Program land. These principles guide the Governance Committee Alternative and the other action alternatives:

- **Willing Seller/Lessor:** When the Program acquires land or water, no condemnation of land or water rights will occur. The Program will acquire interests (purchase, lease, easement, or other arrangements) in water and land only from willing sellers and lessors.

- **Incremental Approach:** The Program will be implemented in phases, or increments, with only the initial 13-year increment under review at this time.

- **Adaptive Management:** Program implementation will occur in increments that will be tracked and evaluated so that the Program can be adjusted over time to meet the needs of the target species, with an initial 13-year increment. The adaptive management process will include documenting baseline data for target species habitat, monitoring target species and their habitats,

[10]Note: The long-term land objectives were based upon recommendations of the Platte River Habitat Conservation Report (Management Alternatives Work Group, 1993).

setting objectives and timetables for review, developing specific milestones and research activities, evaluating species and habitat responses to Program activities, incorporating peer review, evaluating Program effectiveness, and reviewing and adjusting Program goals and objectives.

While the Program may adjust its activities and the policies that guide those activities based upon information obtained during the Program's First Increment, it is not expected that the resulting environmental consequences will, in any case, be significantly larger in scale and scope than the impacts assessed in this FEIS.

- **Taxes on Program Land:** The Program will pay taxes or their equivalent on Program lands to avoid reducing tax revenues to local entities or shifting tax burdens to others.

POSSIBLE SUBSEQUENT PROGRAM INCREMENTS

The proposed Program would occur in increments. This document describes the Program's First Increment, expected to be 13 years from the date an Implementation Agreement is signed. As noted, any subsequent Program increments will be subject to complete NEPA and ESA compliance prior to implementation. This incremental approach has been taken due to uncertainties about the best approach to restoring habitat for the target species and assisting in their recovery. During the Program's First Increment, it is expected that significant new information will be collected about the species, their habitat needs, and how the habitat and the species respond to the restoration activities undertaken by the Program. The Governance Committee has identified the information which they believe, at this time, is most important for assessing changes in habitat and response of the target species. These data needs have guided formulation of the Integrated Monitoring and Research Plan. As the Program monitors these environmental indicators, this information will enable adjustments to Program strategies and objectives through the adaptive management process.

It is therefore not certain that the current Program objectives will remain the same at the end of the Program's First Increment, or whether new or modified objectives will serve as the measure of Program accomplishment at the end of the Program's First Increment. Ultimately, it will be the responsibility of the Service to determine, during and at the end of the Program's First Increment, whether sufficient progress has been made toward habitat restoration and what objectives should guide any subsequent increments.

ENDANGERED SPECIES ACT CONSULTATION

Under the ESA, Federal agencies must ensure that projects they operate, or for which they provide Federal authorizations, permits, or funds (i.e., for which there is a "Federal nexus"), are not likely to jeopardize the continued existence of any threatened or endangered species or to adversely modify or destroy designated critical habitat. The likelihood of such impacts is assessed through ESA Section 7 consultations with the Service (see *The ESA Section 7 Consultation Process With and Without a Cooperative Program* in volume 2).

If a proposed action is found likely to jeopardize the continued existence of listed species or adversely modify designated critical habitat, the Service, through consultation with Federal action agencies, is required to develop ESA compliance measures. Ultimately, it is the responsibility of the Federal action agencies to ensure that their actions are not likely to jeopardize the continued existence of listed species or adversely modify designated critical habitat.

One purpose of the Program is to provide ESA compliance for existing and new water-related activities in the Basin upstream of the Loup River confluence for effects to the target species river habitats in the Central and Lower Platte River. Since 1978, most major water projects or activities in the Basin have been found to likely jeopardize one or more of the target species (see Service, 1978; 1979; and written communication, 1997). Numerous other water projects with a Federal connection or nexus in the Basin in Wyoming, Colorado, and Nebraska are now, or will soon be, undergoing a review of their impacts on endangered species under Section 7(a)(2) of the ESA. Potentially hundreds of projects and authorizations relating to water projects will require such reviews. While many of these are Federal water facilities, the majority are private, municipal, or state facilities or operations requiring Federal approvals (see *The ESA Section 7 Consultation Process With and Without a Cooperative Program* in volume 2).

BIOLOGICAL ASSESSMENT

Under the ESA, the Federal action agency must assess the potential effects of a proposed Federal action (in this case, the implementation of a Program and continued operation of certain Reclamation and Service projects in the Basin upstream of the Loup River confluence) on listed and proposed species and their designated and proposed critical habitat. When conducting an intra-Service consultation, the Service also includes an analysis of effects on species which are candidates for listing. This FEIS serves as the biological assessment of the effects of the proposed action on listed, proposed and candidate species and designated critical habitat, which supports development of the Biological Opinion (BO). Required effects determinations are found in chapter 5, "Environmental Consequences."

BIOLOGICAL OPINION

Following receipt of this FEIS, the Service will develop a final programmatic BO for the preferred alternative.

ENDANGERED SPECIES ACT SECTION 7 CONSULTATION PROCESS WITHIN THE PROGRAM

Implementation of a Program does not alter the legal requirement for Federal agencies to consult with the Service and, where consultation concludes that the continued existence of listed species are likely to be jeopardized, to reduce impacts from the Federal actions to a level that does not jeopardize the species or adversely modify critical habitat. With the Program in place, ESA Section 7 consultations for the effects of continued operations of Reclamation and Service projects in the Basin upstream of the Loup River confluence on the Basinwide distribution of the target species, and on the designated critical habitat in the Central and Lower Platte Rivers, will be completed. Consultations that were completed prior to a Program (and that depend on a Program being implemented) retain their ESA compliance through the Program as long as the project proponents choose to participate in the Program and they comply with any conditions imposed as a result of the Program. With the Program in place, ESA Section 7 consultations for other "Federal-nexus projects"[11] can proceed in a streamlined fashion. Subsequent NEPA and ESA analyses and BOs would "tier"[12] off this Programmatic FEIS and the programmatic BO. That is, for Federal actions and projects participating in the Program, the Programmatic FEIS and BOs will serve as the description of the environmental baseline and environmental consequences for the effects of the Federal actions on the listed species and designated critical habitat in the habitat areas. Further, the Program will serve as the RPA or provide offsetting measures to provide ESA compliance for those ongoing or new Federal actions for effects to the target species.

Streamlined consultations will only address effects to the target species in the Platte River Basin and other listed species inhabiting the Central and Lower Platte River and their designated critical habitats. Impacts to other listed species outside of the Central and Lower Platte River must be addressed separately from the Program.

To comply with the ESA, consultations for any site-specific effects of Federal-nexus Program activities must be completed. For example, the site-specific impacts of the Program's Water Action Plan projects must be evaluated for impacts on other listed species under ESA Section 7 if needed. Depending on the significance of the Federal action, additional NEPA analyses may also "tier" off the Programmatic Environmental Impact Statement (EIS). For example, before construction, site-specific NEPA compliance and ESA consultation must be conducted for the local (nontarget species) effects of the Pathfinder Modification Project.

Future Section 7 consultations on the target species could result in one of three possible outcomes for Federal-nexus projects:

- Complete a streamlined consultation (below) for an **existing** Federal action or project (i.e., the project is "covered" by the Program's habitat and water management activities).

- Complete a streamlined consultation for a **new** Federal action or project (i.e., the project is "covered" by one of the Program's depletion management plans).

[11] A "Federal-nexus project" is a project (in this case, a water-related activity) that is implemented using Federal facilities, or which requires Federal funding, permits, or other permission.

[12] This process is described in the *Council on Environmental Quality Regulations for Implementation of the National Environmental Policy Act,* Section 1508.28, "Tiering."

- Complete ESA Section 7 consultation without relying on Program activities. Individual water project owners and operators with a Federal nexus would be responsible for complying with Section 7 of the ESA.

A "streamlined" consultation is one where the:

(1) Federal action agency determines a project may affect listed species or designated critical habitat and initiates ESA consultation with the Service,

(2) Effects to the target species and their critical habitats have been analyzed in this Programmatic FEIS and programmatic BO, and

(3) Program's actions or the states' or Federal depletion management plans can be used as ESA compliance measures for that project's effects to the target species and their critical habitats.

See the Depletion Plans in the Governance Committee Program Document, Attachment 5: Water Plan, which is located on the attached CD, for a more detailed discussion of the coordination between the states, Service, and the Governance Committee during ESA Section 7 consultations as part of the Program.

ENDANGERED SPECIES ACT COMPLIANCE WITHOUT A PROGRAM

Without a Program, each water project or activity in the Basin that requires Federal approval, permitting, or funding would undergo separate ESA Section 7 consultation separately, implementing separate mitigation measures.[13]

The ESA Section 7 Consultation Process With and Without a Cooperative Program in volume 2 describes the likely process and goals for separate ESA Section 7 consultations in the Basin that would occur without a Basinwide, cooperative Program, and some key points are summarized below. This attachment provides useful information about how compliance with the ESA would likely occur if there were no formal Cooperative Program.

Although it is not possible to foresee just what form compliance with the ESA without a Cooperative Program would take for those projects having a Federal nexus, the following seems likely to occur:

- Owners and users of water projects would be individually responsible for offsetting current and future adverse effects on the target species and critical habitat using a combination of water, land, and financial measures.
- Any interim ESA compliance available during the Cooperative Agreement would be lost for those projects subject to ESA compliance.[14] Consultation would have to be reinitiated. Project owners and operators would not know their requirements, if any, prior to ESA consultation.
- Without a Cooperative Program, it is possible that lawsuits filed by water users, environmental groups, states, or others might greatly complicate required ESA Section 7 consultations. Court orders could require existing projects to cease operations until ESA consultation has been completed.
- The overall goals for restoration of lands and riverflows would likely be higher than the 130,000 to 150,000 acre-feet of flow improvement and 10,000 acres of land habitat proposed for the Program's First Increment.
- There would be no Basinwide, cooperative effort and less likelihood of substantial Government participation in funding to accomplish these water and habitat goals. This would place a greater financial burden on individual project operators.

Other important characteristics of separate ESA compliance could include:

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[13]Section 7 of the ESA states, "*Each Federal agency shall, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency (hereinafter in this section referred to as an "agency action") is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species. . .*" (ESA, Section 7a[2]). "Consultation" is the process by which agencies ensure that their actions will not jeopardize species or their habitat, by undertaking investigations of the likely effects of such action and having those investigations reviewed by the Service or the National Marine Fisheries Service, depending upon the species involved.

[14]Some Basin water projects have taken interim actions or paid interim fees for habitat improvements, which provide compliance with the ESA until a Basinwide Program is undertaken. If no Basinwide Program is implemented, those projects may be subject to separate ESA Section 7 consultation to obtain long-term ESA compliance.

- There would be less flexibility for individual offsetting measures to include "non-complex habitat" lands such as sand pits, small wetlands, and small wet meadows. Instead, offsetting measures for individual projects would likely focus on restoring large areas of degraded river and wet meadow habitat consistent with the concept of habitat complexes. Actions to offset the ongoing erosion and downcutting of the riverbed in the Central Platte Habitat Area would also likely be a necessary component of ESA compliance.

- Lands would be acquired by lease, easement, or purchase by individual project operators. Entities with condemnation authority could elect to exercise their authorities in order to meet their ESA responsibilities.

- Taxes on any habitat lands acquired by tax-exempt entities might not be paid to the counties.

- Existing state water export laws may greatly increase costs of water needed for ESA compliance. Protection of water for ESA purposes within and between states may be limited or nonexistent.

- There would be no formal coordination of adaptive management plans, monitoring, or research efforts between groups, reducing the likelihood that scientific uncertainty related to the target species and their habitat needs would be addressed.

- Federal agency budget and personnel needs would increase in order to complete separate, required consultations on individual projects needing Federal authorization, permits, licenses, or other compliance. Schedules for completion of consultations would be limited by the Service's available budget and personnel.

NATIONAL ENVIRONMENTAL POLICY ACT ANALYSIS OF THE PROGRAM

Under NEPA, Federal agencies are required to prepare an EIS that describes and analyzes any proposed Federal action for which significant environmental consequences can be expected. NEPA requires that a range of reasonable alternatives for meeting the purpose and need be formulated and their environmental consequences be analyzed, compared, and disclosed.

PRESENT CONDITION—THE BASELINE FOR COMPARING ALTERNATIVES (NO ACTION ALTERNATIVE)

The Present Condition that exists in the Basin is used as the quantitative NEPA baseline for comparing alternatives. This baseline is used because these are the conditions that currently exist for the target species and upon which have been based the jeopardy opinions issued by the Service. As such, these conditions will serve as the baseline for measuring improvements in species habitat. Also, given the historic complexity and contentiousness of past ESA Section 7 consultations related to these species, and the length of time required to develop and implement RPAs or offsetting measures as required under the ESA, it seems most likely that habitat conditions over the next decade will remain largely unchanged unless a Basinwide, cooperative Program is implemented. Thus, for the purpose of this NEPA analysis, the Present Condition is the quantification of the No Action Alternative.

Because the Governance Committee established 1997 conditions as reference against which a Program's progress will be measured, the EIS also uses a 1997 hydrologic baseline. This baseline is the historic hydrologic record, from 1947 to 1994, adjusted to reflect 1997 levels of water development and water demands on the Platte River.

For other resources areas (e.g., agricultural economics), more recent data are sometimes used. Chapter 4, details the measurement of the Present Condition.

FORMULATION OF THE ALTERNATIVES

Under NEPA, an EIS must formulate and evaluate a range of reasonable alternatives for meeting the purpose of and need for the proposed action. For the reasons described in the "Program Purposes" section in this chapter, a Basinwide, cooperative approach is essential to significantly benefit the species. To support a cooperative approach, each alternative must generally accord with the "Key Program Principles" section in this chapter. For example, in order for an alternative to be implemented in a Basinwide, cooperative fashion, the alternative could not propose to acquire habitat lands through condemnation. No changes in interstate water compacts, decrees, or water apportionments are considered. None of these key principles were judged by Interior to be a constraint on achieving the Purpose and Need.

The Governance Committee Alternative was formulated by the Governance Committee within the constraints of these principles. The other action alternatives were formulated within these principles by the EIS Team.[15] Chapter 3 details the development and screening of alternatives.

PROGRAMMATIC ANALYSIS

This is a Programmatic FEIS. As such, it broadly evaluates the range of impacts reasonably likely to result from implementing a Program for which many of the site-specific details of implementation are not yet known. For example, the Water Action Plan and the Land Action Plan for the Governance Committee Alternative[16] describe approaches to providing needed water and land for the species. However, the precise location or details of some potential actions, such as leasing of water or land, depend(s) on participation by willing sellers/lessors and, therefore, cannot yet be specified. Effects of the Program must therefore be analyzed at a more general, or programmatic, level at this time.

The analysis for this FEIS assumes full implementation of the alternatives, so that their likely largest environmental consequences can be estimated. In some cases, this means assuming that the initial methods proposed in an alternative for land or water management prove successful and are fully implemented. It is possible that, under the Program's adaptive management approach, an initial method may be found infeasible or ineffective and other approaches might be substituted to accomplish the same results.

Water Elements

Some of the program water elements are described conceptually, but this FEIS provides detail on:

- Changes in reservoir capacities, storage allocations, and reservoir operations including releases and deliveries

- Changes in riverflows and operation of river diversions or alluvial pumping and recharge connected to the Platte River

Land Elements

Land acquisition is described conceptually, but this FEIS provides details on the overall scope and scale of land acquisition, the types of lands likely to be acquired, and the general location of Program lands.

Land management is described conceptually, but with sufficient detail to describe the likely scope and scale of various management actions for both channel and nonchannel lands, and the resulting changes in land cover and use.

The programmatic analysis assesses the impacts of the action alternatives on:

[15] The EIS Team is comprised of staff from Reclamation and the Service. See the *List of Preparers* at the end of this volume.

[16] These are described in detail in the Governance Committee Program Document: Attachment 4, Land Plan, and Attachment 5, Water Plan, all located on the attached CD.

- North Platte River Basin reservoirs (monthly reservoir contents, elevations, releases)
- South Platte River Basin reservoirs below Greeley (monthly reservoir contents, elevations, releases)
- Central Platte River Basin reservoirs (monthly reservoir contents, elevations, releases)
- Riverflows in the North Platte (monthly flows, from Seminoe Reservoir to Lake McConaughy)
- Riverflows in the South Platte (monthly flows, at the state line)
- Riverflows in the Central Platte Habitat Area (daily and monthly flows from Lake McConaughy and the Colorado/Nebraska state line through the Central Platte Habitat Area)
- River channel habitat in the Central Platte Habitat Area (channel geometry, sediment balance, vegetation, open view, etc.)
- Land habitat leased, purchased, or otherwise protected (acres of land in the Central Platte Habitat Area acquired, typical kinds of lands acquired)
- Land characteristics (land use, cover types)
- Wetlands
- Target species and their habitat, and other listed species (key habitat characteristics)
- River and lake fisheries (habitat area, temperature, other variables)
- Hydropower (power generation and capacity)
- Recreation (visitation, economic value)
- Agricultural economy (irrigated acreage, cropping patterns, crop yield revenues)
- Regional economy (income, business taxes, employment)
- Social issues (population, demographics, and growth trends; human health concerns; flooding issues; land use trends)
- Cultural resources (impacts on historic and cultural resources)
- Indian trust assets
- Indian sacred sites

This analysis focuses on the changes in the environment likely to result from implementation of the Program's First Increment. Any proposed subsequent increment of the Program will be subject to further NEPA and ESA analysis at that time.

This Programmatic FEIS does not address the site-specific construction or other local impacts of individual land and water elements. If an alternative is implemented, specific land and water actions will be required which may have local environmental and other effects. These impacts will be addressed in subsequent NEPA compliance documents once decisions are made to proceed with specific elements of the Program. For example, the Governance Committee Alternative calls for restoring the original capacity of Pathfinder Reservoir by raising the existing spillway. This Programmatic FEIS focuses on the effect of that action on the river and reservoir system, regional water deliveries and economic consequences, and riverflows at the habitat areas. If a Program alternative is adopted and a decision is made to pursue the Pathfinder Modification Project, the site-specific construction impacts of this action will be assessed and disclosed in a subsequent, site-specific NEPA document and BO, if needed, prior to construction.

All site-specific NEPA analyses required for implementation of the Program alternative will "tier"[17] off of this programmatic document. That is, for the purpose of meeting NEPA requirements, this document will serve to describe and assess the broad, system wide, and cumulative habitat impacts of the alternatives and will be referenced in NEPA compliance documents prepared to assess the local and site-specific impacts of implementing or constructing individual elements of the selected alternative.

Aspects of the alternatives that would require additional NEPA compliance analysis to address their site-specific and local impacts include, for example:

- All Program Water Action Plan elements, including construction of any facilities or leasing or transfer of water
- Pathfinder Dam Modification: local effects of construction
- Program land modification to restore or maintain habitat on Program lands

The extent of NEPA analysis required will depend upon the specific action proposed. Each Program action will require compliance with other applicable Federal laws, such as the Clean Water Act, the Fish and Wildlife Coordination Act (FWCA), the National Historic Preservation Act, and the Endangered Species Act.

TIMEFRAME FOR NEPA AND PROGRAM IMPLEMENTATION

The Program's First Increment will begin after the Programmatic FEIS and final BO are completed, a Record of Decision has been signed by the Secretary, and the three states and Interior have signed an implementing agreement. These actions are scheduled to be completed in 2006. Where necessary, site-specific NEPA compliance will be undertaken prior to construction of individual Program elements.

[17]This process is described in the Council on Environmental Quality Regulations for Implementation of the National Environmental Policy Act, section 1508.28, "Tiering."

RELATED ACTIONS AND CUMULATIVE IMPACTS

Existing Projects That Have Completed Endangered Species Act Compliance for the Target Species

As described in the *History of ESA Consultations on Platte River Target Species* in volume 2, there is a lengthy history of ESA consultations and development of RPAs or other measures which allowed previous projects to proceed in compliance with the ESA. These projects, such as the Grayrocks Dam and Reservoir in Wyoming, for which mitigation measures have already been implemented, are part of the Present Condition for this FEIS. A list of such projects is provided in the attachment cited above.

Other Projects (Both Existing and New) That May Rely on This Program for Endangered Species Act Compliance for the Target Species in the Central and Lower Platte River Basins

Other existing projects are relying upon implementation of this Program to provide compliance with the ESA for effects to the target species, due to their continued operations during the Program's First Increment. These projects may have license measures or permit conditions imposed as part of a completed consultation process that assumed implementation of a program. If no program is implemented, the Service may seek to reinitiate ESA Section 7 consultation with the appropriate Federal action agencies regarding these projects.

The existence of a program does not alter the legal requirement for Federal agencies to consult with the Service and offset impacts to listed species and critical habitat occurring from Federal actions. With the Program in place, ESA Section 7 consultations are completed for the effects of continued operations of Reclamation and Service projects in the Basin on the target species and on other listed species and designated critical habitat in the Central and Lower Platte Habitat Areas.

Examples also include the Nebraska water projects operated by Central Nebraska Public Power and Irrigation District and Nebraska Public Power District (CNPPID) (Kingsley Dam, Keystone Diversion Dam, Tri-County Diversion Dam, and associated water delivery canals and powerplants in the Central Platte), which have received operating licenses from the Federal Energy Regulatory Commission (FERC) (Projects No. 1417 and 1835). The Reasonable and Prudent Alternative for these projects relied on the implementation of a program; therefore, the Service anticipates seeking to reinitiate consultation with FERC on those licenses if the Program fails or is not initiated.

A list of many of these projects appears in the *History of ESA Consultations on Platte River Target Species* in volume 2.

For discussion of the streamlined ESA consultation process where a Program provides ESA compliance measures for existing and new water-related activities for Basinwide effects to target species upstream of the Loup River confluence, see the attachment, *The ESA Section 7 Consultation Process With and Without a Cooperative Program*, in volume 2. With a program in place, ESA Section 7 consultations for Federal-nexus projects and their effects to target species and designated critical habitat would proceed in a streamlined manner and "tier" off the Programmatic FEIS and programmatic BO in subsequent NEPA analysis and biological opinions for the specific Federal action. Existing projects may be provided ESA compliance for effects to the target species and critical habitat by the Program's actions, and new projects may be provided ESA compliance through the Program's Depletions Plans.

For NEPA purposes, existing operations of these projects are also part of the Present Condition against which the impacts of a Program are measured.

Cumulative Effects of the Program

Program actions may interact with nonprogram actions to produce both positive and negative effects on Program benefits, the target species, their habitat, and other resources and values. The effects of these actions are considered to be cumulative effects. Both the NEPA and ESA require an analysis of cumulative effects on affected resources. The regulations implementing NEPA require that the cumulative effects analysis consider the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of the agency (Federal or non-Federal) or person undertaking the action.

The regulations implementing the ESA require an evaluation of the effects of future state or private activities, not involving Federal activities that are reasonably certain to occur within the action area of the Federal action that is the subject of ESA consultation. The ESA does not include Federal actions in the cumulative effects analysis because Federal actions that have already completed consultation become part of the environmental baseline, and those that have not completed consultation will require some level of consideration and/or consultation in the future. The effect of these actions and the distinction between statutory analyses is addressed in detail in the "Cumulative Impacts" section in chapter 5.

ISSUES IDENTIFIED DURING SCOPING

A public involvement program, beginning with public scoping meetings, encouraged the public, Government agencies, and other concerned groups to identify issues related to the proposed Federal action. Some overarching issues were identified during scoping and the planning process (table 1-1) and were considered throughout the analysis. Some of the issues in table 1-1 are required by Federal regulation to be addressed.

Additional information concerning public involvement is included in chapter 6, "Consultation and Coordination."

Table 1-1.—Key Public Issues Addressed in the Final Environmental Impact Statement

Issue of Concern	Indicators
Flows for the target species	Riverflows at the habitat (peaks, minimums, timing, frequency, velocity, useable river, and roost area).
Channel habitat for the target species	Extent of braided river, open areas, channel width, sediment erosion and transport, potential for channel incision, and potential for sandbar building.
Land habitat for the target species	Extent of wet meadow habitat, sandpit habitat, palestrine wetland habitat, agricultural food supply, disturbance factors.
Availability of water for agriculture, municipal, and other uses	Hydrology and groundwater hydrology; irrigation deliveries and supplies.
Agricultural economics	Changes in agricultural lands irrigated, cropping patterns, production, and revenues.
Regional economics	Changes in regional employment, income, indirect business taxes, and sales.
Recreation	Changes in lake elevations, streamflows, and associated fisheries; visitation and projected expenditures for lake and stream recreation.
Reservoir fisheries	Changes in fish habitat and reservoir productivity for key species.
Forage fish	Changes in riverflow, useable habitat, water temperature, and fish mortality.
Hydropower generation	Changes in Basin hydropower capacity and generation.
Water quality	Changes in river temperature, turbidity, and other constituents.
Flooding	Change in frequency of out-of-bank flooding; changes in groundwater levels near the river.
Human health	Changes in populations of insects that carry human diseases; change in populations of migratory waterfowl and nuisance resident waterfowl.
Land use	Changes in area of various land cover types and activities, including agriculture and mining operations.
Forest management	Impacts of forest management on water quantity.

SIGNIFICANT CHANGES FROM THE DRAFT ENVIRONMENTAL IMPACT STATEMENT, BASED ON PUBLIC COMMENTS

- **Chapter 1: "Introduction":** Expanded to provide a more detailed discussion of the Purpose and Need and the ESA consultation process with the Program.

- **Chapter 2: "History of Habitat Use and Habitat Trends for Target Species":**

  - Includes latest data on habitat use by whooping cranes and population trends for all target species

  - Contains more field data and analysis of trends in river geomorphology

- **Chapter 3: "Description of the Alternatives":**

  - Provides a single description of the Governance Committee Alternative, rather than two implementation scenarios based on modifications by the Governance Committee

  - Replaces the Water Leasing Alternative with the Full Water Leasing Alternative, which involves greater use of water leasing to provide the Program's water supply

  - Provides more detail regarding the Federal and state Depletion Management Plans, both in chapter 3 and in the plan descriptions in the Governance Committee Program Documents

- **Chapter 4: "Affected Environment and the Present Condition" and Chapter 5: "Environmental Consequences":**

  - Contains significant new data and analysis of river geomorphology

  - Contains a new section assessing the potential impact of alternatives on wetlands

  - Contains a significantly expanded analysis of impacts on the North Platte reservoir and stream fisheries and related recreation

  - Has additional analysis of potential impacts on coldwater streams and related resources in the Nebraska Panhandle area

  - Has additional analysis of potential impacts on water use above Seminoe Reservoir on the North Platte River.

  - Discusses CNPPID's hydrocycling from the Jeffrey 2 Powerplant in the "Cumulative Impacts" section in chapter 5.

Many smaller changes to the document are discussed in the *Public Comments on the DEIS and Responses From the EIS Team* in volume 2.

PARTICIPATING AGENCIES AND ORGANIZATIONS

GOVERNANCE COMMITTEE

A Governance Committee was established in 1997 by the Cooperative Agreement to review, direct, and provide oversight for Cooperative Agreement activities. Governance Committee membership consists of the entities and their current representatives shown in table 1-2.

Table 1-2.—Current Governance Committee Member Entities and Representatives and Voting Status

Member Entity	Voting Status	Current Representatives
State of Wyoming	One vote	Director, Wyoming Water Development Office (primary)
		State Engineer (alternate)
Upper North Platte Water Users	One vote	Goshen Irrigation District (primary)
		Pathfinder Irrigation District (alternate)
State of Nebraska	One vote	Department of Natural Resources (primary and alternate)
Downstream Water Users	One vote	Nebraska Public Power District (primary)
		Central Nebraska Public Power and Irrigation District (alternate)
State of Colorado	One vote	Commissioner of Agriculture (primary)
		Vacant
Colorado Water Users	One vote	Northern Colorado Water Conservancy District (primary and alternate)
		Denver Water Department (alternate)
Environmental Groups	Two votes	National Audubon Society
		The Platte River Whooping Crane Trust
		National Wildlife Federation
		Nebraska Wildlife Federation
		American Rivers
U.S. Department of the Interior	Two votes	U.S. Fish and Wildlife Service (primary and alternate)
		Bureau of Reclamation (primary and alternate)
Executive Director	Nonvoting	WEST Inc., Cheyenne, Wyoming (contractor)

NEPA COOPERATING AGENCIES

Interior is the lead Federal agency for this FEIS, with Reclamation and the Service jointly preparing the documents. The other cooperating agencies for this FEIS are:

- Carbon County, Wyoming
- U.S. Environmental Protection Agency (EPA)
- Natural Resource Conservation Service (NRCS)
- U.S. Geological Survey (USGS)
- U.S. Forest Service
- U.S. Army Corps of Engineers (Corps)
- Western Area Power Administration (Western)

LEGAL AUTHORITIES

The Cooperative Agreement established a Governance Committee, pursuant to section 4(f)(2) of the ESA (16 U.S.C. 1531 et seq.), to represent the three states, water users, environmental groups, and Federal agencies, and to develop a proposal for the Program's implementation. Other specific Federal authorities for the Federal Action and Cooperative Agreement include:

- **Reclamation Law:** Under applicable Federal laws, Reclamation is responsible for operation of Reclamation projects in the North and South Platte River Basins.

- **The Endangered Species Act**

  - **Section 2 of the ESA:** All Federal departments and agencies shall seek to conserve endangered species and threatened species and shall use their authorities in furtherance of the purposes of this Act, and cooperate with state and local agencies in those efforts.

  - **Section 4(f) of the ESA (16 U.S.C. 1536[f]):** Directs the Secretary to develop and implement plans for the conservation and survival of endangered species.

  - **Section 5 of the ESA:** The Secretary of the Interior shall establish and implement a program to conserve fish, wildlife, and plants, including those which are listed as endangered species or threatened species pursuant to section 4 of this Act.

  - **Section 6 of the ESA:** In carrying out the program authorized by this Act, the Secretary of the Interior shall cooperate to the maximum extent practicable with the states. Such cooperation shall include consultation with the states concerned before acquiring any land or water, or interest therein, for the purpose of conserving any endangered species or threatened species.

  - **Section 7 of the ESA:** Federal agencies are to implement their programs and authorities to further ESA purposes and to insure that their actions are not likely to jeopardize listed species or adversely modify critical habitat (discussed above).

  - **Section 9 of the ESA:** It is unlawful for any person subject to the jurisdiction of the United States to take any threatened or endangered species within the United States.

- **Fish and Wildlife Coordination Act (16 U.S.C. 662 et seq.):** Federal agencies are required to consult with the Service and with state wildlife agencies on the impacts to fish and wildlife resources of Federal or federally licensed or permitted water projects that have the potential to modify a body of water, and to mitigate such impacts.

Other relevant laws and Executive Orders (EO) addressed in the planning process or subsequent site-specific NEPA and ESA analysis include:

- **Environmental**

  - Clean Water Act of 1977 (33 U.S.C. 1251 et seq.)
  - EO 11988, Floodplain Management, 1977
  - EO 11990, Protection of Wetlands, 1977
  - EO 11991, Protection and Enhancement of Environmental Quality, 1977
  - Farmland Protection Policy Act of 1981 (Public Law [P.L.] 97-98)
  - Fish and Wildlife Coordination Act of 1958 (16 U.S.C. 661 et seq.)
  - Migratory Bird Treaty Act, 1918, as amended (16 U.S.C. 703 et seq. and EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds)
  - Bald Eagle Protection Act of 1940 (16 U.S.C. 668 et seq.)
  - National Historic Preservation Act (NHPA) (16 U.S.C. 470 et seq.)
  - National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 et seq.)
  - National Forest Management Act of 1976 (16 U.S.C. 1600)

- **Cultural Preservation**

  - Archaeological and Historic Preservation Act (16 U.S.C. 469 et seq.)
  - Archaeological Resources Protection Act of 1979 (16 U.S.C. 470 et seq.)
  - Historic Sites, Buildings, and Antiquities Act (16 U.S.C. 461 et seq.)
  - NHPA (16 U.S.C. 470 et seq.)
  - EO 11593, Protection and Enhancement of the Cultural Environment, 1971

- **American Indian**

  - American Indian Religious Freedom Act of 1978, as amended (42 U.S.C. 1996)
  - Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. 3001 et seq.)
  - Religious Freedom Restoration Act of 1993 (P.L. 13-141)
  - EO 13007, Indian Sacred Sites
  - Secretarial Orders 3175, 3206, and 3215, Indian trust assets

- **Others**

  - Reclamation Reform Act of 1982 (P.L. 97-293)
  - EO 12898, Environmental Justice in Minority and Low Income Populations, 1994

Chapter 2

History of Habitat Use and Habitat Trends for Target Species

INTRODUCTION

The Central and Lower Platte River and surrounding area provide habitat for the four target species: the whooping crane, interior least tern, piping plover, and pallid sturgeon. This chapter describes the Central and Lower Platte Habitat Areas, how the species historically used the habitat, and how changes in the river and surrounding area have altered the available habitat. Population trends for the species are also described. For the purpose of the Endangered Species Act (ESA) biological assessment, this chapter provides the description of the status of the species and their habitat.

The map of the Platte River in Nebraska (figure 2-1) shows several features important to this study.

- Cross-hatched in black is the area along the Central Platte River that has been designated as critical habitat for the whooping crane.
- Outlined in brown is the area along the Central Platte River that has been identified as the focus area of the Platte River Recovery Implementation Program (Program) for restoration of whooping crane, piping plover, and least tern habitat (Central Platte Habitat Area).
- Cross-hatched in red is the reach of the Platte River from the Elkhorn River to the Missouri River that has been identified for the Program as the area of pallid sturgeon habitat in the Lower Platte River (Lower Platte Habitat Area).

Target Species: (Clockwise From Upper Left) Whooping Crane, Interior Least Tern, Pallid Sturgeon, Piping Plover

(Whooping Crane Photograph - Michael Forsberg)

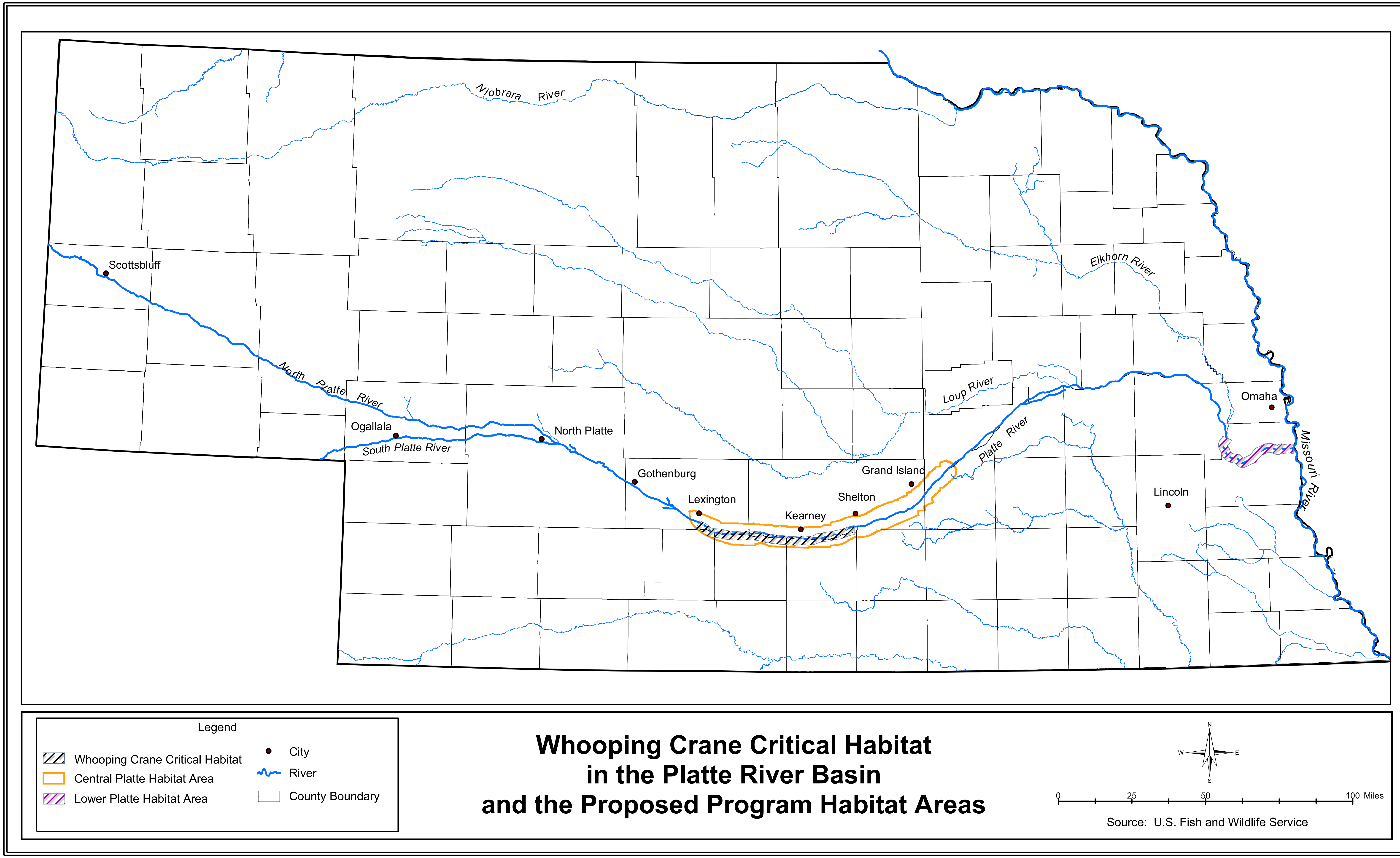


Figure 2-1.— Central Platte map showing critical habitat for whooping cranes and the Central and Lower Platte Habitat Areas.

THE TARGET SPECIES

This section briefly describes the four target species and their range. Trends in population, and factors affecting those trends, are discussed at the end of this chapter.

WHOOPING CRANE

The whooping crane is found only in North America and is this continent's tallest bird. It is the rarest crane and one of the rarest bird species in the world. Historically, its range extended from the Arctic coast south to central Mexico and from the Rocky Mountain region in Utah eastward to the Atlantic coast.

Whooping Crane Populations

The only self-sustaining and wild population of whooping cranes nests in and around Wood Buffalo National Park in the southern Northwest Territories and northern Alberta. This population of 215 birds winters along the coast of Texas, near Corpus Christi, on the Aransas National Wildlife Refuge and nearby areas. The migration route passes through Alberta, Saskatchewan, Montana, North and South Dakota, Nebraska, Kansas, Oklahoma, and Texas. The species was listed as endangered in 1967. The population numbered 43 at the time of critical habitat determination in 1978, and there were 215 cranes in March 2005.

The primary migrational route of the Aransas-Wood Buffalo whooping crane population crosses central Nebraska in a 150-mile-wide corridor that angles south-southeast to north-northwest (Austin and Reichert, 2001). About 85 percent of the whooping crane sightings in Nebraska have occurred within that corridor, with the remainder occurring west of the corridor. At its intersection of the Platte River in central Nebraska, the migration corridor roughly overlies the river reach between the cities of North Platte and Grand Island.

Though crane detection is based on chance observation, during the spring migration crane stopovers are more frequently observed on the Platte River than at any other site within the migration path. During the recent 20-year period (1985-2004), the number of sighted cranes confirmed on the Platte River in a single year has ranged from 2 to 33 birds.

Roughly 85 percent of the reported stopovers on the Platte River (1975-2005) have been between Kearney and Grand Island, Nebraska, where they are generally found using the sections of river having wide channels (U.S. Fish and Wildlife Service [Service], 1975-2005, file records). Preliminary data (2001-2003) from surveys for the long-term monitoring program of the Platte River Cooperative Agreement (WEST Inc., 2005) tend to confirm that wide river sections in the Kearney-Grand Island reach are the areas that the majority of whooping cranes use along the Platte River.

Whooping Crane Critical Habitat

Critical habitat for the whooping crane along the Platte River was designated in 1978. It covers a stretch of land roughly 3 miles on each side of the river from Lexington to Shelton, Nebraska (figure 2-1).

Critical habitat consists of specific geographic areas that are determined to be essential for the conservation of a federally listed threatened or endangered species. Primary constituent elements define areas that are essential to the conservation of the species, and that may require special management consideration, and include, but are not limited to:

- Space for individual and population growth, and for normal behavior
- Food, water, air, light, minerals, or other nutritional or physiological requirements
- Cover or shelter
- Sites for breeding, reproduction, and rearing (or development) of offspring
- Habitats protected from disturbance or that are representative of the historic geographical and ecological distribution of a species (50 Code of Federal Regulations § 17.95).

INTERIOR LEAST TERN

The interior least tern is the smallest tern species in North America.

Interior Least Tern Populations

There are two populations of least tern: the California (or coastal) least tern and the interior least tern. Interior least terns nest along major river systems in the interior of the United States (U.S.), including the Missouri, Mississippi, Platte, Ohio, Red, and Rio Grande Rivers. Least tern colonies are located in wide, open, sparsely vegetated river channels on sandbars, where nests consist of a scrape in the loose, sandy substrate. These river systems have undergone significant habitat degradation in the past century. The interior least tern population was listed as endangered in June 1985, when census data indicated that there were approximately 5,000 birds. The recovery plan for the interior least tern identified habitat degradation as the primary threat to survival. The plan specifically identified channelization and impoundment as being responsible for the actual and functional loss of ephemeral riverine sandbars on which the birds nest (Service, 1990). Sandbars that are still physically created are frequently too low to provide security from even the smallest flood events. Least terns not only depend on river systems for nesting habitat, but for foraging habitat as well. Least terns forage almost exclusively on small, narrow-bodied, schooling fish (Atwood and Kelly, 1984; Wilson et al., 1993; and Schweitzer and Leslie, 1996).

Interior Least Tern Habitat

Interior least terns have evolved to nest on riverine sandbars. Productivity varied from year to year, mirroring the suitability of the ephemeral sandbars. Populations were maintained through low productivity periods by periodic high productivity years (Mertz, 1971 and Kirsch and Sidle, 1999). With increased habitat degradation, years of high productivity became less frequent, resulting in population decline.

Within the Platte River Basin (Basin), least terns currently nest on riverine sandbars, bare sand and gravel areas created by aggregate mining (sandpits) close to a large river, and on the shoreline of Lake McConaughy. Historical sighting data are evidence that the least tern migrated through and nested within the Platte River valley of Nebraska. Most records are from the Lower Platte River and Loup River, since most explorers traveled along the Missouri River and took shorter excursions up the tributaries. Records and/or specimens of the least tern in the Lower Platte River area span from the Paul Wilhelm's journey in 1823 to the current day (Ducey, 1985 and 2000).

Least terns were documented nesting at Capital Lake, in Lincoln, Nebraska, in 1917, 1920, and 1922 (Pickwell, 1925 and Ducey, 1985), and on the South Platte River near North Platte, Nebraska, from 1926-1929 (Ducey, 1985). These early records show that the least tern was present and nesting in Nebraska and within the Platte River system prior to the construction of all but one of the major reservoirs on the Platte River system (Pathfinder Dam was constructed in 1909).

Interior least terns were also documented on the North Platte River near Torrington and Fort Laramie, Wyoming, in 1929, 1932, and 1933 (McCreary, 1934).

PIPING PLOVER

The piping plover is a small shore bird related to the more common killdeer.

Piping Plover Populations

There are three populations of piping plover: the Atlantic coast, Great Lakes, and Northern Great Plains populations. The Northern Great Plains represents the largest of the three populations, supporting 2,953 birds in 2001. This population encompasses the alkali lakes and wetlands of prairie Canada and North Dakota, reservoir shorelines along the Missouri River and Lake McConaughy, and riverine sandbars of the Missouri and its major tributaries, including the Platte River. The Northern Great Plains piping plover was listed as threatened in January 1986. The Service's recovery plan for piping plover lists overhunting as being responsible for the first major population decline, with habitat degradation and human disturbance causing subsequent population declines (Haig, 1992).

Piping Plover Habitat

In the Platte River Basin, piping plovers nest on riverine sandbars, bare sand and gravel areas created by aggregate mining (sandpits) in close proximity to a large river, and the shoreline of Lake McConaughy. Piping plovers are semi-colonial. They nest in virtually the same habitat as do least terns, and the two species are considered loose nest associates. Nests are located in wide, open, sparsely vegetated river channels on sandbars. The nests consist of a scrape in loose, sandy/gravelly substrate. Piping plovers will tolerate slightly more vegetative cover than do least terns. Piping plovers forage visually on invertebrates in very shallow water and moist substrates (Corn and Armbruster, 1993 [inclusive] and Cuthbert et al., 1999). Therefore, piping plovers not only require habitat that provides good visibility with sparse vegetation and a suitable substrate in which to build the nest scrape, but habitat with good invertebrate productivity.

Like the least tern, piping plovers have evolved nesting on riverine sandbars and other ephemeral habitats. Productivity varied from year to year, mirroring the suitability of habitat. Populations were likely maintained through low productivity periods by periodic high productivity years. With increased habitat degradation, years of high productivity became less frequent, resulting in population declines.

Historical sightings are evidence of the occurrence of piping plover within the Platte River valley from the early 1800s. Most records are from the Lower Platte River and Loup River, since most explorers traveled along the Missouri River, taking shorter excursions up the tributaries. Records and/or specimens of the piping plover in the Lower Platte River area span from 1813 by Hayden and Grinnell (Ducey, 2000) to present. There were numerous additional sightings documented by Hayden during the Warren Expedition. Anderson documented piping plovers on the Middle Loup River near Dannebrog in 1899 and 1900 (Moser, 1942). Piping plovers were later reported in the North Platte-Stapleton, Nebraska, area in 1944 by members of the Nebraska Ornithological Union (1944).

Efforts to document habitat use and census the piping plover regionwide did not occur until after 1986, when it was listed under the ESA. Since then, efforts to census plovers have increased. In 1991, the first standardized, rangewide census was conducted on both the wintering and breeding grounds. This census has taken place every 5 years since, with the last one conducted in 2001.

Piping Plover Designated Critical Habitat

Critical habitat was designated in September 2002 for the Northern Great Plains piping plover in parts of Minnesota, Montana, Nebraska, North Dakota, and South Dakota. Designated areas within the Basin include the Platte River, from Lexington downstream to the confluence with the Missouri River, and the Loup River in its entirety. In response to a legal suit by a consortium of water users in Nebraska, the Nebraska portion of the designated critical habitat was vacated on October 13, 2005, and remanded to the Service for redesignation.

PALLID STURGEON

The pallid sturgeon is one of the largest (30 to 60 inches, 76 to 152 centimeters) fishes found in the Missouri-Mississippi River drainage, with specimens weighing up to 85 pounds (39 kilograms). It is usually white to light brown on the back and white underneath. It has a flattened, shovel-shaped snout. This species is a bottom dweller, usually found in areas of strong current and firm sand bottom in the main channel of large, turbid rivers such as the Missouri River. Pallid sturgeons are slow-growing, late-maturing fish. Spawning occurs from April through August. The diet of the pallid sturgeon is made up of small fish and aquatic invertebrates. Multiple studies have stressed the role of flood plain connectivity in production of prey fish and aquatic invertebrates (Crance, 1988; Schlosser, 1989; Killgore and Baker, 1996; and Fisher, 1999).

Pallid Sturgeon Populations

The species was listed as endangered in 1990.

Pallid Sturgeon Habitat

Studies in the Platte River and elsewhere have found significant pallid sturgeon use of in-channel structure, principally the downstream edges of sand and gravel bars, and submerged dunes (Snook, 2001; Bramblett, 1996; and Hurley, 1999). Formation of these in-channel structures occurs primarily during high flows, as sediment and gravels are moved and deposited.

HABITAT FEATURES HISTORICALLY USED BY THE TARGET SPECIES

The target species historically have depended upon several aspects of the Platte River and nearby habitat, described below:

- Wide, open, shallow channel areas for whooping crane roosting and bare sandbars for nesting and foraging of the piping plover and interior least tern, free of human disturbance
- Riverflows conducive to whooping crane roosting in spring and fall
- Riverflows conducive to nesting by piping plover and interior least tern
- Riverflows that support forage fish for the interior least tern
- Lowland grasslands and wetlands for whooping crane foraging
- Agricultural grain fields near the river
- Lower Platte River habitat for the pallid sturgeon:
  - Abundance of macro-bedforms in the river, such as sandbars
  - A significant springtime rise in the river that provides a spawning cue, nutrient cycling, and reproductive habitat for the pallid sturgeon food base.

Each of these features is discussed in turn in the following subsections.

OPEN CHANNEL HABITAT

The three bird species rely on an open channel for roosting and nesting because it provides security from predators by permitting longer sight distances and physical separation from surrounding lands. “Open” channel is the area between riverbanks that is without high islands, perennial woody vegetation, or other obstructions that would block the vision of roosting or nesting birds.

For example, whooping cranes sighted on the Platte River show a preference for using wider areas of the river. Figure 2-2 shows that, while only limited areas of the river are wider than 750 feet, cranes disproportionately are found roosting on these sections as opposed to narrower parts of the river. Note that the amount of river channel greater than 750 feet (red line) is quite small, but the whooping crane use of these areas (black line) is quite high. The analysis for figure 2-2 is based upon whooping crane observations from 1964 to 2000. Preliminary analysis of recent aerial surveys of whooping cranes undertaken by the Governance Committee in 2001 and 2002 indicates a similar preference for wider areas of the river channel:

> *“The analysis of the selection ratios for the width groupings based on percentiles indicate selection for locations with wetted widths greater than 497 feet, with strongest selection for widths greater than 757 feet. When groupings were based on a*

biological paradigm, the selection ratios indicate selection for locations with wetted widths greater than 500 feet, with strongest selection for widths between 700 and 900 feet."

(WEST Inc., 2005)

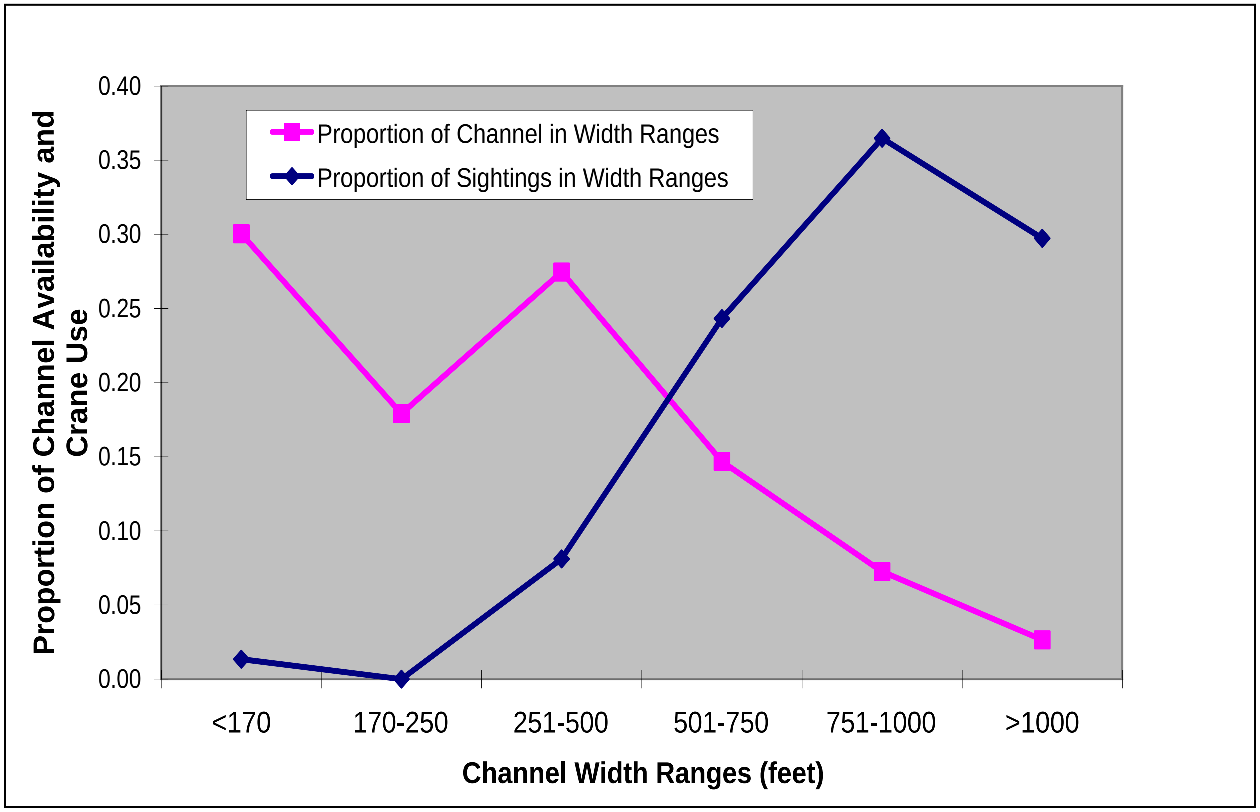


Figure 2-2.—Whooping crane use of channel areas of various widths versus availability of channel areas of varying width.[1]

OPEN CHANNEL WITH SANDBARS

The three bird species use open, generally unvegetated channel areas and sandbars for roosting (shallow water and wide channels for whooping cranes) or nesting (wide channels and dry sandbars for interior least terns and piping plovers). To be appropriate for species' use, these sandbars must be sparsely vegetated, providing unrestricted views for the bird species. Historically on the Central Platte River, the sandbars were overtopped by the spring peak flows and the sands shifted and moved by the river, scouring away or burying new vegetation and rebuilding sandbars. Nesting habitats for terns and plovers on the Platte, Niobrara, and Missouri Rivers typically are dry sandbars located midstream in wide, open channels and having less than 25 percent vegetative cover (Faanes, 1983; Schwalbach, 1988; and Ziewitz et al., 1992). To provide secure nesting sites, sandbars must be high enough to not be overtopped once the spring flood has passed. River islands, in contrast with sandbars, have tops higher than the

[1]Data on whooping crane roosting is from the "*Draft Baseline Report,"* Platte River Cooperative Agreement (Service, 2001). Data on channel width are from the Platte River EIS Office, 1998 Geographical Information System database (Friesen et al., 2000).

annual riverflows and, hence, are covered with permanent vegetation. Along the Platte River, terns and plovers also nest on bare areas created by aggregate mining, and on lake beaches, especially where protection is provided from predators and human disturbance.

WHOOPING CRANE ROOSTING FLOWS

Whooping cranes are wary birds. When whooping cranes roost (or rest), they prefer shallow bodies of water having large, unobstructed views. On the Platte River and other rivers, channels preferred by whooping cranes are generally 500 to 1,200 feet wide. These habitat characteristics apparently provide the cranes with a water barrier to predators, long viewing distance of approaching predators, and distance for the cranes to take flight or escape, sometimes referred to as "escape cover."

Whooping cranes stand in channel areas with fine sand, and a shallow, slow streamflow to roost, even though the main channel of the river may, and often does, contain faster and deeper water. The distance in a single direction from the roost to tall vegetation can vary.

INTERIOR LEAST TERN AND PIPING PLOVER NESTING FLOWS

Historically, nesting habitat for terns and plovers was created by high spring and early summer flows that built sandbars and scoured new vegetation from existing sandbars. As these high spring flows receded, birds began nesting at higher elevations of the sandbars as they were exposed and began to dry. Nests at these higher elevations were frequently spared inundation during all but major summer storm events. Therefore, the flow requirements for nesting are threefold:

(1) Flows must be high enough in the spring to shift sediments and create sandbars with high elevations.

(2) Flows must recede early in the nesting season to allow birds to initiate nests at these elevations.

(3) Flows for the remainder of the nesting season need to recede to avoid inundation of nests, while still providing sufficient protection from terrestrial predators, providing habitat for fish that are eaten by terns, and supporting insect populations eaten by plovers.

FLOWS TO SUPPORT FORAGE FISH

Interior least terns eat small fish of several species in the Platte River as their primary source of food. Interior least terns feed on adults of small-sized fish species and the small-sized, young life stages of large-sized species (Lingle, 1988 and Wilson, 1991).

Optimum physical habitat for the fish community in the Central Platte River is created by flows that approach 1,200 cubic feet per second (cfs) in the spring and summer and 1,000 cfs in the fall (Bowman, 1994). Higher flows in spring help maintain backwaters, sloughs, and side channels, which provide spawning and nursery habitats. The summer base flows also help maintain moderate water temperature and reduce the frequency and duration of potential lethal water temperatures for fish in the summer throughout the Central Platte River (Dinan, 1992; Fessell, 1996; Sinokrot et al., 1996; and Zander, 1996).

LOWLAND GRASSLANDS AND WET MEADOWS

Platte River lowland grasslands provide a reliable source of high-protein food needed by whooping cranes during spring and fall migrations, including invertebrates and amphibians. Resting and foraging during spring migration ensure that the birds arrive in a healthy condition on the breeding grounds at Wood Buffalo National Park, Canada.

Wet meadows are a type of ecological system that consists of a complex of grasslands and wetlands close to the Platte River. Wet meadows share an interconnected water table with the river and are occasionally flooded by overbank flows from the river. They generally have standing water during a portion of the year (primarily spring and early summer) and are characterized by high water tables, poor drainage, nutrient rich soils, and an undulating topography reminiscent of the braided channels from which they were formed over geologic time scales.

Whooping cranes are generally regarded as more dependent on wetland feeding habitats than sandhill cranes (Johnsgard, 1996). Historic accounts indicate that whooping cranes were observed in the Platte River valley "*feeding in the lagoons on aquatic plants and animals, and in the hay meadows or fields on insects, and in late autumn on waste grains and insects in wheat stubble fields, all usually in the immediate vicinity of the river*" (Swenk, 1933). Other Platte River residents reported that whooping cranes were regularly observed feeding in a series of "frog ponds" that extended in a particular 6-mile stretch along the river near Kearney during the 1940s (Currier et al., 1985).

In general, the foods used by migrating whooping cranes and available in wet meadows along the Platte River include small fish, snakes, frogs, frog egg masses, crayfish, grasshoppers, crickets, and other insects (Service, 1981; Currier et al., 1985; Ballinger, 1980; Cochnar and Jensen, 1981; Freeman and Perkins, 1992; and Davis and Vohs, 1993). Many of these organisms depend on aquatic moisture regimes or seasonally moist or saturated soils for all or part of their life cycle. Biodiversity–or diversity of species and life forms of organisms–of the communities is associated with soil moisture regimes (Seibert, 1994).

Figure 2-3 illustrates one of the larger remaining wet meadows along the Platte River. It also shows where some representative species occur (an aerial photograph of this wet meadow, during high spring runoff, is found in the "Whooping Cranes" section in chapter 4). Historically, wet meadows have been supported by a high water table and occasional river overflow–conditions influenced by high springtime riverflows and precipitation (Woodbury, 1847; Wesche et al., 1994; Hurr, 1983; Henszey and Wesche, 1993; and Henszey et al., 2004).

These wet meadows generally form a mosaic, with tall grasses mixed with wetlands occupying old channels, depressions, deep swales, cut-off oxbow, slow-flowing streams, and pond margins. The undulating topography with a shallow groundwater table provides both lowland grassland communities in higher, drier areas and wetland habitats in lower, wetter areas. This provides a diversity of food sources for many birds and mammals, including whooping cranes and sandhill cranes.

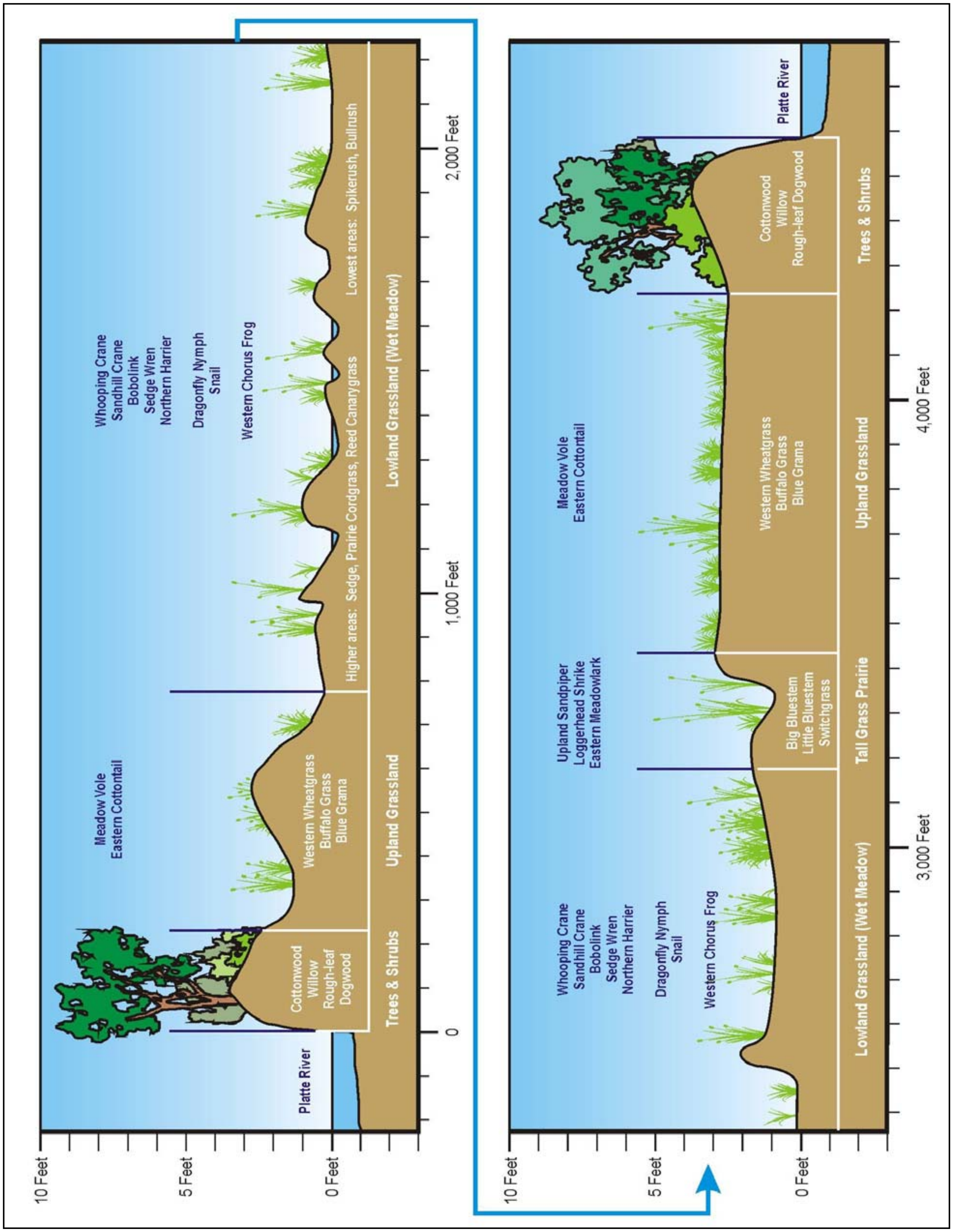


Figure 2-3.—Cross-section of a wet meadow complex, illustrating important habitat features. Topography taken from a survey across Morman Island, Nebraska.[2]

[2]For clarity, the vertical scale is exaggerated and plants are enlarged.

CROPLAND

As wetlands in the migratory path of the whooping cranes have historically declined, waste grains have become an important food source, even though grains cannot supply all the nutritional requirements of the cranes. On the Platte River, whooping cranes spend a large amount of the day probing in grain fields. Although the specific composition of matter taken in the Platte River valley is not known, waste corn, other small cereal grains, and insects are presumed to be major food items.

Investigation of sandhill cranes on the Platte River suggests that the amount of waste grain available is also becoming more limited, affecting the birds' feeding energetics and physical condition. Though cornfields and other croplands are abundant in the affected area, increased harvest efficiency and increased competition from other water birds (which have become concentrated in a smaller reach of the suitable riverine habitat) have decreased the amount of waste grain available (Krapu, 2003). Recent studies indicate that the available waste corn has decreased by roughly 60 percent in late winter, and by as much as 96 percent in late spring, from similar surveys of the late 1970s. Soybeans, the other major row crop in the affected area, have limited value as food for whooping cranes.

RIVER HABITAT FOR THE PALLID STURGEON

Pallid sturgeon require large, turbid, free-flowing rivers with sandy and rocky/gravelly substrate (Gilbraith et al., 1988). Historically, these habitats were continually changing as a result of high flows and sediment loads. Pallid sturgeon depend on small fish, as well as aquatic invertebrates, as a food source (Kallemeyn, 1983; Carlson et al., 1985; and Service, 1993 [sturgeon]).

Periodic high riverflows provide the transport and the rearrangement of sediments to create a diversity of bottom contours and substrate, an influx of organic matter, and overbank flooding which maintains flow connections with backwater areas. The February to July period is the period in which large, habitat-forming flows most frequently occur and is the primary production period for the prey base for the pallid sturgeon. High spring flows may be particularly important for pallid sturgeons using the Platte River. The April to June period is the critical spawning period for pallid sturgeon. Twenty of twenty-three captures of pallid sturgeon in the Lower Platte River corresponded with years when May to June flows in the Lower Platte River were above normal.

HISTORY OF LAND AND WATER DEVELOPMENT

Many of the habitat features used by the target species have changed over the last century. This section describes how land and water development in the Platte River Basin has affected the habitat.

The historic Platte River in Nebraska (before the 1880s) was a broad and braided river subject to high spring floods, great loads of sediment, and occasional summer droughts. These conditions caused continuous movement of the braided river channels and sandbars, resulting in a channel that was very broad, shallow, sandy, and generally unvegetated (Murphy et al., 2004 and Johnson, 1994). The general conditions of the river channel habitat in the Central Platte River are depicted in a photograph taken in October 1866 near present-day Cozad, Nebraska (figure 2-4). This photograph shows the very broad river with few islands and with the active channel free of significant vegetation. Downstream areas are generally thought to have had more islands, as discussed further below. More descriptions of the early Platte River can be found in Simons and Associates (2000), Murphy et al. (2004), Johnson and Boettcher (2000), and National Research Council (2005), and literature cited in those reports.

The extensive sandbars and flats provided roosting sites for cranes and nesting sites for terns and plovers. The river supported native fish populations, primarily minnow species, that were forage food for the terns. The broad flood plain of the river contained extensive low meadows that were saturated in the spring, providing invertebrate and native plant foods for the cranes during their spring stopover. Large spring floods and heavy sediment loads helped create good pallid sturgeon conditions in the Lower Platte River.

The following sections describe how these habitats have changed over the last 150 years. Special attention is given to describing how settlement and development of the Basin have affected riverflows and sediment transport, which, in turn, have affected the key aspects of river and riverine habitat used by the target species.

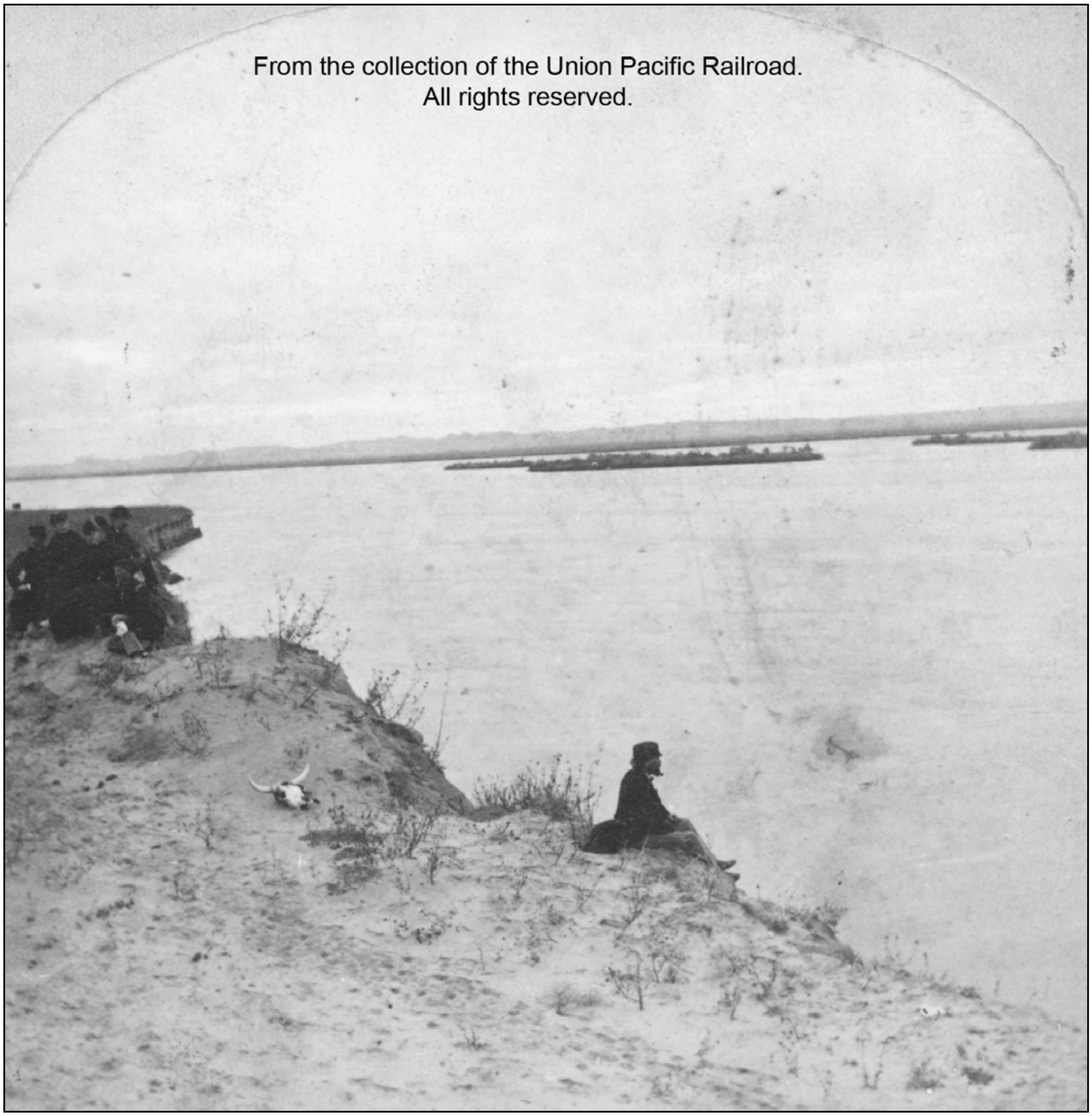


Figure 2-4.—The Platte River opposite Platte City, Nebraska (near present-day Cozad, Nebraska), October 1866. (John Carbutt, photographer. From the collection of the Union Pacific Railroad. All rights to photograph reserved.)

WATER RESOURCES

In 1820, the area of the Platte River Basin west of the 100th meridian (west of Kearney, Nebraska) was called "The Great American Desert" (Eschner et al., 1983). Rainfall in the western portion of the Basin was marginal for farming and varied greatly from year to year. Irrigation was a necessity for reliable crop yields.

Water resource development in the Platte River began in the mid-1800s. Before water development, the Platte River averaged more than 2.8 million acre-feet (MAF) of flow annually at Grand Island (Simons and Associates, 2000). However, the pattern of flow was uneven—the Platte River ran high in the spring due to the mountain snowmelt, but flows diminished dramatically in the summer months when irrigation water was needed the most. Flows also varied substantially from year to year.

Figures 2-5, 2-6, and 2-7 show the location of the North, South, and Central Platte Rivers.

Water Diversions and Storage

To meet increasing agricultural water needs, water was diverted through canals to fields and was also stored in reservoirs. Before 1900, nearly 4,000 canals had been constructed to divert waters from the North, South, and Central Platte Rivers. This number reached nearly 7,000 by 1930 (Eschner et al., 1983).

By the late 1880s, the waters of the South and North Platte River Basins were largely over-appropriated; that is, the demand for irrigation water exceeded the available supply, especially during the late summer.

Transbasin diversions (diversion of water from one river basin to another) were also initiated in an effort to meet water supply needs—particularly diversion from the Colorado River Basin to the South Platte River Basin. The major transbasin diversions into the South Platte River Basin include the Colorado-Big Thompson Project, Windy Gap Project, Moffat Tunnel Collection System, and the Roberts Tunnel Collection System.

In 1895, approximately 25,000 acre-feet of water were transferred into the South Platte River Basin. Between 1990 and 1999, annual diversions into the South Platte River Basin averaged more than 350,000 acre-feet per year (Hydrosphere, 2000 and Colorado Water Conservation Board, 2002). Transbasin diversions made into the North Platte River Basin totaled about 16,500 acre-feet per year. Table 2-1 displays diversions for both the North and South Platte River Basins. (It should be noted that the 1990s was a relatively wet decade; under more typical conditions, the transbasin diversions would possibly be greater.) Hydrosphere (1999) estimates that diversions into the South Platte River Basin average about 430,000 acre-feet per year under current conditions.

Table 2-1.—Diversions into the North and South Platte River Basins, 1990-1999

Diversion and Major Purpose	Approximate Mean Annual Diversion (Acre-Feet Per Year)
City of Cheyenne (municipal)	15,000
Continental Divide Ditch (agriculture)	1,000
Ranger Ditch (agriculture)	500
Total diversions into North Platte River Basin	**16,500**
Grand River Ditch (agriculture)	20,460
Colorado-Big Thompson Project (agriculture, power generation, municipal)	200,020
Windy Gap Project (municipal)	8,980
Moffat Tunnel (municipal)	44,318
Berthoud Pass Tunnel (municipal)	950
Vasquez Tunnel (municipal)	2,070
Gumlick Tunnel (a.k.a. Jones Pass Tunnel) (municipal)	2,340
Straight Creek Tunnel (industrial)	316
Vidler Tunnel (municipal augmentation)	643
Harold D. Roberts Tunnel (municipal)	61,789
Boreas Pass Ditch (municipal)	139
Hoosier Pass Tunnel (municipal)	1,401
Aurora Rocky Ford Ditch (municipal)	8,250
Total diversions into South Platte River Basin	**351,676**
Total diversions into North and South Platte River Basins	**368,176**

Between 1900 and 1940, several large dams and reservoirs were built to store the high springtime runoff and thereby increase the available water supply for human uses: Pathfinder, Seminoe, Alcova, and Guernsey Dams in the North Platte River Basin; Antero, Elevenmile Canyon, Cheesman, Riverside, Empire, Jackson, Prewitt, and Milton Dams in the South Platte River Basin. Several of the South Platte River dams store both South Platte River flows and waters brought over from the Colorado River Basin.

In the central portion of the Basin, Kingsley Dam and the Central Nebraska Public Power and Irrigation District (CNPPID) Diversion Dam were constructed across the North Platte River and Platte River, with full project operations beginning in 1943.

Figure 2-8 shows the two major Platte River diversions upstream of the Central Platte Habitat Area. Just below Kingsley Dam, waters of the North Platte River are diverted into the Sutherland Canal. These flows, plus some water from the South Platte River, are returned to the South Platte River via canal at the city of North Platte, Nebraska. The CNPPID Diversion Dam then diverts flows from the Central Platte River downstream of the city of North Platte, Nebraska, into the Tri-County Supply Canal. Return flows from this canal system re-enter the Central Platte River at the Johnson-2 Return Canal upstream of the city of Overton, Nebraska.

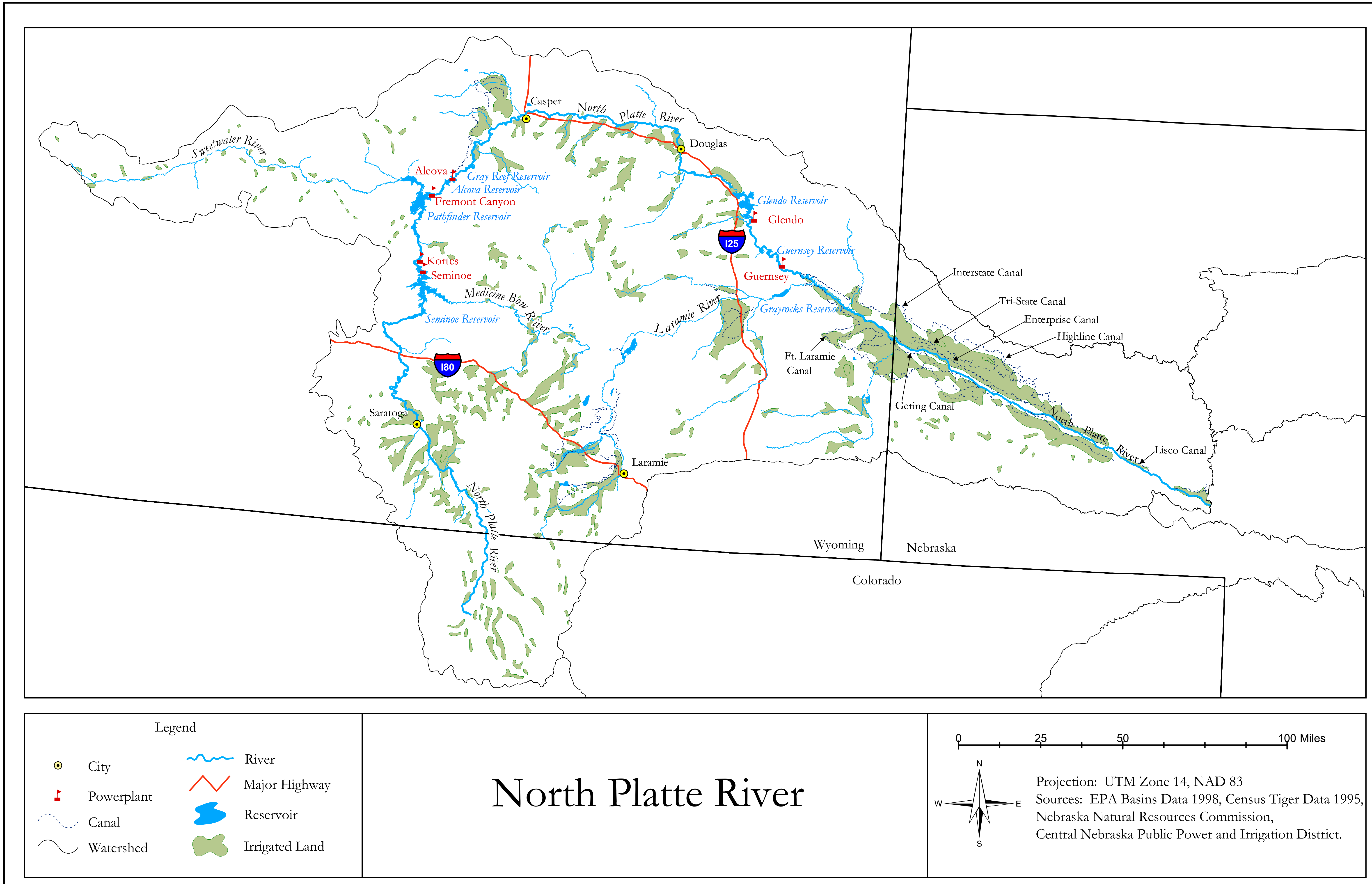
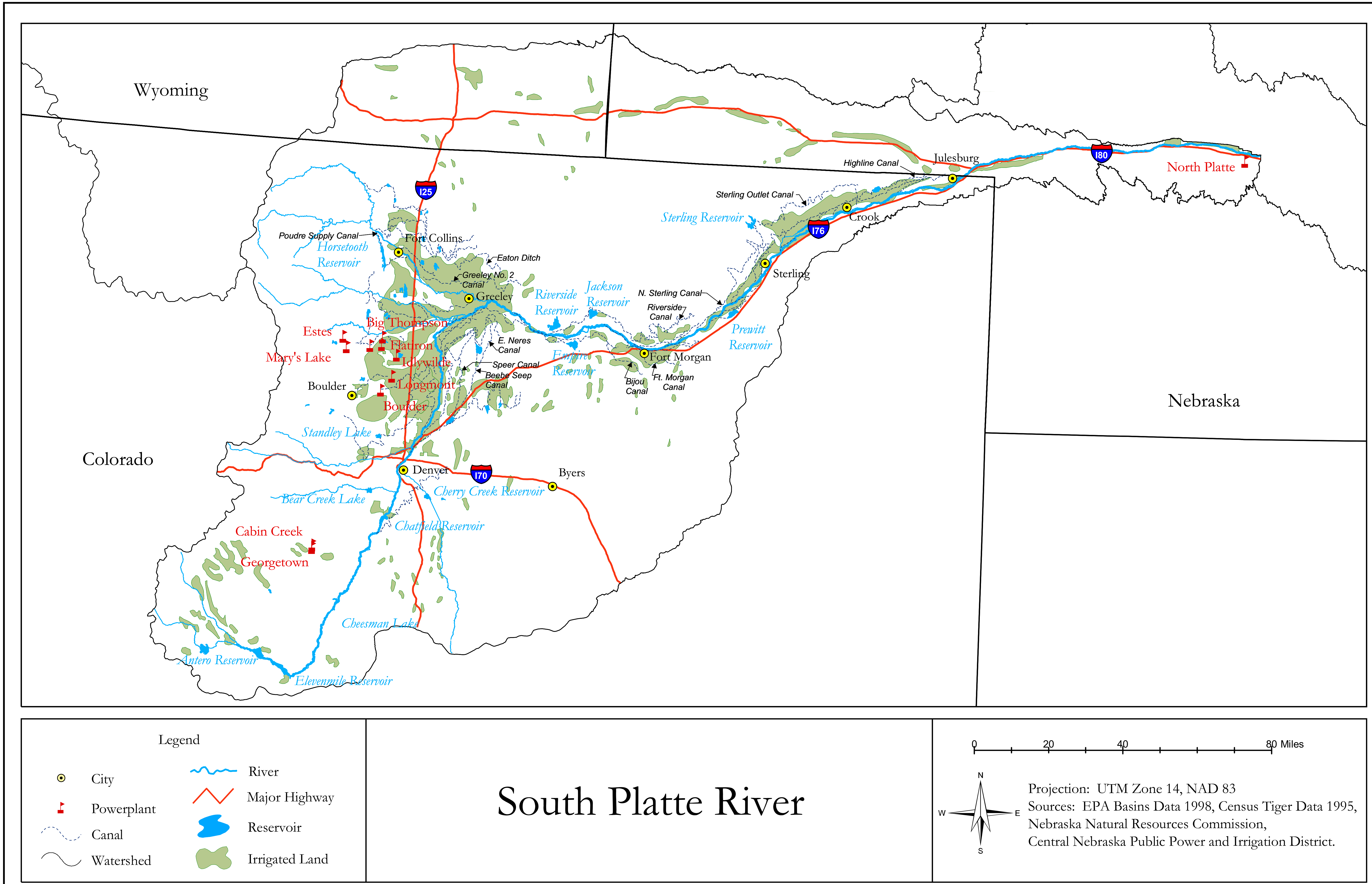


Figure 2-5. — North Platte subbasin.



South Platte River

Projection: UTM Zone 14, NAD 83
Sources: EPA Basins Data 1998, Census Tiger Data 1995, Nebraska Natural Resources Commission, Central Nebraska Public Power and Irrigation District.

Figure 2-6.— South Platte subbasin.

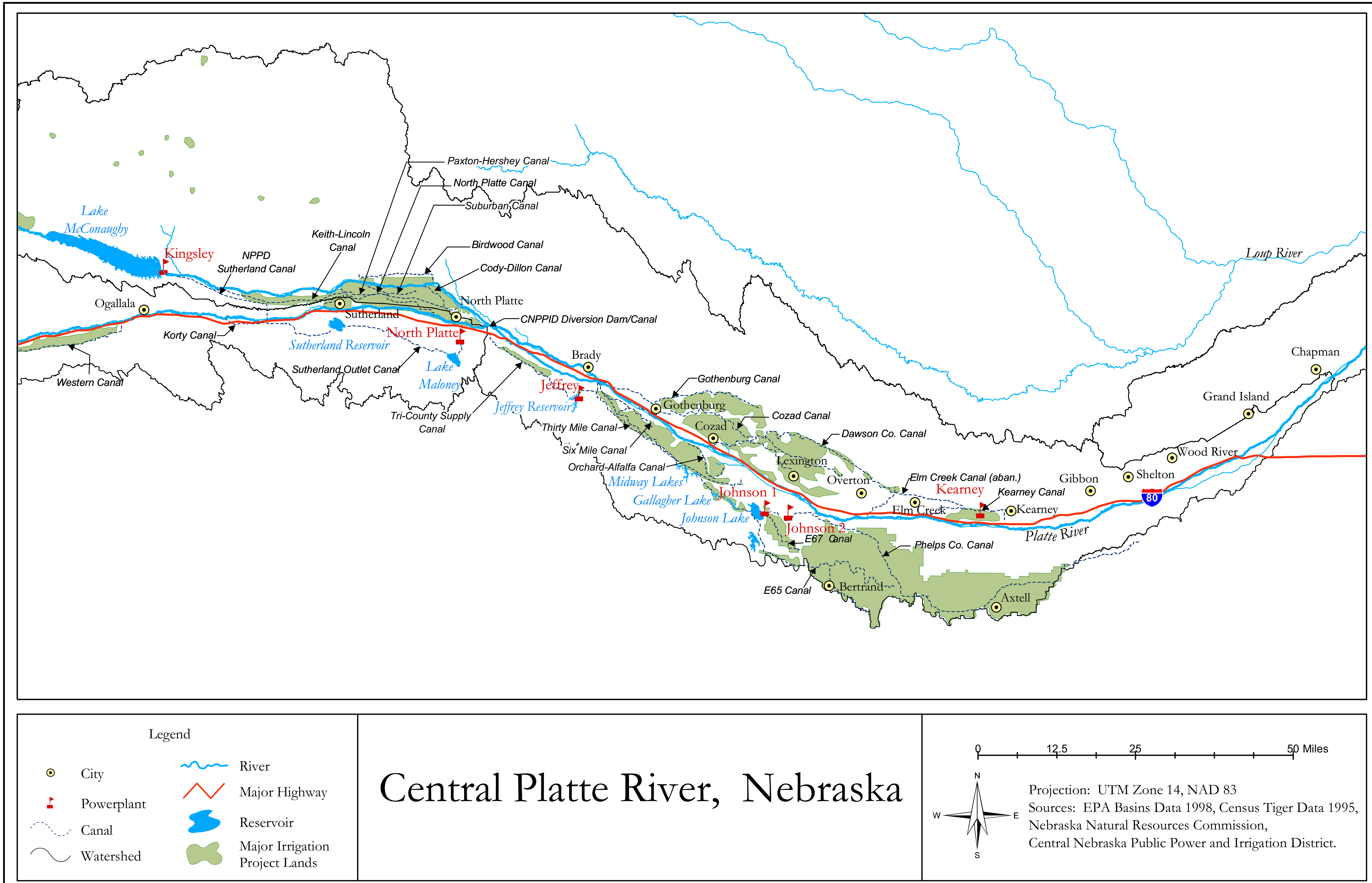


Figure 2-7.— Central Platte subbasin.

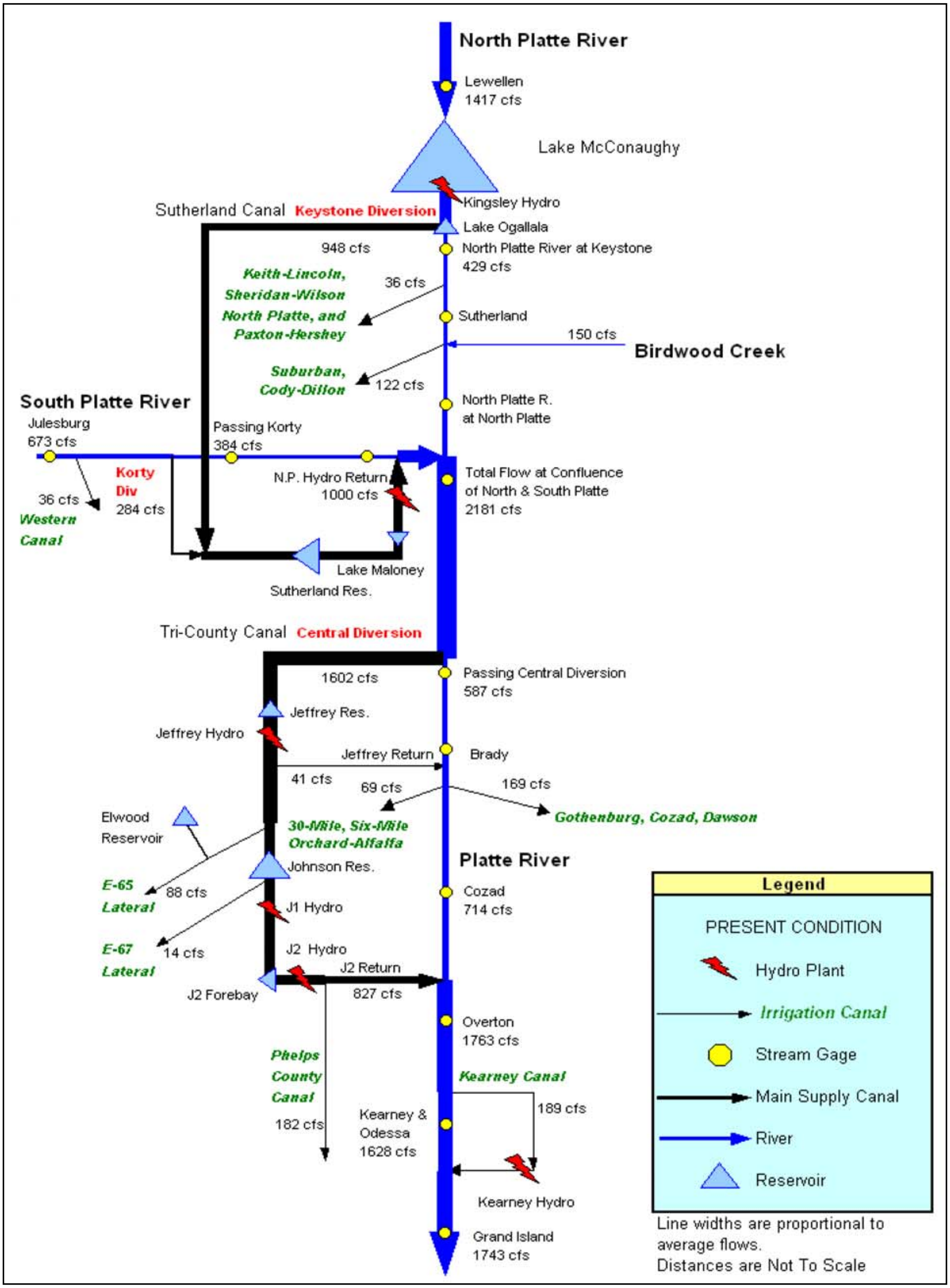


Figure 2-8.—Central Platte River schematic.

Figure 2-9 summarizes the development of reservoir storage in the Basin, showing reservoir storage over time. The larger Basin reservoirs have a combined storage capacity of roughly 7.2 MAF.

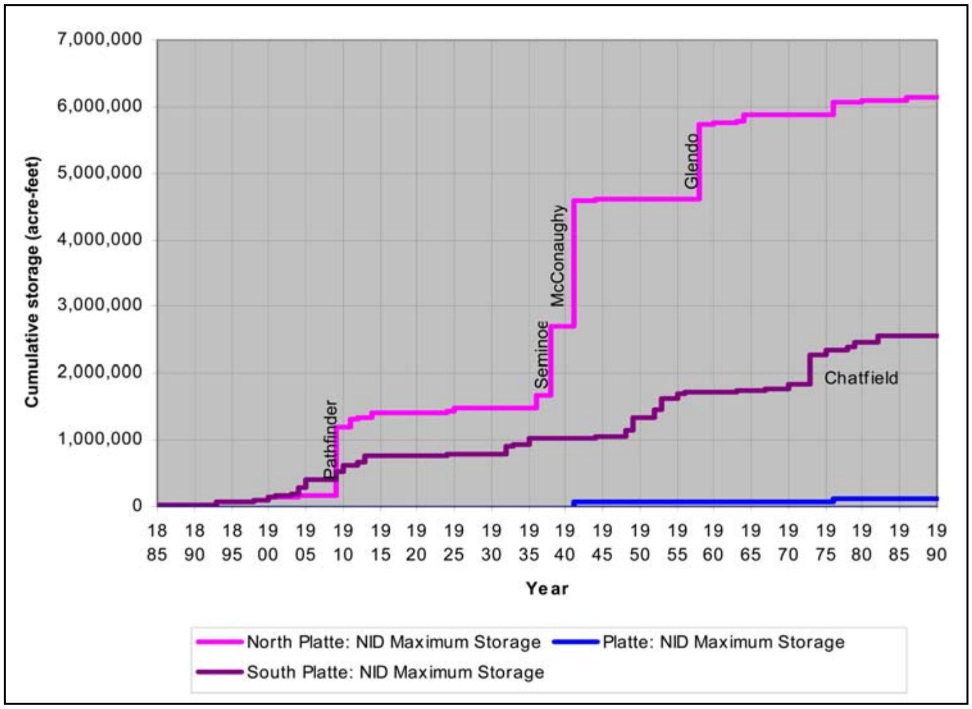


Figure 2-9.—Cumulative useable storage in the reservoirs in the Basin (values are from the National Inventory of Dams Maximum Storage).

Table 2-2 provides summary figures for reservoir storage for each of the Platte River subbasins.

Table 2-2.—Storage Capacity of Major Platte River Basin Reservoirs

State	Storage Capacity (Acre-Feet)
Wyoming	3,526,000
Colorado	1,692,000
Nebraska	2,001,000
Total	**7,219,000**
Source: Eisel and Aiken (1997).	

Groundwater Development

Groundwater was also used to supplement surface water supplies. In 1994, roughly 35 percent of crop irrigation in the South Platte River Basin was estimated to come from groundwater (Bash and Young, 1994).

Particularly in the South and Central Platte River Basins, the most accessible groundwater aquifers near the river are hydrologically connected to the river; thus, pumping groundwater can deplete riverflows. After groundwater pumping increased substantially in the 1960s and 1970s, the State of Colorado developed laws and regulations that integrated the management of surface water and hydrologically connected aquifers. The State of Colorado now regulates groundwater pumping to avoid or offset any effect on the ability of senior water right holders to divert riverflows (MacDonnell, 1988).

Use of wells for irrigation in Nebraska grew substantially during the 1950s drought and more than tripled from 1970 to 1990 (Steele and Wigley, 1990). By 2001, in the Platte River counties downstream from Lake McConaughy to Grand Island, more than 19,000 groundwater wells were used for irrigation (Nebraska Department of Natural Resources, 2001). The State of Nebraska has recently implemented a set of laws and regulations that will integrate the administration of water use from surface and groundwater sources (Nebraska Water Policy Task Force, 2005, available at <http://www.dnr.state.ne.us/LB962/docs/LB962_summary.html>).

Development and use of groundwater in the Basin in Wyoming have been relatively modest (total use of groundwater in Wyoming is only 5 percent of surface water use [Solley, 1997]).

Current Water Use

Most of the cities along the Front Range of Colorado use Platte River water for municipal supplies. Several cities along the North Platte River in Wyoming do also. Further, nearly all of the cities along the Platte River in Nebraska obtain municipal supplies from well fields next to the Platte River, which are significantly supported by riverflows. However, for the States of Wyoming, Colorado, and Nebraska, total water withdrawals for irrigation and livestock are 10 to 15 times larger than for domestic, commercial, industrial, and mining uses combined (U.S. Geological Survey [USGS], 1995, available at <http://water.usgs.gov/watuse/pdf1995/html/>).

Table 2-3 provides estimates of the total irrigated acreage in the Basin above Grand Island, from both surface and groundwater supplies.

Table 2-3.—Irrigated Land Area Estimates for the Platte River Basin, 1995
(Includes Surface- and Groundwater-Irrigated Land)*

	Acres
North Platte River Basin	
Wyoming	**528,000
Colorado	88,000
Nebraska	521,000
South Platte River Basin*	
Wyoming	38,000
Colorado	****1,100,000
Nebraska	226,000
Central Platte River Basin (Below North/South Confluence and Above Grand Island)	
Nebraska	881,000
Total	**3,382,000**

*U.S. Geological Survey (1995 and 1999). 1995 water-use data files for Wyoming, Colorado, and Nebraska <http://water.usgs.gov/watuse/spread95.html>. Values are rounded to nearest 1,000 acres.

**U.S. Geological Survey (1999) estimated 541,000 acres. Wyoming's Statewide Data Inventory estimates "about 528,000 acres" (Wyoming, 2003, available at http://waterplan.state.wy.us/sdi/NP/NP-over.html). The total "baseline acres" for the North Platte River Basin (maximum historic irrigated acreage) identified by Wyoming in their draft depletion management plan of August 14, 2002, is 581,504 acres. The number from Wyoming's Statewide Data Inventory is used here.

***For comparison, the Colorado Department of Agriculture estimated a total of about 885,000 acres of "1995 Irrigated Harvested Colorado Cropland" in the counties that generally correspond to the South Platte River Basin, including Adams, Arapahoe, Boulder, Douglas, Elbert, Jefferson, Larimer, Logan, Morgan, Sedgwick, and Weld (Frank and Carlson, 1999).

****U.S. Geological Survey (1995) estimated 815,000 acres. However, the South Platte River Basin Water Use, Growth and Water Demand Projections (Colorado Department of Natural Resources and Colorado Water Conservation Board, 2002) estimates 1,100,000 irrigated acres in the South Platte River Basin in Colorado in the year 2000.

Consumptive Water Use and Streamflow Depletions in the Platte River Basin

Much of the water used for irrigation returns to the river as runoff from fields or through the ground. The irrigation water that is taken up by crops, transpired by crops, or evaporated into the atmosphere is lost to the river system and, therefore, reduces riverflows. In similar fashion, some of the water diverted to municipal systems does not return to the river. This water lost to the river system is termed the consumptive use.

Estimates of consumptive use of water in the Basin can be derived from a variety of sources. Table 2-4 summarizes the demands for water supply in the Basin based primarily on USGS's 1995 Water-Use Data Files (USGS, 1999 [water use]), which were developed with information from the corresponding state water resource agencies. Some adjustments have been made as described by the Service (2002 [flow]).

Table 2-4.—Estimated 1995 Demands for Water in the Platte River Basin, Above the Loup River Confluence

Platte River Basin Above the Loup River Confluence (Irrigated Acreage)	
Surface water irrigation	1.9 million acres
Groundwater irrigation	1.6 million acres
Total irrigation	**3.5 million acres**
Population served with water supply	3.0 million
Source: USGS (1999) and Service (2002).	

Table 2-5 summarizes Basinwide estimates of consumptive use, based primarily on per-acre estimates of agricultural consumptive use in various parts of the Basin, as well as reservoir evaporation estimates from Reclamation in 1992, and municipal and industrial consumptive use, based on per-capita estimates for the South Platte River Basin, from the State of Colorado.

Table 2-5.—Estimated Consumptive Use of Water in the Platte River Basin, Above the Loup River Confluence

Estimated Mean Annual Consumptive Use, Platte River Basin Above Loup River Confluence (Acre-Feet)	
Surface water irrigation	1,640,000
Groundwater irrigation	1,190,000
Municipal and industrial use	270,000
Lake, reservoir, pond, and major canal evaporation	829,000
Total	**3,929,000**
Source: Reclamation (1992) and State of Colorado (1998).	

All of these activities can deplete streamflow in the Platte River system. However, attempts to convert consumptive use to net streamflow depletions must also consider that:

- Platte River Basin consumptive uses are partially offset by supplies provided from transbasin imports (approximately 450,000 acre-feet in the average year) and pumping of nontributary groundwater (quantity unknown, but assumed to be tens of thousands of acre-feet per year).
- The depletive effect on the river from irrigation and municipal use of groundwater connected to the Platte River is likely large but is difficult to quantify, due to varying proximity of wells to the river and the varying lagged effects on riverflows.
- One acre-foot of consumptive use in the upper Basin equates to something less than 1 acre-foot of depletions in the Central or Lower Platte River. This is because a portion of the consumptively used native flow would not have arrived at the lower reaches anyway because of evaporation, evapotranspiration, or recharge of nontributary aquifers.

Most of the groundwater withdrawn for agricultural use in the Basin comes from aquifers connected to the surface water system and, thus, is generally depletive to Platte River flows. However, the depletive effects may be delayed by many months or years, and not all of the groundwater is tributary. To develop the very conservative estimate of overall river depletions from Basin consumptive use summarized in the table below, the analysis ignores depletions to Platte River flows resulting from groundwater use (a large depletion, but difficult to quantify), as well as accretions associated with nontributary groundwater supplies (a much smaller accretion, also difficult to quantify).

Table 2-6 shows this conservative estimate of consumptive use in the Basin above the Loup River confluence, after accounting for offsetting imports.

Table 2-6.—Estimated Annual Consumptive Use of Water in the Platte River Basin After Accounting for Offsetting Imports

	(Acre-Feet)
Surface water irrigation consumptive use	1,640,000
Lake, reservoir, pond, canal evaporation	829,000
Municipal and industrial consumptive use	270,000
Total consumptive use	**2,739,000**
Minus transbasin imports	-450,000
Net consumptive use	**2, 289,000**

Based on the assumption that only 50 percent of the consumptive use in the Basin above the Loup River confluence becomes a depletion to flow in the Central Platte River, the estimated depletions to Central Platte River flows in an average year are at least 1.14 MAF, or about 1,575 cfs of year-round flow. This can be compared to a current average annual flow of 1.4 MAF in the Platte River at Grand Island from 1970 to 1998. [Over the longer time period of 1942 to 1998, average flows at Grand Island are 1.18 MAF (Stroup et al., 2003)]. This result matches reasonably well with the estimate by Simons and Associates (2000) that the average annual flow at Grand Island, Nebraska, has been roughly halved from the pre-development period.

Changes in Riverflows

The Platte River is one of the most highly developed rivers in the U.S., in terms of the amount of water stored and diverted compared to the total annual flow (USGS, 2000).[3] The USGS has described the general effect of large dams and diversions on river systems as follows:

> *"The river emerging from a dam is not the same river that entered its reservoir. That new river may be hotter or colder. Its daily discharge may vary wildly, while its seasonal pattern of high spring floods and low winter flow may be inhibited beyond recognition. Suddenly starved of its sediment load, the clear waters of a river below a*

[3]This holds true for the Platte River as a whole. Thirty-three miles above its confluence with the Missouri River, the Platte River is joined by the Elkhorn River, which is still largely an unregulated stream. In these last 33 miles, the Platte River flow becomes much less regulated.

dam may scour its bed and banks. An entirely new succession of riparian plants and animals may move into the river and valley below the dam. Native fishes may die or be severely stressed."

(USGS, 1996, page 7)

The following sections discuss in more detail the effect of water and land development on habitat for the target species.

Annual Volumes

The bankfull discharge and the mean annual flow in a river strongly influence the width of the river channel (Leopold, 1994). Prior to the construction of the first large storage reservoir, the mean annual flow of the Platte River near Overton, Nebraska, was 2.65 MAF per year during the period between 1895 and 1909, and 84 percent of this flow came from the North Platte River. During the period 1910 to 1935, the mean annual flow decreased to 2.29 MAF per year. With additional reservoir construction and periods of drought, the mean annual flow decreased to 0.83 MAF per year during the period 1936 to 1969. During the period 1970 to 1998, the mean annual flow of the Platte River near Overton, Nebraska, increased to 1.4 MAF per year, but only 58 percent of this flow was supplied from the North Platte River (Randle and Samad, 2003).

See also table 2-7 for changes in flows at several locations and time periods for USGS gauges on the North, South, and Central Platte Rivers. The stream gauges located upstream of major water resource development are denoted by shaded rows in the tables. (Because some farming and ranching still occur upstream of most of these gauges, the climatic impacts implied by these upstream gauges may be slightly overstated. Conversely, transbasin imports have supplemented flows in most South Platte River tributaries along Colorado's Front Range to at least a minor extent; gauge sites in table 2-7 are limited to those with the smallest imports.)

Table 2-7.—Mean Platte River Flows

Gauging Station	Mean River Flows (cfs)				Percent Change in Mean Flow Relative to the 1910 to 1935 Period		
	1895 to 1909	1910 to 1935	1936 to 1969	1970 to 1999	1895 to 1909	1936 to 1969	1970 to 1999
North Platte River Basin							
North Platte River Near Northgate, Colorado	NA*	502	383	432	NA	-24 percent	-14 percent
North Platte River at Saratoga, Wyoming	1,670**	1,310	1,000	NA	27 percent	-24 percent	NA
North Platte River at North Platte, Nebraska	3,190	2,750	646	862	16 percent	-77 percent	-69 percent
South Platte River Basin							
Clear Creek, Colorado	242	231	223	242	5 percent	-4 percent	5 percent
Middle Boulder Creek, Colorado	61	58	56	59	5 percent	-2 percent	2 percent
St. Vrain River at Lyons, Colorado	153	131	118	126	17 percent	-10 percent	-3 percent
South Platte River at North Platte, Nebraska	582	492	322	619	18 percent	-35 percent	26 percent
Platte River Stations							
Platte River at North Platte, Nebraska	3,780	3,240	968	1,480	17 percent	-70 percent	-54 percent
Platte River Near Cozad, Nebraska	3,550	3,040	461	981	17 percent	-85 percent	-68 percent
Platte River Near Overton, Nebraska	3,660	3,160	1,140	2,100	16 percent	-64 percent	-34 percent
Platte River Near Grand Island, Nebraska	3,580	2,950	1,080	2,110	21 percent	-63 percent	-28 percent

Source: Randle and Samad (2003).

Note: Shaded rows denote stream gauges that are located upstream of reservoirs and major irrigation.

*NA equals not available.

**Minimum values based on incomplete daily records for this period. Actual values would be somewhat higher if the complete records were available.

Peak Flows

Peak flows are the highest annual flows in the river, usually associated with spring runoff or intense rainfall events. Peak flows have a significant effect on the amount of vegetation that can become established in the river channel which, in turn, affects the extent of open views for the three bird species.

Annual peak flows of the Platte River near Grand Island, Nebraska, exceeded 17,000 cfs in 2 out of 3 years during the period 1895 to 1909. During the period 1970 to 1999, annual peak flows exceeded 6,000 cfs in 2 out of 3 years, or about one-third the peak flow of the earlier period (Randle and Samad, 2003). Peak flows began dropping in 1909, following completion of Pathfinder Dam, which created the first large reservoir on the North Platte River. In 1940, after several reservoirs were completed, the peak flow on the North Platte River at North Platte, Nebraska, was seldom more than 5,000 cfs. Other monitored locations on the Platte River (Overton and Grand Island, Nebraska) showed similar results (Simons and Associates, 2000).

Table 2-8 shows the 1.5-year peak flows for USGS gauges on the North, South, and Central Platte Rivers.

Table 2-8.—Platte River 1.5-Year Peak Flows

	1.5-Year Peak Flows (cfs)				**Percent Change in 1.5-Year Peak Flows Relative to the 1910 to 1935 Period**		
Gauging Station	**1895 to 1909**	**1910 to 1935**	**1936 to 1969**	**1970 to 1999**	**1895 to 1909**	**1936 to 1969**	**1970 to 1999**
North Platte River Basin							
North Platte River Near Northgate, Colorado	NA*	2,600	2,220	2,430	NA	-15 percent	-7 percent
North Platte River at Saratoga, Wyoming	9,200	7,720	5,710	NA	19 percent	-26 percent	NA
North Platte River at North Platte, Nebraska	16,300	8,150	2,160	2,380	100 percent	-73 percent	-71 percent
South Platte River Basin							
Cache La Poudre River at Canyon Mouth, Colorado	3,103	2,700	2,492	2,737	15 percent	-8 percent	1 percent
St. Vrain River at Lyons, Colorado	898	744	962	904	21 percent	29 percent	21 percent
South Platte River at North Platte, Nebraska	2,330	1,430	712	1,420	63 percent	-50 percent	-1 percent
Platte River Stations							
Platte River Near Cozad, Nebraska	17,600	9,140	1,980	2,590	93 percent	-78 percent	-72 percent
Platte River Near Overton, Nebraska	19,400	9,000	3,490	4,750	116 percent	-61 percent	-47 percent
Platte River Near Grand Island, Nebraska	17,300	10,100	4,500	6,010	71 percent	-55 percent	-40 percent

Source: Randle and Samad (2003).

Note: Shaded rows denote stream gauges that are located upstream of reservoirs and major irrigation.

*NA equals not available.

Figure 2-10 compares the median daily flow over two periods of record at Duncan, Nebraska.[4] As this graph shows, the peak median daily flow from 1895 to 1909 was more than 15,000 cfs. In recent times, the peak median daily flow is between 3,000 and 4,000 cfs.

[4]Duncan, Nebraska, was selected because it is the next river gauge downstream from Grand Island, Nebraska, and above other significant tributaries, for which a long period of record can be assembled.

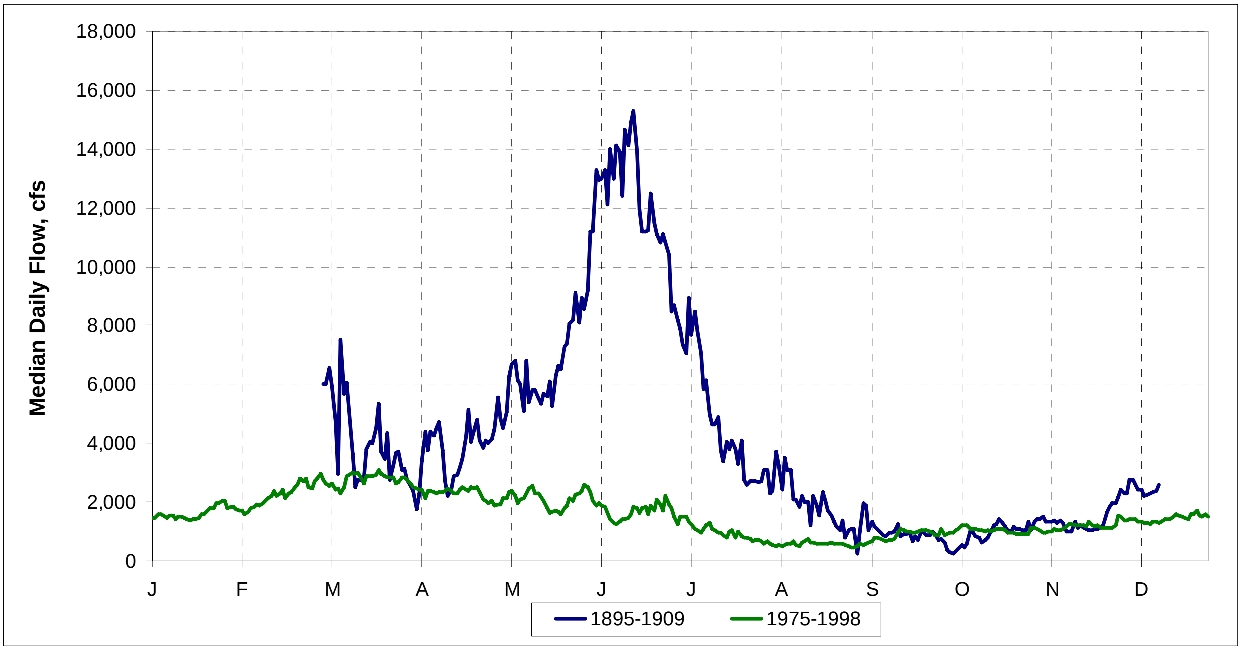


Figure 2-10.—Median mean daily flows at Duncan, Nebraska.

Although the largest reservoirs were constructed on the North Platte River, the construction of reservoirs and diversions on the South Platte River also affected peak flows. As mentioned, by 1907 more than 900,000 acres were under irrigation in the South Platte River valley, with 450,000 acre-feet in storage. Analysis of South Platte River diversions and storage indicates that peak flows in the South Platte River are currently 3,000 to 5,000 cfs lower in May and June than during pre-development conditions (Hydrosphere, 2002).

Minimum Flows

A reduction in the yearly minimum flow in the river may negatively affect fish populations, as well as allow growth of vegetation over a greater part of the riverbed. In general, when reservoirs are built to provide irrigation supplies, peak flows are stored and released later in the summer for irrigation. Some of the water applied to crops returns to the river and augments summer flows. In some cases, most of the water in a river in the summer consists of irrigation return flows. The resulting summer flow may or may not be greater than would have existed without the storage and diversion of water.

The effect of historic water development on low summer flows in the Platte River is hard to quantify, given the lack of gauge records from the early development period (pre-1900), and the fact that very low flows are often poorly measured by early gauges. In terms of systematic data, Eschner et al. (1983) reports that "*little is known about the low-flow behavior of the river above the confluence with the Loup River prior to irrigation*." However, there are many accounts from early European explorers and travelers who reported the Platte River as dry over significant reaches during the summer, or of its flow being too low to navigate with small boats (Simons and Associates, 2000). However, in the Second Hydrographic Report for Nebraska by the Bureau of Irrigation, Water Power, and Drainage (1933), the authors found that:

"Statistics do not show the river as being entirely dry at North Platte until after the middle 'nineties' [1890s] when the irrigation ditches in the upper portion of the North Platte River, and many of the tributaries diverted water for irrigation."

(Flo Engineering, Inc., 1992)

It seems certain that the flow in the pre-development Platte River was very low in the summer in many years. Following water development, late summer flows still fall to near zero at Grand Island in many years. Over the period 1941 to 1997, 23 years had late summer flows at or near zero (i.e., monthly average flow was equal to 5 cfs or less).

For the Overton, Nebraska, gauge, which has one of the longest data records for the Central Platte River, the 10-year average annual minimum flow has been increasing since 1940, probably reflecting the influence of return flows to the river from irrigation. However, this 10-year average currently remains below the average minimum flow level for the years 1915 to 1930.

Timing of Flows

The pattern of flows during the year can affect the ability of the tern and plover species to nest in the spring without subsequent inundation of nests in the summer. The natural annual pattern of flows in the Central Platte River was driven primarily by the spring snowmelt. Seasonal flows were moderate from October through February, with high flows in the spring and early summer and with flows declining through the rest of the summer.

Figure 2-11 shows some of the changes in seasonal flow patterns. This figure shows the day of the year on which the annual peak flow occurred at Overton, Nebraska, for years between 1902 and 1998. Prior to construction of large dams (before 1910), the annual peaks clustered in late May and June. As more dams were constructed, the annual peaks occurred over a broader period until, most recently, flows in nearly every month of the year have the potential to be the annual peak.

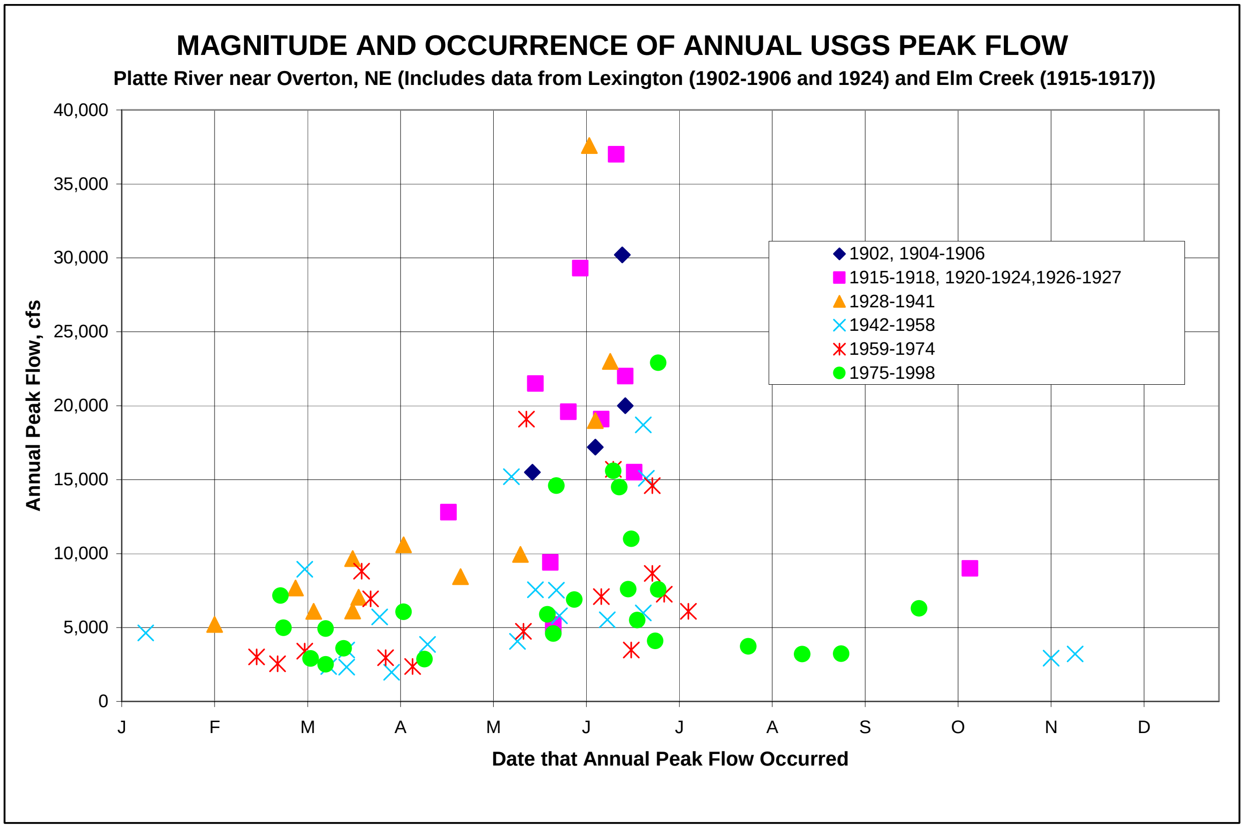


Figure 2-11.—Changes in seasonal flow patterns.

Effects of Climate on Flows and River Form

Climate is generally defined as the prevailing long-term weather conditions, including long-term averages in rainfall, runoff, and temperature over many decades or centuries. Long-term trends in climate can affect the amount, location, and timing of precipitation and riverflows and, hence, other habitat characteristics. The question of how or whether climate in the Basin has changed, and how that may have affected the river and related resources, is relevant to this discussion of other trends and influences. For example, a braided river channel cannot be maintained below a certain threshold of sediment-transport capacity, and this capacity is affected by the amount and velocity of riverflow (Leopold and Wolman, 1957).

The science of tree-ring analysis has considerably extended the traditional record of climate based on instrument measurements. Instrumented data in the Basin are available back to approximately 1895; however, the technique of correlating tree rings to historic climate conditions (paleodendrology) provides information back to the 1600s or 1700s in the West. Tree-ring data have been used to extend the period of record for the Palmer Drought Severity Indices (PDSI) and for some hydrological records of streamflow. The PDSI is a drought model derived by Palmer (1965) and computed from temperature and precipitation data to provide a measure of climatic stress on crops and water supplies.

Some have suggested that a drier climate (rather than upstream water use, diversion, and storage) may be the primary reason why much of the Central Platte River flows have been reduced so much from pre-settlement conditions.

The available climate record does not support this interpretation. Both reconstructed streamflow records and PDSI suggest that the climate history of the Platte River Basin is characterized by short periods of wet and dry, with durations of 3 to 10 years, fluctuating around a central average (figure 2-12). As measured by PDSI, the first three decades of the 20th century were unusually wet; however, no general long-term trend of drying is apparent for the remainder of the century. In fact, the last two decades of the 20th century also were relatively wet.

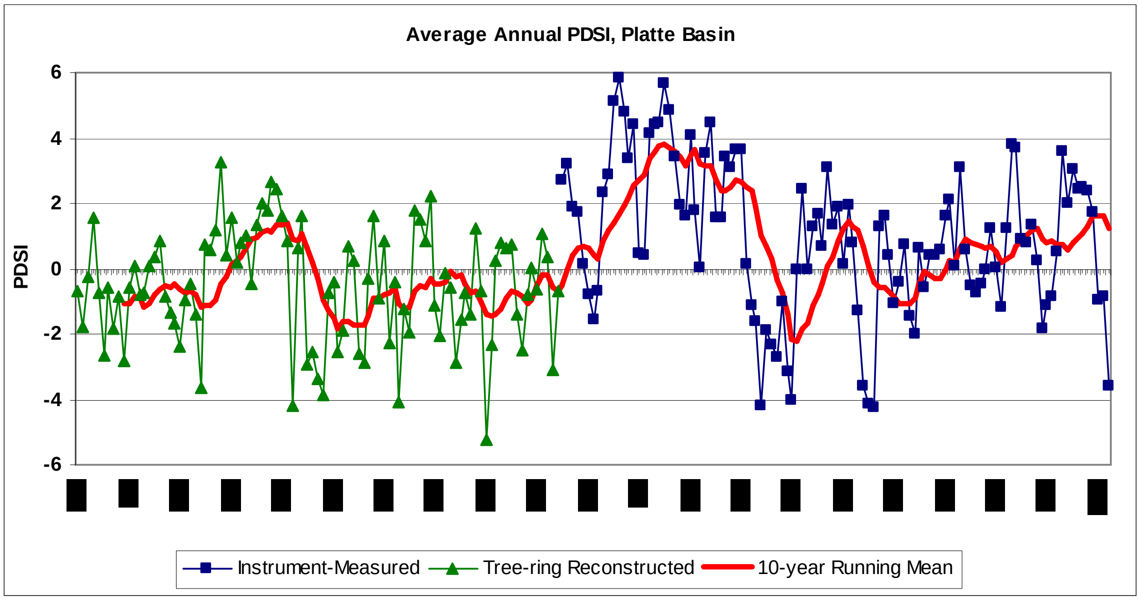


Figure 2-12.—Platte River Basin PDSI values, 1800-2000.[5]

Climate reconstructions based on tree-ring data for the Great Plains region indicate that while there were significant multiyear droughts in the 20th century these dry periods were exceeded several times previously in the 18th and 19th centuries (Cleaveland and Duvick, 1992; Woodhouse and Overpeck, 1998; and Woodhouse, 2001). Figure 2-12 shows that the 1800s had periods of both drought and above-average precipitation that preceded widespread European settlement.

This indicates that the conditions of the Platte River, as photographed and described in the mid- to late 1800s, represent a river that had recently been through droughts of similar intensity that lasted longer than those seen in the 20th century. Climate and streamflow records also indicate that the pronounced reduction in flows in the Central Platte River during the first part of the 20th century occurred while precipitation was above average, again illustrating how construction of large storage and diversion projects can overwhelm the decadal variation in annual precipitation.

[5]Values for 1800-1894 are PDSI estimates from tree-ring reconstructions (National Climate Data Center, 2005, accessed at: <http://www.ncdc.noaa.gov/paleo/usclient2.html>, August 2005), averages of Cell 58 (centered on 41° latitude, 104.5° longitude), and Cell 68 (41° latitude, 101.5° longitude). From: Reconstruction of Past Drought Across the Conterminous United States from a Network of Climatically Sensitive Tree-Ring Data. Values for 1895 through 2000 are instrument-measured estimates averaged for National Climate Data Center "divisions" (CO-4, WY-10, WY-8, NE-1, NE-5, NE-7, and NE-8).

Although there does not appear to have been a significant and consistent downward trend in precipitation resulting from climatic change, annual flows of the Central Platte River have been affected by the year-to-year variations in precipitation. The short-term fluctuations can be approximated from streamflow records in the Basin, measured at gauges located upstream of reservoirs, major irrigation diversions, and major pumping well systems.

Comparing changes in flow in upper Basin versus downstream locations can be instructive, particularly comparing data shown in tables 2-7 and 2-8, summary values for mean annual flow and 1.5-year peak flows for USGS gauges on the North Platte River, South Platte River, and Central Platte River.

The magnitude of the changes in flow at gauges upstream of major water use indicates that climatic fluctuations cannot account for the large and consistent reductions in mean annual flow and 1.5-year peak flows measured at gauges downstream of major water use. The changes in flow at upstream gauges primarily attributable to variations in precipitation are considerably less than the changes in flow noted at gauges downstream of reservoirs, major irrigation diversions, and irrigation wells. For example, compared to the period 1910 to 1935, mean flows today (1970 through 1999), above the major water storage and diversion facilities, range from a decline of 14 percent (Northgate, Colorado, on the North Platte River) to an increase of 5 percent (Clear Creek near Golden, Colorado, on the South Platte River). Below the major storage and diversion facilities, flows today have declined by 28 percent (Grand Island, Nebraska, on the Central Platte River).

A review of Platte River data by the National Academy of Sciences led the academy to conclude that "*direct human influences are likely to be much more important than climate in determining conditions for the threatened and endangered species of the central and lower Platte River*" (National Research Council, 2005, page 17). However, the Academy also noted that "*exact interactions between climate and the system are poorly known*" and that "*longer-term background effects of climate are worthy of further investigation.*"

Among relevant "background" considerations is whether long-term climate trends are occurring that could alter riverflows in ways that either impede or promote habitat recovery efforts. Conclusive research on climate trends in the Platte River Basin is scarce; however, Pielke et al. (2002) cite evidence that there is a regional warming trend in night-time temperatures "consistent with theories of climate warming." Increased Basin temperatures could have the effect of depressing riverflows by increasing Basin losses to evaporation and evapotranspiration, unless offset by increased precipitation or changes in land cover. At the end of the Program's First Increment, 13 years of additional climate observations and modeling should provide a clearer picture of Basin climate trends (if any) and their implications for subsequent Program recovery efforts.

Changes in Runoff Pattern Due to Land Cover Change

In addition to any changes in precipitation or temperature over time, changes in the vegetative cover in a river basin and changes in surface infiltration capacities can also affect the amount of water reaching the stream system.

Urbanization

Apart from the effects on streamflows caused by water storage and diversion for municipal use, urbanization changes the pattern of runoff by increasing substantially the amount and rate of rainfall runoff to streams. Urban and suburban development increases greatly the impervious surface area, such as streets, roofs, and parking lots, which prevents infiltration of rainfall into the ground. In most cases, this has the overall effect of increasing the storm-induced peak flows in streams near cities or suburban areas. Urbanization has likely had a small effect on the pattern of riverflows in the Central Platte Habitat Area, given the relatively limited extent of urban areas near the habitat.

Agricultural Practices

On a larger scale, changes in land cover due to agriculture in the Platte River Basin, as a whole, has likely had varying impacts on the riverflows and sediment load. During the early period of agricultural development, when prairie lands were first plowed and native vegetation was removed, runoff from agricultural areas was likely increased somewhat over historic rates. Sediment loads also may have increased, especially prior to the widespread adoption of improved methods of soil and water conservation, such as contour farming, erosion-control structures, and minimum tillage. In recent decades, as these practices have been implemented to reduce farm runoff, minimize erosion, and retain water and soil moisture, overall runoff from agricultural lands has likely decreased.

Forest Cover

Much of the annual flow volume in the Platte River originates from snowpack in high altitude forests in the Rocky Mountains. Runoff from the forested areas of the upper Basin can be influenced by the extent, age, and condition of forest cover.

Numerous studies document the change in age and condition of the headwaters forests of the Platte River from the mid- to late 1800s to the present (e.g., Troendle and Nankervis, 2000; Troendle et al., 2003; and MacDonald and Stednick, 2003). The age and density of Platte River Basin headwater forests in the mid- to late 1800s were near a historic minimum due to natural disturbance cycles that were perhaps exaggerated by extensive cutting and burning of the forest by early pioneers, miners, and railroads. Since that minimum, forest age and density have generally increased during the 20th century. Increases are primarily due to natural forest growth. In some vegetation types, such as ponderosa pine, wildfire suppression may also be a factor. However, recent surveys of forest health conditions indicate that forests in the Platte River Basin are undergoing substantial mortality from fire, drought, insects, and disease, and may be cycling back to a younger condition.

Models of long-term forest growth and runoff suggest that there may be roughly a 150-year cycle of forest maturation and decline that affects the amount of annual precipitation which either is consumed by the vegetation or evaporates. The amount of water consumed or evaporated by forest vegetation varies by approximately .25 acre-feet per acre over this growth and decline cycle, on average. This quantity is greater in areas with more precipitation and runoff (generally, higher-elevation zones) and less in drier areas. Where annual precipitation is less than 18 to 20 inches, changes in runoff resulting from changes in forest cover are generally negligible (MacDonald and Stednick, 2003). MacDonald and Stednick estimate that from the late 1800s minimum forest density to today, runoff to the North Platte River from national forest lands may have decreased by 11 to 13 percent.

Forest Management

Public and private forest management has changed considerably in the last 100 years. Management of forests in the public domain was primarily custodial for the first half of the 20th century. Since 1940, rates of timber harvest on public lands have varied over time, with lower rates from 1940 to 1960 and higher rates from the mid-1960s to 1990. Current rates of timber harvest have declined from the highest rates in the 1980s. Timber harvest can have some effect on overall water yield, as increased harvest results in increased runoff. For example, 4,600 acre-feet of increased annual runoff has been projected in the North Platte River Basin due to timber harvest on national forest lands, if one assumes that 1997-2001 rates of timber harvest are continued through 2017 (Troendle et al., 2003).

The magnitude of the changes in flow at gauges upstream of major water use indicates that changes in forest cover cannot account for the large and consistent reductions in mean annual flow and 1.5-year peak flows measured at gauges downstream of major water uses.

CENTRAL PLATTE RIVER CHANNEL

Desirable riverine habitat for whooping crane, least tern, and piping plover include wide areas of water with unobstructed sight distances and bare sandbars for roosting, nesting, and security from predators. Journal entries from the mid-1800s provide descriptions of the braided characteristics of the Central Platte River. Based on 1900 USGS maps and 1938 aerial photographs, the plan form of the river remained predominantly braided to 1938, although the width of the river declined significantly through these years. In contrast, the current plan form of the Central Platte River now includes meandering and anastomosed reaches, which have small width to depth ratios and do not provide the preferred habitat of wide water and bare protruding sandbars. The width of the river also has declined further from 1938.

The plan form of a river is influenced by flows, sediment load, and bank stability, which is affected by soils, vegetation, and topography (Bridge, 1993 and 2003 and Thorne, 1997). River conditions today, including flow, sediment load, and river corridor topography, vary from conditions in 1900 or 1938. This section describes the shift in conditions since 1900 and the processes that brought changes to the river plan form, thereby altering key habitat characteristics.

The Nineteenth Century River

Although data measurements by the USGS did not begin in this area until the end of the 1800s, written narratives of settlers provide some insights on the river in the 19th century. *The Great Platte River Road* (Mattes, 1969), describes the history of early explorers and the personal diary and journal accounts of pioneers migrating west along the Platte River from the 1840s through the 1860s. One account, from James Evans in 1850, describes his first view of the Platte River:

> *"From the sandhills, it had the appearance of a great inland sea. It looked wider than the Mississippi and showed to much better advantage, there being no timber on the banks to check the scope of the human eye. Grand Island, which lays just opposite in the middle of the river is one hundred miles long, and has some cottonwood trees upon it. There is no tree timber here growing upon the margin of the river, not even a willow switch. There are, however, some timber and brush growing upon the various small islands in the river which can be obtained by wading the rapid sloughs two or three hundred yards across. My first impression on beholding Platte River was, that*

> *as it looked so wide and so muddy, and rolled along within three feet of the top of the bank with such majesty that it was unusually swollen and perfectly impassable. Judge my surprise when I learned that it was only three or four feet deep."*
>
> (Mattes, 1969, page 162)

As part of the Utah Expedition from 1857 to 1858, Captain Gove (Mattes, 1969, page 240) found that the Platte River width varied from 700 yards (2,100 feet) to 2 miles. When Richard Hickman first saw the Platte River in flood stage in 1852 (Mattes, 1969, page 163), he remarked that it was so large "*it had the appearance of being navigable for the largest size steamboats.*" Rufas Sage saw the Platte River during normal flow in 1841 and wrote that "*its waters are very shallow, and are scattered over their broad bed in almost innumerable channels, nearly obscured by the naked sand-bars that bechequer*[6] *its entire course through the grand prairie.*" Rufas Sage also wrote that "*the valley of the Platte is six or seven miles wide, and the river itself between one and two miles from bank to bank*" (Mattes, 1969, page 240).

Many sources from the early to mid-1800s described the Platte River as muddy and turbid, indicating a high amount of sediment transport and deposition (Eschner et al., 1983; James, 1823; McKinstry, 1975; Williams, 1969; Kelly, 1851; and Baydo, 1971).

In the early to mid-1800s, the bed of the Platte River was described as mostly sand with some mud and gravel (Eschner et al., 1983) and as quicksand (Rollins, 1935; Williams, 1969; and Fremont, 1845). According to accounts in 1820 and 1849, the sand was continually shifting into different sandbars due to water action and sediment deposition (James, 1823 and Mattes, 1969).

In 1901, the Platte River and its two principal tributaries were described by Gannett in some detail in USGS Water Supply and Irrigation Paper No. 44.

> *"These two branches [North Platte River and South Platte River] meet at North Platte, and below their junction the Platte has an average fall of about 6 feet per mile, maintaining that slope with remarkable uniformity. The river is a peculiar one in the fact that it has a relatively steep slope and an extremely straight course… It is subject to great fluctuations in [flow] volume. In the springtime, when the mountain snows are melting, it is a river a mile in width, while at other times of the year it is almost or quite dry."*
>
> (Gannett, 1901)

[6] "Bechequer" or "be-chequer" likely means that numerous sandbars were distributed in a checker pattern over the channel bed.

Changes in River Channel

Simons and Associates (2000) summarized the changes to Platte River characteristics between the pre-development river and current conditions in table 2-9.

Table 2-9.—Summary of River Channel Conditions (Pre-Development and Current)

Factor	Pre-Development Condition*	Current Condition
Annual flow	2.8 MAF	1.4 MAF (on average, ranging from 0.6 to 2.8 MAF)
Peak flow	15,000 to 45,000 cfs, exceeding 17,000 cfs in 2 out of 3 years	3,000 to 24,000 cfs, exceeding 6,000 cfs in 2 out of 3 years
Periods of no flow	No flow may have occurred along significant reaches of river during the summer months	Relatively infrequent and relatively short occurrences of no flow
Bed material	Sand (medium diameter 0.41 millimeter)	Sand (medium diameter 0.86 millimeter), some gravel
Bed forms	Shifting bars, described as continually changing forms with short offsets like shingles on a roof	Large-scale sandbars and islands
Sediment load	Large sediment load (1.6 million tons per year). River described as muddy and turbid	Significant sand load (but less than pre-development) and significantly reduced wash load (due to diversions and return flow). Total sediment load estimated to be 0.7 million ton per year
Channel classification	Braided with sandbars and wooded islands	Braided/anabranched [anastomosed, also meander reaches], with significantly greater extent of wooded islands and bars than under pre-development
Total channel width	1 to 2 miles (predominantly, with narrower reaches)	292 to 3,311 feet, averaging 1,260 feet
Active channel width	Estimated 90 percent of total channel width	9 to 28 percent of pre-development total channel width
Riparian vegetation	Densely wooded islands (primarily willow and cottonwood) with relatively narrow and relatively sparser band of bank vegetation. Bank vegetation limited by prairie fires and buffalo	Densely wooded islands with extensive woody riparian vegetation along banks; covers 72 to 91 percent of pre-development total channel width

Note: Adapted from Simons and Associates (2000).

*Or earliest data available.

Changes in Channel Width

Channel width, or active channel width, has been used frequently in the past to characterize changes to the Platte River and the reduction in desirable habitat for the whooping crane, piping plover, and interior least tern. This measurement relies on the presence of vegetation to denote the edges of the active channel. When riverflows no longer fill the historical banks during high flow periods, vegetation can expand to more areas between the historical banks. Figure 2-13 indicates trends of expanded vegetation, and, subsequently, reductions in active channel width and reductions in preferred habitat, for several Central Platte River locations over the last 135 years. More information on these measurements can be found in the *River Geomorphology Appendix* in volume 3.

For reasons explained in the rest of this chapter, channel widths along the river (shown in figure 2-13) have reduced by as much as 80 to 90 percent of the former 1860s channel in the upstream reaches, with lesser amounts of decrease in the reaches near Grand Island, Nebraska (Williams, 1978; Lyons and Randle, 1988; and Simons and Associates, 2000). The large decrease in channel width occurred in the 20th century. The rates of channel narrowing tended to be fastest for the upstream reaches, with slower rates of narrowing in the downstream reaches. The greatest reductions in channel width occurred during the 1900 to 1960 period, with smaller reductions, or even channel widening, during the 1960 to 2000 period. Currier (1996) and Johnson (1997) also have documented continued narrowing in the lower reaches of the Central Platte River, although they disagree on the reasons for it.

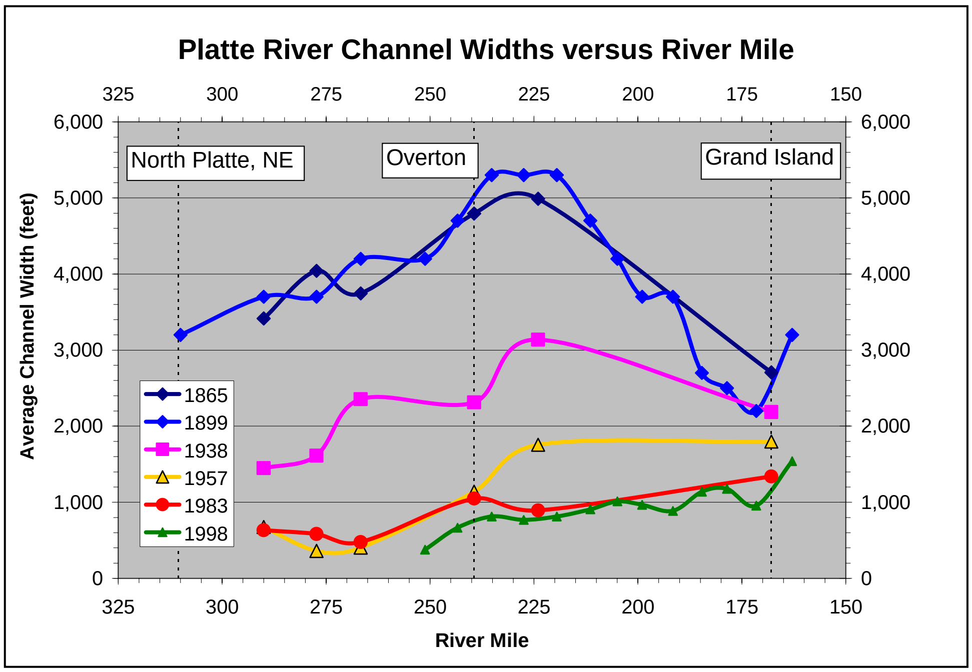


Figure 2-13.—Changes in active channel width in the Central Platte River.[7]

Most notable is the pattern of narrowing from upstream to downstream. In 1865, the Central Platte River was wider in the western end and narrowed toward Grand Island. While all reaches of the Central Platte River have narrowed, the channel has narrowed most dramatically between North Platte and Overton, Nebraska. Today, the channel is narrower in the west and wider downstream toward Grand Island.

Figure 2-14 illustrates channel narrowing in the Central Platte River near Overton, Nebraska, from 1860 to 1998. Historically, this was one of the widest reaches of the river, and it is now one of the narrowest. The series of images in these figures includes the General Land Office map created in 1860; the USGS survey map from 1889; the 1904 township property survey; and aerial photographs from 1938, 1951, and 1998. On each figure, a yellow or red line is superimposed to indicate the location of the 1998 river survey transect.

[7]The width is measured between the borders of vegetation along each bank of the Central Platte River. Distance along the Platte River is denoted as river mileage beginning at Plattsmouth, Nebraska, (river mile 0) and increasing in the upstream direction.

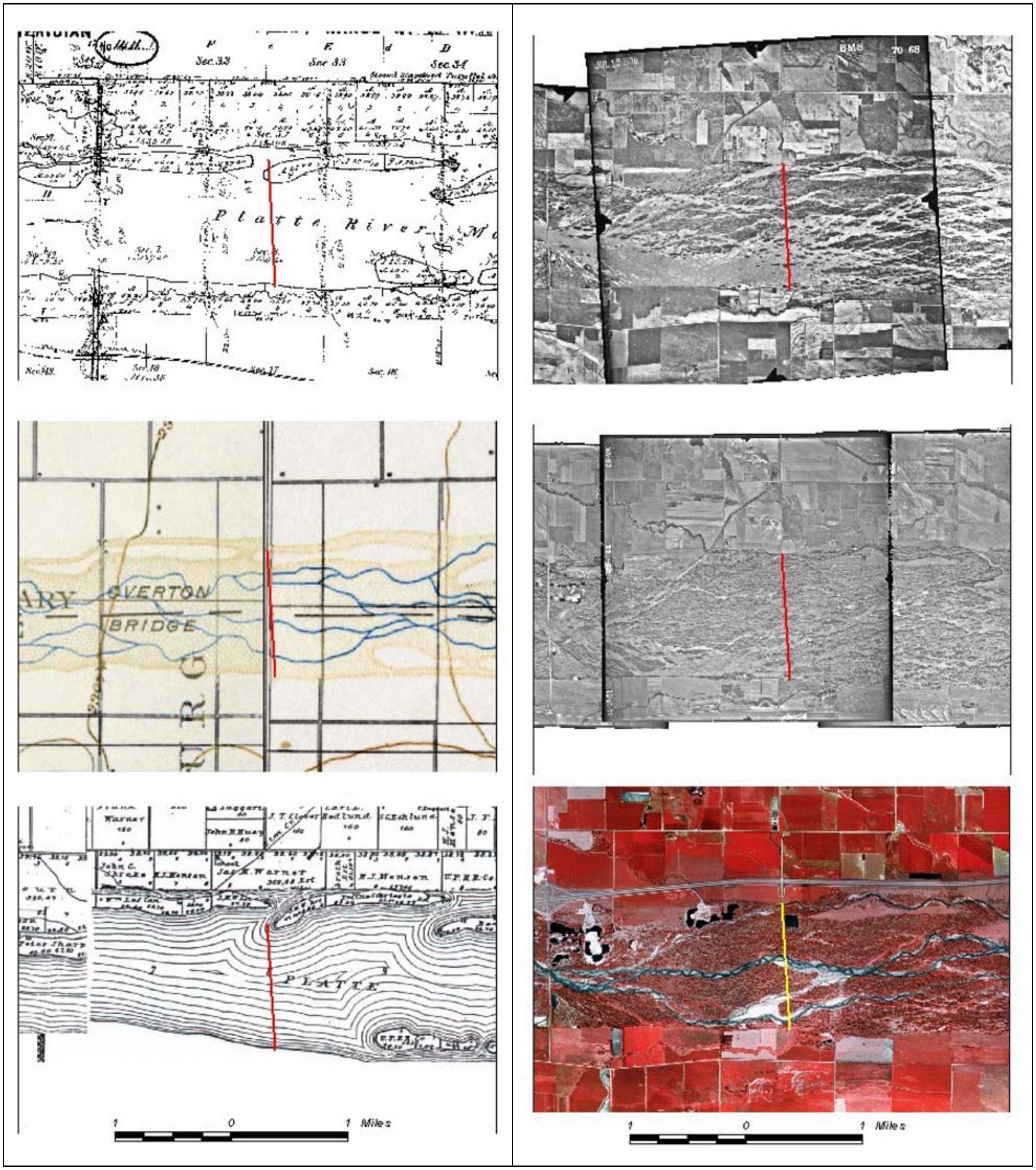


Figure 2-14.—Central Platte River channel near Overton, Nebraska, in (left to right, top to bottom) 1860, 1889, 1904, 1938, 1951, and 1998.[8]

[8]Red or yellow line depicts the same length in approximately the same location.

Changes in River Plan Form

Plan form is the form or pattern of the river as seen from the air, as discussed in Schumm's river classification (see sidebar 2-1, "River Plan Form"). Many of the plan form characteristics described in Simons and Associates (2000), including river width, depend on plan form (see table 2-9, "Summary of River Channel Conditions"). A wide, shallow river with a single channel and multiple, mid-channel sandbars is typical of a braided plan form. A narrow, deep river with a pronounced sinusoidal flow path and alternating point bars when bedload is present are characteristics of a meander plan form. Multiple meander channels in a river section, separated by vegetated islands, are representative of an anastomosed channel.

To depict changes in the river over time, a comparison of plan form, based on USGS topography maps from the period 1896 to 1902 (figure 2-15), black and white aerial photographs from 1938 (figures 2-16 and 2-17), and color infra-red aerial photographs from 1998 (Freisen et al., 2000), is shown in table 2-10. Similar to river width in figure 2-14, the most striking contrasts in plan form can be noted in the Central Platte River upstream of Overton, Nebraska. Although predominantly braided in the 1896 to 1902 period (generally referred to as 1900 in later references), and in 1938, the aerial photographs from 1998 show a meander channel which rarely braids, but has sandbars, indicating high sediment bedload for this classification (see sidebar 2-1, "River Plan Form"). The plan form change from braided to meander channel is illustrated in figure 2-16, with 1938 and 1998 photographs of the same area at river mile 253.

Table 2-10.—Plan Form Classification of the Central Platte River in 1896 to 1902, 1938, and 1998

River Mile	Location	USGS Topographic Maps, 1896-1902	Black and White Aerial Photographs, 1938	Infrared Aerial Photographs, 1998-2001
277	Gothenburg, Nebraska	Braided	Braided	Meandering
239	Overton, Nebraska	Braided	Braided and anastomosed	Anastomosed with some braided
210	Downstream of Kearney, Nebraska, begin island reach.	Braided	Braided	Braided and anastomosed in main channels
168-159	Grand Island to Chapman, Nebraska	Braided	Braided	Alternating braided and anastomosed

Sidebar 2-1.—River Plan Form

The type of river plan form or classification of the river provides pertinent information on the type of habitat to be found in that reach. Plan form is the pattern or shape of channels as seen from the air. Three common categories for rivers are straight, meandering, and braided, with the fourth category, anastomosed, making its way into the literature in the 1980s (Bridge, 2003). In the Central Platte River, meandering, anastomosed, and braided conditions are commonly seen:

- A **meandering** river is often a single, deep, and narrow channel which follows a sinusoidal pattern.
- An **anastomosed** channel has multiple narrow and deep channels separated by vegetated islands. The channels of an anastomosed plan form can remain relatively straight or develop meanders.
- A **braided** river has a single channel at high flow but can divide into multiple sinusoidal patterns at low flows. The braided river is wide and shallow and is an efficient transporter of sediment. A braided condition generally has a wide, single channel with the largest width to depth ratio of the four classifications. This plan form is also typified by multiple in-channel sandbars.

The descriptor "anabranched" is also used to describe plan form but is not commonly used as a classification. An anabranched river has multiple or split channels but, unlike anastomosed channel, the dividing islands or sandbars do not have to be vegetated. An anastomosed river is always anabranched, but an anabranched river is not always anastomosed. The multiple channels of a braided river at low flow are also anabranched, and a meandering river can be anabranched at a specific location if flows split around sandbars or an island.

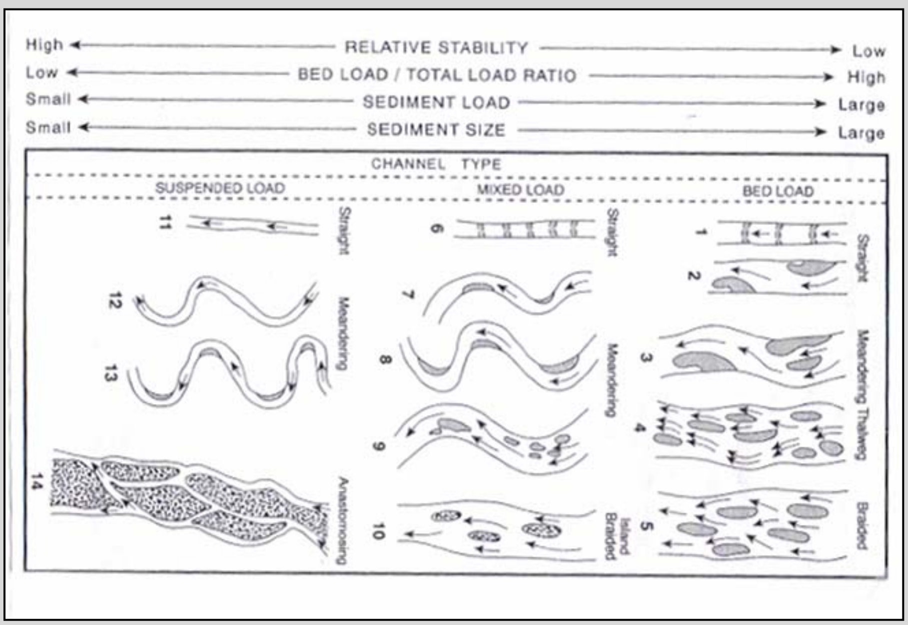


Figure a.—Schumm's classification of channel pattern reflecting processes, as presented by Knighton (1998).

Reproduced from David Knighton, *Fluvial Forms and Processes, Revised edition* (Arnold, 1998),

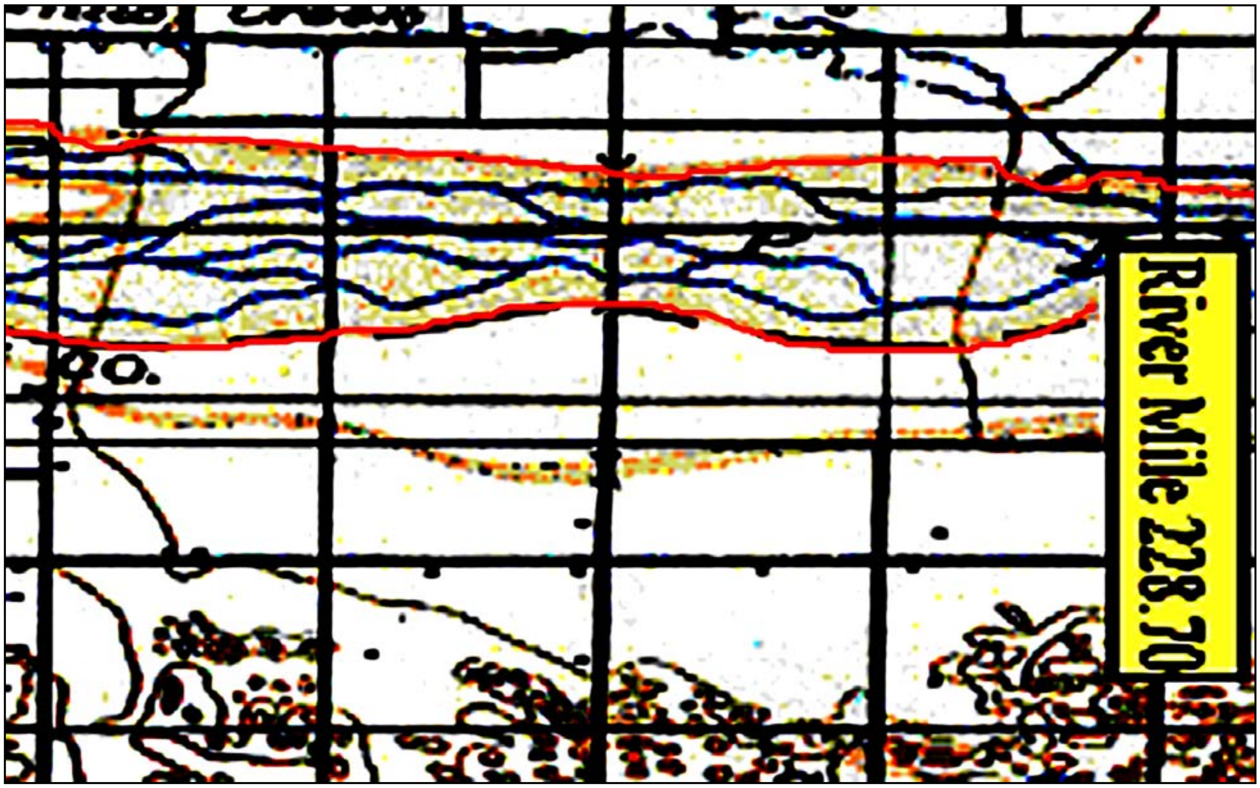


Figure 2-15.—Portion of the USGS topographic map of the Central Platte River near Kearney, Nebraska, from 1896.[9]

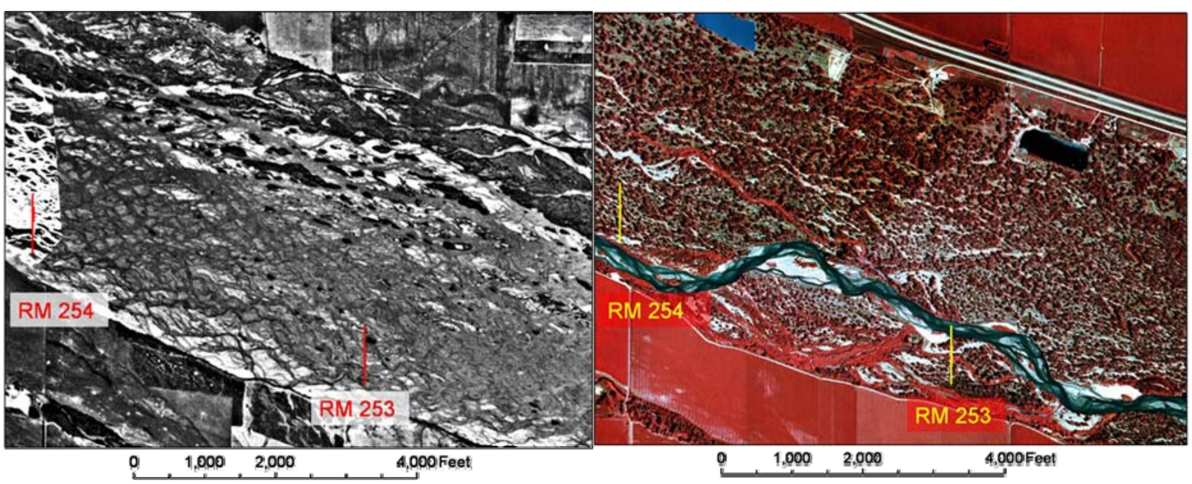


Figure 2-16.—The 1938 river (on the left) is still a wide and shallow braided channel. By 1998 (on right), the channel has evolved to a single, narrow, meander plan form.[10]

[9]One square equals 1 mile. The stipled areas between the added red lines denote locations of bare sand.

[10]Red or yellow lines depict river mile marker.

The plan form between Overton, Nebraska, and the island reach downstream of Kearney, Nebraska, has generally evolved from braided to anastomosed, as illustrated in figure 2-17. With an anastomosed plan form, side channels tend to meander while the main channels can remain braided if sufficient flow remains in the main channel. Within this second reach, there is also a braided section downstream of Elm Creek in 1998. The third reach that begins downstream of Kearney and continues to Grand Island was generally braided in 1900 and 1938, but in 1998 may braid or anastomose. In the downstream reach from Grand Island to Chapman, the river in 1998 alternates between braided and anastomosed reaches.

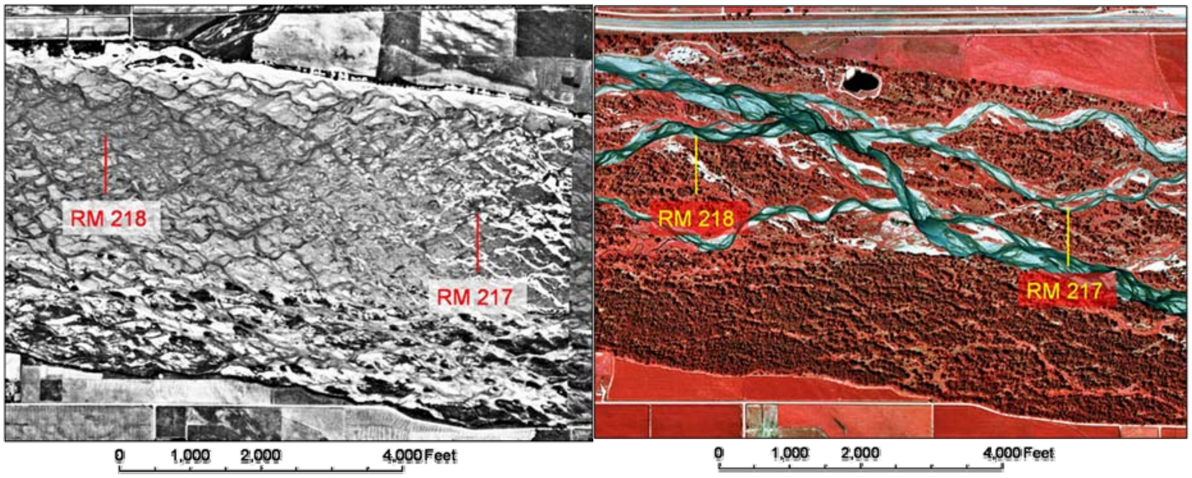


Figure 2-17.—A single braided channel under 1938 conditions (on left) and anastomosed under the Present Condition with multiple channels separated by vegetated islands.[11]

In 1900 and 1938, the river was predominantly braided between Gothenburg and Chapman, Nebraska; by 1998, the upstream reach meandered; the reach from Overton, Nebraska, to downstream of Kearney, Nebraska, was predominantly anastomosed; and the remaining two downstream reaches were mixed with braided and anastomosed channel (table 2-10, "Plan Form Classification of the Central Platte River in 1896 to 1902, 1938, and 1998"). An understanding of the processes that have altered these changes in plan form is an aid to determining methods for enhancing the current habitat. The main factors identified as instigating change and controlling plan form in the Central Platte River are:

- ➢ Water flows (flow regime)
- ➢ Topographic influences
- ➢ Sediment (sediment regime)

Flow Impacts on Channel and Plan Form

Prior to 1938, most of the flow in the Central Platte River originated from the North Platte River, and the South Platte River was a lesser, but still significant, source of flow. Downstream of the confluence of the North and South Platte Rivers, there were small increases in flow from tributaries such as Pawnee Creek, Spring Creek, Buffalo Creek, Plum Creek, and Elm Creek, Nebraska, discharging primarily in the summer. The mean annual flow at North Platte, Nebraska, was approximately equivalent to the mean

[11]Red or yellow lines depict river mile marker.

annual flow at Overton, Nebraska, and approximately equal to the mean annual flow at Grand Island (figure 2-18), with small flow increases from groundwater seepage between the confluence of the North and South Platte Rivers and the present-day town of Cozad, Nebraska, and some flow lost to groundwater seepage between the present day towns of Cozad and Chapman, Nebraska (Lugn and Wenzil, 1938). Large peak flows occurred in the late spring from snowmelt (figure 2-10).

The construction of large water resource projects in the 20th century (figure 2-9) reduced both mean annual flows and 1.5-year peak flows (figure 2-18 and figure 2-19). The 1970 to 1999 mean annual flows of the Platte River upstream from Jeffrey Island near Overton, Nebraska (as represented by Cozad, Nebraska, values), are just over one-fourth of the mean annual flows at the start of the 20th century (Randle and Samad, 2003). At Overton, Nebraska, just downstream of the Jeffrey Island confluence, the mean annual flows of the Central Platte River are described by Simons and Associates (2000) as one-half of the mean annual flows occurring at the beginning of the 20th century. The decade around the year 1900 was a wetter than normal climate period (Murphy et al., 2004). A less extreme wet period occurred in the decade of the 1990s, which included year 1998. The 1.5-year peak flows, under the Present Condition, at Overton and Grand Island, Nebraska, have been reduced to one-third of 1895-1909 flows, and reduced to one-eighth of these flows at
Cozad, Nebraska.

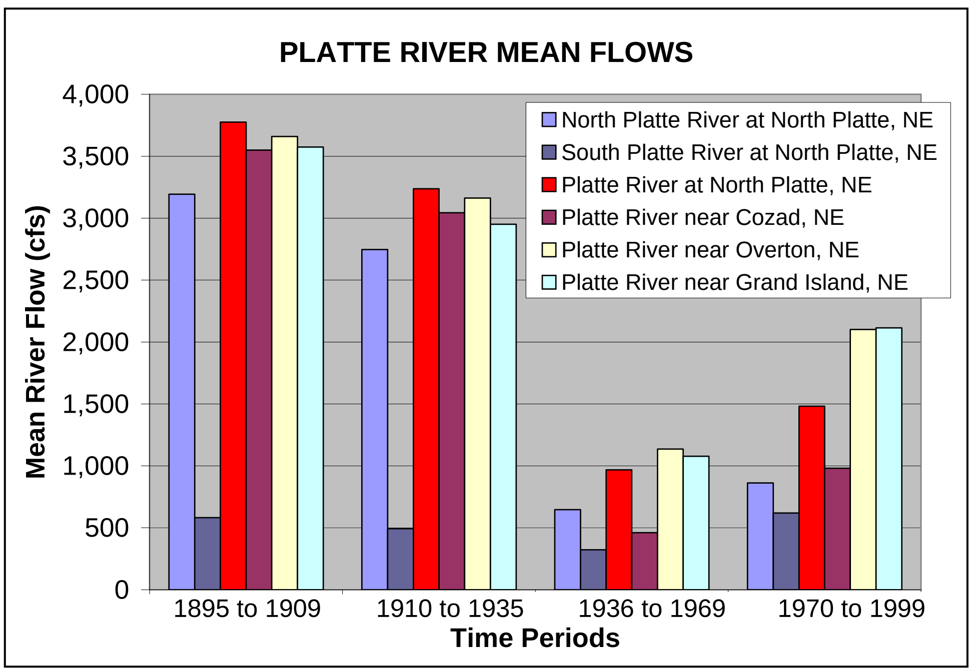


Figure 2-18.—Platte River mean flows.[12]

[12]Source: Randle and Samad (2003).

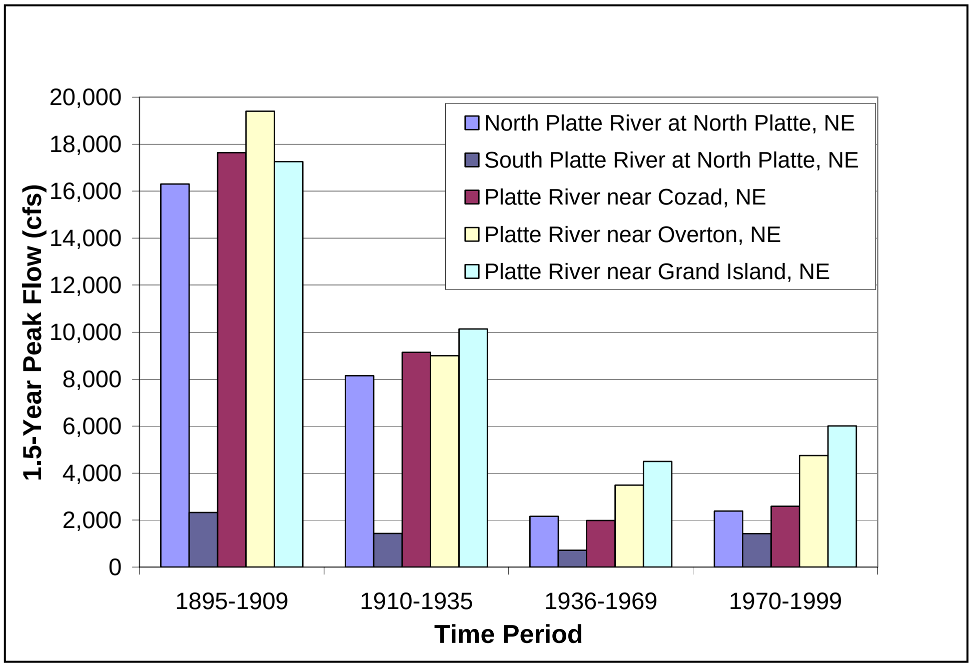


Figure 2-19.—Platte River 1.5-year peak flows.[13]

The greater reduction in flows upstream of Overton, Nebraska, is due to the Tri-County Supply Canal, which began operation in 1941. The Tri-County Supply Canal flows are used for irrigation and hydropower generation. Approximately half the flows diverted from the river at North Platte, Nebraska, and conveyed in the canal parallel to the river, are discharged 61 miles downstream via the Johnson-2 Return to the south channel of Jeffrey Island. Downstream of Jeffrey Island, approximately one-half the mean annual flow at Overton, Nebraska, is from the upstream river, and one-half is from the Tri-County Supply Canal. See figure 2-8 in the "History of Land and Water Development" section in this chapter.

By 1938, the year the aerial black and white photographs were taken, two major dams on the North Platte River, Pathfinder (1909) and Guernsey (1928), had been built, with Alcova (1938), Seminoe (1939), Kingsley (1941), and Glendo (1958) not yet impacting channel morphology (figure 2-9). The Tri-County Supply Canal was under construction but did not begin operation until 1941.

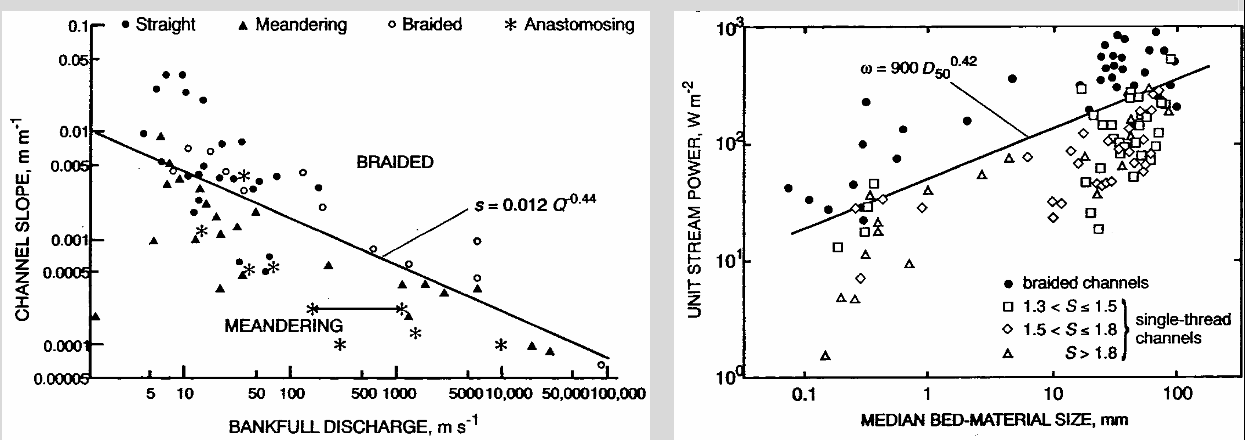
A braided river requires more stream power than a meandering or anastomosed river. As shown in sidebar 2-2, "Stream Power and Plan Form," if the flow reduction is sufficient to cross a threshold, channel plan form will evolve to the more narrow and deep channels of a meandering or anastomosed river. Between Gothenburg and Overton, Nebraska, the change in plan form after 1938 is primarily a consequence of significant flow reduction (see table 2-10, "Plan Form Classification of the Central Platte River in 1896 to 1902, 1938, and 1998"). The current flows, that are one-fourth of mean annual flows in 1900, do not retain sufficient stream power at the existing slope to support a wide braided plan form.

[13]Source: Randle and Samad (2003).

Sidebar 2-2.—Stream Power and Plan Form

Leopold and Wolman (1957) presented the concept of continuum of channel pattern, which demonstrates that channels braid at high stream power (a factor of discharge Q and slope So) and meander at lower stream power (figures a and b). Secondary factors influencing channel plan form were identified in later studies and include the sediment load and grain size, and the stability of the bank (Bridge, 2003). These factors tend to obscure or shift the divide as shown in figure a between a braided and a meandering channel. The anastomosed plan form, where flow has divided into multiple channels separated by vegetated islands, most often has lower stream power similar to a meandering plan form, but it can also occur under conditions of higher stream power (Knighton, 1998).

When flow splits into the separate channels of an anastomosed plan form, the stream power in individual channels is reduced. Flow splits and anastomosed plan forms are undesirable to the Program because an anastomosed channel is narrow and deep, as indicated by a smaller width to depth ratio, and it does not match preferred habitat for whooping crane, interior least tern, and piping plover. If the river is transporting a full load of sediment and the bed slope does not change, the threshold for braiding occurs at a lower flow rate. If the bed slope of the river is reduced, a higher flow rate is needed before a braided river can develop. When there is a shortage of sediment, the anastomosed plan form has less tendency to change since channel avulsions, abrupt realignments due to aggradation, are less likely to occur.



Figures a and b.—Anastomosed channels in relation to braided and meandering plan forms as considered with respect to channel slope and bankfull discharge, after Leopold and Wolman (1957) (figure a), and as considered with respect to unit stream power and median bed-material grain size (figure b), after van den Berg, 1995 (Knighton, 1998).

Sediment Impacts on Channel and Plan Form

The sediment transport values shown in table 2-11 were calculated by Randle and Samad (2003) using flows reported in figures 2-18 and 2-19, and sediment rating curves by Simons and Associates (2000) and Kircher (1983). In 1900, predating major reservoirs or construction of the Tri-County Canal, sediment transported from the main tributaries, the North and South Platte Rivers, was the primary sediment source to the Central Platte River (Murphy et al., 2004). Tributaries including Plum Creek, Spring Creek, Elm Creek, North Dry Creek, and Dry Creek introduced additional sediment, but the volume of tributary sediment estimated from the Universal Soil Loss Equation is less than 15 percent of the total sediment budget today. In 1900, the percent would be less than half that value, making tributary contributions of sediment relatively small with respect to sediment loads carried downstream during spring snowmelt flows. The persistence of this sediment balance over time is supported by the consistent channel gradient from North Platte to Chapman, Nebraska (Gannett, 1901).

Table 2-11.—Platte River Average Annual Sediment Loads

Platte River Stream Gauge Location	Average Annual Sediment Load for Each Time Period (Tons Per Year)			
	1895 to 1909	1910 to 1935	1936 to 1969	1970 to 1999
From Randle and Samad (2003), based on sediment discharge equations by Simons and Associates (2000)				
Platte River at North Platte, Nebraska	1,530,000	1,380,000	500,000	812,000
Platte River Near Cozad, Nebraska	1,730,000	1,300,000	132,000	396,000
Platte River Near Overton, Nebraska	1,810,000	1,380,000	347,000	817,000
Platte River Near Grand Island, Nebraska	1,670,000	1,270,005	381,000	845,000
From Randle and Samad (2003), based on sediment discharge equations by Kircher (1983)				
Platte River at North Platte, Nebraska	2,130,000	1,670,000	365,000	680,000
Platte River Near Cozad, Nebraska	1,540,000	1,190,000	126,000	361,000
Platte River Near Overton, Nebraska	1,600,000	1,260,000	335,000	760,000
Platte River Near Grand Island, Nebraska	1,680,000	1,250,000	365,000	826,000

Degradation

By 1998, sediment transport had been reduced between North Plate and Overton, Nebraska, due to the one-half reduction in flow. In table 2-11, the Cozad, Nebraska, value represents the sediment load transported by flows remaining in the Central Platte River and presumably conveyed to the Central Platte Habitat Area. The Tri-County Supply Canal discharges flow 61 miles downstream at the Johnson-2 Return in the south channel at Jeffrey Island. Canal flow discharged at the Johnson-2 Return, just upstream of Overton, Nebraska, brings almost no sediment into the river due to the low sediment transport rate of the canal, erosion resistant canal linings, and passage of canal flow through storage areas that settle out sediment. Although the canal discharge is relatively sediment free, it has the capacity to transport a sediment load similar to flows in the north channel of Jeffrey Island. As a result, a sediment imbalance is created in the Central Platte River, and erosion of the bed and banks of the channel begin directly at the discharge of the Johnson-2 Return. In 1900, sediment to the Central Platte River was predominantly supplied by upstream flows. More recently, however, it can be seen from table 2-11 that the river transports 410,000 more tons of sediment at Overton, Nebraska, than have been supplied by upstream flows from Cozad, Nebraska.

Repeat surveys of the Central Platte River by Reclamation, between 1985 and 2005, show a continuing trend of riverbed degradation beginning at the clear water return flows of the Johnson-2 Return and continuing downstream beyond Elm Creek (Holburn et al., 2006). One cross section from Murphy et al. (2004) is shown in figure 2-20. Over a recent period of 13 to 18 years, degradation ranges from approximately 6 feet near the Johnson-2 Return to 1 foot nearly 18 miles downstream. Photographs showing the high banks of the incised south channel at Jeffrey Island can be seen in figures 2-21 and 2-22.

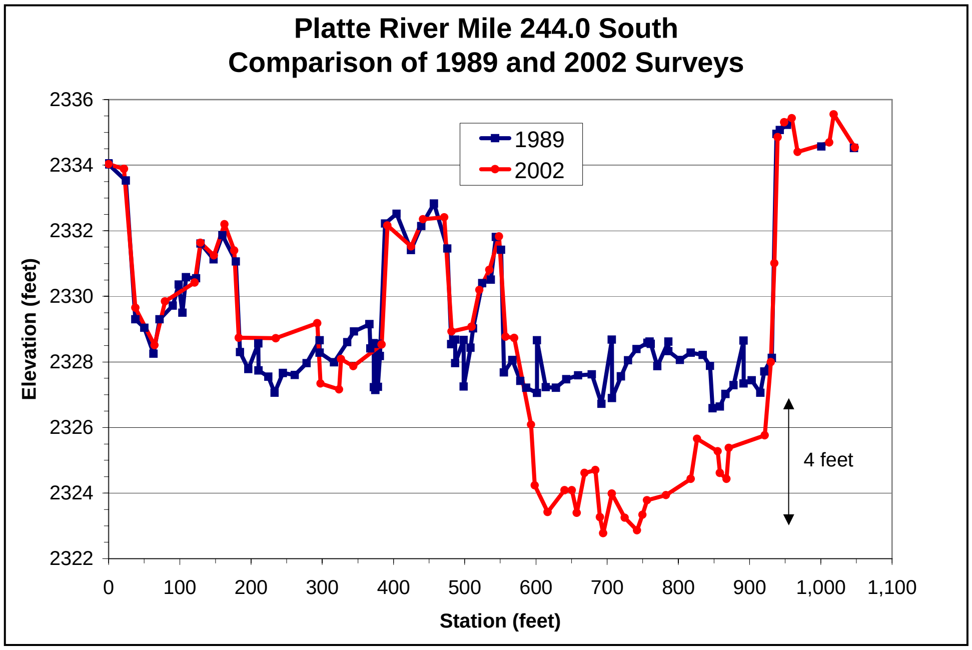


Figure 2-20.—Comparison of 1989 and 2002 Platte River channel cross section surveys at river mile 244.0 in the south channel of Jeffrey Island

Figure 2-21.—Views of the high banks of the incised south channel at Jeffrey Island, at river mile 246.5, looking upstream.[14]

[14]Surveyor's plate shows exact location.

Figure 2-22.—Views of the high banks of the incised south channel at Jeffrey Island, at river mile 245, looking upstream.

A comparison of the north and south channel cross sections at Jeffrey Island is shown in figure 2-23 (Murphy et al., 2004). Flows in the south channel at Jeffrey Island originate from the Johnson-2 Return and are relatively sediment free and erosive. Flows in the north channel are Platte River flows that convey bedload from upstream. Degradation from the Johnson-2 Return was increased in the south channel by construction of a dike by a local landowner across the upstream inlet to the south channel. If the dike was not present, less degradation would be evident in the south channel, but that lesser measure of degradation would have translated upstream towards Lexington, Nebraska. The measured difference in bed elevation of 13 feet between the north and south channels (figure 2-23) indicates degradation has occurred since both operation of the Johnson-2 Return and construction of the Jeffrey Island dike. At the time of the 2002 channel survey, the thalweg of the south channel had degraded 13.3 feet lower than the thalweg of the north channel.

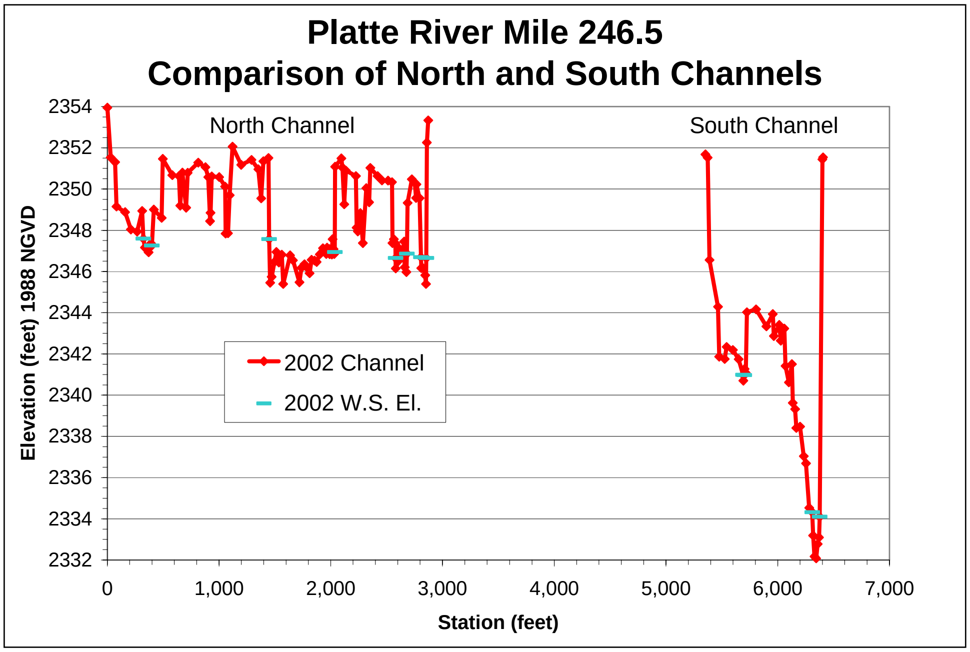


Figure 2-23.—A survey from 2002 of the Platte River, at river mile 246.5, comparing the cross sections of the north and south channels at Jeffrey Island, immediately downstream of the Johnson-2 Return Canal.

In table 2-11, the sediment imbalance persists only to Overton, Nebraska. A more detailed summary of sediment transport is presented in the "River Geomorphology" section in chapter 4 and shows the sediment deficit persisting downstream of Elm Creek, Nebraska (Holburn et al., 2006). By the time flows reach Kearney, the deficit appears to have been eliminated by sediment eroded from the bed and banks and from some tributary inputs of sand. However, this process of erosion has generally altered channel shape and plan form to more narrow and deep anastomosed channels.

The immediate effect of a reduction in width-to-depth ratio in reaches of the Central Platte River is a reduction in open view width or unvegetated width of the river, and a lowered water table in areas in the vicinity of the channel. Reducing water surface elevation of the channel increases drainage from sloughs and removes wet meadow areas from the influence of fluctuating water levels in the river. Existing mid-channel sandbars, or sandbars along the banks of the river that are no longer inundated, now support the growth of vegetation. If these vegetated surfaces increase elevation due to sediment deposition at high flows, the feature shifts to coverage by dryland communities of plants as opposed to supporting wetland plant communities.

Figure 2-24 illustrates the differences of mean annual flow, sediment load, and river configuration between periods 1895 to 1909 and 1970 to 1999. These periods are selected to correspond to available mapping from 1896 to 1902 and to aerial photography from 1998 for assessing plan form change and processes (table 2-10, "Plan Form Classification of the Central Platte River in 1896 to 1902, 1938, and 1998"). The period 1895 to 1909 is a wetter climatic period and predates large reservoir construction and operation of the Tri-County Canal and Johnson-2 Return (Murphy et al., 2004). Tan shading on the river represents riverflows transporting sediment near capacity. Blue shading on the river represents clear waterflows. Blue/tan shading denotes reaches gaining sediment from erosion of bed and banks and from tributaries. The width of the river indicates mean annual flow based on values from the periods 1895 to 1909 and 1970 to 1999 (Randle and Samad, 2003). These periods were selected to correspond with the USGS topographic maps (1896 to 1902) and the maps of infra-red aerial photography (1998).

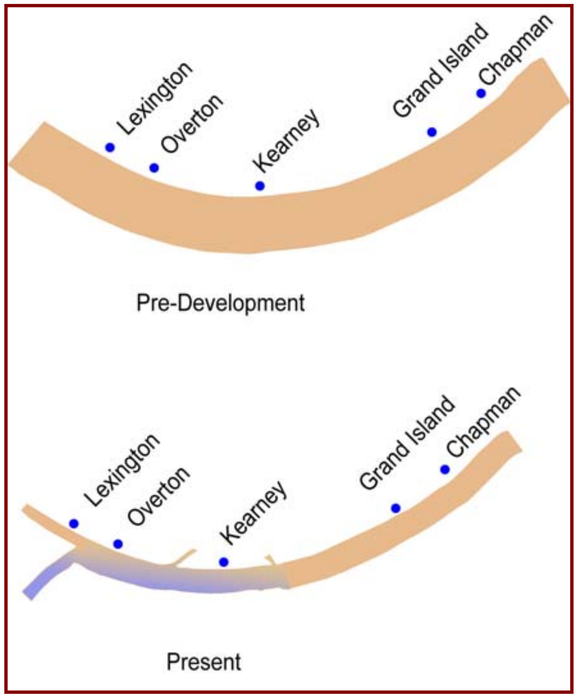


Figure 2-24.—Representation of changes to flow and sediment in the Central Platte River between the periods 1895 and 1909, and 1970 and 1999 (Randle and Samad, 2003).

Aggradation

Downstream of Kearney, an aggrading trend has been noted between river miles 204 and 191 (Holburn et al., 2006). This reach contains more frequent occurrence of a braided plan form in 1998 (table 2-10, "Plan Form Classification of the Central Platte River in 1896 to 1902, 1938, and 1998"). The sediment transport capacity of the river drops in this reach, and some of the transported sediment settles on the bed of the river. Deposition generally produces more wide and shallow reaches of river and supports the development of sandbars. See sidebar 2-3, "Changes to Sediment Transport Near North Platte, Nebraska" for a description of a second location of significant aggradation at North Platte, Nebraska, upstream of the Central Platte Habitat Area.

Sidebar 2-3.—Changes to Sediment Transport Near North Platte, Nebraska

Disruptions in sediment transport also occur upstream of the Central Platte Habitat Area.

The trapping of sediment in Lake McConaughy and the clear water releases to the downstream river channel have resulted in 12 feet of channel degradation immediately downstream from the Keystone Diversion Dam (Murphy et al., 2004). In contrast, the riverbed has aggraded further downstream, in the reach where the North Platte River passes the city of North Platte, Nebraska (J.F. Sato and Associates, 2005). Where the flow rate or velocity of the river is diminished, sediment is deposited in the channels, and the flow that the channel can carry is reduced. The channel degradation below the dam and the local rainstorms along 58 river miles both contribute sediment to the downstream reach where aggradation occurs near North Platte, Nebraska. With no large, high flow events to flush sediment through, the deposition accumulates.

During the period 1895 to 1909, annual peak flows of 10,000 to 15,000 cfs were common (figure 2-10). Following construction of upstream dams and the Sutherland Canal, annual peak flows were usually below 3,000 cfs and have only exceeded 4,500 cfs four times since Lake McConaughy was constructed. Figure a shows the water surface elevation of riverflows at North Platte, Nebraska. For a given flow rate, this water surface elevation has been increasing over time causing more frequent out-of-bank flooding. High flows in 1971 and 1983 scoured out some of the riverbed, temporarily increasing the channel conveyance capacity at this gauge, but subsequent deposition has continued the trend toward reduced capacity (J.F. Sato and Associates, 2005). In similar fashion, Reclamation surveys at four locations in 1989 and 1998 have documented riverbed aggradation downstream from the Tri-County Diversion Dam (Holburn et al, 2006).

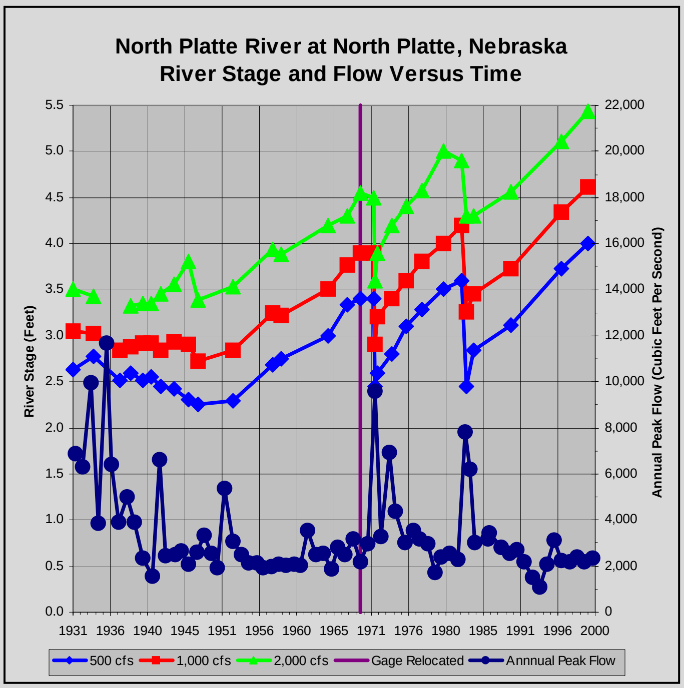


Figure a.—The stage (water surface elevation) of riverflows in the North Platte River at North Platte, Nebraska, has been increasing over time for the same volume of flow.

Reduced Slope and Coarser Grain Size

Due to degradation, the channel bed slope in Reach 2 at the Johnson-2 Return Canal (RM 247) is 0.0008 foot per foot and transitions to 0.0012 foot per foot at Overton, Nebraska (see the *River Geomorphology Appendix* in volume 3). Downstream of Reach 2 and Overton, Nebraska, the slope of the

Central Platte River is generally 0.0012 foot per foot. A reduction in slope equates to a reduction in the stream power of the river. As discussed in sidebar 2-2, "Stream Power and Plan Form," a meander plan form is prevalent at flatter slopes, while a braided plan form occurs with steeper slopes. As shown in the 1998 infra-red aerial in figure 2-25, the north channel of Jeffrey Island has the pronounced bends of a meandering river. The south channel of Jeffrey Island transitions from the pronounced bends of a meandering river at the Johnson-2 Return (RM 247) to the multiple channels of an anastomosed plan form and some braiding as both sediment transport and slope increase near the downstream end of Jeffrey Island.

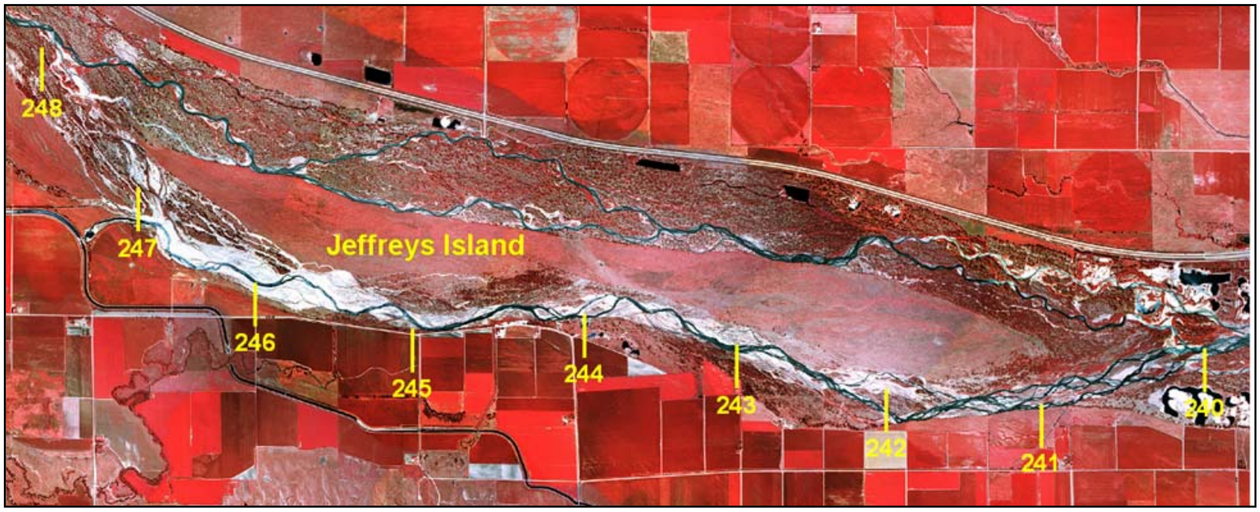


Figure 2-25.—The north and south channel of Jeffrey Island.

In degrading reaches, the rate of bed erosion can eventually slow if the slope of the riverbed flattens or if the armoring process builds a protective surface of course grains on the riverbed. Armoring occurs when the smaller particles of the riverbed are removed by flows, leaving larger particles behind to protect the surface from further erosion. Concurrently, the cross section of the river evolves to a narrower, deeper channel, characterized by a smaller width to depth ratio, which increases the erosive effect of the flow. Armoring continues until the river cross section and the river grain size reach a form consistent with the flow and sediment conditions. The process of armoring is undesirable in the Platte River because a coarser bed grain size does not support a channel geometry that is as wide as the channel geometry supported by a finer grain size.

Bed material data were collected from the Platte River channel near bridges in 1931 and 1980 and along the river (at bridges and between bridges) in 1989. Data from three sets of bedload samples, including 1931 data from the U.S. Army Corps of Engineers (1935), 1979-80 data from Kircher (1983), and unpublished Reclamation data from 1989 are shown in figure 2-26. These samples demonstrate the changes that have occurred in median grain size. The coarsest grain size and largest change in median grain size can be found in the river upstream of Overton, Nebraska. The median grain size decreases downstream of Overton, Nebraska, which generally indicates the occurrence of less erosive conditions.

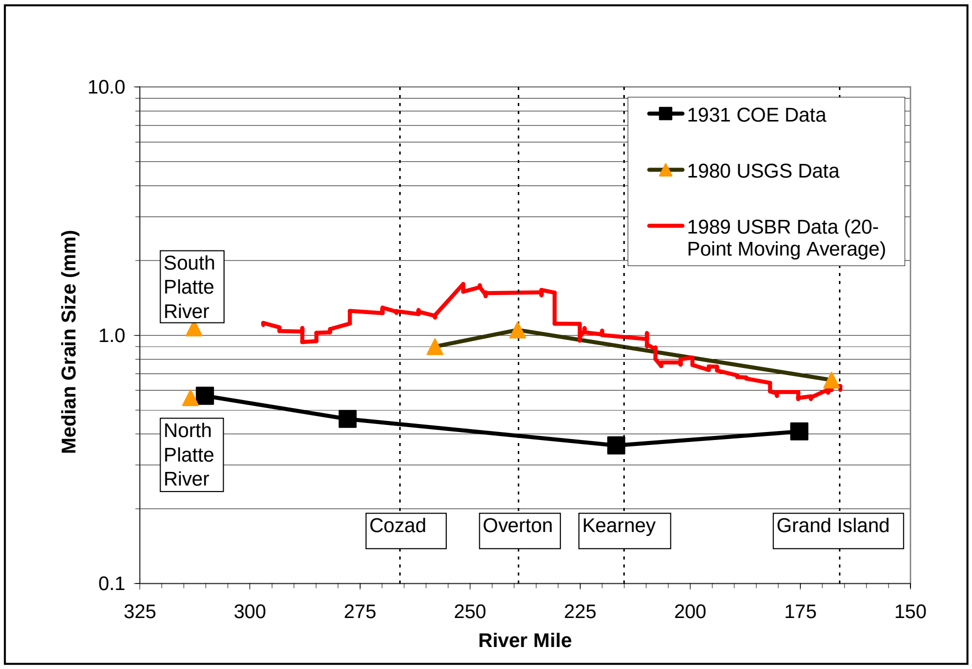


Figure 2-26.—Median bed-material grain size comparisons between 1931, 1980, and 1989.

A USGS report (Chen et al., 1999) also reports reaches of bed degradation in the Central Platte River. The report indicates channel deepening, and coarsening of the bed-material grain size, for the Central Platte River at Cozad, Odessa, and Grand Island, Nebraska, between the years 1913 to 1995. The coarsening of the channel grain size decreases with distance downstream from Jeffrey Island.

Topography Impacts on Channel and Plan Form

Between the cities of Gothenburg and Lexington, the change in river plan form is primarily due to reductions in flow and flow diversions to the Tri-County Canal. Downstream of Lexington, river plan form has also been impacted by an interruption in the supply of sediment from operation of the Tri-County Supply Canal and the Johnson-2 Return beginning in 1941. With the reduction in flows and alteration of sediment transport since the aerial photographs were taken in 1938, topography has had an increasing impact on the plan form (table 2-10, "Plan Form Classification of the Central Platte River in 1896 to 1902, 1938, and 1998"), most notably downstream of Overton, Nebraska. As used here, topography encompasses both natural features and features constructed by man, including bridge crossings, levees, and riverbank revetments.

Figure 2-27 shows the impact of natural topography on the present plan form. The large sandbar of pre-1938 flows (left) becomes vegetated and confines 1998 flows (right) to a braided channel on the south side of the river. The sandbar becomes a remnant. Downstream of this remnant sandbar, the single channel of a braided plan form unravels into multiple channels of an anastomosed plan form by 1998. Old braid scars in the flood plain of the pre-1938 river now divert flows into multiple small channels separated by vegetated islands. Figure 2-17 shows a similar phenomenon at RM 217-218, with a remnant sandbar confining flows to the north side of the river by 1998. Unlike conditions at RM 190-191 (figure 2-27), the sandbar in RM 217-218 is not sufficient to confine 1998 flows to a single channel and an anastomosed plan form persists at this location despite the remnant sandbar.

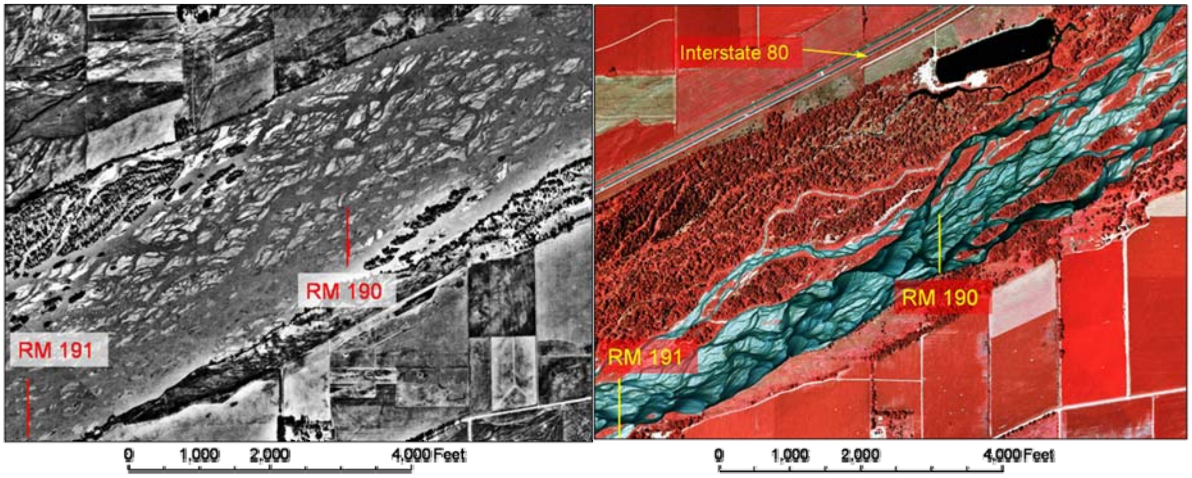


Figure 2-27.—Old (1938) and new (1998) photographs showing the impact of natural topography on the plan form of the river. Red or yellow lines are 1 mile long.

Bridges constructed over the Central Platte River, and riprap levees protecting gravel mining operations, ponds, and housing developments, until recently were viewed as causes of channel narrowing. The 1938 photograph in figure 2-28 illustrates how bridges could constrict the Platte River, causing a deeper (as assumed from darker shading in photograph) and more narrow channel in the vicinity of the bridge. However, it is now understood that after the reduction in flows from pre-1938 conditions, the bridges can have an opposite effect. Bridges and levees reduce the width of the remnant flood plain of pre-1938 flows (river corridor) and help to consolidate the multiple channels of an anastomosed plan form. The old bridge at the higher flows of 1938 caused a constriction of flow. In 1998, the bridge abutments consolidate flow to maintain a wide, shallow channel under current flow conditions. As shown in the 1998 photograph of figure 2-28, the multiple anastomosed channels upstream of Kearney are diverted back towards the main channel by riprap banks and bridge abutment. The consolidation of flow increases stream power (see sidebar 2-2, "Stream Power and Plan Form"), and the resulting single channel has the wide, shallow form of a braided river for a short distance downstream.

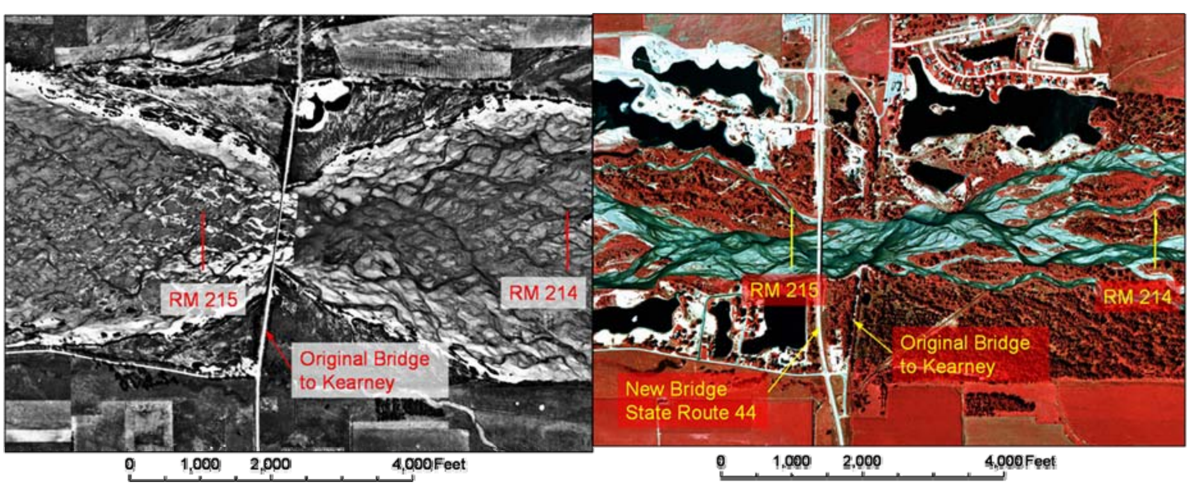


Figure 2-28.—Old (1938) and new (1998) Kearney, Nebraska, bridge. Red or yellow lines depict river mile marker.

The Platte River is braided when the width of the pre-1938 flood plain (the river corridor) is reduced by natural or manmade features. The braided plan form provides the wide, shallow river and sandbars preferred by roosting whooping cranes and nesting interior least terns and piping plovers. When the river corridor is wide and unrestricted, the main river unravels into multiple small channels of an anastomosed plan form. An anastomosed channel generally does not provide the desired habitat of wide, shallow river and protruding mid-channel sandbars.

In summary, flow regime appears to be generally responsible for plan form change from Gothenburg downstream to the north channel of Jeffrey Island, while in the south channel of Jeffrey Island upstream of Overton, Nebraska, the sediment regime has driven plan form changes. In the second reach between Overton and Kearney, Nebraska, both sediment regime and topography have had a significant impact. Finally, under the Present Condition of flow and sediment transport, topography determines the plan form of the river in the two study reaches beginning downstream of Kearney and ending at Chapman. The plan form in these reaches alternates between braided and anastomosed river depending on natural features and features constructed by man.

EXPANSION OF VEGETATION INTO THE RIVER FLOOD PLAIN

The extent of vegetation in the river channel affects the quality of habitat for the whooping crane, piping plover, and interior least tern. The historic Platte River, as a braided, sandbed river subject to high spring floods, contained very extensive areas of open, unvegetated channel, with numerous sandbars becoming exposed as spring floods receded. As described in the National Research Council Report, *Endangered and Threatened Species of the Platte River*:[15]

> *"The active channel of the river was generally without vegetation except during summer low-flow conditions, when annual plants colonized portions of the exposed bed. Although the stream was not normally more than a foot deep (except during floods), its current was swift, and the unstable sandy sediments were not a suitable substrate for vegetation.*
>
> *"During the presettlement period, the outer banks of the central Platte River marking the general limits of fluvial activity were apparently the locations of cottonwood-dominated woodlands, with trees growing in isolation from each other or in limited groves. Accounts of surveyors and travelers usually described the trees on the banks as scattered, sparse, or absent in some cases from the outer, high banks of the river. Cottonwoods along the banks were often in a broken line of trees."*
>
> (National Research Council, 2005)

Early survey maps of the river show most areas of the Central Platte River as more than 1 mile wide, with very few islands (USGS, 1896-1902). According to travelers' journals, numerous small wooded islands dotted the wide river channels, but the area of those islands is not precisely known (Kellogg, 1905; Slichter and Wolff, 1906; Currier and Stubbendieck, 1985; and Johnson and Boettcher, 2000). Johnson (1994) found a detailed survey of the river channel at Fort McPherson, which showed roughly 12 percent of channel width occupied by islands. As many have noted, islands seemed to have been less numerous in the upper reaches (see, for example, the photograph in figure 2-4 in the "History of Land and Water

[15]See the "Conclusions and Recommendations" section of this report (National Research Council, 2005) in volume 2.

Development" section in this chapter) and more numerous in the lower reaches. A conservative estimate, therefore, would be that roughly 80 to 85 percent of the historic river channel was active channel free of permanent vegetation.

Permanent vegetation and woodland began to expand into the Central Platte River in the early 1900s. By 1938 (the date of first aerial photographs), Johnson (1994) concludes that only 53 percent of the channel area remained unvegetated from Brady to Wood River, Nebraska, on average. The Environmental Impact Statement (EIS) Team has analyzed the 1938 and 1998 aerial photographs of the Central Platte Habitat Area using the Geographic Information System (GIS) database and reached a similar conclusion. Of the historic river channel area (high bank to high bank), roughly 50 percent of this area had become vegetated by 1938. From Lexington to Grand Island, Nebraska, roughly 27,000 acres of unvegetated channel remained.

Johnson (1994) found that from 1938 to 1986, on average, an additional 50 percent of open channel area was lost in the Central Platte River between Overton and Shelton, Nebraska (Johnson, 1994, figure 8). The EIS Team's analysis indicates that from 1938 to 1998, the unvegetated portion of the channel between Lexington and Grand Island had been reduced to roughly 9,500 acres, an additional 65 percent loss.

Perhaps more importantly, the areas of open channel with significant, unobstructed view declined even more precipitously. Areas with open view greater than 750 feet in width declined by more than 90 percent; areas greater than 1,000 feet declined by more than 97 percent (see the *Land and GIS Appendix* in volume 3 for details). These changes can be seen in figure 2-29, based on aerial photographs of the river channel near Kearney, Nebraska, taken in 1938, 1969, and 1982. Today, dense vegetation and forest occupy from 72 to 91 percent of the pre-1900s channel area (Simons and Associates, 2000).

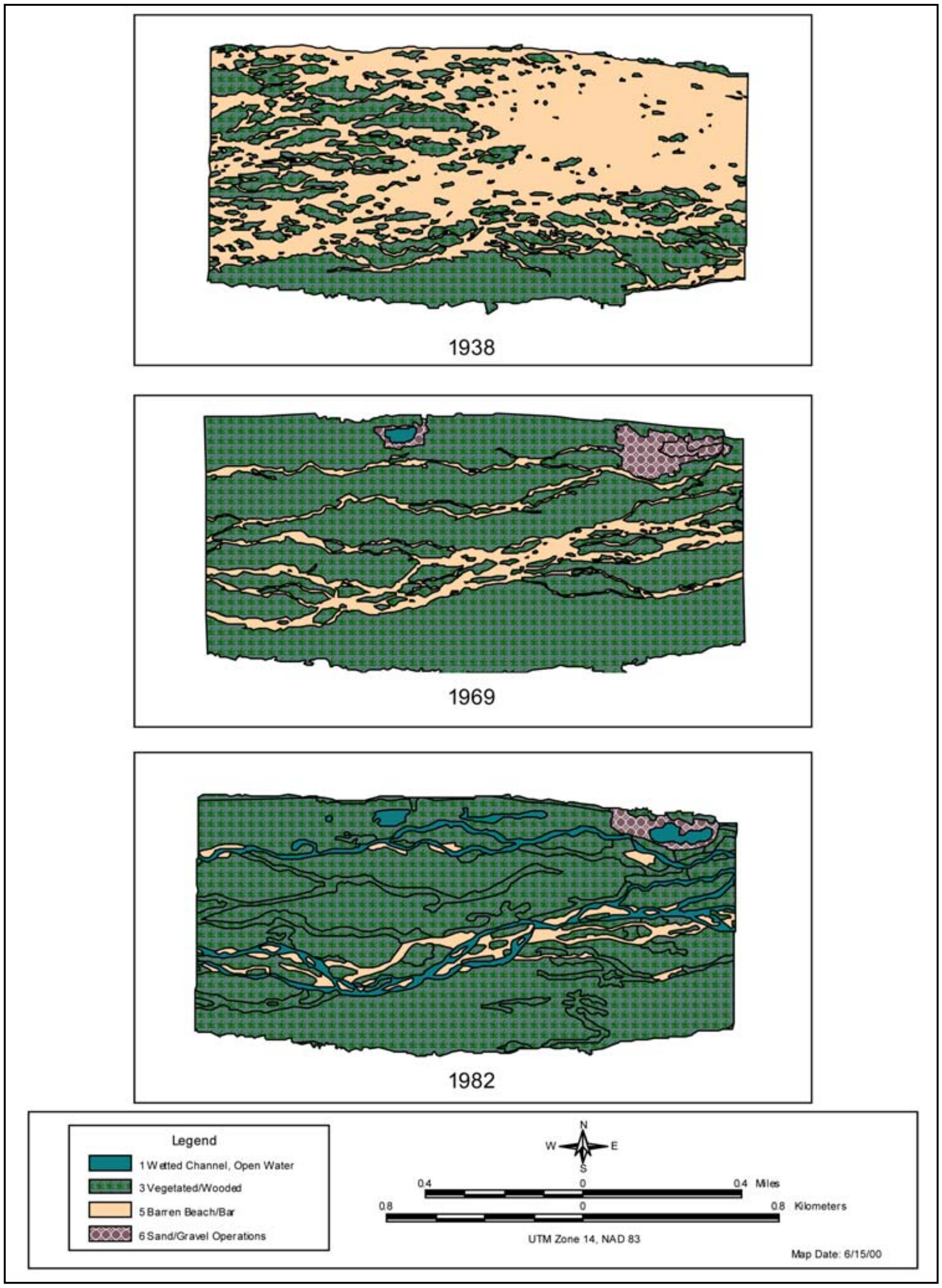


Figure 2-29.—GIS maps, based on aerial photographs, showing encroachment of vegetation into the historic Platte River channel near Kearney, Nebraska.

Johnson (1994) summarized these changes:

> *"Although a frequent response of western rivers to flow alteration has been a decline in pioneer Populus [cottonwood] forests, the opposite has occurred in the central Great Plains along developed rivers such as the Platte and the Arkansas. For example, the Platte, South Platte, and North Platte rivers have been transformed from*

> *sparsely wooded pre-settlement conditions with wide, unvegetated channels to a modern condition with extensive Populus-Salix [cottonwood-willow] woodlands lining much narrowed channels."*
>
> (Johnson, 1994)

When investigating the causes of woodland expansion into the historic Platte River channel, Johnson (1994) concluded that, "*low June flows in the developed river, caused by upstream storage and diversion of water for agriculture, have allowed extensive plant recruitment and a buildup of tree populations in the formerly active channels of the Platte River and its two major tributarie*s." The variables Johnson found most strongly correlated with loss of open channel habitat were the reduced volume and peak of June flows.

CHANGES IN WET MEADOWS

Maps of the Platte River valley between Fort Kearney and Grand Island produced in 1847 indicate extensive wetlands, sloughs, and bayous within that area. Lieutenant Daniel Woodbury, an engineer of the U.S. Army, described the valley bottomlands near the prospective Fort Kearney site as grasslands with extensive "sloughs" and "bayous." Portions of this characterization follow:

> *"The banks of the river are very low – 5 to 7 feet – and still even the low bottom presents no appearance of being overflowed. The reason for this is readily found in the great aggregate width of the channels – nearly two miles – and in the sandy formation of the western prairies. . ..*
>
> *". . .The lower bottom bordering the river and sometimes extending back half a mile from it is marked by a heavy growth of tall grass or weeds and is soft in many places, even now when the river is at its lowest stage. It is almost everywhere avoided by the great Pawnee trail and the emigrant roads and is quite moist and soft in the spring. . ..*
>
> *". . .On the island prairies, which are either lower or of an intermediate elevation between lower and higher bottoms, and on the mainland we found a great abundance of grass. . .. The natural fertility of the lower bottoms is greatly increased by the extraordinary irrigation supplied by the river. In the spring when the snow melts upon the mountains the river is high and the water percolating freely through the sand underlying the adjacent ground renders it soft and moist in many cases to the very surface. The irrigation is gradually withdrawn in summer and fall as the harvest season approaches. In fact that season must depend much upon the irrigation and therefore vary much with the elevation of the bottom. It is therefore not surprising that we should find green grass on the Platte four weeks later than at other places. . .."*
>
> (Woodbury, 1847)

According to several sources, wetlands and wet meadows have been significantly reduced in the last 100 years (Schildman and Hurt, 1981; Currier et al., 1985; and Sidle et al., 1989). Farmers leveled and drained wetlands because spring water levels did not dissipate in time for planting. The reduction of river stage, especially springtime pulse flows, caused by cumulative water storage and diversion has facilitated land leveling, groundwater drainage, and conversion of wet meadows to row crop agriculture and other land uses. Declines in riverflows and a downcutting of the river channel in some locations have further lowered surface and groundwater levels in the river and in surrounding lands. Pumping of groundwater can also cause lowering of the groundwater levels. (See, for example, *Groundwater-Level Changes in*

Nebraska from Pre-Development to Spring 2005 (University of Nebraska, 2005). Other impacts include fragmentation by roads, suburban sprawl, and industrial development (i.e., sand and gravel mining). Interstate 80, a major interstate highway, follows the Platte River for more than 100 miles in central Nebraska. Due to the highway's construction near the river, the habitats near the river have been significantly degraded. Historically, these areas were wet meadows and slough that "*provided some of the best nesting and feeding habitat for migratory birds along the Platte River*" (Currier et al., 1985).

Currier et al. (1985) estimated native grassland and wet meadow acreage in the Central Platte River had declined 73 percent since the beginning of development. Between 1938 and 1982, wet meadow acreage along the Platte River and North Platte River valleys had declined by about 112,000 acres, or 45 percent, and exhibited a continuing downward trend (Sidle et al., 1989). By 1989, remaining parcels of wet meadows comprised 11,330 acres, or less than 5 percent, of the Central Platte River valley near the river (Sidle et al., 1989).

The effective habitat value of wet meadows remaining in many reaches of the river is further reduced because of the small size and discontinuity (fragmentation) of the parcels and potential threats from adjacent land use practices including housing developments. Larger tracts of wet meadows tend to provide a more diverse mosaic of microhabitats. Larger tracts also provide whooping cranes with the isolation and security required for feeding, loafing, and socializing activities.

Changes in Pallid Sturgeon Habitat in the Lower Platte River

Little data are available on the quality of pallid sturgeon habitat prior to water resources development in the Basin. The following describes the historic changes in the Lower Platte River for two factors known to influence habitat quality—riverflows and sediment transport.

Riverflows

The Service (2003) has estimated the degree to which depletions above the Loup River confluence have affected flows at Louisville, Nebraska (table 2-12). Large uncertainties are associated with these estimates, but they are useful as general indicators of historic change in riverflows.

Table 2-12.—Estimated Depletions to Flow at Louisville, Nebraska

		Estimated Lower Platte River Depletions From Development Above the Loup River Confluence		
	Current-Day Mean Annual Flow at Louisville (cfs)	**Acre-Feet**	**Cubic Feet Per Second**	**Percent of Total Louisville Flow**
February	7,604	118,000	2,100	22
March	11,251	76,000	1,230	10
April	10,083	107,000	1,800	15
May	9,958	294,000	4,780	32
June	11,406	365,000	6,130	35
July	6,387	68,000	1,110	15
August	4,196	35,000	570	12
September	4,343	48,000	810	16
February through July		1,028,000		23
July through September		151,000		14

This information suggests that water development above the Loup River confluence has reduced flow during the February through July timeframe by approximately 23 percent overall, and during July through September by approximately 14 percent overall.

Sediment Transport

As a result of flow reductions and reductions in peak flow events, the transport of sediment past Grand Island is estimated to have dropped by about one-half from the period 1895 to 1909, in comparison to the period 1970 to 1999 (see table 2-9, "Summary of River Channel Conditions"). The limited data available imply the sediment transport between Grand Island and Chapman is, in a large-scale analysis, relatively consistent and matches the current channel and flow conditions. The upstream imbalance in sediment transport, which is created by the Tri-County diversion and return flows, appears to be generally offset by erosion of the channel bed upstream of Grand Island. There is a concern that the sediment shortage caused by the upstream diversion will, in the future, impact the downstream reach of the Central Platte River. This translates to a concern over how future transport of sediment from the Central Platte River could affect pallid sturgeon habitat in the Lower Platte River.

TARGET SPECIES—POPULATION TRENDS

The changes in the Central Platte River reach, resulting from development of water projects and other activities in the Basin, have led to substantial loss of roosting and foraging habitat for the whooping crane and nesting and foraging habitat for the piping plover and interior least tern. It is also believed that these changes have diminished suitable habitat for the pallid sturgeon in the Lower Platte River reach (Service, 1997).

The whooping crane, piping plover, interior least tern, and pallid sturgeon that use the Platte River habitat also use other habitats during their life history. Therefore, it is not easy to establish the extent to which loss of Platte River habitat has contributed to decline of each species. In some cases, loss of habitat may more critically be a constraint on the recovery of the species.

WHOOPING CRANE

Estimated whooping crane populations in 1860 to 1870 were between 500 to 1,300 (Allen, 1952 and Banks, 1978). Hunting and a loss of habitat caused a decrease in population numbers in the late 1880s. In 1941, the migratory population numbered 16 individuals, including 6 to 8 breeding birds (Service, 1997). A number of recovery and habitat protection activities were initiated, including captive breeding and experimental release of captive-bred birds.

As of March 2000, 188 whooping cranes were recorded in the wild flock that migrates through the Great Plains and across the affected area of the Platte River Basin. In March 2002, the population had dropped to 173 birds, but it rebounded to 215 birds by February 2005. At that time, there were approximately 446 birds in wild and captive populations (Whooping Crane Recovery Team Meeting, Patuxent Wildlife Research Refuge, Laurel, Maryland; February 8-9, 2005; unpublished information).

Approximately 83 percent of adult whooping crane mortality for the Aransas-Wood Buffalo population occurs between the time they leave their wintering area in the spring and return to their wintering area in the fall. The National Research Council (2005) observed that although the total mortality of the birds' annual cycle is reasonably well known, the causes of death are more problematic. Of 133 adults and subadults that disappeared away from winter areas between April and November (nesting is rather well monitored, and mortality on breeding areas is assumed to be low) from 1950 to 1987, the cause of death is known in only 13 cases, 5 of these cases were due to collisions with power lines (Lewis et al., 1992).

Causes of whooping crane mortality include collisions with power lines, gunshot injuries, and ingestion of toxic material, infectious bacteria (Snyder et al., 1997), and viral disease (Lewis et al., 1992). Other hazards include exposure to storm events and, in combination with a variety of other factors, the physiological stress of migration. Whooping cranes may be susceptible to a variety of diseases known to occur in sandhill cranes and other water birds (Olsen et al., 1997). Predation is, by far, the greatest principal cause of mortality for captive-reared birds released in Florida (Nesbitt et al., 2001 and Gee et al., 2001) and for the Wisconsin-Florida experimental migratory population (Stehn, 2005).

The National Research Council (2005) concluded that the current conditions of the Central Platte Habitat Area adversely affect the likelihood of survival of the whooping crane, but to an unknown degree. The National Research Council also concluded that the Platte River habitat is important to the continued existence and the recovery of the cranes.

PIPING PLOVER

The International Piping Plover Census within the U.S. Great Plains and Prairie Canada population reported 3,468 birds in 1991, 3,284 in 1996, and 2,953 in 2001. Nebraska piping plover numbers were 398 in 1991, 375 in 1996, and 308 in 2001 (Haig and Plissner, 1992; Plissner and Haig, 1997; and Ferland and Haig, 2002). Table 2-13 shows 1987-1998 long-term averages of individual adult interior least terns and piping plovers on the Platte River system. Great Plains nesting sites (including the Basin), which have been monitored a minimum of 10 years, have shown a decline in piping plover population. Statewide in Nebraska, interior least terns and piping plovers are undergoing a significant population decline (Kirsch, 2001). A population growth model indicated that the piping plover is declining by 7 percent annually, and total extinction is possible in approximately 80 years (Ryan et al., 1993). The 308 piping plovers observed in Nebraska during the 2001 survey represent an 18- and 34-percent decline from 1996 (375 adults) and 1991 (398 adults), respectively.

During the 2001 international census, 213 piping plovers were counted along the North Platte, South Platte, Platte, North Loup, and Elkhorn Rivers in Nebraska. Another 87 piping plovers were counted along the Niobrara River, resulting in a total of 300 birds counted in Nebraska. This represents a decrease of 18 and 25 percent from the 1996 and 1991 census totals, respectively.

Table 2-13.—Current Status of Piping Plovers and Interior Least Terns (1987-1998 Long-Term Averages)

	Piping Plover (Individuals)	Interior Least Tern (Individuals)
South Platte River	2	2
North Platte River (Lake McConaughy) (1990-1998)	71	12
Upper Platte River	9	27
Central Platte River	58	147
Lower Platte River	100	375
Platte River System	240	563
Source: Working database from Nebraska Game and Parks data.		

The National Research Council states:

> *"The[National Research Council Committee on Endangered and Threatened Species in the Platte River Basin] committee concluded that current central Platte River habitat conditions adversely affect the likelihood of survival of the piping plover, and, on the basis of available understanding, those conditions have adversely affected the recovery of the piping plover."*
>
> (National Research Council, 2005, Page 9)

INTERIOR LEAST TERN

During the period from 1988 to 1997, throughout their range, interior least tern populations ranged from almost 5,400 to 9,000 adult birds. In the Central Basin region, populations ranged from a low of 119 (1995) to a high of 197 (1991) adult birds. Population analysis indicates population trends are generally positive in most of the interior least tern's range. However, population trends are generally negative for the Platte River.

For the interior least tern population as a whole, the largest number of birds occurs along the Lower Mississippi River (52 to 79 percent), with the Platte River in Nebraska accounting for the second largest number (6.2 to 13.6 percent) (Kirsch and Sidle, 1999).

In 1996, 701 least terns were counted along the North Platte, South Platte, Platte, Loup, North Loup, and Elkhorn Rivers in Nebraska, and another 321 along the Niobrara, resulting in a total of 1,022 birds counted in Nebraska in 1996. The 290 least terns counted along the Lower Platte River, represented 65 percent of the least terns counted on the North Platte, South Platte, and Platte Rivers, and 41 percent of the statewide population.

In 2001, 615 least terns were counted along the North Platte, South Platte, Platte, Loup, North Loup, and Elkhorn Rivers, and another 150 along the Niobrara, resulting in a total of 765 terns counted in Nebraska. This represents a decrease of 25 percent from the 1996 census.

As noted by the National Research Council in their review:

> *"The central Platte subpopulation of least terns declined from 1991 to 2001. The number of terns using the Platte River is about two-thirds of the number needed to reach the interior least tern recovery goal for the Platte. The interior tern is nesting in substantial numbers on the adjacent lower Platte River but numbers continue to decline on the central Platte, reflecting declining habitat conditions there. The decline in the tern population on the central Platte River has been coincidental with the loss of numerous bare sandbars and beaches along the river. Control of flows and diversion of water from the channel are the causes of these geomorphic changes. . ..*
>
> *"The [National Research Council Committee on Endangered and Threatened Species in the Platte River Basin] committee concluded that current habitat conditions on the central Platte River adversely affect the likelihood of survival of the interior least tern – in much the same fashion as they affect the likelihood of survival of the piping plover – and that on the basis of available information, current habitat conditions in the central Platte River adversely affect the likelihood of recovery of the piping plover."*
>
> (National Research Council, 2005, Page 10)

PALLID STURGEON

Because the pallid sturgeon was not recognized as a species until 1905, little is known of early population numbers. Studies show a probable decline since 1905; catch records are very rare (Service, 1993). Three larval pallid sturgeon have been collected, all in 1998 and 1999, in Lisbon Chute, a natural chute formed by the Missouri River on its flood plain during the flood of 1993. Sturgeon larvae of the genus

Scaphirhynchus have been captured in the Lower Platte River in several years. However, due to the early life stage of the collected larvae, it was not possible to identify them to the species level, so it is unclear whether they are pallid sturgeon or the more common shovelnose sturgeon.

Of 42 occurrences of pallid sturgeon reported[16] in the lower Missouri River Basin in Nebraska[17] from 1980 through 2001, 23 are from the Platte River, Elkhorn River, or the Missouri River near the Platte River confluence. Thus, 55 percent of the observations in Nebraska are from an area representing about 10 percent of the range. Subsequent to 2001, numerous pallid sturgeon captures have been reported in and around the Platte River. However, during this time, substantial numbers of hatchery-reared pallid sturgeon were stocked in this area. For this reason, only those pallid sturgeon captured prior to the hatchery stocking have been reported.

The Platte River in Nebraska and the Yellowstone River in Montana are among the largest tributaries in the Missouri River Basin. Because of its importance to the lower Missouri River Basin, the Platte River figures prominently in the recovery plan for the pallid sturgeon.

The National Research Council (2005) found that, currently, the Lower Platte River does not adversely affect the survival of the pallid sturgeon because this part of the river still provides:

> *"[S]everal of the habitat characteristics apparently preferred by the species: a braided channel of shifting sandbars and islands; a sandy substrate; relatively warm, turbid waters; and a flow regime that is similar to conditions found in the Upper Missouri River and its tributaries before the installation of large dams on the Missouri."*
>
> (National Research Council, 2005, Page 10)

The National Research Council concluded that:

> *"The population of pallid sturgeon is so low in numbers, and habitat such as the lower Platte River that replicates the original undisturbed habitat of the species is so rare that the lower Platte River is pivotal in the management and recovery of the species."*
>
> (National Research Council, 2005, Page 11)

[16]Only angler captures of individuals representing the strongest "pallid sturgeon" characteristics are considered "confirmed" by the Nebraska Game and Parks Commission. Angler captures where the specimen displays less absolute characteristics are considered "unconfirmed," as their actual species is not known. As a result, the confirmed Nebraska Game and Parks Commission angler capture record is the most conservative estimate of angler captures.

[17]When considering species with a range of several thousand river miles, it is necessary to identify a meaningful area of analysis. Data were used for the Missouri River and tributaries along the Nebraska border, below Gavins Point Dam, South Dakota. The uppermost boundary of this stretch is at an impassable barrier, while the lowermost boundary is roughly approximate to where the Missouri River becomes hydrologically and physiographically different from the Nebraska reach. This area could be extended downstream to the mouth of the Kansas River. However, far fewer captures from that additional reach are known, possibly due to the lack of a similar angler capture database in Kansas. For this reason, the Nebraska State line was established as the reach division.

Chapter 3

Description of the Alternatives

INTRODUCTION

This chapter describes the goals and objectives of the first 13 years of implementation of the proposed Platte River Recovery Implementation Program (Program) (Program's First Increment). It then describes the four action alternatives evaluated in this Final Environmental Impact Statement (FEIS). Each of the action alternatives addresses the purpose of and need for the Program's First Increment as described in the "Need for the Program" section in chapter 1.

A summary table of impacts for each alternative appears at the end of this chapter.

Heavily Wooded Section of Central Platte River Channel, Near Cozad, Nebraska

Channel Islands Cleared of Vegetation, Whooping Crane Maintenance Trust Property, Near Alda, Nebraska

PROGRAM'S FIRST INCREMENT OBJECTIVES

The Cooperative Agreement for Platte River Research and Other Efforts Relating to Endangered Species Habitats Along the Central Platte River, Nebraska (Cooperative Agreement) established the general, long-term goal of improving and maintaining the target species-associated habitats to provide Endangered Species Act (ESA) compliance for existing and certain new water related activities covered by the Program in the Basin (see the "Program Purposes" section in chapter 1). Objectives established for the Program's First Increment are (more details, definitions, and specific targets for habitat restoration are described in the following sections):

- **Land Habitat Restoration:** Protect and/or restore 10,000 acres of habitat in the Central Platte River area.
- **Program Target Riverflows:** Provide water capable of improving the occurrence of U.S. Fish and Wildlife Service (Service) flow targets by 130 to 150 thousand acre-feet (kaf) on an average annual basis through changes in the timing, magnitude, frequency, and duration of flows.
- **Pallid Sturgeon Habitat:** Test the assumption that managing flow in the Central Platte River also improves habitat for the pallid sturgeon in the Lower Platte River.[1]

[1]The "Program Impacts to the Pallid Sturgeon" section, later in this chapter, addresses the steps that will be taken to consider Program impacts and to provide offsetting measures, if necessary, for the pallid sturgeon.

COMMON FEATURES AND OBJECTIVES FOR ALL ACTION ALTERNATIVES

Every action alternative addresses the same general habitat objectives for land habitat restoration, target riverflows, and steps to avoid adverse Program impacts on the pallid sturgeon. The alternatives differ in the emphasis they place on each objective, but each alternative aims to provide significant improvements in habitat for the target species.

These characteristics will serve as the initial definition and focus for creating or restoring habitat complexes and non-complex lands during the Program's First Increment, but they may be changed as new information is developed as part of an adaptive management process (see sidebar 3-2, "Adaptive Management Plan" later in this chapter).

Two types of land and riverine habitat are planned for restoration and protection: habitat complexes and non-complex habitat.

HABITAT COMPLEXES

Each of the alternatives would create habitat complexes along the Central Platte River to meet the needs of the whooping cranes, interior least terns, and piping plovers, as described in chapter 2, "History of Habitat Use and Habitat Trends for Target Species." Habitat complexes include wide and long areas of unobstructed channels with shallow depths which provide adequate roost security for whooping cranes, and with unvegetated sandbars which provide nesting habitat for interior least and plovers. Habitat complexes also include wet meadow areas near the river for crane foraging, loafing, and courtship. Complexes also may include lands that, while not channel roost area or wet meadows, provide an important "buffer" from human disturbance (e.g., roads, dwellings). Characteristics for the components of habitat complexes are summarized from the Governance Committee's Land Plan[2] in table 3-1.

[2]Governance Committee's Program Document is on the CD attached to this volume, or it is available on request from <http://www.platteriver.org>.

Table 3-1.—Summary of the Habitat Complex Guidelines

Riverine Habitat	Characteristics
Location	Platte River between Lexington and Chapman, Nebraska.
Channel area	Approximately 2 miles long, 1,150 feet wide, and includes both sides of the river.
Water depth	A range of depths with approximately 40 percent of the channel area less than 0.7-foot deep during whooping crane migration periods.
Wetted width	90 to 100 percent of channel area inundated during migration periods.
Water velocity	During migration seasons, velocity should be less than 4 miles per hour in shallow areas.
Sandbars/channel morphology	Nonpermanent sandbars and low, nonpermanent islands, high enough to provide dry sand during the interior least /plover nesting season and free of vegetation that inhibits use by interior least , plover, or crane.
Proximity to wet meadow	Within 2 miles, but contiguous is preferred.
Distance from disturbance	*For whooping cranes*: In general, not less than 0.5 mile distant or appropriately screened from potential disturbances. *For interior least terns/piping plovers*: In general, not less than 0.25 mile distant or appropriately protected from human disturbances.
Unobstructed view	Adequate visibility upstream, downstream, and across the channel.
Flight hazards	Overhead lines should be avoided, if possible.
Security	Sufficient control while target species are present to avoid human disturbance.
Wet Meadow Habitat	**Characteristics**
Location	Within 2 miles of the above-described channel area.
Size	Approximately 640 contiguous acres or more.
Distance from disturbance	In general, not less than 0.5 mile distant or appropriately screened from potential disturbance.
Vegetation composition	Native prairie grasses and herbaceous vegetation, lacking or mostly lacking sizable trees and shrubs, occurring in a mosaic of wetland (hydrophytic) and upland (nonhydrophytic) plants.
Hydrology	Swales subirrigated by groundwater seasonally near the soil surface and by precipitation and surface water, with the root zone saturated for at least 5 to 12.5 percent of the growing season. Except following precipitation events, higher areas may remain dry.
Topography and soils	The topography is generally level or low undulating surface, dissected by swales and depressions. Mosaic of wetland soils with low salinity in swales and nonwetland soils occurring in uplands.
Food sources	Capable of supporting aquatic, semiaquatic, and terrestrial fauna and flora characteristic of wet meadows; especially aquatic invertebrates, beetles, insect larvae, and amphibians.
Buffer	**Characteristics**
Security	That portion of a complex used to isolate channel areas and wet meadows from potential disturbances. In general, the buffer is up to 0.5 mile wide.
Source: Governance Committee Program Document: Attachment 4: Land Plan, Table 1	

NON-COMPLEX HABITAT

Non-complex habitat is land that, while not approximating the characteristics summarized in table 3-1, may provide demonstrable benefits to the target species.

These habitats include the ponds and surrounding sand and gravel areas that result from gravel mining along the Central Platte River (sandpits) that are, or could be, managed as nesting areas for interior least terns and piping plovers, and nonriparian wet meadows or wetlands that, while not meeting the targeted criteria for a habitat complex, may provide foraging or roosting habitat for cranes. Characteristics of non-complex habitat are summarized in table 3-2.

Table 3-2.—Summary of Non-Complex Habitat Guidelines

Sandpit Habitat for Interior Least Terns and Piping Plovers	**Characteristics**
Location	Within 2 miles of a river channel, between Lexington and Chapman.
Size	Approximately 3 acres or greater of nesting substrate that may be extended to include a management zone surrounding the nesting area.
Topography and soils	Open expanse of bare or sparsely vegetated (<25 percent) dry, sandy, or sand and gravel substrate.
Security	Sufficient control to avoid human disturbance to interior least terns and piping plovers.
Nonriparian Habitat for Whooping Cranes	**Characteristics**
Location	Off-channel but within 3.5 miles of the centerline of the channel area, between Lexington and Chapman.
Type of habitat	Wetland or wet meadow areas.
Wetlands	Depressional wetlands with semipermanent, permanent, or seasonal shallow body(ies) of water that are typically wet during whooping crane migration.
Wet meadows	A generally level or low and undulating surface, dissected by swales and depressions. The area consists of a mosaic of wetland and upland soils and plants.
Distance from disturbance	In general, not less than 0.25 mile distant or appropriately screened from potential disturbance.
Unobstructed view	Good visibility in all directions.
Security	Sufficient control to avoid human disturbance to target species.
Source: Governance Committee Program Document: Attachment 4: Land Plan, Table 2	

Land Restoration and Management

Some of the lands acquired or managed by the Program may already approximate the habitat characteristics described in tables 3-1 and 3-2. In these cases, little restoration will be required, and management will focus on protecting and maintaining those habitat qualities through controlling disturbance factors, controlling weeds and other invasive plants, promoting desirable plant communities, and other measures.

Where Program lands do not approximate the desired habitat qualities, efforts will be undertaken, within the resources of the Program and within the capacities of the specific lands, to restore or enhance habitat to more closely approximate the characteristics in tables 3-1 and 3-2.

The "best-case scenario" would be to acquire lands that approximate or have the potential to approximate through restoration or enhancement the target habitat complex characteristics in tabled 3-1 or 3-2. While "best efforts" will be taken to acquire such lands, the realities of budget, geography, and willing seller/lessor policy may make it difficult to acquire contiguous lands that meet the size and physical characteristics described within the Program's First Increment. For these and other reasons, the exact dimensions and proportions of the target habitat complex would not be required for lands to be considered habitat complexes. Habitat complexes may not have all of the types of habitat and habitat characteristics described in tables 3-1 or 3-2. Further, land ownership patterns in the Central Platte River area suggest that habitat complexes will generally be formed from lands acquired through multiple transactions over a period of time.

Land restoration and enhancement methods to be used on Program lands may include measures for both river channel and nonchannel habitat restoration.[3] All methods of restoration will be tested, monitored, and applied more widely if effective.

River Channel Habitat Restoration

- Vegetation clearing and discing on banks and islands to improve sight distance across and along the river and to create roosting and nesting opportunities
- Lowering elevation of vegetated islands and riverbanks to improve sight distance and create sandbars
- Moving river sand from islands or banks back into the active river channel to offset ongoing erosion of the channel and support formation of new sandbars
- Creating higher flows within the existing riverbanks to help create sandbars
- Blocking or diverting higher flows from narrow river subchannels into the main channel
- Other actions to create and maintain sandbars in the river channel

Nonchannel Habitat Restoration

Habitat Complexes

- Removing trees and shrubs to help restore wet meadows
- Restoring swales and sloughs (and other measures such as blocking existing agricultural drains) to improve hydrologic conditions in wet meadows
- Haying, grazing, and prescribed burning to promote desirable plant communities
- Converting cropland to grassland for wet meadows
- Seeding with native plant species to improve food availability
- Restricting land use activities during migration periods to reduce disturbance of the target bird species

[3]For more discussion of potential habitat management and restoration methods, see the Platte River Endangered Species Partnership (2000), "Habitat Management Methods for Least Terns, Piping Plovers, and Whooping Cranes," as well as the Governance Committee Program Document: Attachment 3: Adaptive Management Plan.

- Taking other actions to reduce disturbance, such as screening roads and relocating structures and access points
- Augmenting water supplies for wet meadows from existing drains or wells
- Making improvements in river stage to improve subirrigation of wet meadows adjacent to the river

Non-Complex Habitat

- Controlling vegetation to maintain open sandy areas for interior least and plover nesting
- Controlling predators to reduce predation of nests
- Reducing human disturbance
- Maintaining existing hydrology in wetlands

Restoration activities would be scheduled and managed to avoid impacts to nesting and roosting target bird species.

Riverflow Restoration and Management

A significant objective of the Program is to improve target species habitat by improving the timing and magnitude of riverflows in the Central Platte Habitat Area. The primary objective is to increase occurrence of the Service's flow recommendations for species flows and annual pulse flows. Another management objective from the Adaptive Management Plan is to increase the occurrence of short-duration near-bankfull flows in the Central Platte Habitat Area. Both objectives are discussed below.

Service's Instream Flow Recommendations

As described in chapter 2, the flows in the Central Platte Habitat Area have been significantly altered from historic conditions, resulting in loss of habitat for target species. In 1994, the Service developed instream flow recommendations for restoring and maintaining river habitat for a myriad of species in the Central Platte Habitat Area, including the whooping crane, interior least tern, and piping plover (Bowman, 1994 and Bowman and Carlson, 1994). In these documents, the Service recommended and prioritized minimum flows for specific time periods of the year under wet conditions, dry conditions, and normal conditions. See the *Service Draft Instream Flow Recommendations* in volume 2.

The flow recommendations are broadly categorized into "species flows," "annual pulse flows," and "peak flows." As described in the Governance Committee Program Document: Attachment 5: Water Plan, Section 11: Water Plan Reference Materials, all of these categories are relevant to, and must be considered in, the Service's evaluation of the adequacy of proposed actions. However, only the first two of these categories are being used as benchmarks for measuring Program flow improvements:

- "Species flows" are flow levels at Grand Island, Nebraska, that are needed to provide good physical aquatic habitat conditions for the whooping crane, interior least tern, and piping plover during the times these species use the river, and to promote favorable aquatic conditions throughout the year (e.g., maintain healthy populations of fish for interior least to eat).

- **"Annual pulse flows"** are flows in excess of species flows that are needed to help maintain the variety of ecological processes of the river channel and adjacent low areas to provide favorable physical, chemical, and biological conditions for the species (including a wide channel that is generally free of vegetation, adjacent backwaters and wet meadow areas, etc.).

Species Flows

Species flows were established as recommended "wet year," "dry year," and "normal year" minimum flows for various periods of the year (for example, from February 1 through March 22) for the purpose of sustaining the species and their habitat. The species flows are summarized in table 3-3.

Table 3-3.—Species Flows at Grand Island (cfs)

Period	Wet Year*	Normal Year*	Dry Year*
January 1 – January 31	1,000	1,000	600
February 1 – March 22	1,800	1,800	1,200
March 23 – May 10	2,400	2,400	1,700
May 11 – September 15	1,200	1,200	800
September 16 – September 30	1,000	1,000	600
October 1 – November 15	2,400	1,800	1,300
November 16 – December 31	1,000	1,000	600
*"Wet years" are defined as the wettest 33 percent, "dry years" as the driest 25 percent, and "normal years" all other years.			

Adequate flows at the times of the year shown in table 3-3 are expected to provide multiple benefits to the river ecosystem and the target species. Table 3-4 lists some of the expected key benefits of species flows.

Table 3-4.—Key Benefits of Species Flows

Period	Key Biological Benefits of Species Flows
January 1 – January 31	Promote the winter survival of native fish community and aquatic insects. Provide foraging habitat for bald eagles and other raptors.
February 1 – March 22	Provide migrating waterfowl and other bird species with suitable migration habitat at a time when other nearby wetland habitats may be frozen. Form and move ice, which scours vegetation and shapes the channel.
March 23 – May 10	Provide whooping crane night roosting habitat. Provide channel habitat for water-dependent organisms, including spawning fish, mussels, and migratory waterfowl, wading birds, and shorebirds.
May 11 – September 15	Provide shorebird nests with a degree of protection from terrestrial predators. Protect native fish communities from losses due to high water temperatures.
September 16 – September 30	Maintain and prevent loss of the native fish community and promote survival of fish young-of-year.
October 1 – November 15	Provide fall migration and roosting habitat for migratory bird species, including the whooping crane. Maintain aquatic life (e.g., promote growth of young-of-year fish).
November 16 – December 31	Maintain habitats necessary to support fish communities. Provide bald eagle feeding habitat and opportunities.

Annual Pulse Flows

The Service also recommends that pulse flows occur annually during natural periods for high runoff: February to mid-March and May through June. These “annual pulse flows” would be in the range of 2,000 to 3,600 cubic feet per second (cfs) for 7 to 30 days, and the 10-year running average of the 30-consecutive-day flow would be 3,400 cfs in May through June. Table 3-5 shows the specific frequency and magnitude of flow targets for annual pulse flows.

Table 3-5.—Annual Pulse Flow Targets at Grand Island (cfs)

Exceedance Probability (Recurrence Interval)	Recommended Flow (cfs)	Notes
75 percent (3 of 4 years)	3,100 to 3,600 (February – March)	30-day duration for February – March
	3,000 (May – June)	7- to 30-day duration for May – June
	3,400 (May – June)	10-year running mean of 30-consecutive-day exceedance
100 percent (all years)	2,000 to 2,500 (February – March)	30-day duration for February – March

Together, the species flows and annual pulse flows constitute “Program target flows.” These will be used by the Program as the initial benchmarks for measuring Program flow improvements, but this does not preclude the potential importance of other (higher) flows for habitat recovery, as described below.

Peak Flows

The Service also recommends that flows in excess of the annual pulse flows described above occur in the Platte River on a periodic basis (Bowman and Carlson, 1994). These “peak flow” recommendations are summarized in table 3-6.

Table 3-6.—Peak Flow Targets at Grand Island (cfs)

Exceedance probability (recurrence interval)	Recommended flow (cfs)	Notes
20 percent (1 in 5 years)	16,000 (February – June)	5-day duration At least 50 percent of these flows should occur between May 20 – June 20 May – June preferred for habitat benefits February – June OK for channel maintenance
40 percent (2 in 5 years)	12,000 (February – June)	5-day duration
10-year running average of 5-consecutive-day exceedance	8,300 to 10,800 (February – June)	

Taken together, these peak and annual pulse flows are expected to serve multiple functions, listed below, at different times of the year.

In February and March:

- Bring the groundwater levels in grasslands and wet meadows adjacent to the river up near to the surface in some areas and above soil surface in some lowest areas of grasslands. This causes soil invertebrates (worms, insects, and others) to move up to the soil surface where they are more available for consumption by migratory birds and other animals.[4]
- Cause and/or contribute to the breakup and movement of ice to scour vegetation off sandbars in the active channel; this effect is especially important in years of low flow.
- Redistribute sediment in the active channel which helps maintain braided river characteristics.
- Help provide spawning cues for pallid sturgeon in the Lower Platte River.
- Help maintain and rehabilitate pallid sturgeon habitat in the Lower Platte River.

In May and June:

- Maintain and enhance the physical structure of wide, open, unvegetated, and braided river channel characteristics for resting, feeding, and roosting by migratory birds
- Maintain and enhance the occurrence of soil moisture and pooled water for the lower trophic levels of the food chain in low grasslands and promote biologically diverse communities in the ecosystem over the long term

[4]The Service's discussion of pulse flows recognizes the value to the river and adjacent wet meadows of springtime flood events which may exceed bankfull capacity of the river. These events help keep the river connected to the flood plain and maintain the hydrology of wet meadows. The Service recognizes the value of ensuring that these natural events continue. However, if a Recovery Implementation Program is implemented, the Program would not **create** or contribute to out-of-bank flooding by releasing Program water. All Program water releases would be made within existing safe channel capacity.

- Facilitate upstream migration for spawning pallid sturgeon and downstream transport of eggs and larvae

- Help maintain and rehabilitate pallid sturgeon habitat in the Lower Platte River

- Maintain and rehabilitate backwaters and side channels as spawning and nursery habitat to:

  - Promote critical stages in the life cycles of fishes, mollusks, and other aquatic organisms
  - Promote movement and (re)distribution of fishes, mollusks, and other aquatic organisms
  - Facilitate nutrient recycling in the flood plain (Bowman and Carlson, 1994)

- Keep water levels higher during interior least and plover nest initiation and construction to reduce nest loss that may result from later, uncontrolled, high summer flows

Short-Duration Near-Bankfull Flows

For purposes of the recovery and maintenance of desirable channel habitat conditions for the target avian species, various pulse flow recommendations based on different concepts have been proposed (Johnson, 1994; Bowman and Carlson, 1994; Murphy et al., 2004). Flows of approximately 1- to 3-days' duration, with magnitudes approaching, but not exceeding, bankfull channel capacity through the Central Platte Habitat Area, are currently proposed to occur on an annual or near-annual basis, along with other measures (e.g., clearing and leveling adjacent vegetated areas) to test the ability of the Program to scour vegetation encroaching on channel areas and to mobilize sand and build ephemeral sandbars to benefit the nesting target species.

Current bankfull capacity in the Central Platte Habitat Area is greater than or equal to 10,000 cfs. Desired short-duration near-bankfull flows would be in the range of 6,000 to 9,000 cfs. For Program accounting purposes, when Program waters are released to achieve these flows, such use shall not decrease the target flow shortage reduction credited to the Program's initial three water projects or to any subsequently approved Program water project.

Based on information currently available, various opinions exist among scientists on channel forming processes and on the physical and biological effects of high flows of various magnitudes and frequencies (e.g., see National Resource Council, 2005, page 142). Investigations by Reclamation and the Service (Murphy et al., 2004 and Randle and Samad, 2003) have highlighted the importance of testing near-bankfull flows in the Central Platte Habitat Area as a long-term management strategy for maintaining and/or restoring channel conditions essential to the recovery of the three bird species, within the Program-designed framework of adaptive resource management. As such, the effectiveness of "near-bankfull" flows in achieving Program channel-restoration objectives remains to be determined through the Program's adaptive management process.

River Habitat for the Pallid Sturgeon

One goal (or purpose) of all action alternatives is to negate or offset any adverse impacts from the Program to the pallid sturgeon in the Lower Platte River. The "Program Impacts to the Pallid Sturgeon" section, later in this chapter, describes the process that the Program will follow to provide those measures, if necessary for the pallid sturgeon during the Program's First Increment.

Program Management of Flows

The action alternatives improve occurrence of flow targets at Grand Island through a combination of three general approaches:

- **Reducing Consumption of Riverflows:** Consumptive use[5] of water in the Basin is reduced typically by reducing the irrigation of crops. This allows for reduced diversion or depletion of river water, thereby increasing riverflows and the improvement in the occurrence of flow targets. Reducing consumptive use of river water also tends to keep Basin reservoirs at a higher level, increasing the likelihood of spillway releases and higher flows through the Central Platte Habitat Area. Leasing water from irrigators, and the associated reduction in diversions and consumption of water by crops, is an example of this approach.

- **Retiming of Flows:** Flow targets for the endangered species can be achieved by shifting the pattern of riverflows to times that are more beneficial to the species. This can be done either by changing the pattern of releases from existing reservoir storage, by increasing the amount of water that is stored and then later released, or by diverting riverflows into groundwater recharge facilities (canals, ponds), where those waters will return to the river later through groundwater return flow.

- **Increasing the Draw on Existing Water Supplies:** Riverflows for the species can be improved by increasing the releases from existing reservoir storage, such as the release of water from Environmental Accounts (EAs) in Pathfinder Reservoir, Wyoming, or Lake McConaughy, Nebraska.

All of the above approaches are included in the action alternatives, and each has some potential effect on other flow uses. Reduced consumption of riverflows increases achievement of flow targets while (usually) reducing agricultural production and its associated economic activity. Retiming of riverflows improves target flows but changes the pattern of reservoir releases or river diversions to groundwater, and it may affect such activities as hydropower generation. Increased demand upon existing water supplies leads to lower reservoir levels as stored waters are used to improve occurrence of target flows, which can, in turn, affect irrigation deliveries, fisheries, recreation, and power generation. This FEIS aims to describe this mixture of effects and assess their impact on important resources and economic activities.

None of the action alternatives manages sufficient amounts of water to achieve completely the target flow conditions shown in table 3-3 (species flows) and table 3-5 (annual pulse flows) that create good habitat conditions for the target species. The Governance Committee Alternative, for example, would move roughly one-third of the way toward achieving flow targets. Figure 3-3, later in this chapter, shows median riverflows at Overton, Nebraska (over the months of the year) for the Present Condition and the Governance Committee Alternative, compared to the species flows and annual pulse flow targets. Note that species and annual pulse flows over various water years (wet, dry, very dry) are combined to provide one comparison line for targets. See the *Service Draft Instream Flow Recommendations* in volume 2.

[5]"Consumptive use" is the amount of water taken from a stream system that is lost to the system, usually through conversion to crops, evapotranspiration, industrial or municipal consumption, or other unrecoverable losses.

This shortfall means that the Program managers, especially the Environmental Account (EA) Manager, will need to make choices about how to allocate the limited Program waters to improve flows at various times of the year. A plan will be developed each year by the EA Manager, in coordination with the Program, describing how available Program water is expected to be used.[6] However, adjustments will be made to reflect changing conditions.

One overriding principle is that Program water will not be released to increase riverflows if doing so would cause out-of-bank flooding downstream. All Program water releases will be made within existing riverbanks.

Program Impacts to the Pallid Sturgeon

The relatively distant location of the pallid sturgeon habitat area at the lower end of the Lower Platte River results in special challenges to the Program's ability to provide direct benefits to the species and challenges to the ability to predict Program effects on the species. The results of the study approved by the Governance Committee in 2002 indicate that anticipated Program actions would result in only small changes to these flow parameters in the Lower Platte River and, therefore, provide marginal benefits to the pallid sturgeon (Service, 2002 [flow]). Some small hydrologic benefits to the species may be realized during some seasons (primarily summer), but these benefits may be offset by adverse hydrologic impacts during other seasons (primarily spring). Potentially significant benefits in sediment availability from the Central Platte River are likely, but impossible to quantify, as current sediment models do not extend through the Lower Platte River reach.

Nevertheless, one of the Governance Committee Alternative's long-term goals is ". . . *testing the assumption that managing flow in the Central Platte River also improves the pallid sturgeon's Lower Platte Habitat Area"* (Governance Committee Program Document: Chapter II: Program Goals). As a result, on October 31, 2002, the Governance Committee adopted a plan for research and monitoring of the pallid sturgeon and its Lower Platte Habitat Area. This roughly $4 million effort will address a number of different life history and habitat informational needs for the species in its Lower Platte Habitat Area.

To address the potential adverse impacts to important life history requirements of the pallid sturgeon modeled during the spring, the Governance Committee has adopted a plan to study the effects of river stage changes, particularly under high flow conditions, and has committed to concluding this study by the end of year three of the Program's First Increment. If, through this pallid sturgeon research plan, reductions in peak flows caused by the Program are deemed to adversely affect the pallid sturgeon, the Governance Committee will develop and implement appropriate conservation measures that either negate or offset the occurrence of those adverse impacts on the pallid sturgeon.

[6]Under the proposed Program, a Reservoir Coordinating Committee (RCC) and an Environmental Account Committee (EAC), composed of representatives from the participating organizations, will coordinate and oversee development of annual water operating plans and their implementation.

PROGRAM PRINCIPLES FOR ALL THE ACTION ALTERNATIVES

In achieving the Program habitat objectives, each action alternative incorporates the following elements or adheres to the following key Program principles that Interior considers to be fundamental to implementing a cooperative, Basinwide approach to habitat restoration.[7]

(1) W**illing Seller/Lessor:** No condemnation of land or water rights will occur. The Program will acquire interests (purchase, lease, easement, or other arrangements) in water and land only from willing sellers and lessors (Governance Committee Program Document).

(2) **Incremental Approach:** Any Program will be implemented in increments, with only the Program's First Increment under review at this time (Governance Committee Program Document).

(3) **Adaptive Management:** The effectiveness of the Program will be improved, based upon learning from the initial steps. Sidebar 3-1, "Addressing Scientific Uncertainty" (later in this chapter) discusses Program aspects that address scientific uncertainty. The initial effects of the Program on the species' habitat and the species' response to changes in the habitat will be monitored and evaluated. Program goals, hypotheses, or methods will be adjusted, as appropriate, based on results of monitoring and research and experience gained in implementing the Program.[8] The Governance Committee developed an Adaptive Management Plan to guide this process and recognizes the importance of implementing the Adaptive Management Plan. The Adaptive Management Plan also contains initial objectives and plans for the first stages of Program management of some key land and water elements (Governance Committee Program Document: Attachment 3: Adaptive Management Plan); however, the Governance Committee did not intend the Adaptive Management Plan to determine ESA compliance or to automatically or implicitly establish Program requirements. (See sidebar 3-2, "Adaptive Management Plan.") The Adaptive Management Plan is expected to change and adjust during the Program's First Increment as new information is learned.

(4) **Integrated Monitoring and Research Plan:** As part of the Adaptive Management Plan, a systematic program of monitoring and research will be used to track and evaluate target species status and habitat use and the effects of the activities implemented in the Program's First Increment on the associated habitats and the response of the target species to those effects. The IMRP is designed to provide information useful in habitat management and evaluation, consistent with the overall adaptive management approach (see sidebar 3-2, "Adaptive Management Plan" and Governance Committee Program Document: Attachment 3: Adaptive Management Plan). See also sidebar 3-1, "Addressing Scientific Uncertainty."

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[7]Several key aspects of the Governance Committee Alternative have been incorporated into all action alternatives, such as the Depletion Management Plans, institutional arrangements, and cost sharing. While the parties to the Cooperative Agreement have not agreed that these actions would be taken should an alternative other than the Governance Committee Alternative be adopted, these elements are included in all action alternatives to facilitate comparison of impacts.

[8]The Program's adaptive management process allows for the Governance Committee to make changes to many aspects of the Program's activities to adjust to new information, peer review, or experience during the First Increment of the Program. Any changes must still address the Program's objectives for the Program's First Increment. Changes to fundamental aspects of the Program's First Increment, such as to the Program flow targets, to regulatory certainty afforded by the Program, to the Program principles of willing seller and payment of taxes, or to signatories' funding obligations, must be agreed to unanimously by the states and Interior.

(5) **Water Protection, Tracking, and Accounting:** Each state would take whatever steps are necessary to account for or provide legal and institutional protections within that state for Program water to and through the Central Platte Habitat Area. Each state will use its own method of regulating, tracking, and accounting for Program-provided water.

(6) **New Depletion Management:** Each state and the Federal Government would develop means to track and offset effects of new and expanded (post-July 1, 1997) water-related activities that would cause depletion to species and annual pulse flow targets at the Central Platte Habitat Area (see the "Service's Instream Flow Recommendations" section in this chapter and the *Service's Instream Flow Recommendations* in volume 2).

(7) **Water Management:** Program water would be managed to improve habitat conditions for the target species. The Service has recommended priorities to guide use of water from the Lake McConaughy EA and other Program water elements. The Service's EA Manager would coordinate management of this water to improve riverflows with the Program's Executive Director and the other water managers participating in the Program, through the Reservoir Coordinating Committee (RCC) and the Environmental Account Committee (EAC) (Governance Committee Program Document: Attachment 5: Water Plan).

(8) **Land Management:** Each action alternative includes acquisition of interest in lands in varying amounts, and management of those lands to approximate the habitat characteristics described in the Governance Committee Program Document: Attachment 4: Land Plan, tables 1 and 2. Two specific tracts of land already owned by Program participating entities have been designated for inclusion in the Governance Committee Alternative, and they are assumed to be part of the other action alternatives as well.

- **Cottonwood Ranch Habitat:** Nebraska Public Power District (NPPD) has acquired a 2,650-acre portion of the Cottonwood Ranch near Elm Creek, Nebraska, that would be managed as part of the Program.

- **Wyoming Water Development Commission Property:** The State of Wyoming owns 470 acres along the Platte River near Kearney, Nebraska, that would be managed as part of the Program.

(9) **Pallid Sturgeon:** Each action alternative includes a process to negate or offset any Program-caused adverse impacts to the pallid sturgeon in the Program's First Increment.

(10) **Institutional Framework:** The action alternatives all require organizational structures to provide oversight and coordinate implementation of a Program. The Governance Committee Program Document proposes that a new Governance Committee would be established to guide implementation of the Program, having the same representation as the Cooperative Agreement Governance Committee. Also proposed is an Executive Director with staff for day-to-day program implementation, a Finance Committee to manage cost-sharing and approval of funds, and committees providing advice on land management, water management, technical issues, and scientific issues. (For more details, see the Governance Committee Program Document: Attachment 6: Organizational Structure for the Platte River Recovery Implementation Program).

Funding and/or Program resources are contributed by the Federal Government and the States of Wyoming, Colorado, and Nebraska. Changes in state water law, Federal laws and project authorizations, and Federal and private contracts may be necessary to implement specific projects. This FEIS analysis assumes that all such arrangements—legal, financial, and institutional structures—are in place and functioning during the Program's First Increment.

(11) **Cost Sharing:** A cost-sharing framework will be used to fund the Program, with Wyoming, Colorado, and Nebraska providing no less than 50 percent of the contributions necessary to carry out the Program (or others on behalf of their state) and the Federal Government providing the remaining contributions. For this analysis, it is assumed that any action alternative is fully funded and fully implemented.

(12) **Good Neighbor Policy:** The Program shall be carried out in such a way that the Program will be viewed as a "good neighbor" by the residents of central Nebraska and others who might be affected by Program activities. All land management would be in accordance with a "Good Neighbor Policy" and related policies (Governance Committee Program Document: Attachment 4: Land Plan), which, among other things, stipulate that:

- The Program will pay taxes or their equivalent on Program lands, to avoid reducing tax revenues to local entities or shifting tax burdens to other entities.
- The Program will comply with applicable local, state, and Federal laws and, to the extent permitted by such laws, will be responsible for its actions to the same extent as a private individual under similar circumstances.
- The Program will emphasize the prevention, as opposed to the correction, of actions that cause adverse effects on adjacent landowners or others.
- The Program will have local representatives readily accessible so that the nature and cause of any problem can be quickly determined and needed corrective actions can be taken in a timely manner.

The Program will require its contractors to carry appropriate insurance to cover documented damage claims resulting from their actions.

Sidebar 3-1.—Addressing Scientific Uncertainty

The issues related to the target species, the effects of water development on their habitat, and the habitat improvements needed to protect the species, have all been the subject of political and scientific debate over the last two decades. It is often the case that scientific data on endangered species is limited, partly because the species' numbers are so few. At the same time, the ESA has been interpreted by the courts to require that actions be taken to protect the species and, where scientific uncertainty exists, that resource managers err on the side of protecting the species. Decisions are to be based upon the best available information. However, disagreements about what constitutes the "best available information" persist.

The states and other groups have questioned the Service decisions regarding designation of critical habitat for some of the target species, the Service's development of target riverflows for the species, and other aspects of the recommended habitat improvements. At the request of the Governance Committee, the U.S. Department of the Interior (Interior) funded the National Academy of Science to conduct a review and evaluation of:

- The science related to the designation of critical habitat along the Platte River for two of the target species
- The importance of this habitat area to the continued existence and recovery of the four target species
- The Service's flow targets for the species, and characterization of suitable habitat
- Interior's interpretation of the geomorphology of the Platte River

The National Academy of Science findings (see the National Research Council, 2005, conclusions and news release in volume 2), confirmed Interior's use of best science available at the time regarding the designation of critical habitat, the importance of the habitat to the species and their recovery, the Service's definitions of suitable habitat, and Interior's understanding of the geomorphic river processes that have changed the habitat over the years. The National Academy of Science identified several areas where additional information should be collected by the Program and where methods should be updated, including definitions of habitat and approaches to habitat restoration.

Several aspects of the Program were developed to further address scientific uncertainties:

- First, the Program has been formulated as an incremental Program. Rather than trying to implement the entire solution at once, the Program is phased. The First Increment of the Program aims to meet only partially the Service's current objectives for the habitat. At the end of the Program's First Increment, both progress and the Program's ultimate goals will be reassessed, allowing for consideration of new information.

- Second, the Program employs an intensive monitoring process, tracking Program implementation and results.

- Third, the Program undertakes active research on key questions, aiming to reduce scientific uncertainties.

- Fourth, the design of monitoring and research and all results and findings are open to public inspection and subject to formal scientific peer review.

- Fifth, the Program is based upon adaptive management, meaning that Program objectives and methods can be reviewed and revised as information becomes available from any source, including research, monitoring, and peer review.

Together, these measures seek to ensure that Program actions are based upon good scientific information and can be continuously improved as more information becomes available. The Program proponents hope that this approach will also increase the public's understanding of and trust in the Program.

Sidebar 3-2.—Adaptive Management Plan

The Adaptive Management Plan is a systematic process for improving Program management by: (1) designing Program activities to test hypotheses, (2) monitoring the effects of Program actions, and (3) applying information learned from research and monitoring to improve Program management. The Adaptive Management Plan is a large and complex document. See the Governance Committee Program Document: Attachment 3: Adaptive Management Plan.

Figure a shows a flow chart example of how Program actions might be implemented under an adaptive management framework.

The Integrated Monitoring and Research Plan (IMRP), part of the Adaptive Management Plan, will collect data on biological responses to program activities, assess resulting changes in habitat or species response, and also test research hypotheses important to Program management. Information derived using the IMRP, along with information from the Service, state agencies, and others will be used to evaluate the Program's First Increment and overall species recovery. Table a is an example of 1 out of 17 tables that list the IMRP data collection needs.

The Program's biological response monitoring and research is designed to:

(1) provide data to evaluate the effectiveness of the Program to meet goals and objectives for the habitat of target species,

(2) provide data to evaluate the relative importance of Program habitat protection and restoration measures to the target species,

(3) provide data to support adaptive management decisions regarding activities periodically during the Program's First Increment, and

(4) provide scientifically defensible data to facilitate development of milestones for future Program increments.

Program monitoring is designed to provide unbiased estimates of population and habitat parameters over space and time with acceptable precision.

Program research is designed to evaluate the merit of specific hypothesized relationships among species and habitat associations and cause and effect relationships of species and habitat response to Program management. Figure a shows the process for testing hypotheses.

The Governance Committee will regularly evaluate Program management activities, and the criteria that guide those Program activities, such as land and water acquisition and management criteria, and others, as described in the Governance Committee Program Document and its attachments (e.g., Milestones Document, Land, Water, and Adaptive Management Plans). The Governance Committee evaluations will:

(1) assess whether the Program activities and criteria being examined are working as originally envisioned,
(2) recommend modifications justified by new information,
(3) determine whether there are other or better uses for the resources committed to the activity and criteria,
(4) assess whether success or failure could be determined by monitoring over the time period evaluated, and
(5) develop alternative activities and criteria in accordance with Program adaptive management.

Table a.— Example of Integrated Monitoring and Research Plan Data Collection Needs

Program Effects on Whooping Crane Habitat	Potential Sources of Current and Future Data	Possible Analysis Methods	Timeframe
A. Channel Roost Habitat			
1. Program effects on immediate (daily) quantity and quality of aquatic roosting habitat during migration periods			
Data needs: Water depth Active channel width Wetted width	Whooping Crane roost transects U.S. Geological Survey (USGS)/ Reclamation sediment transects (nearest to whooping crane roost transects)	Geographic Information System (GIS) database Whooping crane instream flow model	During migrations, frequency determined by whooping crane observations
Data need: Discharge	USGS gauging station (nearest to whooping crane roost transects)	Whooping crane instream flow model	Daily during migration; 10-13 years
2. Program effects on quantity, quality, and spatial distribution of open-channel roosting habitat			
Data need: Continuous active channel width	Aerial/satellite photographs Videography GIS database Permanent transects	Trend analysis Quantitative before/after by bridge segment	Annually
3. Program effects on sustainability of channel habitat			
Etc.			

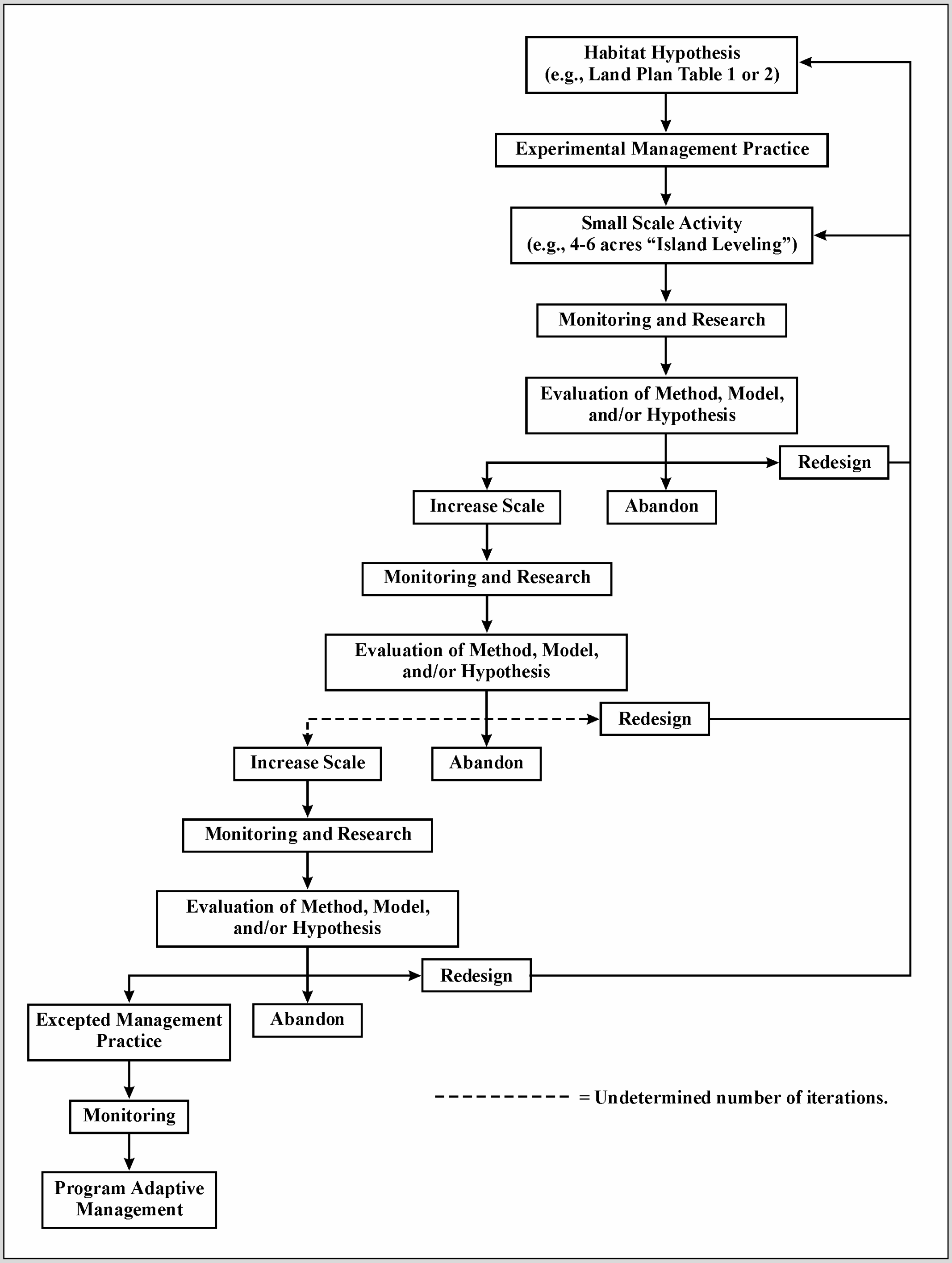

Figure a.—Adaptive management flowchart.

THE ACTION ALTERNATIVES

All of the action alternatives address only the Program's First Increment. Each action alternative emphasizes a different focus or approach. Many additional combinations of the elements that make up the alternatives are possible. While this programmatic analysis is not intended to portray all possible combinations of elements, it does describe a reasonable range of land and water actions, given the resources likely to be available for the Program's First Increment.

The action alternatives are:

- **Governance Committee Alternative:** This alternative has two components, each consisting of a variety of specific actions:
  - The land habitat component protects, restores, and maintains at least 10,000 acres of habitat in the Central Platte Habitat Area.
  - The water component improves occurrence of species and annual pulse flow targets by an average of 130 to 150 kaf annually.
- **Full Water Leasing Alternative:** Water leasing is emphasized in addressing the Program's water goals. This alternative, which provides nearly all of the Program water through water leasing, replaces the "Water Leasing Alternative" analyzed in the draft EIS (DEIS), which incorporated a smaller amount of leased water. Provides 10,000 acres of Central Platte Habitat Area under Program management and improves achievement of species and annual pulse flow targets by 137 kaf on an average annual basis.
- **Wet Meadow Alternative**: This alternative focuses on restoring wet meadow areas near the river. This alternative explores the benefits to the species from substantial increases in nonriverine habitat, but with reduced quantities of water to achieve target flows. Provides 17,053 acres of Central Platte Habitat Area under Program management and improves achievement of species and annual pulse flow targets by 116 kaf on an average annual basis.
- **Water Emphasis Alternative:** This alternative focuses on acquiring water for the Program. There is less emphasis on land habitat management. This alternative explores the benefits to the target species of substantial increases in Program water supplies, particularly in reservoir storage, but reduced management of nonriverine habitat. Provides 7,475 acres of Central Platte Habitat Area under Program management and improves achievement of species and annual pulse flow targets by 184 kaf on an average annual basis.

All of these FEIS action alternatives are based upon a Basinwide, cooperative approach. However, negotiations related to such an approach have occurred only for the Governance Committee Alternative, and the agreement of all parties to a cooperative approach for the other alternatives should not be inferred. Some of these FEIS action alternatives would require using existing facilities for water storage or management. Presentation of these action alternatives does not imply that parties who currently own, manage, or use these facilities endorse, support, or agree to such use of their facilities.

While some elements in the alternatives may not be supported by individual members of the Governance Committee, it is important under the National Environmental Policy Act (NEPA) to carefully consider and evaluate a range of options, even if those options have not previously been agreed to by all participants.

ACTIONS CONSIDERED BUT ELIMINATED

During the development of the alternatives, many individual elements were considered. Each element was subjected to a screening analysis. The *Platte River EIS Screening Report* in volume 2 describes the process in detail for evaluating individual elements.

Dozens of elements were evaluated for inclusion in the action alternatives. An individual element was not carried forward to include in an alternative if:

(1) It does not address the purpose and need for the Program; for example:

- It does not provide improvements in the associated habitat areas along the Platte River (e.g., some comments suggested creating habitat in other states or cloning the species).
- It does not provide significant flow improvement at the Central Platte Habitat Area (e.g., increased timber cutting or weather modification in the Platte River headwaters provide increased flows near the headwaters, but not at the habitat area).

(2) It is much more expensive than other options (e.g., build a pipeline around Kingsley Dam to transport sediment to the Central Platte Habitat Area or build a large new reservoir offstream in the Habitat Area).

(3) It would likely adversely affect other endangered species (e.g., increased transbasin diversions from the Colorado River to the Platte River Basin).

ALTERNATIVE FORMULATION

From remaining elements, three alternatives were formulated by the EIS team to be analyzed together with the Governance Committee's proposal in the December 2004 DEIS. This formulation was guided principally by the purpose and need. The formulation of alternatives was also guided by adherence to some key principles contained in the Cooperative Agreement, which was signed by Interior and the states. These principles are deemed necessary to implement a Basinwide, cooperative Recovery Implementation Program (Program), which Interior believes is essential to secure defined benefits for the target species and their associated habitats to assist in their conservation and recovery. For example, no alternative condemns land or creates out-of-bank flooding.

Two changes in the set of alternatives were made for the FEIS. First, the DEIS analyzed two approaches to implementing the Governance Committee Alternative. This was necessary because some significant gaps or uncertainties in the description of the Governance Committee's proposal existed at the time of the DEIS preparation. Since release of the DEIS, the Governance Committee has made significant revisions and additions to their proposal. Because of this, the FEIS can describe the likely environmental consequences of the Governance Committee's proposal using one implementation scenario rather than two.

Second, for the FEIS, the DEIS Water Leasing Alternative was replaced with a new alternative referred to as the Full Water Leasing Alternative, an alternative that maximizes the use of water leasing to provide water to the Program. This was done to more fully explore the benefits and costs of emphasizing reduction in Basin consumptive use as a means to provide water for the Program and to reduce as much as possible the overlap between alternatives in the elements they employ.

PRESENT CONDITION—THE BASELINE FOR COMPARING ALTERNATIVES (NO ACTION ALTERNATIVE)

The Present Condition that exists in the Basin is used as the quantitative NEPA baseline for comparing alternatives. This baseline is used because these are the conditions that currently exist for the target species and upon which have been based the jeopardy opinions issued by the Service. As such, these conditions will serve as the baseline for measuring improvements in species habitat. Also, given the historic complexity and contentiousness of past Section 7 consultations related to these species, and the length of time required to develop and implement reasonable and prudent alternatives (RPA) or offsetting measures as required under ESA, it does not seem likely that significant restoration activities will be implemented in the next 13 years unless a Basinwide, cooperative Program is undertaken. Thus, for the purpose of this NEPA analysis, the Present Condition is the quantification of the No Action Alternative.

Because the Governance Committee established 1997 conditions as the reference against which a Program's progress will be measured, the EIS also uses a 1997 hydrologic baseline. This baseline is the historic hydrologic record, from 1947 to 1994, adjusted to reflect 1997 levels of water development and water demands on the Platte River.[9]

For other resources areas (e.g., agricultural economics), more recent data are sometimes used. Chapter 4 details the measurement of the Present Condition.

[9]The 1998 Federal Energy Regulatory Commission (FERC) license requirements of the CNPPID and NPPD projects, number 1417 and 1835, are considered part of the Program rather than the Present Condition for the FEIS analysis.

GOVERNANCE COMMITTEE ALTERNATIVE

INTRODUCTION

The Cooperative Agreement created a Governance Committee to complete the development of a proposed Program. The Governance Committee's proposal, described in detail in the Governance Committee Program Document,[10] is evaluated as the Governance Committee Alternative.

The water component of the Governance Committee Alternative improves the occurrence of species and annual pulse flows by at least 130 kaf on an average annual basis by the end of the Program's First Increment, as measured at Grand Island, Nebraska.[11] The land habitat component of the Governance Committee Alternative protects, restores where appropriate, and maintains at least 10,000 acres of habitat in the Central Platte River Basin between Lexington and Chapman, Nebraska.

WATER ELEMENTS

This section describes the several elements of the Governance Committee Alternative that provide and/or manage water to improve flows to and through the Central Platte Habitat Area. Table 3-7 lists the water projects included in the Governance Committee Alternative and shows their overall expected water yields, in terms of improvements in meeting species and annual pulse flow targets. Figure 3-1 shows the location of each water element.

Under the Cooperative Agreement, the overall objective for the Water Plan is to reduce the average annual shortages to species and annual pulse flow shortages by 130 to 150 kaf. The objective for this Water Action Plan (described later in this section) is to contribute 64 kaf of this reduction in shortages. As discussed below, the FEIS analysis arrives at estimates of water yield that, in some cases, differ somewhat from those target reductions either for individual elements or for the aggregate yield of all the Governance Committee Alternative actions.

[10]The Governance Committee Alternative, as described in the Governance Committee Program Document, has been summarized for purposes of this FEIS. Any discrepancies between the representations made in this FEIS and the Governance Committee Program Document are unintentional and the Governance Committee Program Document will prevail during the implementation of the Program. The Governance Committee Program Document is on the attached CD and is also available on request from <http://www.platteriver.org>.

[11]The Cooperative Agreement standard for measurement of water benefits for the species is providing water capable of reducing target flow shortages. Whenever current riverflows fall short of Service species and annual pulse flow targets at Grand Island, Nebraska, a "shortage" occurs. Reductions in these shortages, or improvements in achieving the target flows, can result from either adding water to the river, or from shifting water from one time period to another (called "re-regulation" or "retiming").

Table 3-7.—Average Annual Program Water Contribution to Species' Target Flows Under the Governance Committee Alternative (kaf)

Program Water Features and Elements	**Projected Improvement Toward Target Flows (average kaf per year)**
State Projects	
Total for these elements: Lake McConaughy EA Pathfinder Modification Project EA Tamarack Project, Phase I	80
Water Action Plan Conservation/Supply Activities	
Total for these elements: **Wyoming** 1. Pathfinder Wyoming Account 2. Glendo Reservoir Storage 3. Water Leasing 4. La Prele Reservoir Leasing **Colorado** 1. Tamarack Project, Phase III **Nebraska** 1. Offstream Reservoir in the Central Platte 2. Water Leasing 3. Water Management Incentives 4. Groundwater Management in the Central Platte Groundwater Mound Area 5. Dry Creek/Fort Kearney Cutoffs 6. Dawson and Gothenburg Canal Groundwater Recharge 7. Central Platte Power Interference 8. Net Controllable Conserved Water	70*
Total	150
*This is the reconnaissance-level estimate of improvement toward target flows produced by the Water Action Plan. These estimates would be confirmed or further refined through feasibility-level studies as the Program is implemented.	

The Governance Committee Alternative's water elements implemented during the Program's First Increment would improve achievement of the Service's species and annual pulse flows by approximately 150 kaf on an average annual basis.

Three State Projects

Wyoming, Colorado, and Nebraska each provide an initial Program water project to the Governance Committee Alternative as a foundation for the Program Water Plan. Together, these three state projects increase achievement of target flows by roughly 80 kaf on an average annual basis. Details of the operation of the three state projects are in the Governance Committee Program Document: Attachment 5, Water Plan.

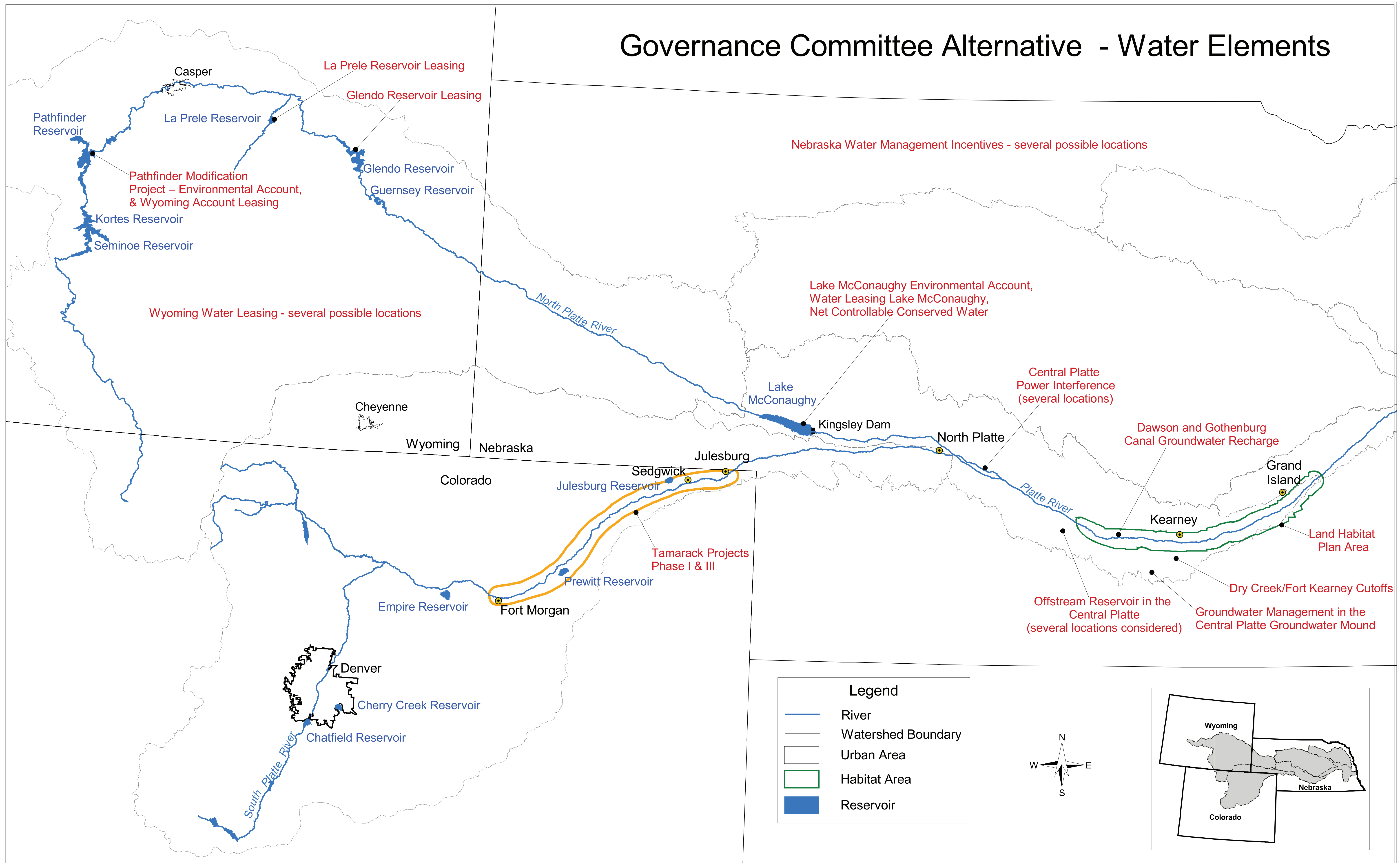

Figure 3-1.— Water elements map for Governance Committee alternative.

Wyoming—Pathfinder Modification Project Environmental Account

Pathfinder Dam was completed in 1909. It is located on the North Platte River, about 3 miles below its confluence with the Sweetwater River and about 47 miles southwest of Casper, Wyoming. In the years since construction, accumulated sediment has reduced the reservoir's original storage capacity from 1,070,000 to 1,016,507 acre-feet—a loss of 53,493 acre-feet. The Pathfinder Modification Project would restore the capacity of the existing Pathfinder Reservoir by approximately 54 kaf to recapture storage space lost to sediment. The modification would raise the elevation of the existing spillway by approximately 2.4 feet. The recaptured storage space would store water under the existing 1904 storage right for Pathfinder Reservoir and would enjoy the same entitlements as other uses in the reservoir, except that the recaptured storage space would not "place regulatory calls" on existing water rights upstream of Pathfinder Reservoir, other than the rights pertaining to Seminoe Reservoir.

Approximately 34 kaf of the recovered 54-kaf volume would be accounted for in a Pathfinder EA and operated for the benefit of the endangered species and habitat in central Nebraska. Generally, it is expected that any water accruing to the Pathfinder EA would be moved downstream to the Lake McConaughy EA (see below) in September of each year.

A change of use will be required on the Pathfinder Reservoir water right to allow the approximately 54 kaf of storage to be used for municipal and environmental purposes. Additional Federal authorization may also be required. The water right change of use and additional Federal authorization would apply only to the approximately 54 kaf of storage involved in the Pathfinder Modification Project.

Colorado—Tamarack Project, Phase I

The purpose of Colorado's proposed Tamarack Project, Phase I, is to retime the flow of water in the South Platte River that leaves the State of Colorado, to increase achievement of target flows at Grand Island, Nebraska, by 10 kaf on an average annual basis. The project involves diversion of water during periods when flows at Grand Island, Nebraska, are in excess of flow targets and when water is available under the South Platte River Compact. The water is diverted to small storage/recharge ponds, infiltrates into the underlying alluvial aquifer, and is timed to return to the river during periods of shortage to species and annual pulse flow targets.

The components of the Tamarack Project, Phase I, will be developed within the 40 miles above the state line, beginning at about the Tamarack Ranch State Wildlife Area, which is owned by the Colorado Division of Wildlife (CDOW) near Crook, Colorado. The goal for the development of Tamarack I facilities will focus on private and public lands nearest the state line so interception of accretions by Colorado ditches will be minimized. These facilities will include wells located adjacent to the South Platte River that pump groundwater from the alluvial aquifer, canals that divert water from the South Platte River, and off-channel reservoirs.

The Tamarack Project would divert approximately 30 kaf per year of the South Platte River flows for retiming of riverflows to offset shortages. When operating recharge facilities, water that percolates into the groundwater alluvium from these facilities will return to the South Platte River at a later time. Inflows to canals and recharge basins will be identified as Tamarack I water, new Depletion Management Plan water, or water for state wildlife area purposes. All such inflows will be measured, and recharge or seepage will be computed as inflows minus evaporation. Evaporation in acre-feet will be determined by using available weather station data and the surface areas of the recharge sites. Recharge basins are typically located in sandy upland areas with high infiltration rates such that exposed water surface areas are minimal, resulting in low evaporation amounts. The evaporation computed for existing recharge projects in the Lower South Platte River Basin in Colorado is typically less than 1 percent of gross flows. Colorado will identify and account for contributions from off-channel reservoirs in the same manner as recharge accounting.

In operating Tamarack I Colorado will make a good faith effort to minimize canal interception. All such facilities will be operated by Colorado and its water users in compliance with the requirements of the South Platte River Compact and for Program purposes during times of excesses to target flows. But Tamarack I facilities may also be operated for purposes other than the Program, subject to requirements of state law and the South Platte River Compact so long as such operate does not interfere with the use of those facilities for the purposes described in this plan or Colorado's new depletion plan and any associated new depletions are mitigated in accordance with Colorado's new depletions plan. Water re-timed by the project will not be protected from diversion downstream in Colorado, and may be used by Colorado water users, but any Tamarack I accretions intercepted by Colorado canals will be accounted for, reported to other parties to the Cooperative Agreement and will not count towards satisfying Colorado's other Program obligations. (See Governance Committee Program Document: Attachment 5: Section 3, Colorado's Initial Water Project [Tamarack I]).

Nebraska—Lake McConaughy Environmental Account

The State of Nebraska has proposed an EA in Lake McConaughy that was established as a result of the relicensing of the Districts' (CNPPID and NPPD) Federal Energy Regulatory Commission (FERC) projects in 1998 and that depended on implementing a future Program. The Lake McConaughy EA would receive 10 percent of the storable inflows to Lake McConaughy during the months of October through April, up to a maximum of 100 kaf in any 1 year. The amount in the account also would be set at 100 kaf any time Lake McConaughy fills. Water not released from the EA in 1 year carries over to the next year, as long as a limit of 200 kaf is not exceeded. Within certain limitations, the EA manager (a Service employee) determines when water is to be released from that account.

Under the Governance Committee Alternative, the operations for Lake McConaughy are adjusted to maintain roughly the same level of releases for other uses that occur under the Present Condition, even though lake levels would be reduced somewhat (due to the additional demand on the reservoir created by the EA). For further details, see Governance Committee Program Document: Attachment 5: Water Plan, Section 11: Water Plan Reference Materials, Appendix C: OPSTUDY Assumptions Regarding Water Operations for Diversions at Keystone and the Central District Supply Canal.

Water Action Plan

In addition to the three state projects, above, the Governance Committee Alternative includes a Water Action Plan that contains 13 water supply and conservation projects and activities to supply an additional average of 50 to 70 kaf per year of improvement toward meeting target flows. As summarized in table 3-7, the 13 presently identified conservation and water supply projects are expected to yield 70 kaf of improvement toward target flows.[12] The individual projects and how they were analyzed for this FEIS are described below by state. In some cases, the yield of such projects, as analyzed in this FEIS, differs from the original Water Action Plan estimate and is so noted.

Wyoming—Water Supply and Conservation Projects

Projects in Wyoming identified under the Water Action Plan are described below.

Pathfinder Modification Project, Wyoming Account

The Pathfinder Modification Project would restore the original storage capacity of the reservoir by raising the spillway crest. In addition to the Environmental Account, this would provide 20,000 acre-feet of storage space (over current conditions) for a Wyoming Account. Water in the Wyoming Account will serve as a supplemental water supply for Wyoming municipalities along the North Platte River during times of water rights regulation and as a replacement water supply to meet certain obligations specified in the settlement agreement for the *Nebraska v. Wyoming* law suit. The Wyoming Account will be operated to provide a firm annual yield of 9,600 acre-feet per year. In the event that water in the Wyoming Account is not needed to meet municipal or replacement water requirements, it may by used to assure compliance with Wyoming's Depletions Plan or as an additional supply to the Program. Wyoming could annually lease the unneeded portion of the yield to the Program (an estimated average of 4,800 acre feet per year for the First Increment of the Program) through temporary use agreements.

Glendo Reservoir Storage

Glendo Dam and Reservoir are located on the North Platte River, about 4-1/2 miles southeast of the town of Glendo, Wyoming. Wyoming would annually lease the unneeded portion of its share of Glendo storage water to the Program (an estimated average of 2,650 acre-feet per year for the Programs' First Increment) when the water is not needed to meet long-term contracts or other obligations in Wyoming.

Water Leasing

The members of irrigation districts or individual farmers who are willing to participate in temporary water leasing as part of the Program are not known. An incentive program would be established for willing Wyoming irrigators to make temporary leases of their water available to the Program. The goal would be to lease approximately 16,500 acre-feet of water per year. The Program would obtain control of the amount corresponding to consumptive use of this water, or approximately 8,200 acre-feet, and the remaining portion would be released to maintain return flows. The shortage reduction at the Central Platte Habitat Area would be about 3,900 acre-feet on an average annual basis.[13]

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[12]Details of the Water Action Plan can be found in the Governance Committee Program Document: Attachment 5: Water Plan, Section 6: Reconnaissance-Level Water Action Plan. The conservation and water supply projects in the Water Action Plan were identified through reconnaissance-level studies. The results of more detailed project development and feasibility studies carried out as part of the Water Action Plan may cause some projects to be abandoned. If so, "substitute" projects would be identified, if necessary, to meet the overall Water Action Plan goals. This FEIS assesses the effects of the proposed projects on the river system and on the species' habitat. The local impacts of construction of any such projects would be addressed in subsequent NEPA and ESA documents prior to implementation, including analysis of effects on other listed species.

[13]For the FEIS analysis, it is assumed that when farmers lease water to the Program, other sources of water will not be used to replace the leased supply. This will avoid any secondary impacts on groundwater and riverflows.

Under existing law and institutional arrangements in Wyoming, leasing and protecting water for Program use from direct flow diverters would be very difficult. Leasing water from reservoirs that serve multiple irrigation districts without multiple accounts in the reservoir would also not be an efficient method of obtaining water for the Program. Therefore, under present laws and institutional arrangements, the most practical method for obtaining water for the Program in Wyoming is to lease water from the Kendrick Project near Casper and from reservoir storage in the Laramie River Basin. These approaches are assumed for the EIS analysis.

La Prele Reservoir Water Leasing

La Prele Reservoir is an existing irrigation and industrial supply reservoir in Wyoming, located on La Prele Creek, approximately 13 miles upstream of its confluence with the North Platte River. Under La Prele Reservoir leasing, the Panhandle Eastern Pipeline Company, which holds right to 5 kaf of storage space in La Prele Reservoir, would lease the space to the Program. The average annual yield from this space is estimated by the FEIS analysis at 1,865 acre-feet per year at the reservoir.[14]

Colorado—Water Supply and Conservation Projects

The project in Colorado identified under the Water Action Plan is described below.

Tamarack Project, Phase III

Colorado proposes to provide an estimated average of 17 kaf of water per year to the Governance Committee Alternative through additional retiming from various locations downstream from the Balzac gauge. The potential individual recharge sites will be located on public and private lands and may include acquiring water previously developed by private individuals and ditch and reservoir companies from approximately Fort Morgan, Colorado, to the state line. Most activities would likely occur within a few miles of the South Platte River.

Nebraska—Water Supply and Conservation Projects

Projects in Nebraska identified under the Water Action Plan are described below.

Offstream Reservoir in the Central Platte

The Water Action Plan identified six possible sites for offstream storage reservoirs in the Brady to Lexington reach of the Platte River. This FEIS has used one of these sites, a reservoir located near the Johnson-2 Return Channel, with a storage capacity of 3,436 acre-feet for this analysis. This is the capacity presented in the Water Action Plan in order to simulate the yield to the Program from this project. The reservoir would store excess flows from Tri-County Supply Canal to be released back to the river at times advantageous to the species. The project is expected to yield about 14 kaf per year of

[14]The Water Action Plan's objective for this element is 2,200 acre-feet per year.

improvements to target flows for the Program, of which 7 kaf of improvements are credited to the Program, and the remainder reserved by the State of Nebraska offset future depletions to target flows. This project would be cost-shared between the Program and the State of Nebraska.[15]

Water Leasing in Nebraska

Under this activity, willing farmers would have the opportunity to lease some of their water rights to the Program. Of the water leased to the Program, only the portion that would have been consumed through irrigation of crops would be allocated to the Program for management. The remainder would be managed under the direction of the Nebraska Department of Natural Resources (NDNR) to ensure that no injury to appropriators would occur because of reductions in historic return flows.

The Water Action Plan includes leasing sufficient rights to obtain Program management of approximately 8,400 acre-feet per year of water that would otherwise be consumptively used. After accounting for transit losses, this would yield an average 7-kaf-per-year improvement toward target flows at Grand Island, Nebraska.[16]

For the EIS analysis, all Program water leasing in Nebraska was assumed to occur for water users below the confluence of the North and South Platte Rivers. This somewhat reduces the maximum amount of irrigation deliveries that must be moved through the North Platte River at North Platte (see chapter 2 for a discussion of the loss of channel capacity in this region) and improves the opportunities for moving Program water to the Central Platte Habitat Area.

Water Management Incentives in Nebraska

Water management incentives would include paying willing farmers with storage rights in Lake McConaughy to reduce their need for irrigation deliveries by adopting water-saving measures. Conservation measures could include conservation cropping, deficit irrigation, land fallowing, or improving irrigation technology. Only the avoided consumptive use of water would be available to the Program for management. The expected yield, through a combination of these measures, is an average improvement toward target flows of 7 kaf on an average annual basis.

Groundwater Management in the Central Platte Groundwater Mound

Additional groundwater management would be implemented in the high groundwater area south of the Central Platte River (groundwater mound) that has built up due to percolation of irrigation water and seepage from canals and reservoirs. Management would be implemented to avoid permanent "mining" of the groundwater table and may include:

- Pumping water from the groundwater mound (where it is judged to be too high or a nuisance) into creeks that drain back to the Platte River.

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[15]The Water Action Plan's objective for this element is a yield of 8 kaf per year, with 5,000 acre-feet per year going to the Program.

[16]For the FEIS analysis, it is assumed that when farmers lease water to the Program, other sources of water will not be used to replace the leased supply. This will avoid any secondary impacts on groundwater and riverflows.

- ➢ Paying willing farmers to dryland farm every other year and using their water supplies for Program purposes.
- ➢ Paying willing surface water irrigators to use groundwater instead of their Lake McConaughy storage, which would be allocated to the Program.
- ➢ Diverting excess water from CNPPID's supply canal in the fall and winter that is excess to target flows and recharging the groundwater mound with this water, then pumping an equivalent amount from the mound during the following irrigation season for irrigation. This would allow water normally released from Lake McConaughy in the summer for irrigation to be managed by the Program without causing long-term declines in the groundwater table.

The goal for these options is to provide an average improvement toward target flows of 6 kaf on an average annual basis, of which 1,400 acre-feet per year would be credited to the Program; the remainder is reserved by the State of Nebraska to offset future depletions to the Platte River.

Dry Creek/Fort Kearney Cutoffs

The Dry Creek/Fort Kearney Cutoffs consist of two options. The first option, the Dry Creek cutoff, just south of Kearney, Nebraska, involves a "cutoff" (creating a small drainage channel) from Lost Creek to North Dry Creek, and the second option, the Fort Kearney cutoff, involves a cutoff from Lost Creek to the Fort Kearney Improvement Project Area. The two options could return existing flows in Lost Creek or releases from the Funk Lagoon to the Platte River, providing an estimated annual average of 2,200 acre-feet per year of water to the Central Platte Habitat Area (based on yield tables in the Water Action Plan).[17]

Dawson and Gothenburg Canal Groundwater Recharge

The Gothenburg and Dawson canals divert water from the Central Platte River just upstream of the Central Platte Habitat Area. The recharge project would involve diverting riverflows into the canals outside of the irrigation season, when flows in the river are in excess of target flows. These waters would return to the river through groundwater flows over a period of years, with approximately 28 percent of return flows occurring within 9 years. The average diversions to the Gothenburg and Dawson canals would be approximately 19 and 26 kaf per year, respectively, providing an estimated additional average of 2,600 acre-feet per year to target flows, of which 1,800 acre-feet would be allocated to the Program.[18]

Central Platte Power Interference

Year-round releases are made from Lake McConaughy that generate hydropower at the Kingsley Dam hydropower plant and at the CNPPID and NPPD canal powerplants. Waters not diverted for irrigation return to the Platte River above the Central Platte Habitat Area. Under the Central Platte Power Interference element, the Program would pay the districts to modify their schedule of water releases to shift some of the riverflows from periods of excess to periods of flow shortage, thus improving the overall attainment of target flows by an average of 1,400 acre-feet per year.

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[17]The Water Action Plan objective for this element is 4 kaf per year. Because this water enters the Platte River roughly half way through the Central Platte Habitat Area, it is credited with 2,200 acre-feet in the FEIS analysis.

[18]Due to the 9-year lag time for return flows, most of the benefits to the Program would accrue after the Program's First Increment (see Boyle Engineering, 1999, for details).

Net Controllable Conserved Water

CNPPID has undertaken various conservation measures to reduce its total diversions from the Platte River, based on an agreement with the National Wildlife Federation. These measures have included:

- Revision of operations for Elwood Reservoir to minimize seepage
- Canal improvements, such as installation of pipelines, earth compaction, and membrane lining
- Onfarm irrigation system improvements, such as installing center pivots, gated pipe, flowmeters, and surge valves
- Management improvements, such as changes in irrigation scheduling, adjustments to irrigation set times, and alternate flow irrigation

The current estimate is that these measures have resulted in approximately 10,900 acre-feet per year of conserved water of which approximately 5 kaf is purchased annually by the Program under this element.

PROGRAM RELEASES AND FLOWS

This section describes how the Governance Committee Alternative would manage Program water to improve habitat flows. Except where noted, details can be found in the Governance Committee Program Document, Section 6: Conforming Federal Funding or Authorizations.

Pathfinder Environmental Account Water

Program water stored in the Pathfinder Reservoir EA typically would be released in September to flow downstream to Lake McConaughy in Nebraska and stored there as part of its EA.

Tamarack Water

Water that has been retimed through the Tamarack Project would flow downstream to Nebraska. Within Colorado, any diversion of this Program water will be tracked and will not be credited as a Program water contribution if it does not reach the state line. Nebraska initially will rely on accounting to track this water within Nebraska to the associated habitats. The effectiveness of this strategy to accomplish Program objectives will be assessed. If permitting is deemed necessary to protect this water, Colorado will cooperate with Nebraska to enable acquisition of the needed permits (see the Governance Committee Program Document: Attachment 2: Milestones, Section 2.3).

Lake McConaughy Environmental Account Management

The Cooperative Agreement and CNPPID's FERC license require that all releases made from the EA to augment streamflows would be in amounts low enough to keep the riverflows below flood stage (as determined by the National Weather Service [NWS]) and within the existing capacity of the river channel.

Managing EA Water to Improve Achievement of Target Flows

As discussed in the "Water Diversions and Storage" section in chapter 2, the water management facilities on the Central Platte River are complex. Water is stored, diverted, and returned at many points and serves many functions and water users. The facilities are managed by multiple agencies. Coordination of water operations is an important part of the Governance Committee Alternative and the improvement of flows in the Central Platte Habitat Area.[19] This is especially true given that most of the flow improvements for the Governance Committee Alternative result from a retiming of riverflows rather than a change in the annual volume of flows.

Figure 3-2 illustrates one of the ways that the Governance Committee Alternative's water could be managed to improve attainment of target flows at Grand Island, Nebraska, on an average annual basis, compared both to the Present Condition and to the target flows for each month. The graphic highlights the releases from the EA. (Note that the flow targets shown in this figure are, in some cases, combinations of species and annual pulse flow targets.) As shown, the Governance Committee Alternative stores or diverts water from the months of November, December, and January. Program waters are released to increase flows in March, April, May, August, and September. Many other patterns of EA release are possible that would still produce roughly the same amount of improvement in meeting Service species and annual pulse flow targets, even though the consequential negative and beneficial impacts on the resources could widely differ.

Figure 3-2.—The Present Condition median riverflows at Grand Island, Nebraska, and flows under the Governance Committee Alternative, compared to the Service's species and annual pulse flow targets.

[19]The EAC is chaired by the EA manager and provides guidance/input to the EA manager for the development of the EA annual operating plan. (See the *Lake McConaughy EA 2005 Operating Plan* in volume 2 as an example.) The RCC provides a forum to coordinate the annual operating plans of other projects and to discuss projected water supply conditions in the Basin. The RCC is for coordination purposes only. (See the Governance Committee Program Document: Attachment 5: Water Plan, Section 1: Program Water Management Process).

Addressing the North Platte River Channel Restriction

Improving attainment of target flows and achieving short-duration near-bankfull flows requires moving significant amounts of water from the Program's Lake McConaughy EA downstream to the Central Platte Habitat Area. This can be done using a combination of flows from Lake McConaughy down the North Platte River and flows through the canal system. However, in the past several years, the carrying capacity of the North Platte River channel at North Platte, Nebraska, has been reduced[20] (see chapter 2 and JF Sato and Associates, 2005). This reduces the Program's capacity to move water to the habitat, especially during the irrigation season when irrigation deliveries are filling most of the channel's capacity. The Governance Committee has agreed to implement measures that allow a safe conveyance capacity of at least 3,000 cfs in this reach of the North Platte River while the feasibility study, discussed below, is underway and the results are being implemented.

The Governance Committee has proposed to undertake a feasibility study by the end of year 2 of the Program's First Increment to evaluate the feasibility of delivering during the Program's First Increment:

- 5,000 cfs of Program water for 3 days to the upper end of the associated habitat (at Overton gauge) for pulse flows when other demands for conveyance of water deliveries are low (normally September 1 to May 31)
- Quantities of Program water that are likely to yield 800 cfs at the Central Platte Habitat Area during the irrigation season

The Governance Committee will implement measures expected to achieve these objectives by year 5 of the Program, unless the feasibility study and the adaptive management process find that these deliveries are infeasible or unnecessary and the Governance Committee concurs. If the evaluation finds these deliveries are infeasible, the Governance Committee commits to develop alternative means of providing similar benefits to the target avian species and their associated habitats. (Governance Committee Program Document: Attachment 5: Water Plan.)

This FEIS analysis assumes that these two objectives (the North Platte River transport capacity at the city of North Platte and achieving the above flow targets) are accomplished.

Short-Duration Near-Bankfull Flows

In addition to managing Program water to improve occurrence of species and annual target flows, Interior believes that it is important to create short-duration near-bankfull flows within banks on an annual or near-annual basis, if possible. The goal for these near-bankfull flows is to create flow through the Central Platte Habitat Area that is high enough to overtop most existing sandbars to scour away annual vegetation and to mobilize the riverbed sand. These flows are aimed at building new sandbars or raising existing sandbars to higher elevations and helping to maintain existing nesting and roosting habitat free of vegetation. These 1- to 3-day flows may also help maintain sloughs and backwaters and provide some minimal support for wetlands and wet meadows adjacent to the river. The ultimate target range for the near-bankfull flows would be 6,000 to 9,000 cfs in the Central Platte Habitat Area where bankfull

[20]"During the past eight years (the last time that the stage was evaluated), it appears that there has been a significant narrowing and filling of the river channel. In 1994, the FS [floodstage] of 6.0 feet equated to a flow of around 3804 cfs. The same stage now equates to a flow of around 2584 cfs, or about a 1220 cfs reduction in flow. Of greater concern is that flooding now seems to begin around 5.7 feet with a flow of only 1980 cfs—a reduction of 1824 cfs (which is about one half of previous flow)" (National Weather Service, 2002).

capacity is roughly 10,000 cfs. While these flows could be created at various times during the year, the most likely times would be in the late winter, prior to the crane migration season; the late spring, prior to the interior least and plover nesting season; or at the end of summer after the irrigation season.

The Adaptive Management Plan provides some initial targets for the creation of short-duration near-bankfull flows.

Using the Program's ability to deliver 5,000 cfs of Program water at Overton gauge, the Program will seek to create annual (usually springtime) flows near bankfull in the Central Platte River for a period at Grand Island sufficient to mobilize sediment and build sandbars.

- Testing will start in the first year of the Program with a flow target of up to 5,000 cfs for 3 days at Overton gauge. A plan for achieving this objective will be developed by the EAC and implemented during the first year of the Program.

- Using the EA in Lake McConaughy, as well as the flexibility in the CNPPID and NPPD canal and reservoir system, short-duration releases will be added to South Platte River flows to create short-duration near-bankfull flows in the Central Platte Habitat Area during spring or outside of the main irrigation season. These flow events will be tested in stages and adjusted accordingly based on their success at aiding the construction of braided channels, increasing sandbar heights, and restricting establishment of new vegetation in the active channel.

- The Program will also investigate the augmentation of winter pulse flows to enhance ice scour.

MANAGEMENT OF NEW DEPLETIONS

The Program seeks to ensure that other water-related actions do not reduce achievement of target flows. Each state and the Federal agencies have therefore developed a plan to mitigate or avoid any future depletions that increase shortages to the species and annual pulse flow targets (Governance Committee Program Document: Attachment 5: Water Plan) or otherwise undermine Program flow improvements.[21] This FEIS analysis assumes that these plans are implemented as part of any Program, although the states' depletion management plans were developed in the context of the Governance Committee Alternative only.

Each plan is briefly summarized. Please note that the Depletion Management Plans are complex. See the technical and legal details in the full text of the plans in the Governance Committee Program Document: Attachment 5: Water Plan.

Wyoming

Wyoming's Depletions Plan will serve the following purposes:

- Develop existing water-related baselines that define the existing water-related activities (on or before July 1, 1997) that are covered by the Program

[21] For example, from the adoption of the Cooperative Agreement in 1997 through June 30, 2002, an additional 4,407 new wells were drilled in Nebraska that may create depletions to the Central Platte River. (Nebraska Department of Natural Resources, 2003). The groundwater/surface water models developed as a result of the Nebraska Cooperative Hydrology Study will be used to determine the amount of new depletions represented by these new wells. These depletions would then be offset in accordance with the state's Depletion Management Plan.

- Establish a method for determining if the existing water-related baselines are exceeded and developing a mitigation plan for any excess depletions

- Determine a method for the reporting and mitigating of new water-related activities (post-July 1, 1997)

Existing Water Use

The Plan includes two existing water-related baselines for the North Platte River Basin and one for the South Platte River Basin:

- The first North Platte baseline addresses irrigation water use in the North Platte Basin above Guernsey Dam to the Wyoming–Colorado State line. If Wyoming complies with the acreage and consumptive use limitations for this area in the Modified North Platte Decree, it will be deemed that the existing depletions resulting from these uses are covered by this baseline and the Program. In addition, if the Casper Alcova Irrigation District does not irrigate more lands than allowed by its Wyoming water rights, the existing depletions resulting from these uses are covered by this baseline and the Program.

- The second North Platte baseline covers the existing irrigation water use in the Upper Laramie, Lower Laramie, Horse Creek, and the area below Guernsey Dam. In addition, the baseline covers all municipal, industrial, and other water use in the North Platte River Basin. Under-runs[22] by one sector can be used to offset over-runs in another sector. One example, annual under-runs in municipal use can be used to offset annual overruns in irrigation use and vice versa.

For several years prior to July 1, 1997, water from Wyoming's South Platte River Basin only passed into Nebraska and Colorado during some spring runoff or large rainfall events. The only new water use that could impact these events would be the construction or enlargement of reservoirs to store what little water passes the state line. Therefore, the South Platte baseline is the existing reservoir capacity as of July 1, 1997.

Wyoming's Depletions Plan will be managed by a state Coordinator within the State Engineer's Office. The Coordinator will be responsible for the development of the following reports:

- The first report will be completed by December 31, 2007, and will compare Wyoming's water use in the 2007 water year (October 1, 2006 through September 30, 2007) against the existing water-related baselines. If a baseline is exceeded, a mitigation plan must be developed and approved by the Governance Committee.

- Beginning on December 31, 2008, annual reports will be provided to determine if annual uses exceed the existing water-related baselines. If a baseline is exceeded, a mitigation plan must be developed that would replace any excess depletions during the following year. Excess depletions that occur in the irrigation season must be replaced in the following irrigation season. Excess depletions that occur in the nonirrigation season must be replaced in the following nonirrigation season.

[22] Under-runs are water use less than the baseline.

New Water-Related Activities

Each state Coordinator will complete the following tasks related to new water-related activities:

- Monitor the issuance of water rights and state funding of water projects to determine if the proposed water uses are covered by the Program or if they are new water uses that must be mitigated.
- If the activities are determined to be new uses that require Federal approval, the Coordinator will be available to assist in the ESA consultations with the Federal agencies if requested by the project proponents.
- If the activities are determined to be new uses that do not require Federal approval, the state Coordinator will require that the depletions from the new uses be mitigated. The mitigation can be the retirement of existing uses. For example, if a subdivision is constructed on irrigated lands, the retirement of the irrigated lands could offset the new depletions resulting from the subdivision. In addition, changes in use approved by the Wyoming Board of Control would be an example of a retired use being used for a new use. Mitigation can also be provided with replacement water for the depletions.

Wyoming Water Bank

The Wyoming Water Development Commission (WWDC) is evaluating the feasibility of a Wyoming Water Bank. The components of the water bank may include:

- Water in the Wyoming Account of the Pathfinder Modification Project not needed to meet the annual demands of the municipal customers or other priority uses.
- Uncontracted storage water in Wyoming's allocation of Glendo storage water not needed for other priority uses.
- Nonhydrologically connected groundwater wells.
- Permanently retired water uses (depletions) that are included under an existing water-related activity baseline.
- Other possible sources will also be investigated.

The primary goals of the WWDC will be to obtain enough water in the bank to address the following:

- Provide sufficient replacement water to offset any depletion in excess of the existing water-related baselines caused by the exercise of water rights issued on or before July 1, 1997, and the infrastructure in place at that time.

- Provide sufficient replacement water to offset any excess depletion caused by projects that were initiated between September 30, 1996, and September 30, 2007. However, if there are individual large new depletions in this timeframe, the project proponents may be required to provide the mitigation for those depletions. The State Engineer's Office has conditioned new permits issued since July 1, 1997, warning of this possibility.

- Provide sufficient replacement water for future domestic wells and stock ponds.

The extent to which the WWDC can achieve its primary goals depends on the water supply that can be obtained from the various components of the Wyoming Water Bank. It is very unlikely that there will be sufficient water in the Wyoming Water Bank to assist with the mitigation of new water-related activities beyond those related to domestic wells and stock ponds. Proponents of new water-related activities will likely need to provide mitigation for their projects.

Colorado

The Colorado's Plan for Future Depletions[23] is divided into Colorado South Platte River Basin and Colorado North Platte River Basin sections.

South Platte River Basin

The South Platte portion of the future depletions plan assumes that as Colorado grows, new water development will be driven by population growth and will come from a mixture of transbasin imports, nontributary groundwater, agricultural to urban conversion (all net additions of water), native Basin water, waste water reuse/exchange, and conservation (net reductions of water or neutral). On the whole, this mix of water development is anticipated to result in a net increase in yearly waterflow at the state line. However, the months of May and June may experience net depletions at the state line due primarily to new projects that deplete undeveloped native Basin flows. The South Platte new depletions plan simply retimes the net increase in water from times of net additions to times of net reductions to avoid increasing shortages to program target flows.

In addition to the assumptions concerning effects of future population growth, Colorado also assumes that total irrigated agricultural acreage in the Colorado portion of the South Platte Basin will not increase beyond the amounts irrigated in 1997.

To verify the assumptions in its plan for future depletions, Colorado will track changes in population, irrigated lands, and water use every 5 years. In the event that material assumptions underlying the plan are unfounded, Colorado has committed to make changes to its plan to address the new facts.

The Colorado retiming projects divert water in priority through existing ditch headgates or wells in the alluvium of the South Platte River downstream of Colorado's Washington County line. After diversion, this water recharges the alluvial aquifer of the South Platte River. The accretions from the recharge are timed to augment South Platte River flows during months in which a net depletive effect would otherwise occur.

[23] Governance Committee Program Document: Attachment 5: Water Plan, Section 9: Colorado's Plan for Future Depletions.

To the extent that Colorado constructs projects or obtains the ability to re-regulate water in excess of the total depletive effect for those months in which a net depletive effect will occur, such capacity will be available for use in the next succeeding reporting period or for other purposes.

It is important to note that the Colorado Depletions Plan does not restrict or regulate future water use in the South Platte River Basin, nor does it import water from other basins for the purpose of adding water to the South Platte River to meet Program target flows. The plan merely tracks how future changes in water use and storage affect the timing of riverflows near the state line with Nebraska and then operates the retiming projects to offset those changes timing of those flows.

North Platte River Basin

The State of Colorado expects little new water use, beyond historical uses, in the Colorado portion of the North Platte River Basin and, therefore, has not developed a plan for future depletions for this Basin at this time. Colorado will report irrigated acreage and the population in Jackson County to the Governance Committee. Colorado will mitigate new depletions that occur if the irrigated acreage exceeds 134,467 or the Jackson County population exceeds 2,022 persons. Once the Jackson County population exceeds 1,900, Colorado will propose a plan for future depletions for Jackson County.

In the event that a plan for future depletions is needed in the North Platte River Basin, Colorado commits to replace depletions from new water-related activities on a one-to-one basis in the North Platte River Basin after consideration of timing, location, and shortages to Program target flows in a manner consistent with the decree in *Nebraska* v. *Wyoming*, 325 U.S. 589 (1945), modified, 345 U.S. 981 (1953).

Nebraska

Nebraska's plan to prevent or mitigate for new depletions to target flows would be implemented primarily through actions taken by the Nebraska Department of Natural Resources (NDNR) and by seven natural resources districts that have land area subject to that plan.

Depletions to target flows and to "state-protected flows" will be estimated and will be offset in quantity, time, and location. For new uses begun between July 1, 1997, and December 31, 2005, the responsibility for implementing such offsets will rest with the state, except to the extent such offsets are required, because:

(1) The new use causing the depletion is subject to the Federal Depletion Management Plan or

(2) A person or entity other than the state has assumed responsibility for offset for specific new depletions.

For new uses begun on or after January 1, 2006, the responsibility for offsetting depletions will be shared by the new water user and the state. To the extent that new uses of groundwater require permits from natural resources districts (presently includes all new wells with pumping capacities greater than 50 gallons per minute), the following new and expanded groundwater uses begun on or after January 1, 2006, will not be allowed, unless the adverse effects of those uses on "state-protected flows" and on target flows will be offset: uses that (1) are located within the North Platte River, South Platte River, or the Platte River watershed in Nebraska, and (2) are so located and constructed that if water were intentionally withdrawn for 40 years, the cumulative stream depletion to the North Platte River, the South Platte River, the Platte River, or a base flow tributary thereto upstream of Chapman, Nebraska, would be greater than or equal to 28 percent of the total groundwater consumed as a result of the withdrawals from those wells. The new groundwater user will be responsible for offsetting any depletions to “state-protected flows,” and the state will be responsible for offsetting any remaining depletions to target flows. If any new surface water uses are permitted (Nebraska currently has a moratorium on new surface water uses upstream of the confluence of the Loup River with the Platte River), the responsibility for offsets would be shared by the new surface water user and the state in much the same way.

In all cases, the offset objective will be to replace the water depleted in the amounts needed, and at the times and locations needed, to prevent harm to the water uses and/or the target flows for which such flow protection is required. The following water sources may be used to offset depletions for which mitigation is required by this plan:

- The portions of the yields from the following reconnaissance-level Water Action Plan projects reserved by Nebraska for offset purposes: the Central Platte offstream reservoir, groundwater mound management, the Dawson/Gothenburg Canal recharge project, and power interference
- Water leasing and water right transfers
- Water management incentives, including but not limited to: irrigation system conversions, changes in tillage practices, changes in cropping mix, and deficit irrigation
- Retirement of or reduction in consumption by existing surface water and groundwater uses
- Other groundwater recharge/retiming projects
- Construction of new surface water storage projects (any peak flow impacts caused by new Nebraska storage projects will be addressed separately in any related Section 7 consultation if and when the amount collectively stored by such new projects will exceed 10 kaf)
- Purchase of storage water from existing surface water storage projects
- Pumping groundwater directly into a stream
- Converting from surface water to groundwater to eliminate a portion of the depletion or to change the timing of the depletion
- Relocating the point of groundwater withdrawal so that the depletion is reduced and/or the timing is changed
- New controlled drainage projects
- Other offset projects, as feasible and appropriate

By December 31, 2008, the state (or other responsible person or entity when applicable) will:

- Put into place the measures necessary to offset in amount, timing, and location the existing depletions to target flows and to state-protected flows caused by new water uses that are not subject to the Federal Depletion Management Plan and are begun between July 1, 1997, and December 31, 2005, and/or
- Will indicate the extent to which it intends to rely on water from one or more Program water projects that have not yet been completed, but for which yields are reserved by Nebraska for the purpose of providing such offsets.

Any additional offset measures that are needed thereafter because of the lag effect of new groundwater uses begun in that same time period will be put into place by the time the depletions from those new uses occur.

Federal

A new Federal depletion is one that occurs after July 1, 1997, which is partially or solely a Federal agency responsibility to address. Generally speaking, this would include depletions from new water-related activities implemented by Federal agencies that provide a primarily "national benefit." Typically, these will be water-related projects for which the associated water rights are held by a Federal Government agency for a national benefit. This would exclude Federal activities in which the major beneficiaries and/or water rights holders are individual water users, permittees, or license holders. Federal activities in which the major beneficiaries and/or water rights holders are individual water users, permittees, or license holders, and which result in new depletions, are not a Federal agency responsibility to address. General categories of known or anticipated "new Federal depletion" have been identified to the extent possible (see Governance Committee Program Document: Attachment 5: Water Plan, Section 10: Federal Depletions Plan for the Platte River Recovery Implementation Program, Table 1). Examples of activities that would be considered predominantly "Federal" in scope and which, therefore, would not be expected to be covered under the states' Depletion Management Plans include, but are not necessarily limited to:

- ➢ New water storage facilities, impoundments, and consumptive water uses at National Wildlife Refuges, waterfowl production areas, and national fish hatcheries
- ➢ New consumptive water uses at national forests, parks, monuments, and historic sites, including recreational, habitat improvement, administrative, and emergency uses
- ➢ New depletions associated with activities at Federal facilities which provide benefits that are primarily national in scope, such as national defense, national security, or national research and development activities (e.g., Rocky Mountain Arsenal, National Renewable Energy Laboratory)

The Federal Depletion Management Plan does not address the impacts, including channel stability, of past and future vegetation management by the U.S. Forest Service in the Platte River Basin.[24] Such impacts will be the subject of further research and analysis during the Program's First Increment, as described in Attachment A of the Federal Depletion Management Plan (U.S. Forest Service, 2005, personal communication).[25]

The scope of the Federal Depletion Management Plan is to cover relatively small new Federal depletion associated with the operation, management, and improvement of Federal lands and Federal facilities providing primarily national benefits to the general public. The plan provides for a maximum of 1,050 acre-feet per year of new Federal depletion between July 1, 1997, and the end of the Program's First Increment, measured in terms of average annual reductions in target flows. These reductions in flows will be quantified:

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[24]It is the position of the U.S. Forest Service that changes to water yield from forested landscapes resulting from the natural variability of the forest condition are not Federal actions and do not constitute depletions that require consultation under Section 7(a)(2) or any other provisions of the ESA. Several entities represented on the Governance Committee do not agree with this position taken by the U.S. Forest Service.

[25]December 2, 2005, letter from Rick D. Cables, Regional Forester.

- At the Colorado–Nebraska State line (if the project is in the South Platte River Basin above this line)
- At the Wyoming–Colorado State line (if the project is in the North Platte River Basin above this line)
- At the Wyoming–Nebraska State line (if the project is in the North Platte River Basin in Wyoming above this line)
- At the uppermost point in the South Platte River, North Platte River, or main stem Platte River above Chapman where the project's aggregate impact on flows can be quantified (if the project is in Nebraska)

Each state has agreed to work with Interior and cooperating Federal agencies in the process of securing up to 350 acre-feet of water annually, if needed, to offset new Federal depletion within the state in a manner consistent with the respective state's Depletion Management Plan.

The Federal Depletion Management Plan is not intended to cover large new Federal depletion (e.g., Federal depletion measured in thousands of acre-feet per year) that could be associated with new or enlarged reservoirs, large well fields, large surface water diversions, or other large-scale activities. Those will be covered through measures developed under separate ESA Section 7 consultation.

The Federal Depletion Management Plan is not intended to address water conservation activities that are implemented on privately owned agricultural lands in the Platte River Basin that may result in new depletions. It will remain the responsibility of Federal agencies to initiate ESA Section 7 consultation with the Service for such Federal actions that are likely to result in new depletions to the Platte River, including water and land conservation activities.

Section 7 Consultation Requirements

New Federal depletion will not be covered by the Program's Federal Depletion Management Plan until the Federal agency undertakes ESA Section 7 consultation, quantifies the new depletion, and agrees to participate in the Program. If a Federal agency chooses to not participate in the Program/Federal Depletion Management Plan, then the Service will request the agency to replace the new depletion to the extent necessary to:

- Be consistent with the Program Agreement, and
- Mitigate the impacts of the new Federal depletion on the occurrence of target flows and on the effectiveness of the Program in reducing shortages to target flows.

Such replacements shall occur in the same state in which the new water-related activity occurs, or the responsible agency shall use other acceptable methods as agreed to by the Service and the Governance Committee.

Options for Mitigating, Offsetting, or Preventing New Federal Depletion

A Federal agency electing to participate in the Program will have several options for addressing the new Federal depletion for which the agency is responsible:

- Replace the new Federal depletion by permanently retiring an equivalent Federal depletive activity

- Provide annual funding to the appropriate parties to ensure that offsetting measures will be implemented consistent with the applicable state Depletion Management Plan, on terms acceptable to the state, as necessary to fully offset the Federal depletion

- Replace the new depletion through other means

Known and anticipated new Federal depletion occurring since July 1, 1997, are identified in the Governance Committee Program Document: Attachment 5: Water Plan, Section 10: Federal Depletions Plan for the Platte River Recovery Implementation Program, table 1. This matrix was developed by Interior by soliciting information about known and anticipated water-use activities in the Platte River Basin from the identified Federal agencies. While an attempt has been made to identify all possible new Federal depletion of significance, this summary is necessarily limited by currently available information and by imperfect knowledge of future activities.

LAND ELEMENTS

The Governance Committee's land objective for the Program's First Increment is protecting; restoring, where appropriate; and maintaining at least 10,000 acres of habitat for the target species in the Central Platte Habitat Area, located between Lexington and Chapman, Nebraska (see the, "Introduction" section in chapter 2 for a discussion and map of the habitat area).[26]

The 10,000 acres of land have been divided into two categories:

- 9,200 acres of lands for habitat complexes with potential to achieve habitat characteristics similar to table 3-1 (habitat complex guidelines).

- 800 acres of non-complex lands, such as sandpits and small palustrine wetlands, with the aim of approximating features described in table 3-2 (non-complex habitat guidelines).

Habitat Complexes

Land management plans will be developed based upon the features on individual parcels managed by the Program rather than strict adherence to table 3-1. To the extent practical, however, the characteristics summarized in table 3-1 will guide development of the parcel's management plan. In general, restoration and enhancement would seek to increase the amount of available open channel habitat for roosting and nesting; the amount of wet meadow habitat for crane foraging, loafing, and courtship; and the continuity of "buffer" lands around channel and wet meadow habitat to minimize disturbance.

Figure 3-3 (a and b) shows an illustrative parcel of Program land from the EIS Geographic Information System. Based upon aerial photography, the land use and vegetative cover type for each parcel of land are represented in the GIS database. This system allows the EIS team to evaluate various approaches to Program management (e.g., tracking acreages that are managed, the effect of management actions, costs). Figure 3-3 (a) shows the parcel before a hypothetical management plan is implemented. Figure 3-3 (b)

[26]The 10,000 acres include two parcels that have already been put forward for inclusion in a Program: the 470-acre State of Wyoming property near Kearney, Nebraska, and the 2,650-acre NPPD Cottonwood Ranch property near Elm Creek, Nebraska.

shows the parcel after habitat restoration. In this figure, the primary management actions have been clearing vegetation from islands in the river and lowering the tops of those islands below the average high water surface. These actions (and subsequent maintenance) are designed to produce increases in unvegetated channel.

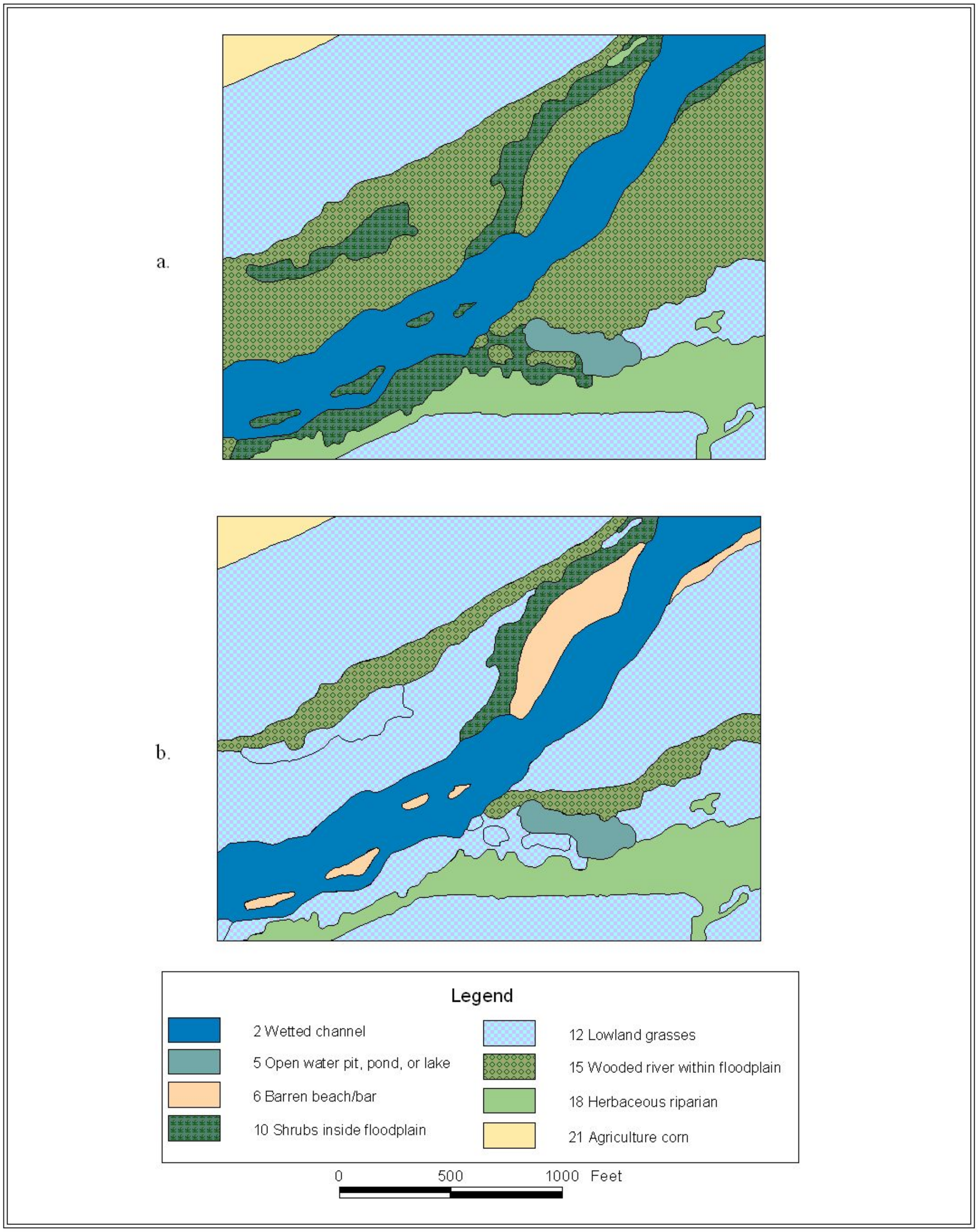


Figure 3-3.—Illustration of land cover type changes resulting from habitat restoration.

Land management outside the river channel could include removing trees and shrubs; restoring sloughs, swales, and wet meadows by reshaping and lowering land; plugging agricultural drains; and reducing downcutting of the river channel through water and sediment management. Water available on the parcel might be directed into these lower areas. The aim is to restore the parcel to look more like the grasslands and wet meadow depicted in the "Lowland Grasslands and Wet Meadows" section in chapter 2.

Non-Complex Habitat

Land management of non-complex habitats would be guided by the habitat characteristics described in table 3-2. There are two types of nonriverine habitats related to non-complex habitats: sandpit habitat for interior least and plovers and nonriparian habitat for whooping cranes.

Managing sandpits may involve, but is not limited to, vegetation control through harrowing, discing, and pre-emergent herbicides. Vegetation management may also include removing grasses, weeds, and willow and cottonwood seedlings as needed. These vegetation management efforts are conducted around potential nesting areas on an annual basis to curtail vegetation encroachment.

Nest predation can also be a significant issue on sandpits. Portable and permanent electric fencing has been used to discourage predators from entering nesting areas. Fencing is configured both to prevent predators from digging under and to discourage avian predators from perching on the fence.

Nonriparian wetlands on Program lands may be restored, when necessary, and will be managed to ensure protection of whooping cranes from human disturbance.

Acquiring and Managing Land for Habitat Complexes

Many factors would guide the Governance Committee's determination whether or not to acquire a particular parcel of land. These factors include but are not limited to:

- **Relative Potential Benefits:** Relative potential benefits to the species from individual properties alone and/or in combination with nearby properties.
- **Type of Interest in Land:** Program lands may include fee title ownership, leases, easements, or other arrangements agreed to by the Governance Committee. It is anticipated that a mix of interests would be acquired during the Program's First Increment. The length of the interest should be sufficient to get a good return of benefits given the costs of acquisition, restoration, and management.
- **Location:** Preferably, no more than one habitat complex per "bridge segment" between Lexington and Chapman. The Program would prefer parcels with the best existing or restorable habitat not already being protected by some entity for wildlife purposes, as well as bridge segments that do not currently have any protected habitat.
- **Size:** Generally, a larger property is preferred over a smaller one to provide greater unobstructed view and protection from disturbance.

- **Habitat Complexes:** Lands that can function as a habitat complex with adjoining, or nearby, already-protected lands (even a small property) are preferred over lands that could function as a complex when considered with adjoining, but unprotected, lands. Wet meadows that are contiguous with channel areas are preferred over wet meadows farther away. Wet meadow and channel habitat is preferred over habitat that simply provides buffer from disturbance.

- **River Area:** Potential to form a habitat complex that encompasses both sides of the river.

- **Restoration:** Likely success of restoration efforts.

- **Cost:** Relative costs of acquisition, restoration, and maintenance activities, as well as other cost effectiveness considerations.

Initial Focus for Habitat Complexes

In addition to the Program land objectives described above, the Adaptive Management Plan describes more specific initial management objectives that will be the initial focus for restoration and protection of habitat complexes.

Location

While the long-term objective is to have 1 habitat complex in each of 10 bridge segments in the Central Platte Habitat Area, the Adaptive Management Plan indicates that the Program's First Increment emphasis will be on the river above Minden, Nebraska, with a target of 6,400 acres of Program habitat complexes in this reach and the remaining 2,800 acres downstream to Chapman.

Restoration

The Adaptive Management Plan also describes a Program's First Increment focus on restoration of habitat, as opposed to protection of existing habitat, with roughly 50 percent of Program lands undergoing significant restoration or enhancement (change in cover type or land category) during the Program's First Increment.

Wet Meadows

The management objective from the Adaptive Management Plan is to increase wet meadow acreage by 10 percent over the 1998 baseline conditions for the Central Platte Habitat Area during the Program's First Increment.

Open Channel Habitat

The management objective from the Adaptive Management Plan is to increase the acreage of channel area greater than 750 feet wide by 30 percent over the 1998 baseline conditions for the Central Platte Habitat Area during the Program's First Increment. Methods to be tested for achieving that result include:

- ➢ Mechanically clear vegetation from islands and banks in the channel as needed to aid the widening process
- ➢ Mechanically lower islands and banks to a level that will be inundated by anticipated annual peak flows
- ➢ Scour channel vegetation, maintain channel width and form, and build higher sandbars through short-duration near-bankfull flows within banks, and use other flow management methods
- ➢ Consolidate higher flows into the widened channel and away from subchannels to maximize stream power and help induce braided channel characteristics (see the "Stream Power and Plan Form" sidebar in chapter 2 and the "River Geomorphology" section in chapter 4 for more details on approaches).

Offsetting Channel Erosion

The management objective from the Adaptive Management Plan is to assist in attaining sediment balance in the river reach above Kearney, Nebraska, through actions on Program lands during the Program's First Increment. Methods for achieving these objectives that will be tested through the adaptive management process include:

- ➢ Starting in year 1 of the Program, move river sand on approximately 20 acres of river islands and banks on Program lands or cooperator lands above Overton into the channel where it can be mobilized by the riverflow. Cleared areas will ultimately be lowered to the elevation that can be overtopped and scoured by a flow of 1,000 cfs. Movement of the island or bank sand into the active channel should occur at a rate that allows the material to be moved by the river but does not raise average bed elevation so much that flow begins to spill into subchannels.
- ➢ Begin investigating alternative methods to attain a sediment balance such as channel plan form changes, tributary delivery improvements, or flow routing changes.
- ➢ Develop a master plan for sustaining sediment balance in the Central Platte Habitat Area over the long term:

Land Management Plans

Land management plans would be developed to address management, restoration, or maintenance appropriate to parcels of land acquired for the Governance Committee Alternative.[27]

[27]Examples of potential management methods can be found in the Platte River Endangered Species Partnership (2000).

Illustrative Scenario for Program Lands under the Governance Committee Alternative

Acquiring interests in lands for the Program is based entirely upon willing sellers. Therefore, it is not possible to determine, prior to Program implementation, exactly which lands will become part of the Program.[28] However, based upon meeting the objectives described above, an illustrative scenario for land acquisition and management has been analyzed. While the ultimate plan implemented for the Program will differ in specific location and management of each land parcel, the overall scale of actions, the types of actions, and, hence, their overall effect on key habitat characteristics should be similar to those produced by this scenario.

Table 3-8 shows the acres of land managed under this scenario for various reaches of the river.

Table 3-8.—Illustrative Distribution of Land Plan Acreage by River Segment, Governance Committee Alternative*

River Reach	Acreage
Lexington to Johnson-2 Return	24
Johnson-2 Return to Overton	195
Overton to Elm Creek	3,110
Elm Creek to Odessa	57
Odessa to Kearney	1,760
Kearney to Minden	1,551
Minden to Gibbon	75
Gibbon to Shelton	1,094
Shelton to Wood River	116
Wood River to Alda	230
Alda to Doniphan	61
Doniphan to Phillips	42
Phillips to Chapman	1,685
Total	**10,000**
*Includes all Program interests in lands, whether fee title, leases, or easements.	

To accomplish the habitat restoration objectives, actions are proposed on Program lands to promote the occurrence of braided river (wide channel and multiple sandbars). The goal is to create additional areas of wide channel with views that are not obstructed by high islands and to increase the occurrence of mid-channel side bars. Actions to increase areas of braided river are especially important in those areas of the Central Platte Habitat Area where the river has become anastomosed with multiple narrow channels divided by vegetated islands. In these areas, actions are taken on Program lands to widen and sustain the primary channel.

[28]Except for the Cottonwood Ranch and the Wyoming Water Development Commission Property, which have already been committed to the Program by their managing entities.

Widening results from cutting riverbanks and lowering islands after removing vegetation. Sustainability is obtained by consolidating high riverflows into the primary channel by blocking or diverting those flows from subchannels during high flow events. The flows consolidated in the primary channel during high flow events, such as short-duration near bankfull flows, increase the river's ability to remove annual vegetation and to mobilize and build sandbars. The illustrative land plans involve various amounts of bank cutting, island leveling, and the consolidation of flows during high flow events.

Where impacts to non-Program lands can be avoided, restriction of flow into subchannels may take several forms. Where subchannels are short and narrow, it may be most useful to block the upper end of the channel with a sand dam, converting the short and narrow channel into a slough or backwater. Where the subchannel is lengthier or wider, the best approach may be to place a sand dam and pipe culvert across the upper end. The dam and culvert could be sized to allow average flows to continue through the subchannel, while diverting the highest flows into the primary channel. Other approaches are possible, all with the objective of diverting the highest flows into the primary channel.

As with all channel restoration work, detailed restoration plans will be developed once a Program is under implementation and specific lands are offered for sale or lease by landowners. At that time, specific permitting under the Clean Water Act will also be necessary through the U.S. Army Corps of Engineers (Corps). Every effort will be made to avoid any adverse consequences or impacts to downstream land owners, as stipulated in the Program's Good Neighbor Policy.

Table 3-9 shows how this land management scenario modifies various land cover types as restoration is undertaken. For example, in this scenario, lands are acquired in areas where the river flood plain is filled with wooded islands. To more closely achieve the habitat characteristics of open channel described in table 3-1 (habitat complex guidelines), the Governance Committee Alternative could convert roughly 300 to 400 acres of vegetated islands in the river channel to wetted channel by removing vegetation and lowering the islands and banks to an elevation that can be overtopped by flows within the riverbanks.

Table 3-9.—Summary of Estimated Land Cover Changes for All Land Parcels Managed in the Governance Committee Alternative

Restoration Activities	Change in Cover Type	Acres	Subtotal
To lowland grassland	Wooded to lowland grassland	2,235	**4,277**
	Herbaceous to lowland grassland	271	
	Agriculture to lowland grassland	1,161	
	Shrubs to lowland grassland	513	
	Upland grassland to lowland grassland	94	
	Emergents to lowland grassland	3	
To wetted channel	Wooded to wetted channel	152	**355**
	Shrubs to wetted channel	163	
	Herbaceous to wetted channel	19	
	Bare sand to wetted channel	19	
	Lowland grassland to wetted channel	2	
	Emergents to wetted channel	0	
To bare sand	Wooded to bare sand	0	**0**
	Shrubs to bare sand	0	
	Herbaceous to bare sand	0	
Restored lands		4,632	4,632
Unmodified lands		4,568	4,568
Total non-complex habitat		800	800
Totals		**10,000**	**10,000**

Figure 3-4 shows how a cross section of the river channel at Cottonwood Ranch might be modified under this scenario to improve channel width and open view. It illustrates the result of clearing vegetation from a high wooded island in the channel and the lowering of the island closer to the average water surface. Also, diverting of high flows from subchannels into the main channel is illustrated.

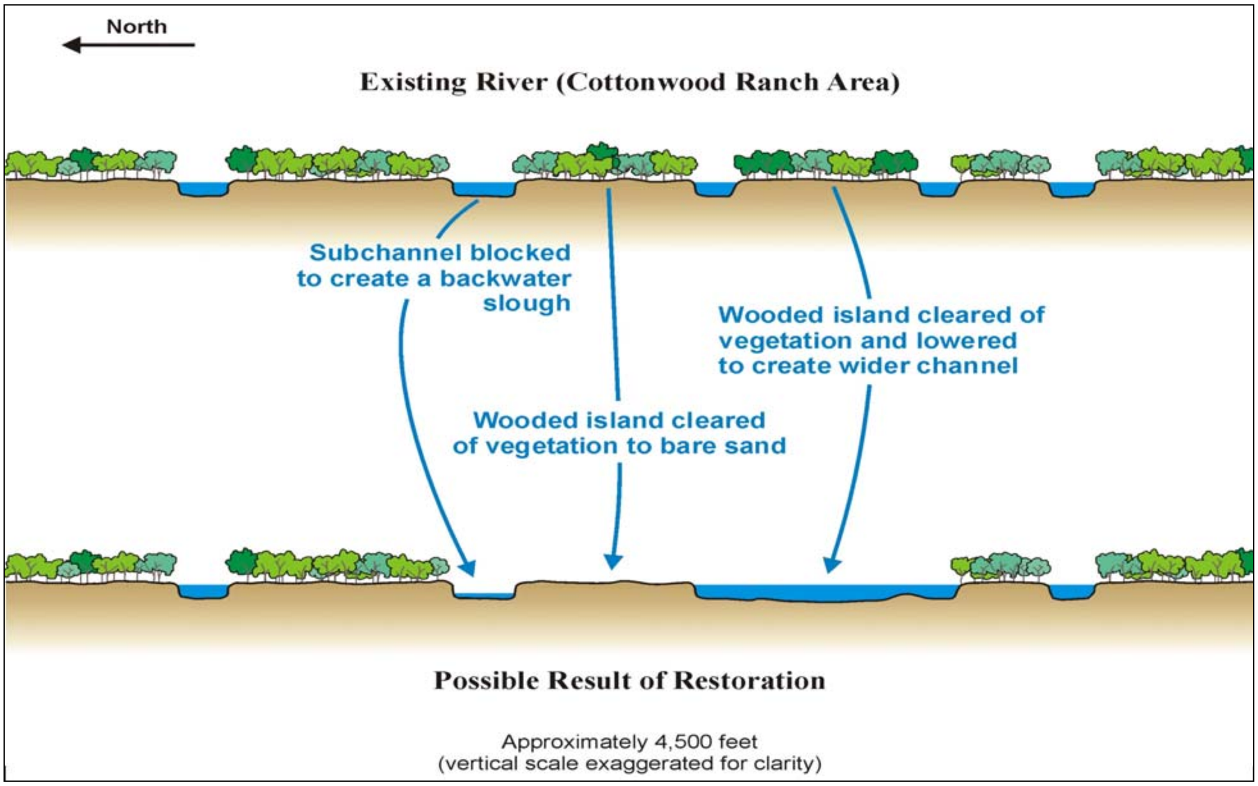


Figure 3-4.—Cross section of the river on Cottonwood Ranch, illustrating the types of channel restoration activities described in this scenario.

Under the Adaptive Management Plan, this process would be accomplished in phases over several years. Initial efforts would be small in scale, with monitoring of progress effects and effectiveness, as described in detail in the Adaptive Management Plan. In this scenario, approximately 300 to 400 acres of vegetated islands on Program lands are cleared and lowered by the end of the Program's First Increment.

SUMMARY OF ASSUMPTIONS FOR ANALYSIS OF THE GOVERNANCE COMMITTEE ALTERNATIVE

As described earlier, the FEIS analysis assumes full implementation of the alternatives in order to describe the largest likely environmental effects. The following is a list of the key assumptions about the Alternative's implementation which form the basis of the FEIS analysis. Some of the actions described below are milestones form the Governance Committee Program Document. Others are initial approaches to habitat restoration outlined in the Governance Committee's Adaptive Management Plan. Under this plan, the Governance Committee may develop alternative means of providing similar benefits to the target avian species and their associated habitat, or modify the objectives using the process defined in the Adaptive Management Plan.

(1) All Governance Committee Alternative water elements are implemented and operational.

(2) The capacity of the North Platte River channel at North Platte, Nebraska, is restored to at least 3,000 cfs.

(3) The capacity to move 5,000 cfs of Program water to Overton, for the creation of short-duration near-bankfull flows through the Central Platte Habitat Area, is accomplished.

(4) The capacity to move 800 cfs of Program water to Overton during the irrigation season is accomplished.

(5) The capacity to create short-duration near-bankfull flows in the Central Platte Habitat Area is increased by using various facilities in the CNPPID and NPPD system (for example, Lake Mahoney, Johnson Lake, and the Johnson-2 Forebay) to store and release a 2-day pulse flow from the Jeffrey and Johnson-2 Return channels.

(6) Methods to consolidate flow and to clear and lower banks and islands to create and maintain wider areas of river channel are successful and are implemented on a scale sufficient to achieve the Adaptive Management Plan objectives for restoring open channel habitat.

(7) Methods to balance the river sediment supply and erosion above Kearney, Nebraska, are successful and implemented on a scale sufficient to achieve the Adaptive Management Plan objective for sediment balance.

(8) The Alternative land plan is implemented. The majority of Program lands for habitat complexes are acquired or managed above Kearney, with roughly 50 percent of Program lands undergoing restoration.

(9) The Federal and State Depletion Management Plans are implemented.

FULL WATER LEASING ALTERNATIVE

The Full Water Leasing Alternative was developed to emphasize nonstructural approaches to meeting the Program's flow goals. The water elements for the Full Leasing Alternative are shown in figure 3-5 and table 3-11. This alternative uses a Lake McConaughy Re-regulation Account (RA) to store conserved water. The reduction in target flow shortages is accomplished by leasing water from willing participants in the three states. This alternative replaces the "Water Leasing Alternative" analyzed in the DEIS and incorporates considerably more water leasing. The aim of this alternative is to explore further the benefits and costs of providing the majority of the Program's water through reduction in consumptive use of Platte River water.

The Program would lease water from willing lessors sufficient to allow release of enough water to improve achievement of target flows by roughly 137 kaf on an average annual basis.

WATER ELEMENTS

The water elements for this alternative (table 3-10) are the Lake McConaughy RA plus water leasing in the three states.

Table 3-10.—Average Annual Program Water Contribution to Species' Target Flows Under the Full Water Leasing Alternative (kaf per year)

Program Water Features and Elements	Projected Improvement Toward Target Flows (kaf per year)
Wyoming Water leasing (approximately 60 to 70 kaf per year leased) Colorado Water leasing (approximately 100 kaf per year leased) Nebraska Water leasing (approximately 60 to 70 kaf per year leased) Lake McConaughy RA 200 kaf	
Total	**137**

Lake McConaughy Re-Regulation Account

Management of the RA would be similar as for the Lake McConaughy EA in the Governance Committee Alternative. Management of Program flows at Grand Island would be similar to that shown in figure 3-2.

For the RA, 200 kaf of space in Lake McConaughy would be allocated for storing and releasing Program water, similar to the EA proposed for the Governance Committee Alternative. The primary difference is that the RA would not acquire 10 percent of the storable inflows to Lake McConaughy; it would only capture and/or regulate Program water acquired through leasing of consumptive use on the North Platte River and Platte Rivers in Wyoming and Nebraska. Water not released from the RA in one year would carry over to the next year, as long as the limit of 200 kaf is not exceeded.

Water Leasing

Each state would lease water for Program purposes by voluntary participation, from existing reservoir storage or direct diverters in that state. The state would provide to the Program only the consumptive use associated with the existing use. The remainder acquired would be managed under direction of the state to maintain the current pattern of return flows. Typically, this means that the Program would manage approximately one-half of the water leased.

The location of the leased water would depend on patterns of participation and state policies. For this FEIS analysis, the amount of water assumed to be leased was divided among reservoirs or projects as follows to illustrate a range of possible effects (table 3-11). In actual implementation, Program water leasing would likely be more widely distributed.[29]

Wyoming: The Program leases 32 percent of the water that each Reclamation district receives from Reclamation reservoirs in the North Platte River Basin. (Such an approach would likely require the creating accounts in the North Platte Project reservoirs (Pathfinder and Guernsey) for each irrigation district that receives water from the North Platte Project.)

Colorado: The Program leases water both from reservoir storage and direct flow diverters on the South Platte River, as shown in table 3-11). These leases are targeted and managed to provide increased flows in May and June to the state line. It is assumed that any such leasing would occur in the Lower South Platte River Basin, below Greeley, where competition for water with municipalities is reduced.

Nebraska: The Program leases 13.8 percent of the water diverted by each irrigation district that has a surface water diversion below North Platte, Nebraska, and that receives water from storage in Lake McConaughy and Sutherland Reservoir.

After accounting for conversion of stored water to consumptive use and for transit losses, this element would yield approximately 137 kaf per year of target flow improvement at the habitat.

[29]For the FEIS analysis, it is assumed that when water is leased by farmers to the Program, the states will require that other sources of water not be used to replace the leased supply that would cause secondary impacts on riverflows.

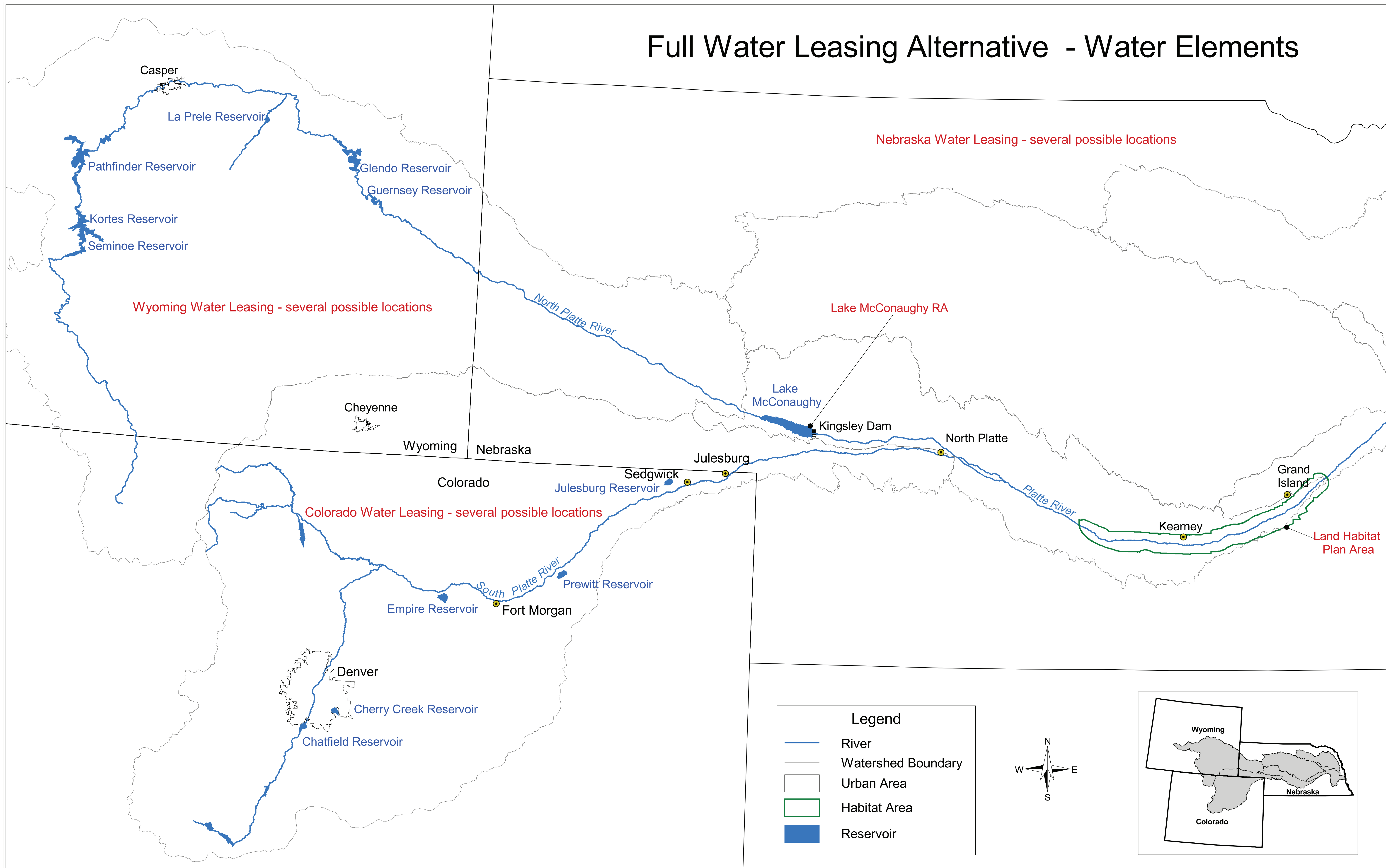


Figure 3-5.—Water elements map for Full Water Leasing alternative.

Table 3-11.—Illustrative Distribution of Water Leased to the Program Under the Full Water Leasing Alternative

	Acre-Feet
Wyoming (North Platte River Reservoirs)*	
North Platte Project	124,100
Kendrick Project	18,800
Glendo Unit	3,465
Colorado	
Jackson Lake	8,000
Empire Reservoir	4,000
Riverside Reservoir	8,000
Prewitt Reservoir	10,000
North Sterling Reservoir	30,000
Julesburg Reservoir	10,000
South Platte River Direct Diverters	28,125
Nebraska (Lake McConaughy and below)	
Lake McConaughy	120,000
*A significant amount of the water in these Wyoming reservoirs serves agricultural lands in the panhandle of Nebraska.	

PROGRAM RELEASES AND FLOWS

The water accrued to the Pathfinder EA and the leased waters in the North Platte River Basin typically would be held in one or more of the North Platte River reservoirs and moved down to the Lake McConaughy RA during September. The leased waters in the South Platte River Basin would likely be released or bypassed in May and June to augment spring flows and sediment transport to the Central Platte Habitat Area.

For this alternative, the capacity to move water to the habitat and to create short-duration near-bankfull flows would be the same as that for the Governance Committee Alternative.

LAND ELEMENTS

The Land Plan for this alternative is the same as for the Governance Committee Alternative.

SUMMARY OF ASSUMPTIONS FOR ANALYSIS OF THE FULL WATER LEASING ALTERNATIVE

(1) All Full Water Leasing Alternative water elements are implemented and operational.

(2) The capacity of the North Platte River channel at North Platte, Nebraska, is restored to at least 3,000 cfs.

(3) The capacity to move 5,000 cfs of Program water to Overton, for the creation of short-duration near-bankfull flows through the Central Platte Habitat Area, is accomplished.

(4) The capacity to move 800 cfs of Program water to Overton during the irrigation season is accomplished.

(5) The capacity to create short-duration near-bankfull flows in the Central Platte Habitat Area is increased by using various facilities in the CNPPID and NPPD system (for example, Lake Mahoney, Johnson Lake, and the Johnson-2 Forebay) to store and release a 2-day pulse flow from the Jeffrey and Johnson-2 Return Channels.

(6) Methods to consolidate flow and to clear and lower banks and islands to create and maintain wider areas of river channel are successful and are implemented on a scale sufficient to achieve the Adaptive Management Plan objectives for restoring open channel habitat.

(7) Methods to balance the river sediment supply and erosion above Kearney, Nebraska, are successful and implemented on a scale sufficient to achieve the Adaptive Management Plan objective for sediment balance.

(8) The Alternative land plan is implemented. The majority of Program lands for habitat complexes are acquired or managed above Kearney, with roughly 50 percent of Program lands undergoing restoration.

(9) The Federal and State Depletion Management Plans are implemented.

WET MEADOW ALTERNATIVE

This alternative focuses Program resources on increasing the amount of wet meadow habitat in the Central Platte Habitat Area. The alternative shifts some resources from water supply and management to land management. Figure 3-6 shows the location of the water elements for this alternative.

WATER ELEMENTS

The Wet Meadow Alternative uses the three state projects, plus a 100-kaf new water right for the Program in Glendo Reservoir. Table 3-12 lists the water elements for the Wet Meadow Alternative.

Table 3-12.—Average Annual Program Water Contribution
to Species' Target Flows Under the Wet Meadow Alternative (kaf per year)

Program Water Features and Elements	Projected Improvement Toward Target Flows (kaf per year)
State Projects	
Total for these elements: Lake McConaughy EA Pathfinder Modification Project EA Tamarack Project, Phase I	80
Additional Water Elements	
Total for these elements: Wyoming Program water right for 100 kaf Glendo storage Glendo Reservoir Storage Pathfinder Wyoming Account	36
Total	**116**

Lake McConaughy EA

See Governance Committee Alternative.

Pathfinder Modification Project EA

See Governance Committee Alternative.

Pathfinder Wyoming Account

See Governance Committee Alternative.

Glendo Reservoir Storage

See Governance Committee Alternative.

Tamarack Project, Phase I

See Governance Committee Alternative.

New Program 100-Kaf Water Right in Glendo Reservoir

This proposal is to reduce the re-regulation space in Glendo Reservoir by 100 kaf and file in Wyoming for a new (junior) water right on that space. Currently, over 300 kaf of the space in Glendo Reservoir is dedicated to the restorage of water that is released in the winter from Pathfinder Reservoir to generate power and maintain Gray Reef Reservoir minimum outflow requirements. Water accruing in priority to the 100-kaf space would be managed for the target species. This produces approximately 38 kaf of reduction in target flow shortages at Grand Island.

A new Wyoming water right would be required to allow this storage to be used for environmental purposes. Additional Federal authorization may also be required. The re-regulation space in Glendo is currently used to (see subsection XVII (g) of the Modified North Platte Decree):

- Replace water that passed the Wyoming–Nebraska State line in excess of the amount ordered by canals with storage contracts below the Wyoming–Nebraska State line;
- Replace evaporation from the storage ownership accounts of Pathfinder Reservoir, Guernsey Reservoir, Seminoe Reservoir, Alcova Reservoir, and Glendo Reservoir; and
- Supplement the natural flow that is available for apportionment between Wyoming and Nebraska.

The FEIS analysis assesses impacts of this change on current water uses.

PROGRAM RELEASES AND FLOWS

The water accrued to the Pathfinder EA and the Program storage right in Glendo Reservoir would be moved down to the Lake McConaughy EA during September. For this alternative, the capacity to move water to the habitat and to create short-duration near-bankfull flows would be the same as that for the Governance Committee Alternative.

Lake McConaughy Environmental Account Management

Management of the EA would be roughly the same as for the Governance Committee Alternative. However, the significantly reduced amount of Program water would mean that achievement of flow targets and vegetation-scouring flows would be impaired.

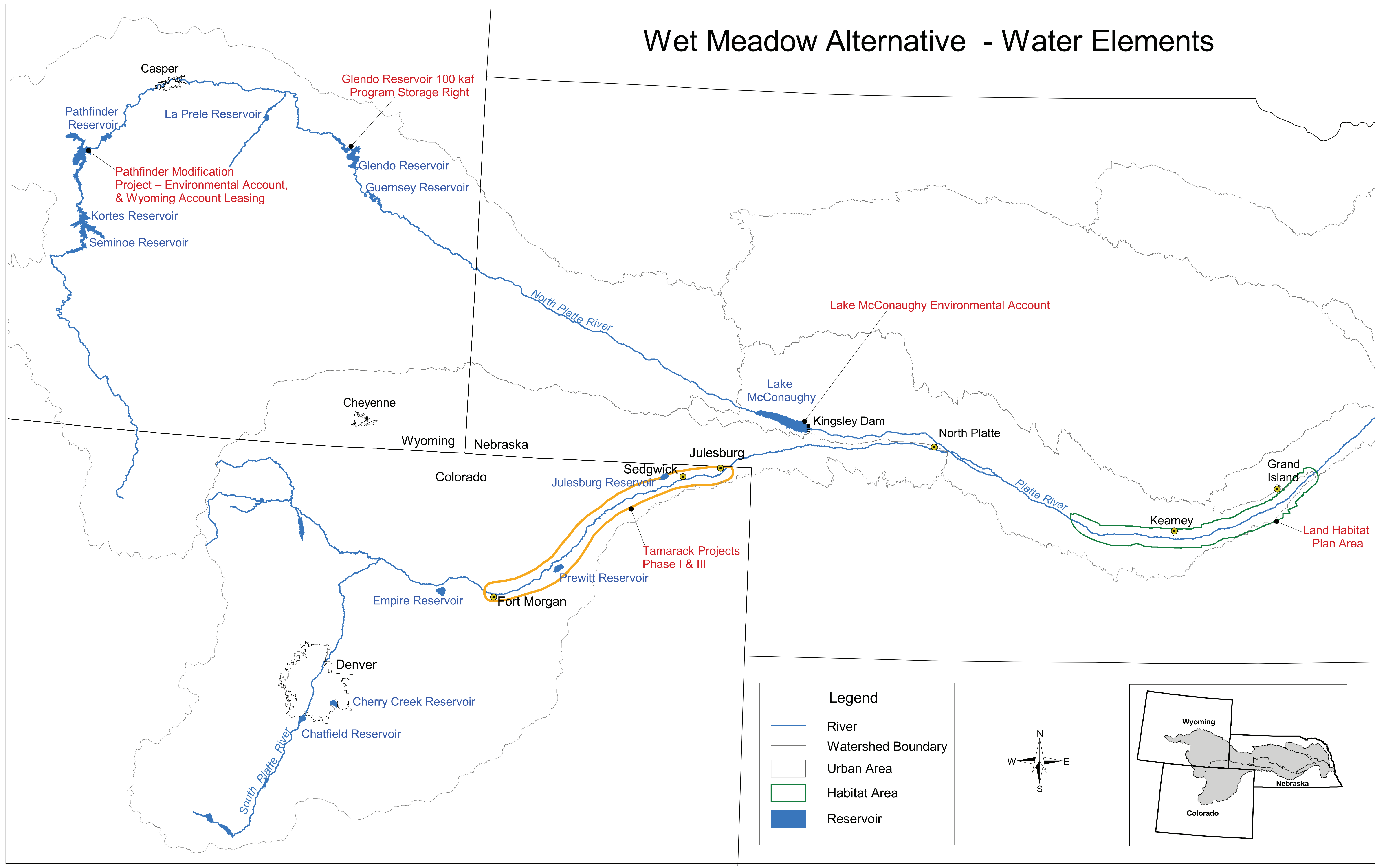


Figure 3-6.—Water elements map for Wet Meadow alternative.

LAND ELEMENTS

Land elements are discussed below and summarized in tables 3-13 and 3-14.

Table 3-13 shows the acres of land managed under the Wet Meadow Alternative for each river reach. This alternative includes the same Land Management Plan as contained in the Governance Committee Alternative, but it adds roughly 7,000 acres of additional wet meadow acquisition and/or restoration. Methods for restoration of wet meadows are described in the Platte River Endangered Species Partnership, *Habitat Management Methods for Least Terns, Piping Plovers, and Whooping Cranes*, 2000. Primary actions include removal of woody and herbaceous vegetation and grading some areas to restore swales and sloughs. Further, actions to restore sediment balance in the river are aimed at reducing the downcutting of the river channel and, in fact, may raise the elevation of the channel bottom in degraded areas. This may result in raising the groundwater level near the river sufficiently to help restore former wet meadows that have been dried up as the river channel degraded and groundwater levels declined.

Table 3-13.—Illustrative Distribution of Program Lands, Managed
by River Reach, for the Wet Meadow Alternative

River Reach	Acreage
Lexington to Johnson-2 Return	24
Johnson-2 Return to Overton	195
Overton to Elm Creek	3,110
Elm Creek to Odessa	2,596
Odessa to Kearney	2,578
Kearney to Minden	2,766
Minden to Gibbon	75
Gibbon to Shelton	2,014
Shelton to Wood River	116
Wood River to Alda	230
Alda to Doniphan	61
Doniphan to Phillips	1,603
Phillips to Chapman	1,685
Total	**17,053**

Land Management

The management of lands for this alternative is similar to the methods and focus for the Governance Committee Alternative. Table 3-14 shows the approximate changes in land cover types associated with this land management strategy.

Table 3-14.—Summary Table of Estimated Land Cover

Restoration Activities	Change in Cover Type	Acres	Subtotal
To lowland grassland	Wooded to lowland grassland	3,864	**8,212**
	Herbaceous to lowland grassland	414	
	Agriculture to lowland grassland	3,188	
	Shrubs to lowland grassland	636	
	Upland grassland to lowland grassland	107	
	Emergents to lowland grassland	3	
To wetted channel	Wooded to wetted channel	152	**355**
	Shrubs to wetted channel	163	
	Herbaceous to wetted channel	19	
	Bare sand to wetted channel	19	
	Lowland grassland to wetted channel	2	
	Emergents to wetted channel	0	
To bare sand	Wooded to bare sand	7	**7**
	Shrubs to bare sand	0	
	Herbaceous to bare sand	0	
Restored lands		8,574	**8,574**
Unmodified lands		7,679	7,679
Total non-complex habitat		800	800
Totals		**17,053**	**17,053**

SUMMARY OF ASSUMPTIONS FOR ANALYSIS OF THE WET MEADOW ALTERNATIVE

(1) All Wet Meadow Alternative water elements are implemented and operational.

(2) The capacity of the North Platte River channel at North Platte, Nebraska, is restored to at least 3,000 cfs.

(3) The capacity to move 5,000 cfs of Program water to Overton, for the creation of short-duration near-bankfull flows through the Central Platte Habitat Area, is accomplished.

(4) The capacity to move 800 cfs of Program water to Overton during the irrigation season is accomplished.

(5) The capacity to create short-duration near-bankfull flows in the Central Platte Habitat Area is increased by using various facilities in the CNPPID and NPPD system (Lake Mahoney, Johnson Lake, and the Johnson-2 Forebay) to store and release a 2-day pulse flow from the Jeffrey and Johnson-2 Return Channels.

(6) Methods to consolidate flow and to clear and lower banks and islands to create and maintain wider areas of river channel are successful and are implemented on a scale sufficient to achieve the Adaptive Management Plan objectives for restoring open channel habitat.

(7) Methods to balance the river sediment supply and erosion above Kearney, Nebraska, are successful and implemented on a scale sufficient to achieve the Adaptive Management Plan objective for sediment balance.

(8) The Alternative land plan is implemented. Majority of Program lands for habitat complexes are acquired or managed above Kearney, with roughly 50 percent of Program lands undergoing restoration.

(9) The Federal and State Depletion Management Plans are implemented.

WATER EMPHASIS ALTERNATIVE

The Water Emphasis Alternative emphasizes acquisition of water for Program purposes, with fewer resources allocated to land habitat. This alternative reduces shortages to target flows at Grand Island, Nebraska, by 184, kaf per year, on average, while its Land Plan manages only 7,475 acres. Figure 3-7 shows the location of the water and land elements for this alternative.

WATER ELEMENT

Table 3-15 shows the water elements for the Water Emphasis Alternative. This alternative improves achievement of target flows by 185 kaf. Additional capacity to move Program water to the habitat is included, as under the Governance Committee Alternative.

Table 3-15.—Average Annual Program Water Contribution to Species' Target Flows Under the Water Emphasis Alternative (kaf per year)

Program Water Features and Elements	Projected Improvement Toward Target Flows (kaf per year)
State Projects	
Total for these elements: Lake McConaughy EA Pathfinder Modification Project EA Tamarack Project, Phase I	80
Additional Water Elements	
Total for these elements: Wyoming 1. Glendo 100 kaf storage right 2. Water leasing (60 to 70 kaf leased per year) 3. Glendo Reservoir Storage 4. Pathfinder Wyoming Account Colorado 1. Tamarack Project, Phase III 2. Water leasing (60 to 70 kaf leased per year) Nebraska 1. Central Platte hydropower re-regulation 2. Water leasing (60 to 70 kaf leased per year) 3. Groundwater management in the Central Platte groundwater mound 4. Riverside drains	104
Total	**184**

Lake McConaughy Environmental Account

See Governance Committee Alternative.

Pathfinder Modification Project Environmental Account

See Governance Committee Alternative.

Pathfinder Wyoming Account

See Governance Committee Alternative.

Glendo Reservoir Storage

See Governance Committee Alternative.

Tamarack Project, Phase I

See Governance Committee Alternative.

Tamarack Project, Phase III

See Governance Committee Alternative.

New Program 100-Kaf Water Right in Glendo Reservoir

See Wet Meadow Alternative.

Central Platte Hydropower Re-regulation

Currently, there are periods when releases from Lake McConaughy, in combination with South Platte River flows and/or downstream river gains, result in flows between Overton and Grand Island which exceed species and annual pulse flows recommendations. In this option, releases for power generation are reduced during periods in which target flows are being exceeded, and the water is instead released during periods of flow shortages. The Program would pay the utilities for any losses in the value of the power generation that result.

For this element, the release of approximately 5,100 acre-feet per year of water would be rescheduled, shifting some releases from the September-April period to the May-August period.

Riverside Drains

This element involves installing agricultural drains in the Central Platte River region under some farmed fields that experience chronically high groundwater and loss of productivity. These drains would lower the groundwater table a few feet and drain these waters to the Platte River. Lands that are actively

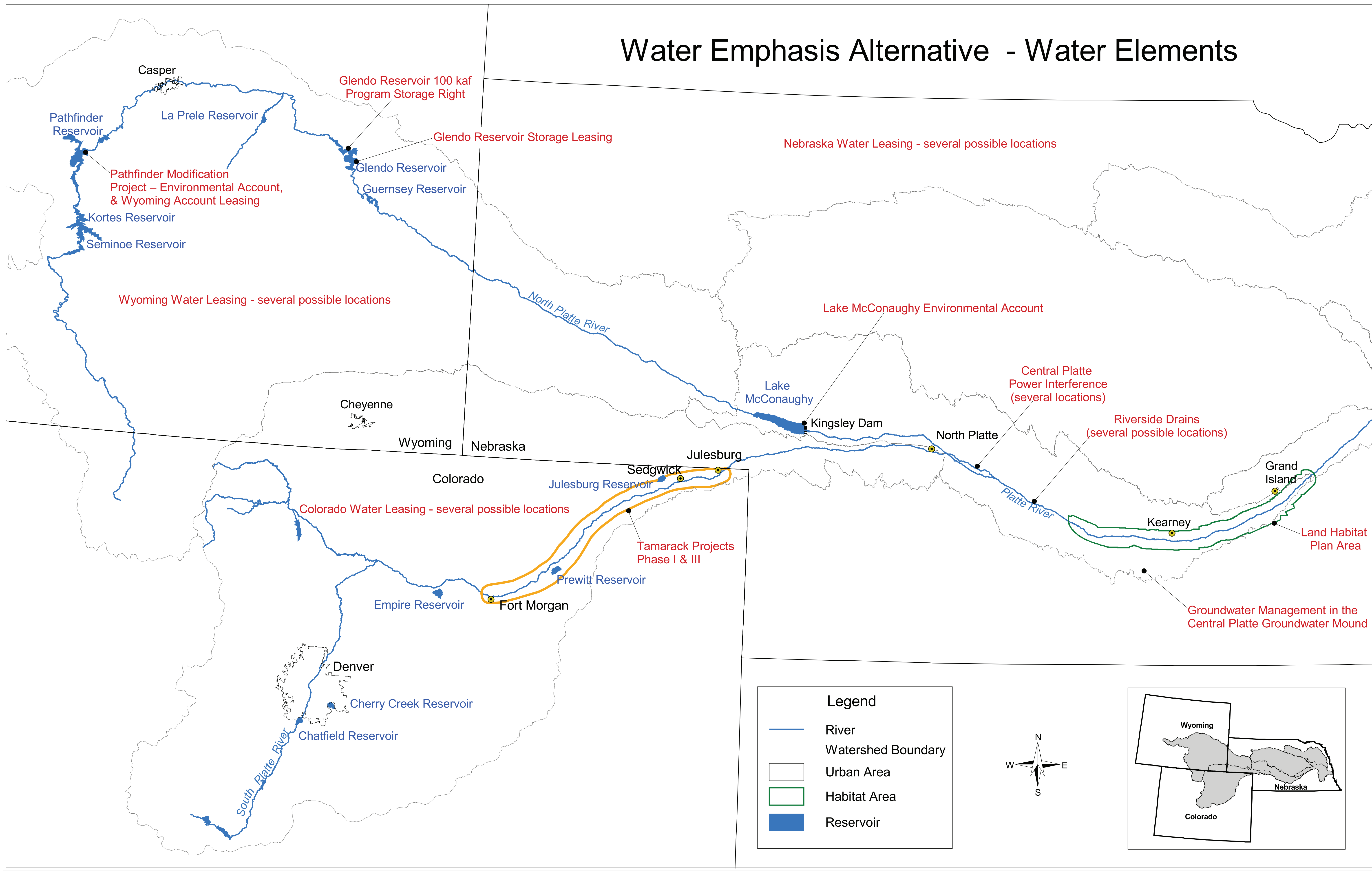


Figure 3-7.—Water elements map for Water Emphasis alternative.

cultivated and have a typical spring water table less than 5 feet below the surface could be considered for drains on a voluntary participation basis. The drains would reduce direct evaporation and evapotranspiration by vegetation, provide supplemental water for instream flows, and benefit farmland.

Lands that appear to be adaptable to this plan lie along either side of the Platte River, on the first or second terrace above the river. On the south side of the river, lands with shallow water tables occur intermittently starting at the Tri-County Canal diversion and continuing about 70 miles to the east edge of Range 21 West. From there, potential candidate lands lie in a continuous strip that extends to the east edge of Range 14 West, a distance of 42 miles. A reasonable estimate for development would be 25 miles of drain in each of the two segments, for a total of 50 miles of drains. The areas meeting the water depth criteria on the north side are discontinuous but more broad than those on the south side. The strip generally lies south of Highway 30 and is one-quarter to 3 miles wide. It extends about 100 miles from the town of Maxwell to east of the town of Kearney. Up to 50 miles of drain could be constructed within this area, about half west and half east of the town of Overton.

If 100 miles of drains were constructed, the flow from the drains would be about 40 kaf per year, of which about 10 kaf per year would be salvaged water (i.e., water that would not otherwise reach the river because it is currently lost through evaporation or evapotranspiration).

Basinwide Water Leasing

The Program would lease water from willing lessors sufficient to allow release of enough water to improve achievement of target flows by roughly 68 kaf on an average annual basis.

Each state would lease water for Program purposes by voluntary participation, most likely from existing reservoir storage in that state. The state would provide to the Program only the consumptive use associated with the storage. The remainder acquired would be managed under direction of the state to maintain the current pattern of return flows. Typically, this means that the Program would manage approximately one-half of the water leased.

The location of the leased water would depend on patterns of participation by water users and state policies. For this analysis, the amount of water assumed to be leased was divided among reservoirs or projects as follows to illustrate a range of possible effects. In actual implementation, Program water leasing would likely be more widely distributed (table 3-16).[30]

Wyoming: Water leasing from Reclamation reservoirs in Wyoming was obtained by leasing 6.9 percent of the water delivered from storage from any irrigation district that receives water from Reclamation in the North Platte River Basin. (This would likely require creating accounts in the North Platte Project reservoirs [Pathfinder and Guernsey] for each irrigation district that receives water from the North Platte Project.)

Colorado: Water leasing in Colorado was obtained by leasing from 11 percent (Empire) to 42 percent (North Sterling) of water storage from six reservoirs along the South Platte River below Greeley, as summarized in table 3-16. Preference was given to leasing from the three most downstream reservoirs (Prewitt, North Sterling, and Julesburg) because water leased from these facilities would likely suffer lesser transit losses and would provide greater yields at the Central

[30]For the FEIS analysis, it is assumed that when water is leased by farmers to the Program, the Program will require that other sources of water not be used to replace the leased supply, in order to avoid any secondary impacts on groundwater and riverflows.

Platte Habitat Area than would water leased from higher in the system. These leases are targeted and managed to provide increased flows in May and June to the state line.

Nebraska: Water leasing in Nebraska below Lake McConaughy was obtained by leasing 6.9 percent of the water diverted by any irrigation district that has a surface water diversion below North Platte, Nebraska, and that receives water from storage in Lake McConaughy and Sutherland Reservoir.

Table 3-16.—Illustrative Distribution of Water Leased to the Program Under the Water Emphasis Alternative

	Acre-Feet
Wyoming	
North Platte Project	29,700
Kendrick Project	10,300
Glendo Unit	300
Colorado	
Jackson Lake	8,000
Empire Reservoir	4,000
Riverside Reservoir	8,000
Prewitt Reservoir	10,000
North Sterling Reservoir	30,000
Julesburg Reservoir	10,000
Nebraska	
Lake McConaughy	60,000

Groundwater Management in the Central Platte

A large groundwater mound has developed in the Central Basin as a result of CNPPID irrigation. This mound, which lies beneath Phelps and Kearney Counties in Nebraska, would be conjunctively used with a system of shallow wells and a groundwater recharge system.

For this alternative, in the fall, approximately 9,600 acre-feet per year of flows, which are in addition to target flows, would be diverted through the CNPPID distribution system and into a recharge system of about 125 wells. In the spring and summer, a similar amount of water would be pumped into the irrigation supply system from this groundwater storage area to substitute for waters that otherwise would be released from Lake McConaughy. The waters not released from Lake McConaughy would enter the EA to be managed for habitat flows.

PROGRAM RELEASES AND FLOWS

The water accrued to the Pathfinder EA and the Program storage right in Glendo Reservoir would be moved down to the Lake McConaughy EA in September. For this alternative, the capacity to move water to the habitat and to create short-duration near-bankfull flows would be the same as that for the Governance Committee Alternative.

Tamarack Water

Through procedures to be developed by the Governance Committee, waters that have been retimed by the Tamarack Project may be exchanged for waters stored in Lake McConaughy, adding to the Lake McConaughy EA.

Lake McConaughy EA Management

The water in the Lake McConaughy EA is stored and released under the direction of the Service. This alternative provides significantly more inflows to the EA, allowing for more releases to support target flows and short-duration near-bankfull flows.

LAND ELEMENTS

Under the Water Emphasis Alternative, relatively more water and less land is managed under the Program. The land habitat component for this alternative is a reduced form of the land plan used for the Governance Committee and Full Water Leasing Alternatives. As shown in table 3-17, the plan involves 7,475 acres of land. Management of the parcels would be similar to that for the Governance Committee Alternative, but on a smaller scale.

Table 3-17.—Illustrative Distribution of Program Lands, by River Reach, for the Water Emphasis Alternative

River Reach	Acreage
Lexington to Johnson-2 Return	24
Johnson-2 Return to Overton	195
Overton to Elm Creek	3,110
Elm Creek to Odessa	57
Odessa to Kearney	1,760
Kearney to Minden	95
Minden to Gibbon	75
Gibbon to Shelton	25
Shelton to Wood River	116
Wood River to Alda	230
Alda to Doniphan	61
Doniphan to Phillips	42
Phillips to Chapman	1,685
Total	**7,475**

Land Management

Land management strategies and methods for this alternative are the same as for the Governance Committee Alternative, except on a smaller scale, due to the fewer total acres managed.

Table 3-18 shows the approximate changes in land cover types associated with this land management strategy for the Water Emphasis Alternative.

Table 3-18.—Summary Table of Estimated Land Cover Changes for All Land Parcels Managed in the Water Emphasis Alternative

Restoration Activities		Acres	Subtotal
To lowland grassland	Wooded to lowland grassland	1,863	**2,986**
	Herbaceous to lowland grassland	225	
	Agriculture to lowland grassland	451	
	Shrubs to lowland grassland	354	
	Upland grassland to lowland grassland	93	
To wetted channel	Wooded to wetted channel	108	**260**
	Shrubs to wetted channel	113	
	Herbaceous to wetted channel	18	
	Bare sand to wetted channel	19	
	Lowland grassland to wetted channel	2	
To bare sand	Wooded to bare sand	0	**0**
	Shrubs to bare sand	0	
	Herbaceous to bare sand	0	
Restored lands		3,246	3,246
Unmodified lands		3,428	3,428
Total non-complex habitat		800	800
Totals		**7,474**	**7,474**

SUMMARY OF ASSUMPTIONS FOR ANALYSIS OF THE WATER EMPHASIS ALTERNATIVE

(1) All Water Emphasis Alternative water elements are implemented and operational.

(2) The capacity of the North Platte River channel at North Platte, Nebraska, is restored to at least 3,000 cfs.

(3) The capacity to move 5,000 cfs of Program water to Overton, for the creation of short-duration near-bankfull flows through the Central Platte Habitat Area, is accomplished.

(4) The capacity to move 800 cfs of Program water to Overton during the irrigation season is accomplished.

(5) The capacity to create short-duration near-bankfull flows in the Central Platte Habitat Area is increased by using various facilities in the CNPPID and NPPD system (for example, Lake Mahoney, Johnson Lake, and the Johnson-2 Forebay) to store and release a 2-day pulse flow from the Jeffrey and Johnson-2 Return Channels.

(6) Methods to consolidate flow and to clear and lower banks and islands to create and maintain wider areas of river channel are successful and are implemented on a scale sufficient to achieve the Adaptive Management Plan objectives for restoring open channel habitat.

(7) Methods to balance the river sediment supply and erosion above Kearney, Nebraska, are successful and implemented on a scale sufficient to achieve the Adaptive Management Plan objective for sediment balance.

(8) The Federal and State Depletion Management Plans are implemented. The Alternative land plan is implemented. The majority of Program lands for habitat complexes are acquired or managed above Kearney, with roughly 50 percent of Program lands undergoing restoration. The Federal and State Depletion Management Plans are implemented.

ALTERNATIVE COMPARISON TABLES

The following tables present comparative information about the alternatives. Table 3-19 displays a summary of the elements contained in each of the action alternatives. Table 3-20 presents a quantitative summary of the principal effects of the action alternatives.

All impacts shown represent changes from the Present Condition. For the hydrologic analysis, most impacts are shown as the annual change from the Present Condition, averaged over the 48-year period of hydrologic record (1947–94) used as the benchmark for effects on reservoir storage, riverflows, irrigation deliveries, and other hydrologic measurements.

Table 3-19.—Summary of Elements

Alternative Element	Present Condition	Governance Committee Alternative	Full Water Leasing Alternative	Wet Meadow Alternative	Water Emphasis Alternative
Program Water Supply		Pathfinder Modification Project EA Lake McConaughy EA Tamarack Project, Phase I Water Action Plan: 13 Conservation and Water Supply Activities	Lake McConaughy Re-regulatory Account Water Leasing (approximately 120 kaf in each state)	Pathfinder Modification Project EA Pathfinder Wyoming Account Glendo Reservoir Storage Lake McConaughy EA Tamarack Project, Phase I Glendo 100 kaf New Program Water Right	Pathfinder Modification Project EA Pathfinder Wyoming Account Glendo Reservoir Storage Lake McConaughy Environmental Account Tamarack Project, Phase I Glendo 100 kaf New Program Water Right Three elements of Water Action Plan Conservation/Supply Activities: - Central Platte Power Regulation - Groundwater Management in the Central Platte Groundwater Mound - Tamarack Project, Phase III Riverside Drains Water Leasing (approximately 60 kaf in each state)
North Platte River Channel Capacity at North Platte, Nebraska	1,980 cubic feet per second	Safe channel capacity is restored to at least 3,000 cubic feet per second All Nebraska water leasing is located below Lake McConaughy to reduce peak irrigation demand by 500 cubic feet per second, reducing somewhat the flows moving through this river reach.			
Capacity to Create Short-Duration Near-Bankfull Flows at the Habitat	----	Program develops capacity to move 5,000 cfs of Program water to Overton, Nebraska.			
Land Plan Focus	Land conditions in 1998	9,200 acres of habitat complexes. Emphasis on restoration of degraded habitat above Kearney. 800 acres of non-complex habitat. Substantial focus on widening river channel and offsetting channel downcutting.		Same land plan as for Governance Committee, plus 7,000 additional acres of wet meadows.	Same basic focus as Governance Committee Alternative, but land plan reduced to 6,674 acres of complex lands, 800 acres of non-complex lands.

Table 3-20.—Summary Table of Impacts for Each Alternative

Summary of Impacts of Each Alternative Compared to the Present Condition				
Resources, Significant Indicators, and Geographic Areas	**Governance Committee Alternative**	**Full Water Leasing Alternative**	**Wet Meadow Alternative**	**Water Emphasis Alternative**
Water				
North Platte Basin				
Annual reservoir storage[31]	Average 3 percent less	Average 4 percent more	Average 9 percent less	Average 6 percent less
Average riverflows in North Platte River above Lake McConaughy 1. Winter 2. Summer	1. No change 2. +4 percent	1. No change 2. +7 percent	1. No change 2. +7 percent	1. No change 2. +8 percent
Flood control	Magnitude of largest floods reduced	No change	Magnitude of largest floods reduced	
Irrigation delivery shortages - number of years[32] 1. North Platte Project 2. Kendrick Project 3. Glendo Unit 4. Non-project Lands	1. 1 more year 2. 4 more years 3. 1 more year 4. 1 more year	1. no change 2. 1 year less 3. 6 more years 4. No change	1. 5 more years 2. 5 more years 3. 5 more years 4. 1 more year	1. 2 more years 2. 4 more years 3. 5 more years 4. No change
South Platte Basin				
Total average annual flows in the lower South Platte River, near the Colorado-Nebraska State line[33]	24 kaf increase	73 kaf increase	28 kaf increase	50 kaf increase
Irrigation water deliveries	No change	43,900 acre-feet fewer deliveries in average year	No change	31,150 acre-feet fewer deliveries in average year
Central Platte Basin				
Lake McConaughy average annual storage	Lower by 9 percent	Higher by 1 percent	Lower by 8 percent	Lower by 5 percent
Number of spills over 48 years[34]	About 52 percent fewer spills	Nearly 17 percent fewer spills	About 48 percent fewer spills	About 41 percent fewer spills
Change in average volume of spills	- 76 kaf	- 4 kaf	-87 kaf	-67 kaf
Average annual diversions for irrigation and power generation: Keystone Diversion 1. Winter 2. Summer	1. + 4 percent 2. + 2 percent	1. +21 percent 2. -9 percent	1. +6 percent 2. + 6 percent	1. +19 percent 2. – 5 percent

[31]Consists of total average storage changes in September for Seminoe, Kortes, Pathfinder, Alcova, Grey Reef, Glendo, and Guernsey Reservoirs.

[32]Out of the 48-year period of record used for the hydrologic analysis.

[33]Includes increases in average flow that are forecast to occur during the Program's First Increment with or without implementation of these alternatives, as a result of projected water development and changes in water use in the South Platte River Basin.

[34]Spills include spillway flows and releases to prevent violating the FERC limits on maximum reservoir elevation.

Summary of Impacts of Each Alternative Compared to the Present Condition				
Resources, Significant Indicators, and Geographic Areas	**Governance Committee Alternative**	**Full Water Leasing Alternative**	**Wet Meadow Alternative**	**Water Emphasis Alternative**
Average annual diversions for irrigation and power generation: Korty Diversion 1. Winter 2. Summer	1. + 12 percent 2. +26 percent	1. +13 percent 2. -3 percent	1. +11 percent 2. +20 percent	1. +8 percent 2. +20 percent
Average annual diversions for irrigation and power generation: Tri-County Diversion 1. Winter 2. Summer	1. +3 percent 2. +4 percent	1. +11 percent 2. no change	1. +4 percent 2. +5 percent	1. +8 percent 2. +3 percent
Average annual improvement toward target flows at Grand Island	150 kaf	137 kaf	116 kaf	184 kaf
River Geomorphology				
Flow (at Overton)				
Increase in mean annual flow	3%	13%	4%	9%
Increase in 1.5-year peak flow	57%	35%	52%	55%
Increase in average annual sandbar height potential	60%	30%	50%	53%
Sediment (Jeffrey Island to Chapman)				
Maximum sediment transport (tons/year) (present condition 620,000)	660,000	745,000	665,000	690,000
Net deposition and erosion (tons/year) with 150,000 tons of sand augmentation (present condition -220,000)	-42,000	-135,000	-58,000	-71,000
Mechanical actions at managed sites				
Increase in area of restoration (acres)	387	387	387	282
Increase in length of braided river (feet)	53,100	53,100	53,100	39,600
Increase in open view width	104%	103%	103%	66%
Plan Form (Jeffrey Island to Chapman)				
Average increase in width-to-depth ratio (weighted by length of 4 reaches)	10%	9%	6%	1%
Average increase in open view width (weighted by length of 4 reaches)	21%	25%	20%	19%
Water Quality				
Central Platte River at Grand Island, Nebraska				
Daily probability of river temp. exceeding 90°C (average for June, July, and August)	Slight improvement at 0.325	Slight improvement at 0.328	Slight improvement at 0.330	Improvement at 0.322
Concentration of copper in river bed sediments	Slight increase or decrease, depending on sand augmentation location			
Central Platte River Vegetation Communities and Species Habitats				
Land Cover Type Area				
Agriculture	-0.4 percent		-1 percent	-0.2 percent
Lowland grasslands	+10 percent		+19 percent	+7 percent
Woodlands	-7 percent		-11 percent	-6 percent
Shrublands	-12 percent		-14 percent	-8 percent

Summary of Impacts of Each Alternative Compared to the Present Condition					
Resources, Significant Indicators, and Geographic Areas		**Governance Committee Alternative**	**Full Water Leasing Alternative**	**Wet Meadow Alternative**	**Water Emphasis Alternative**
Herbaceous riparian		-7 percent		-10 percent	-6 percent
Bare sand		-1 percent			
Emergents		No change			
Sand and gravel pits		-2 percent			
Wetlands Area					
Acres of wetlands		Approximately 4,000 additional acres		Approximately 8,000 additional acres	Approximately 3,000 additional acres
Whooping Crane					
*Channel Roost Habitat**					
Channel area with widths > 500 feet		+20 percent	+19 percent	+20 percent	+15 percent
Channel aquatic characteristics		All increase/improve (+15 - +25 percent)			
Distribution of managed areas		5 GIS/bridge segments			3 GIS/bridge segments
Riverine Habitat Sustainability		See "River Geomorphology." Benefits of each action alternative similarly depend on the location, timing, and scale of the mechanical channel improvements/sedimentation augmentation described.			
Out-of-Channel Feeding and Loafing Habitat					
Changes in acres of grassland		+10 percent		+19 percent	+7 percent
Spring flows for wet meadow maintenance		Reduced in high flows years; modest improvement in moderate flow years	Modest improvements in moderate flow years	Reduced in high flow years; modest improvement in moderate flow years.	
Grain food resources		Restored channel segments could alleviate inter-species competition for waste grain, bur the behavioral response of the competing migratory species (likelihood and timing of population redistribution) remains uncertain.			
Security and Protection					
Percent change in Bank length protected for whooping cranes, piping plovers, and interior least tern	Hershey – Chapman	+14 percent	+14 percent	+24 percent	+9 percent
	Lexington - Chapman	+8 percent	+8 percent	+13 percent	+5 percent
Out-of-channel lands protected (feeding and loafing habitat and habitat buffers)		+9,400 acres	+9,400 acres	+16,500 acres	+6,700 acres
Piping Plovers and Interior Least Terns					
Piping Plovers					
Flow potential to build sandbars		Some increase from Present Conditions (see change in 1.5-year flood event in River Geomorphology above)			
Fledging days (all transects)		+2.3 days	+2.1 days	+2.1 days	+2.6 days
Non-channel nest sites		Likely increase for all alternatives			
River resources		Negative effect North Platte to Lexington – Likely some improvement Lexington to Chapman - Likely unchanged Chapman to Missouri River			

Summary of Impacts of Each Alternative Compared to the Present Condition				
Resources, Significant Indicators, and Geographic Areas	**Governance Committee Alternative**	**Full Water Leasing Alternative**	**Wet Meadow Alternative**	**Water Emphasis Alternative**
Interior Least Terns				
Flow potential to build sandbars	Some increase from Present Conditions (see change in 1.5-year flood event in River Geomorphology above)			
Fledging days (all transects)	+1.8 days	+2 days	+1.3 days	+1.9 days
Non-channel nest sites	Likely increase for all alternatives			
River resources	Negative effect North Platte to Lexington – Likely some improvement Lexington to Chapman - Likely unchanged Chapman to Missouri River			
Pallid Sturgeon				
Spawning flows, habitat forming flows, food base flows, summer flows	No significant differences from Present Condition			
Other Federally Listed Species				
Colorado				
Bald eagle, Black-footed ferret, Canada lynx, Colorado butterfly plant, North Park phacelia, Preble's Meadow Jumping Mouse, Ute ladies'-tresses orchid	No significant impact			
Nebraska				
American burying beetle	May have beneficial impact			
Bald eagle	Minor adverse effect			
Black-footed ferret and Eskimo curlew	No significant impact			
Western prairie fringed orchid	Reduced peak flows diminish wet meadow irrigation at known sites Less adverse impact from Full Water Leasing Alternative.			
Wyoming				
Bald eagle, Black-footed ferret, Canada lynx, Colorado butterfly plant, Preble's meadow jumping mouse, Wyoming toad, Ute ladies-tresses orchid	No significant impact			
State Listed and Species of Special Concern				
Nebraska				
River otter	Beneficial			
Finescale dace, Northern redbellied dace, Lake sturgeon, Saltwort, Massasauga rattlesnake, Sturgeon chub, Platte River caddisfly	No significant impact			
Wyoming				
Wood frog, Western boreal toad, White-faced ibis, American bittern, Snowy egret, Black-crowned night heron, Yellow-billed cuckoo, Lewis' woodpecker, Caspian tern, Forster's tern, Black tern, Common loon, Vagrant shrew	No significant impact			

Summary of Impacts of Each Alternative Compared to the Present Condition				
Resources, Significant Indicators, and Geographic Areas	**Governance Committee Alternative**	**Full Water Leasing Alternative**	**Wet Meadow Alternative**	**Water Emphasis Alternative**
Colorado				
Boreal toad, Northern cricket frog, Northern leopard frog, Plains leopard frog, Wood frog, American white pelican, Burrowing owl, Ferruginous hawk, Greater sage grouse, Greater sandhill crane, Long-billed curlew, Mountain plover, Plains sharp-tailed grouse, Western snowy plover, Western yellow-billed cuckoo, Black-tailed prairie dog, Northern river otter, Swift fox, Common garter snake, Yellow mud turtle	No significant impact			
Common shiner, Brassy minnow, Iowa darter, Lake chub, Plains minnow, Stonecat, Suckermouth minnow	Beneficial impact			
Sandhill Cranes				
Roosting suitability Site scale (proper depth) Bridge scale (width) System scale (hydrology)	General increase at managed sites, variable at non-managed sites General increase in unobstructed view at managed sites Likely reduction in roosting depth abundance in Sutherland to North Platte reach			
Food abundance Invertebrates (acres) Invertebrates (flows) Corn (acres)	Potential increase at managed sites Potential increase in accessibility Some reduction likely			
North Platte Fisheries				
Reservoir volume: months below flag levels out of 48 years:				
Seminoe Reservoir (less than ~200 kaf)	17 additional months	20 fewer months	28 additional months	19 additional months
Seminoe Reservoir (less than ~50 kaf)	7 additional months	No change	10 additional months	7 additional months
Pathfinder Reservoir (less than ~200 kaf)	17 additional months	19 fewer months	40 additional months	23 additional months
Pathfinder Reservoir (less than ~50 kaf)	8 additional months	No change	11 additional months	9 additional months
Glendo Reservoir (less than 63 kaf)	No instances of storage less than 63 kaf			
Average Annual Fish Standing Crop				
Seminoe Reservoir	-1 percent	+3 percent	-5 percent	-3 percent
Pathfinder Reservoir	-3 percent	+4 percent	-6 percent	-4 percent
Alcova and Glendo Reservoir	Changes less than +/- 3 percent			
Lake McConaughy and Lake Ogallala Sport Fishery Analysis				
Lake McConaughy Littoral Habitat Average annual availability	- 2 to 3 percent	No change	-2 to 3 percent	-2 percent
Lake McConaughy Open Water Habitat average annual availability	-10 to 11 percent	+/- 1 percent	-9 to 10 percent	-6 to 8 percent
Percent of years conducive to Walleye reproduction. [Present condition is 75 percent].	40 percent	70 percent	48 percent	50 percent
Percent of years conducive to White Bass reproduction. [Present condition is 13 percent].	12 percent	16 percent	12 percent	12 percent

Summary of Impacts of Each Alternative Compared to the Present Condition				
Resources, Significant Indicators, and Geographic Areas	**Governance Committee Alternative**	**Full Water Leasing Alternative**	**Wet Meadow Alternative**	**Water Emphasis Alternative**
Percent of years conducive to Smallmouth Bass reproduction. [Present condition is 82 percent].	36 percent	No change	38 percent	50 percent
Percent of years conducive to Channel Catfish reproduction.	No significant change			
Percent of years conducive to Gizzard Shad reproduction. [Present condition is 88 percent].	67 percent	93 percent	74 percent	78 percent
Percent of years with August temperature levels in Lake Ogallala stressful to trout. [Present Condition is 4 percent]	19 percent	2 percent	11 percent	12 percent
Central Platte Fisheries				
Months (out of 48 years) with improved physical habitat at Overton	+30 months	+20 months	+28 months	+32 months
Months (out of 48 years) with improved physical habitat at Grand Island	+36 months	+20 months	+28 months	+30 months
Hydropower				
North Platte				
Percent change in electrical generation	+1 percent	No change	+1 percent	+2 percent
Percent change dependable capacity	Summer: -6 percent Winter: 0 percent	Summer: -8 percent Winter: +4 percent	Summer: -4 percent Winter: -1 percent	Summer: -7 percent Winter: -1 percent
Central Platte				
Percent change electrical generation	+4 percent	+6 percent	+6 percent	+6 percent
Percent change dependable capacity	Summer: -4 percent Winter: -3 percent	Summer: -5 percent Winter: +13 percent	Summer: -1 percent Winter: -9 percent	Summer: -4 percent Winter: +17 percent
Recreation in the Platte River Basin				
Change in Recreation Visits				
Wyoming - North Platte Reservoirs[35] average annual visitation	-1.2 percent visits	-0.9 percent visits	-1.2 percent visits	-1.1 percent visits
Average annual impact on fishing visitation for North Platte Reservoirs (over 48 years)	Minimal impact			
Probability of fishery loss in Seminoe Reservoir under severe drought [Present Condition is 0]	.24	0	.57	.24
Probability of fishery loss in Pathfinder Reservoir under severe drought [Present Condition is 0]	.57	0	.68	.68
Average annual change in angler visitation for Pathfinder and Seminoe Reservoirs (total) if severe drought and fishery elimination occurs.	-14,946 visitors	Not applicable	-14,946 visitors	-14,946 visitors
Colorado - South Platte Reservoirs[36]	Not affected	Not available[37]	Not affected	Not available[37]

[35]For Seminoe, Glendo, and Guernsey Reservoirs.

[36]Includes Boyd, Empire, Jackson, North Sterling, Julesburg, Prewitt, and Riverside Reservoirs.

Summary of Impacts of Each Alternative Compared to the Present Condition				
Resources, Significant Indicators, and Geographic Areas	**Governance Committee Alternative**	**Full Water Leasing Alternative**	**Wet Meadow Alternative**	**Water Emphasis Alternative**
Colorado - Tamarack Ranch State Wildlife Area	Slight increase			
Nebraska - Lake McConaughy average annual visitation	-6 percent visits	-2.8 percent visits	-6.3 percent visits	-4.5 percent visits
Agricultural Economic Impacts				
Average Annual Change in Farmed Acres, without Dryland Farming Substitution (by Economic Region)				
Central Platte Habitat Area	-10,700 acres	-38,300 acres	0 acres	-18,800 acres
Lake McConaughy Area	0 acres	-16,100 acres	0 acres	-10,900 acres
Scotts Bluff Area	0 acres	-21,800 acres	-300 acres	-4,900 acres
Eastern Wyoming	-1,000 acres	0 acres		
North Platte Headwaters	-4,900 acres	-5,100 acres	-1,500 acres	-4,300 acres
Eastern Colorado	0 acres	-4,100 acres	0 acres	-2,100 acres
Average Annual Change in Agricultural Revenue ($1,000s), without Dryland Farming Substitution (by Economic Region)				
Central Platte Habitat Area	-$4,421	-$15,476	0	-$7,642
Lake McConaughy Area	0	-$5,138	0	-$3,488
Scotts Bluff Area	8	-$5,509	-$17	-$1,198
Eastern Wyoming	-$115	0		
North Platte Headwaters	-$560	-$583	-$174	-$496
Eastern Colorado	0	-$1,853	0	-$1,123
Primary Program Costs				
Cost of Program elements which have environmental impacts and for which Program expenditures are required. This is not a total Program budget.[38]	**$110,387,000**	**$355,080,000**	**$68,565,000**	**$184,120,000**
Regional Economics[39]				
Average Annual Changes in Regional Sales without Dryland Cropping Substitution ($1,000s)				
Central Platte Habitat Area	-$693	-$11,647	+$3,833	+$3,835
Lake McConaughy Area	+$243	-$1,906	+$152	-$1,555
Scotts Bluff Area	+$8	-$1,545	-$25	-$304
Eastern Wyoming	-$180	-$75	-$217	-$185
North Platte Headwaters	-$584	+$33	-$922	-$906
Eastern Colorado	0	-$762	0	-$638
Average Annual Changes in Regional Income without Dryland CroppingSubstitution ($1,000s)				
Central Platte Habitat Area	-$48	-$2,097	+$897	-$740
Lake McConaughy Area	-$57	-$168	-$30	-$244

[37]Small changes in surface area; impact not assessed due to lack of recreation data.

[38]For example does not include administrative and staffing costs, or the cost of research and monitoring.

[39]All economic impacts represent less than or equal to one tenth of one percent of the regional economic activity.

Summary of Impacts of Each Alternative Compared to the Present Condition				
Resources, Significant Indicators, and Geographic Areas	**Governance Committee Alternative**	**Full Water Leasing Alternative**	**Wet Meadow Alternative**	**Water Emphasis Alternative**
Scotts Bluff Area	+$3	-$262	+$6	-$41
Eastern Wyoming	-$56	-$26	-$76	-$65
North Platte Headwaters	-$228	+$36	-$323	-$304
Eastern Colorado	0	-$126	0	-$127
Social Environment				
Central Platte Habitat Area				
Human health issues, population, and demographics	No Program impacts			
Out-of-bank flooding below Lake McConaughy a. Years with flows > 10,000 cfs b. Change in maximum floodflows (cfs)	a. 2 fewer years[40] b. -3,600 cfs	a. 1 fewer years b. -200 cfs	a. 3 fewer years b. -5,800 cfs	a. 1 fewer years b. -4,500 cfs
Maximum effect of Program water releases on Central Platte Habitat Area groundwater levels (feet)	Program alternatives would raise groundwater levels within 1,000 feet of the river about 3 inches for periods of 3 to 30 days, during years when surface and groundwater levels are normal or low.			
Land use changes in the Central Platte Habitat Area	Agricultural lands reduced by 1 percent or less. Lowland grasslands increased by 7 to 19 percent. River channel woodlands reduced by 6 to 11 percent.			
Cultural Resources				
North Platte Basin				
National Register of Historic Places				
Pathfinder Dam	No impact	Not applicable	No impact	No impact
Potential Disturbance to Archaeological Sites				
Seminoe Reservoir	May be subject to new exposure or erosion during extended drought.	No impact	May be subject to new exposure or erosion during extended drought.	
South Platte Basin				
Tamarack Project, Phases I and III	Construction of recharge ponds, pipelines, pumps, and canals would cause ground disturbance	Not applicable	Construction of recharge ponds, pipelines, pumps, and canals would cause ground disturbance	
Central Platte Basin				
Lake McConaughy	May be subject to new exposure or erosion during extended drought.	No impact	May be subject to new exposure or erosion during extended drought.	
Central Platte Offstream Regulatory Storage Reservoir	Construction would cause extensive ground disturbance	Not applicable		

[40]Out of the 48-year period of record used in the hydrologic analysis.

<table>
<tr><th colspan="5">Summary of Impacts of Each Alternative Compared to the Present Condition</th></tr>
<tr><th>Resources,
Significant Indicators,
and Geographic Areas</th><th>Governance Committee Alternative</th><th>Full Water Leasing Alternative</th><th>Wet Meadow Alternative</th><th>Water Emphasis Alternative</th></tr>
<tr><td>Land acquisition and management in the Central Platte Habitat Area</td><td colspan="4">May include physical modifications or ground disturbance.</td></tr>
<tr><td>Groundwater management in the Central Platte groundwater mound</td><td>Construction of new wells, well pads, and pipelines expected to disturb localized areas</td><td>Not applicable</td><td colspan="2">Construction of new wells, well pads, and pipelines expected to disturb localized areas</td></tr>
<tr><td>Riverside drains</td><td>No impact</td><td colspan="2">Not applicable</td><td>Laying underground piping may affect resources</td></tr>
</table>

Chapter 4

Affected Environment and the Present Condition

INTRODUCTION

This chapter provides an overview of the environmental conditions and resources that may be affected by the action alternatives, and it describes the present conditions existing in the Plate River Basin (Present Condition). In this Final Environmental Impact Statement (FEIS), the No Action Alternative is the Present Condition, which is the baseline for comparing alternatives. The presentation is organized to follow the chain of effects produced by the alternatives. The narrative describes water and land actions which lead to effects on the target and other species, and it then examines the resulting impacts on economic and social resources.

The following sections describe for each resource:

- Introductory material on the affected environment or setting
- The indicators used to describe the Present Condition for the resource
- The methods used to measure the Present Condition (as discussed in chapter 5, "Environmental Consequences") and to predict the effects of the various alternatives on the resource
- The Present Condition for the resource

The identification of the affected environment and resources, the selection of indicators and methods, and the focus of the Present Condition analysis all are chosen to estimate the impacts that are likely to occur from implementation of the action alternatives. This chapter begins, therefore, with a brief overview of the possible Recovery Implementation Program (Program) actions and how these actions affect a cascade of resources. This will help the reader to understand why each resource is discussed and evaluated, why certain indicators are selected, and why impacts on each resource are significant to other affected resources, including the target species and their habitats. More details will be found in each resource section in this chapter and in chapter 5, "Environmental Consequences."

OVERVIEW OF ACTIONS AND AFFECTED RESOURCES

As described in the "Introduction and Overview" section of chapter 1, the primary focus of Program actions is to improve habitat in the Central and Lower Platte Habitat Areas for the target species. Because benefits for the pallid sturgeon in the first 13 years of implementation of the proposed Recovery Implementation Program (Program's First Increment) will be provided through a program of research, with possible (but currently unknown) habitat improvements to follow, the discussion of Program actions will here focus on the actions which ultimately benefit the three target bird species in the Central Platte Habitat Area. Although the action alternatives differ in their emphasis, the general actions and effects are here discussed for all alternatives taken together.

The Program aims to improve both riverflows and land habitat in the Central Platte Habitat Area to increase the availability of habitat used by the target species (described in chapter 2, "History of Habitat Use and Habitat Trends for the Target Species").

Improving Riverflows

Flows in the Central Platte Habitat Area are improved by altering Platte riverflow volumes and timing, generally by increasing spring and summer flows. For example, under the Governance Committee Alternative, these changes in flow are accomplished primarily by storing Program water in an Environmental Account (EA) in Lake McConaughy in Nebraska and making releases to benefit the species. Benefits are also produced by other smaller projects that retime the flows in the South Platte and in the Central Platte.

Accruing water to the Lake McConaughy EA is accomplished by:

- Reallocating a portion of Lake McConaughy inflows to the Lake McConaughy EA
- Storing a portion of inflows to Pathfinder Reservoir in Wyoming in an EA, and then moving those Program waters down to the Lake McConaughy EA
- Accruing additional waters in the Lake McConaughy EA through water leasing

These actions change the reservoir operations in the North Platte system of reservoirs and at Lake McConaughy. They also change flows through the Central Platte Districts' canals, lakes, and powerplants. Reservoir levels, releases through powerplants, and streamflows are altered throughout the system.

- Reservoir storage is affected. This affects irrigation supplies and deliveries, which affects irrigated acreage, crop production, agricultural revenues, and local economies.
- Power generation and economic value are affected.
- Lake and stream fisheries may be affected.
- Lake and river-based recreation may be affected.

Ultimately, flows through the Central Platte Habitat Area are changed to benefit the target bird species.

Improving Land Habitat

Apart from improvements in flows, the roosting, nesting, and foraging habitats for the target bird species is improved by improving channel habitat (channel width, availability of sandbars, etc.), by restoring wet meadows and other land features near the river in the Central Platte Habitat Area, and by reducing human disturbance. Where lands are leased or sold to the Program, some of those lands will be managed in ways that change the land use and vegetative cover, such as converting wooded meadow and agricultural lands to wet meadows, or clearing trees and other vegetation from river islands and moving river sand back into the active channel.

These actions will affect the plan form of the river channel including wetted width and extent of sandbars, as well as the rates of channel erosion and sand deposition. The rate of encroachment of vegetation into the channel will be affected by the frequency of high flows that scour vegetation and inundate or bury plants in sediment.

The amount of each existing land use and cover type may be affected. This will slightly reduce agricultural acreage and production in the Central Platte Habitat Area and input to the local economy.

Ultimately, the availability of channel and wet meadow habitat for the target bird species is increased.

The alternatives also manage some areas of sandpits and palustrine wetlands to improve their value as habitat for the target bird species, primarily by removing vegetation and preventing disturbance or predation of the species using these areas.

ANALYZING THE PRESENT CONDITION AND IMPACTS OF THE ALTERNATIVES

In the Central Platte Habitat Area, several organizations are currently restoring and managing lands for the benefit of the target bird species. About 11,000 acres of lands are managed for crane habitat by the Platte River Whooping Crane Maintenance Trust, the National Audubon Society, The Nature Conservancy, Central Nebraska Public Power and Irrigation District (CNPPD), Nebraska Game and Parks Commission (NGPC), and the Wyoming Water Development Commission (WWDC). Further, approximately 80 acres of sand and gravel mining pits and ponds are actively managed to support nesting by least terns and piping plovers. The efforts of these groups are reflected in the Present Condition of the various habitat components, measured for the Central Platte Habitat Area as a whole.

Both the discussion of the Present Condition in this chapter and the impacts of alternatives in chapter 5, “Environmental Consequences,” follow the same sequence of resources, which mirrors the chain of effects from direct Program actions to effects on the target species and on other aspects of the human environment. Both sections begin with a description of the water resources (reservoir operations, lake levels, streamflows, and water diversions) that would be affected by Program actions. This leads to a discussion of changes in the form of the river channel (river geomorphology) and water quality changes that result throughout the system that, in turn, affect habitat.

The discussion then shifts to consideration of the land resources and how they are modified by the alternatives to affect habitat. Together, these are the resources directly affected by the Program.

Next, this chapter and chapter 5, Environmental Consequences,” describe the habitat and resources used by the target species, either the Present Condition or how they are impacted by the alternatives.

This is followed by discussion of the habitats used by other federally listed species, by sandhill cranes, by state-listed species, and by fisheries in the North Platte and Central Platte Rivers.

The discussion then turns to the social resources associated with the previously described water, land, and biological resources: hydropower generation, water-based recreation, agricultural production and economics, regional economics, social environment, cultural resources, Indian trust assets (ITAs), and potential environmental justice considerations.

This Final Environmental Impact Statement (FEIS) analysis of these resources is a summary of more extensive analyses carried out by the Environmental Impact Statement (EIS) Team. In most cases, the current status and the impact on resources are described using averages of conditions that would occur over a number of years. More details on the range and variability of impacts can be found in the technical appendices associated with each resource, available by request from the Platte River EIS Office. (See "Cover Sheet" for contact information).

GEOGRAPHIC MARKERS

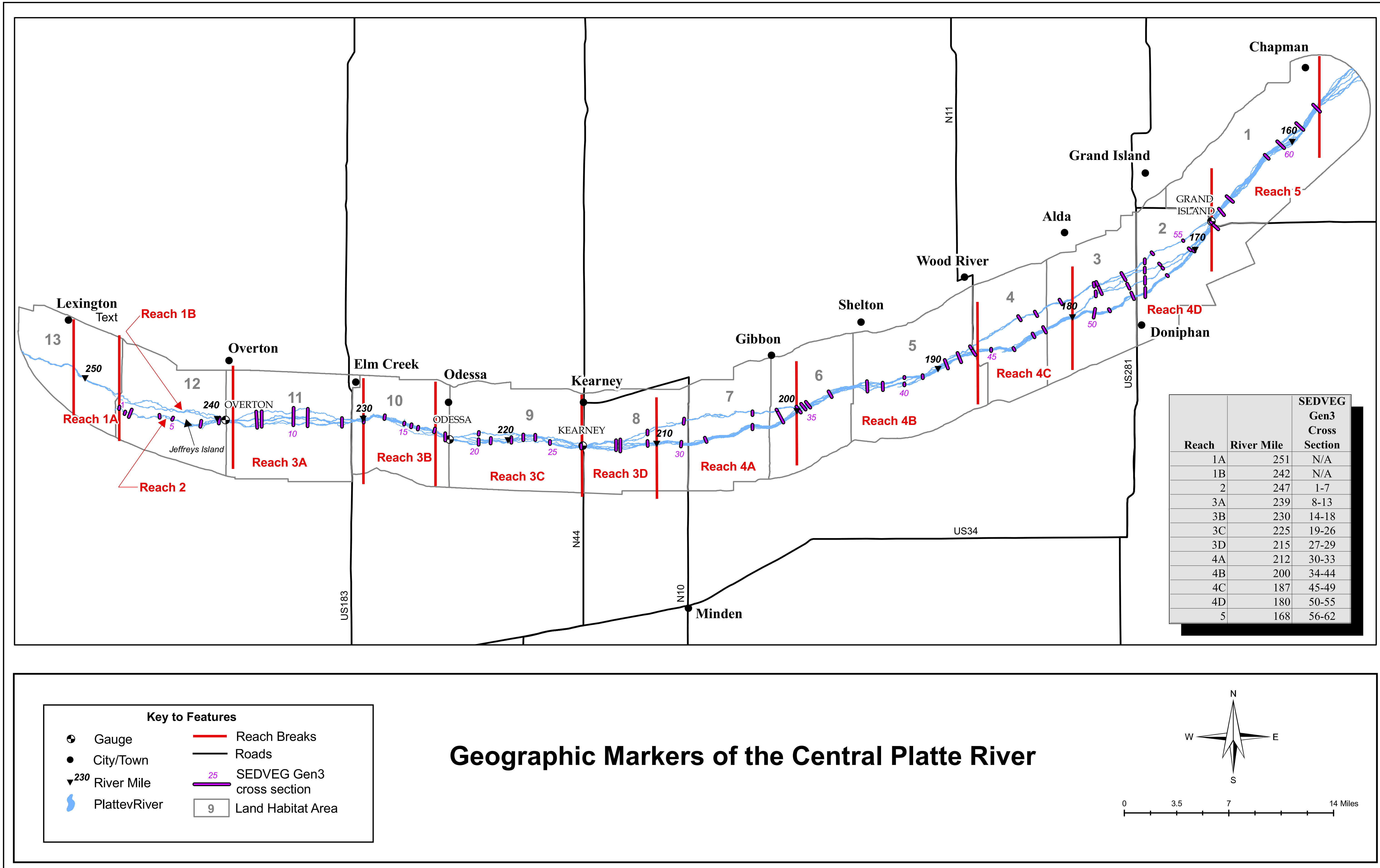
The resources and indicators assessed in this FEIS are located throughout the Platte River Basin (Basin). Maps of the main Platte subbasins are useful in locating most features and river reaches (see the beginning of chapter 2, "History of Habitat Use and Habitat Trends for Target Species" for maps of the subbasins).

Much of the detailed analysis in the following sections focuses on the Central Platte River in Nebraska, where most of the habitat improvements and impacts would occur. The following sections refer to many geographic features (table 4-I-1) in the Central Platte River area—river miles (RMs), "bridge segments," city names, river gauges, and sediment transport and vegetation (SEDVEG Gen3) model transects.

The following geographic markers, summarized in table 4-I-1, are commonly used to locate features along the Central Platte River Basin. Each of these is cross-referenced to the other geographic markers.

- **River Miles:** RMs are measured along the Platte River in an upstream direction, with the "zero mile" at the confluence of the Platte River and the Missouri River. When referring to a location on the river, RMs are often the most useful geographic marker.
- **Bridge Segments:** For many years, research on the Central Platte River has been organized around the reaches or "segments" of the river between the main highway bridges that cross the river. Numbering of the bridge segments starts with "1" near Grand Island and proceeds upstream to Lexington, with 13 segments identified. (Sometimes, these reaches are referred to using the name of the highways crossing these bridges.)
- **Cities:** River reaches are often referred to by the cities at each end of the reach (for example, the Brady-Cozad reach of the river).
- **River Gauges:** Often, hydrologic analysis is associated with a particular gauge along the river system.
- **Sediment Transport and Vegetation Model (SEDVEG Gen3)Transects**: This river simulation model employs a large number of surveyed cross-sections of the river.

Figure 4-I-1 shows river miles, bridge segments, cities, river gauges and SEDVEG Gen3 transects in the Central Platte Habitat Area.



Reach	River Mile	SEDVEG Gen3 Cross Section
1A	251	N/A
1B	242	N/A
2	247	1-7
3A	239	8-13
3B	230	14-18
3C	225	19-26
3D	215	27-29
4A	212	30-33
4B	200	34-44
4C	187	45-49
4D	180	50-55
5	168	56-62

Figure 4-I-1.– Geographic markers of the Central Platte River.

Table 4-I-1.—Geographic Markers for the Central Platte River

Bridge Segment	River Mile	Cities/ Bridge	Bridge/ Highway Name	Gauge	SEDVEG Gen3 Cross Section[1]
1	154 168	Chapman Grand Island	HWY 34/ Hamilton County	Grand Island (RM 168)	62 (RM 157.2) 61 (RM 158.9) 60 (RM 160.9) 59 (RM 162.2) 58 (RM 165.9) 57 (RM 166.9) 56 (RM 167.9)
2	168 175	Grand Island Doniphan	HWY 280		55 (RM 170.3) 54 (RM 172.6) 53 (RM 174.6)
3	175 182	Doniphan Alda			52 (RM 175.5) 51 (RM 177.3) 50 (RM 178.4) 49 (RM 180.3)
4	182 187	Alda Wood River	HWY 11		48 (RM 182.1) 47 (RM 183.2) 46 (RM 184.5)
5	187 196	Wood River Shelton			45 (RM 186.0) 44 (RM 187.4) 43 (RM 188.3) 42 (RM 189.3) 41 (RM 191.2) 40 (RM 192.6) 39 (RM 193.9) 38 (RM 194.9)
6	196 202	Shelton Gibbon			37 (RM 197.4) 36 (RM 199.1) 35 (RM 199.5) 34 (RM 199.8) 33 (RM 201.2)
7	202 208	Gibbon Minden	HWY 10		32 (RM 203.3) 31 (RM 206.6)
8	208 215	Minden Kearney	HWY 44	Kearney (RM 215)	30 (RM 208.6) 29 (RM 210.6) 28 (RM 212.6) 27 (RM 212.9)
9	215 224	Kearney Odessa			26 (RM 215) 25 (RM 217.1) 24 (RM 218.1) 23 (RM 219) 22 (RM 219.8) 21 (RM 221.2) 20 (RM 222)
10	224 231	Odessa Elm Creek	HWY 183		19 (RM 224.3) 18 (RM 225.1) 17 (RM 226.2) 16 (RM 226.7) 15 (RM 227.2) 14 (RM 228.7) 13 (RM 230)

[1]These are also called “transects” in biology.

Bridge Segment	River Mile	Cities/ Bridge	Bridge/ Highway Name	Gauge	SEDVEG Gen3 Cross Section[1]
11	231 239	Elm Creek Overton		Overton (RM 240)	12 (RM 231.5) 11 (RM 233.8) 10 (RM 234.8) 9 (RM 237) 8 (RM 237.5) 7 (RM 239.9)
12	239 247	Overton Lexington			All South Channel at Jeffrey Island 6 (RM 241.1) 5 (RM 243.1) 4 (RM 244) 3 (RM 246) 2 (RM 246.5) 1 (RM 247)
13	247 255	Lexington	HWY 283	Johnson-2 (RM 247)	
CNPPD Diversion Dam (also known as the Tri-County Dam)[2]	310	North Platte		North Platte	
Keystone Diversion Dam[3]					

CENTRAL PLATTE RIVER SCHEMATIC

A schematic of the Central Platte River is also provided, showing the relationships among many features of the river, reservoirs, diversion dams, hydroelectric generation facilities, and canals (figure 4-I-2). The widths of the rivers and canals in this diagram are proportional to the average annual flow in each.

[2]CNPPD diverts flows to the Tri-County Canal from the Tri-County Diversion Dam, just downstream of North Platte at river mile 310. This is also upstream of the Central Platte Habitat Area and upstream of bridge segment 13, but downstream of Keystone Diversion.

[3]The Keystone Diversion Dam diverts flow from the North Platte River to the Nebraska Public Power District (NPPD) irrigation district canals (Sutherland Canals). This occurs upstream of the Central Platte Habitat Area, upstream of bridge segment 13, and upstream of North Platte.

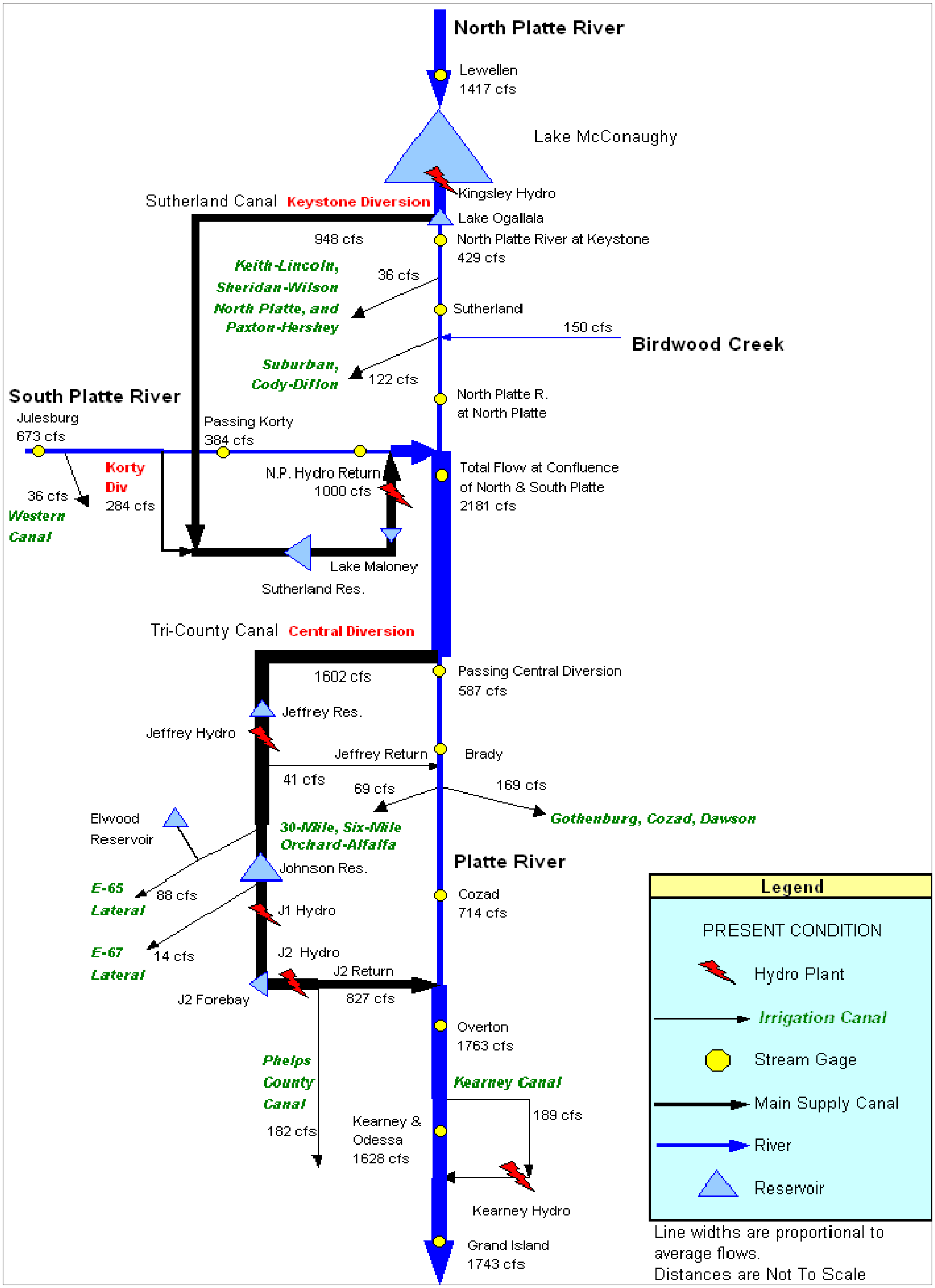


Figure 4-I-2.—Central Platte River schematic displaying average annual flow.

WATER RESOURCES

This section describes the water resources that may be affected by the alternatives in the North Platte, South Platte, and Central Platte Basins, focusing on reservoirs and riverflows, irrigation deliveries, and groundwater. Each of these sections describes the methods used to evaluate both current conditions and the impacts of the alternatives and current conditions for those resources (the Present Condition). Impacts to water resources are described in chapter 5, "Environmental Consequences."

At the end of this section, there is also a discussion of how new water uses are developed in each State under the Present Condition. A parallel discussion about development of new water uses under the alternatives is found in the "Water Resources" section in chapter 5.

Overall, the Basin is a highly regulated and managed water system. Water is stored in reservoirs and released at certain times to meet specific needs and to fulfill contractual requirements. Changing water storage requirements or the amount and timing of water releases at one reservoir could influence water operations throughout the rest of the system.

For this analysis, the Present Condition represents the hydrologic conditions that would exist if the river system were to continue being operated as it was in 1997 and future hydrologic and climatologic conditions were similar to the 48-year period from 1947 - 1994, as adjusted for 1997 irrigation demands and return flows. Specifically, the Present Condition assumes:

- 1997 levels of water resource development
- 1997 operating procedures for all projects
- 1997 irrigation demand levels

From 1947 to 1994 is the longest period with a continuous hydrologic record for which the adjusted data necessary to run the water operation models are available. This period includes substantial variation in hydrologic conditions, including a relatively wet 6-year period (1983 to 1988) and an 11-year dry period (1953 to 1964) (*Water Resources Appendix* in volume 3[4] for details).[5]

However, it is important to note that the Present Condition hydrology is not exactly equal to the historic hydrology from 1947-1994. While the precipitation and runoff are the same, the water storage and diversion facilities and the level of water demand placed on the river have all been updated to 1997 levels of development. Thus, the Present Condition hydrology represents the streamflows, reservoir levels, and diversions that would have occurred from 1947-1994 if current levels of water resources development and use had existed during that period (historic hydrology, but 1997 system demands). This same approach serves as the starting point for modeling the alternatives in chapter 5, "Environmental Consequences."

Another point to keep in mind is that the Present Condition modeling uses average rules of operation for the various reservoirs and diversions. While these rules produce accurate results on average and over the long term, the Present Condition modeling does not exactly reproduce the actual operations in any given

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[4]Volume 3 contains appendices and technical material and is available on request at <http://www.platteriver.org>.

[5]Some readers of the Draft Environmental Impact Statement (DEIS) asked why the recent severe drought (2002-2003) is not included in the hydrologic record used for analyzing the alternatives. One reason, mentioned above, is the lack of complete published hydrologic data for these years. Another reason is the desire not to change the basis of the analysis from the DEIS to the FEIS. Finally, while the recent drought was the most severe on record in terms of some hydrologic indicators, the drought period of 1953 to 1964 (which is included in the FEIS baseline) was significantly longer and, therefore, more severe for a number of other hydrologic variables including Platte system reservoir storage.

year. The operators of facilities on the Platte River system have significant flexibility to adapt to changing conditions. This short-term operational flexibility is not always captured in the model.

NORTH PLATTE RIVER BASIN

For purposes of this analysis, the North Platte River was modeled for the river reach starting at the inflow to Seminoe Reservoir in Wyoming to the inflow to Lake McConaughy in Nebraska. The North Platte River Basin includes seven dams and reservoirs—Seminoe, Kortes, Pathfinder, Alcova, Gray Reef, Glendo, and Guernsey. These reservoirs store water for irrigation, municipalities, recreation, and power generation at six hydropower generation units (Seminoe, Kortes, Fremont Canyon, Alcova, Glendo, and Guernsey).

Water in the North Platte River Basin is primarily managed to provide irrigation water, hydropower generation, recreation, and flood control. The North Platte environments most likely to be affected by the alternatives are Seminoe, Pathfinder, and Glendo Reservoirs and the agricultural operations that they serve. These water project facilities are described in more detail in *Major Water Facilities Likely to Be Affected* in volume 2.

Indicators

The North Platte River Water Utilization Model - EIS version (NPRWUMEIS) output was analyzed to produce data that indicate how the Program is affecting the resources of the North Platte River Basin. There are three categories of these indicators:

- Reservoir storage
- Riverflows
- Irrigation deliveries

The **reservoir storage** indicators are:

- Average end-of-month content
- Average monthly elevations
- Years with low storage
- Average May-August drawdown
- Spills from Guernsey Reservoir

The **riverflow** indicators are:

- Average monthly flows
- Months with flows less than 500 cubic feet per second (cfs)
-

The **irrigation delivery** indicators are:

- Average April-September delivery
- Number of years with shortages
- Average annual shortage for years with shortages

Method of Analysis

The primary analytical tool used for this evaluation is a water operations model developed for the North Platte River Basin. This model simulates reservoir operations and streamflows in the North Platte River Basin, based on water supply and water demands. It was used to simulate the behavior of the North Platte River system under the Present Condition and the evaluated alternatives.

The NPRWUMEIS was developed to evaluate Reclamation projects on the North Platte River for the potential to affect threatened and endangered species in central Nebraska. The NPRWUM model was developed by Reclamation's Wyoming Area Office in cooperation with the U.S. Fish and Wildlife Service (Service). The model was subsequently modified by the staff of the Platte River EIS Office to simulate the alternatives contained in this FEIS.

Present Condition

Reservoir Storage and Spills

Reservoir storage is crucial to irrigation, recreation, fisheries, and power production. For each of the major North Platte reservoirs, the tables below display average end-of-month storage (table 4-WR-1) and elevation (table 4-WR-2) under the Present Condition. Because Reclamation has the ability to move and store water between several reservoirs, the most stable indicator is the total storage in the North Platte River system above Lake McConaughy. In addition, Alcova, Glendo, and Guernsey reservoirs are operated as fixed or semi-fixed reservoirs with storage controlled by releases from upstream reservoirs. Thus, Seminoe and Pathfinder are the main storage reservoirs on the North Platte River above Lake McConaughy.

Table 4-WR-1.—Average End-of-Month Content (kaf)* for the Present Condition (1947-1994)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Seminoe	603	587	565	543	518	509	534	644	751	696	629	609
Pathfinder	520	532	544	555	572	585	612	645	670	529	495	485
Alcova	156	156	156	156	156	156	180	180	180	180	180	180
Glendo	203	245	284	325	366	419	426	447	448	410	242	160
Guernsey	2	5	8	11	13	15	36	40	35	30	30	2
Total	1,484	1,525	1,557	1,590	1,625	1,684	1,788	1,956	2,084	1,845	1,576	1,436
* Kaf = thousand acre-feet												

Table 4-WR-2.—Average End-of-Month Elevation (Feet Mean Sea Level) for the Present Condition (1947-1994)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Seminoe	6,328	6,327	6,326	6,324	6,322	6,321	6,323	6,332	6,340	6,336	6,331	6,329
Pathfinder	5,817	5,817	5,818	5,819	5,820	5,821	5,823	5,826	5,828	5,817	5,815	5,813
Alcova	5,488	5,488	5,488	5,488	5,488	5,488	5,498	5,498	5,498	5,498	5,498	5,498
Glendo	4,599	4,606	4,611	4,616	4,620	4,626	4,627	4,628	4,628	4,625	4,605	4,592
Guernsey	4,382	4,394	4,397	4,400	4,402	4,404	4,416	4,418	4,415	4,413	4,413	4,388

Because stored water is so valuable to recreation, fisheries, irrigation, and power production, occurrences of low reservoir storage were also evaluated. Table 4-WR-3 displays the number of years in which storage for individual North Platte reservoirs was less than the threshold used to indicate low storage. For each reservoir, the low storage indicator was defined on the basis of reservoir size and operations.

Table 4-WR-3.—Years With Storage Less Than the Low Storage Indicator Under the Present Condition (1947-1994)

	Seminoe Reservoir	Pathfinder Reservoir	Glendo Reservoir
Low storage indicator (kaf)	200	200	100
Years with storage less than the low storage indicator	6	12	9

Another factor that also affects fisheries and recreation is amount of water released from a reservoir during the summer. This affects reservoir levels and is referred to as drawdown. The average reservoir drawdown[6] for Seminoe was 21 feet; for Pathfinder, 30 feet; and for Glendo, 46 feet.

Spills are releases from a dam that do not pass through the hydropower turbines. These releases are made when storage levels are so high that all water cannot be accommodated, when predicted inflows are expected to be more than the reservoir can accommodate, or when downstream demand is greater than the turbine capacity. Spills can represent a lost opportunity for additional water storage or power generation. However, within a river system, spills can help generate high flows that provide important downstream benefits.

As discussed earlier, Reclamation has significant flexibility to move and store water between reservoirs. Reservoir spills from all reservoirs upstream of Guernsey Reservoir could be stored in a downstream reservoir in the North Platte system. There were 12 years with spills from Guernsey Reservoir under the Present Condition (1947-1994).

Riverflows

The analysis estimates future riverflows to determine average monthly flows under each alternative. Average flows in the North Platte River under the Present Condition are summarized in table 4-WR-4.

[6]May-August drawdown under the Present Condition (1947-1994).

Table 4-WR-4.—Average Flows in the North Platte River (cfs) Under the Present Condition (1947 to 1994)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Below Kortes Reservoir	689	770	770	747	878	828	1,304	1,847	3,075	2,467	1,624	632
Below Gray Reef Reservoir	653	571	570	569	574	695	643	1,524	2,666	4,603	1,927	641
Below Guernsey Reservoir	156	5	6	9	10	28	749	2,299	3,071	5,176	4,652	2,790
Above Lake McConaughy	1,662	1,495	1,317	1,206	1,285	1,215	1,261	1,741	2,221	1,282	785	1,335

In the North Platte River, two locations have special significance with regard to flows. The river below Kortes and Gray Reef Reservoirs has nationally recognized fisheries, and minimum flows are required by law. The average flow at these two locations is never less than 500 cfs under the Present Condition.

Irrigation Deliveries

Irrigation deliveries refer to water delivered to diversion structures where water is removed from the North Platte River. North Platte irrigation deliveries are separated into projects, which can be served by multiple reservoirs. The North Platte Project, which includes Pathfinder and Guernsey Reservoirs, delivers water to land below Guernsey Reservoir in eastern Wyoming and western Nebraska. The Kendrick Project, which includes Seminoe and Alcova Reservoirs, delivers water to land west of Casper, Wyoming. The Glendo Unit includes Glendo Reservoir and delivers water to the same area as the North Platte Project. Non-program lands are irrigation districts that take water from the North Platte River above Lake McConaughy but do not have contracts with Reclamation to receive water from the North Platte Reservoirs. Table 4-WR-5 summarizes the Present Condition for irrigation deliveries.

Table 4-WR-5.—Average Monthly and Annual Volume of Irrigation Deliveries (kaf) Under the Present Condition (1947 - 1994)

	Apr	May	Jun	Jul	Aug	Sep	Annual
North Platte Project	2	117	134	319	324	200	1,098
Kendrick Project	0	10	16	21	18	9	74
Glendo Unit	0	8	11	16	14	13	64
Non-Program lands	2	29	40	62	66	48	253

The effect of the Program on irrigation deliveries was assessed by projecting the number of years that irrigation deliveries, to the various projects using water from the North Platte River, fall short of a full irrigation supply. Thus, an irrigation delivery “shortage” measures water that was needed for irrigation, but that was not delivered due to an inadequate supply of water. The average annual irrigation delivery shortage for those years that have shortages was also evaluated. Even under the Present Condition, irrigation shortages occur in some drought years. Table 4-WR-6 summarizes the Present Condition for irrigation delivery shortages.

Table 4-WR-6.—Irrigation Delivery Shortages Under the Present Condition (1947-1994)

	Number of Years With Irrigation Shortages	Average Irrigation Shortage (kaf)* for Years With Shortages	Average Shortage as Percent of Annual Irrigation Demand
North Platte Project	2	1	1
Kendrick Project	3	47	67
Glendo Unit	21	9	13
Non-Program Lands	26	1	0.4
*Average is calculated for years with shortages and does not include years with no shortage.			

Effects of the Program on Water Use Above Pathfinder Reservoir

Carbon County has expressed concern about possible effects of the alternatives on water users above Pathfinder Reservoir. The county has provided the EIS Team with extensive documentation regarding the importance of irrigation supplies to the region's economy (Carbon County Land Use Plan, Wyoming, 1998). This section describes how, under Present Conditions, the State of Wyoming's administration of water rights for Pathfinder Reservoir can affect water users above Pathfinder Reservoir. Chapter 5 describes how the alternatives might affect that process of water right administration.

With a 1904 water right, Pathfinder Reservoir is senior to many of the water rights above Pathfinder Reservoir. According to a letter from Kurt Bucholz (Carbon County, 2003, personal communication, Kurt Bucholz, county representative), rough estimates from Wyoming's Division I Book of Tabulated Water Rights indicate that about half of the water rights for irrigation of lands above Pathfinder are junior to 1904.

Criteria for North Platte River Water Rights Administration

Reclamation makes a request to the Wyoming State Engineer for water right administration when it determines that an allocation year may be necessary on the North Platte River. By definition, an allocation year means that the supply forecast to be available to Reclamation's North Platte Project is less than 1,100 kaf. The supply available to the North Platte Project includes storage in the Pathfinder Reservoir and Guernsey Reservoir ownerships plus the forecasted inflow above Guernsey through the end of July.

If the State Engineer places a call for water right administration on the North Platte River above Pathfinder Reservoir in response to Reclamation's determination that an allocation year may be necessary, water rights junior to Pathfinder are not allowed to divert water and water rights senior to Pathfinder are limited to 1 cfs per 70 acres (Supreme Court, 2000, Appendix G, Exhibit 5, page 191, of the *Nebraska vs. Wyoming* Settlement Agreement[7]). Prior to May 1, the Bureau of Reclamation has the right to place a priority call for Pathfinder Reservoir whenever there is a projected allocation of the North Platte Project, without the need to formally request such call. After May 1st, the Bureau of Reclamation has the right to place a priority call for Pathfinder Reservoir whenever there is a projected allocation of the North Platte Project, but Reclamation must formally request such a call. Administration of water rights on the river is at the discretion of the Wyoming State Engineer. This water right administration is limited to lands above Pathfinder Reservoir in the State of Wyoming. The criteria which trigger a call for

[7] *Nebraska v. Wyoming*, 325 U.S. 589 (1945), modified and supplemented, *Nebraska v. Wyoming*, 345 U.S. 981 (1953), further modified, *Nebraska v. Wyoming*, 534 U.S. 40 (2001).

water right administration for Pathfinder Reservoir are found in Exhibit 5 to Appendix G of the Modified North Platte Decree Final Settlement Stipulation in accordance with the criteria contained in the Technical Appendix to Appendix E to the Stipulation Among the State of Wyoming, the State of Nebraska, and the United States relating to the allocation of water during periods of shortage (Settlement Stipulation, Appendix E). Exhibit 5 provides language regarding placing of a priority call and the Technical Appendix identifies the calculations for the "Forecasted Supply" for October 1, February 1, March 1, and April 1.

For the Present Condition, analyzed over the 48-year period of the hydrologic baseline, water right administration occurs nine times each in February, March, and April.

Modeling Wyoming's Future Depletion Management Plan for the Platte River EIS

The Pathfinder Modification Stipulation, agreed to by the parties to the *Nebraska* v. *Wyoming* lawsuit (Wyoming, Colorado, Nebraska, United States in September 1997), provides for the Pathfinder Modification Project, which would increase the capacity of the existing Pathfinder Reservoir by approximately 54 kaf. The increased capacity is proposed to be filled with water stored under the existing 1904 storage right for Pathfinder Reservoir, with the exception that regulatory calls cannot be placed on existing water rights upstream of Pathfinder Reservoir other than the storage rights pertaining to Seminoe Reservoir.

The Pathfinder Modification Project will serve both environmental and municipal uses. A Pathfinder EA of 34 kaf will be operated for the endangered species and habitat in Central Nebraska in accordance with certain conditions. A municipal account of 20 kaf will provide municipal water to North Platte communities in Wyoming through contracts between the municipalities and the State of Wyoming in accordance with certain conditions.

In addition to the Pathfinder municipal account,[8] there is a 1953 Order Modifying and Supplementing the North Platte Decree (1953 Order) that provides for the storage of 40 kaf in Glendo Reservoir during any water year for the irrigation of lands in western Nebraska and in southeastern Wyoming below Guernsey Reservoir. Of the 40 kaf available for irrigation, the 1953 Order allocates 25 kaf for the irrigation of lands in western Nebraska and 15 kaf of storage for the irrigation of lands in southeastern Wyoming.

A stipulation entitled "Amendment of the 1953 Order to Provide for Use of Glendo Storage Water" (Glendo Stipulation)[9] was agreed to by the parties to the *Nebraska v. Wyoming* lawsuit (Wyoming, Colorado, Nebraska, United States), in September 1997. The Glendo Stipulation provides for several changes to the 1953 Order that relax the conditions under which Glendo storage water can be used. Significant changes include the following:

- The potential use of Glendo storage water was expanded to municipal, industrial, and other uses, and the service area expanded from the North Platte River Basin to the Platte River Basin.

[8]The Supreme Court's Final Settlement Stipulation in 2000 references "the North Platte Decree, 325 U.S. 665 (1945), as modified 345 U.S. 981 (1953).

[9]The Glendo Stipulation ("Amendment to the 1953 Order to Provide for Use of Glendo Storage Water") is provided as Appendix C to the Nebraska v. Wyoming Final Settlement Stipulation.

➢ Glendo storage may be used for fish and wildlife purposes downstream of Glendo Reservoir. Any releases made for such purposes shall be administered and protected as storage water in accordance with Wyoming and Nebraska law.

These changes facilitate the use of Glendo storage water as a component of the Program and for meeting Wyoming's future depletions. Of the 15 kaf of Glendo storage water allocated to Wyoming, there are currently contracts for 4,400 acre-feet. The remaining 10,600 acre-feet is leased by the Bureau of Reclamation under temporary water service contracts for up to 1 year. Wyoming is considering negotiating a contract with the Reclamation for all of the remaining 10,600 acre-feet of storage (Wyoming, December 16, 1999, proposal).

These two accounts are included in the NPREIS model, with demands to simulate future depletions in Wyoming. The demand from these accounts is removed from the river, and no water is returned to the river. Thus, the NPREIS model simulates 100-percent consumptive use of the water from these accounts.

South Platte River Basin

The potentially affected environment in the South Platte River Basin consists of the river, riverine, and upland areas within a few miles of the river from Fort Morgan to the state line that might be affected by groundwater recharge projects, and the reservoirs and river, downstream from Greeley, Colorado, that might be affected by water leasing activities.

For this analysis, the South Platte River was simulated from Henderson to Julesburg, Colorado. The major tributaries are inputs to the South Platte EIS model and were not themselves simulated.

The alternatives analyzed in this FEIS affect water resources in the South Platte River Basin through the Tamarack groundwater recharge projects, and, through other similar flow re-regulation projects the State of Colorado may implement, and through water leasing from various South Platte reservoirs. The Tamarack Projects may affect flows in the river and nearby canals and groundwater levels along the lower reaches of the South Platte River in Colorado.

Method of Analysis

Riverflows

The South Platte River Basin was analyzed for this report using the South Platte River EIS Model (SPREISM), developed by Hydrosphere Resource Consultants of Boulder, Colorado (Hydrosphere, 2001). The model simulates the operation of the main stem of the South Platte River from Chatfield Reservoir (south of Denver, Colorado) to the Nebraska State line, estimating riverflows, diversions, return flows, reservoir releases, and losses associated with evaporation and seepage. For purposes of this analysis, the South Platte River Basin was treated as ending at Julesburg, Colorado, near the Nebraska border.

SPREISM was designed to estimate South Platte Riverflows at Julesburg under the Present Condition and with various EIS alternatives superimposed upon the Present Condition. The Present Condition representative of 1997 water development was created by modifying the 1947-1994 natural flow hydrologic record. This was accomplished by adjusting historical inflows, diversions, gains, and losses during this period to reflect current water development conditions, many aspects of which did not exist throughout the historic period. For this reason, SPREISM represents adjusted rather than actual historic conditions. The model is not intended to reflect future water development scenarios. However, future water development scenarios in the Basin consistent with Colorado's future depletion management plan were considered and separately modeled, as described below under the subsection "Future South Platte River Basin Development and Colorado's Plan for Future Depletions."

Groundwater Recharge

The Tamarack Project, Phases I and III, are modeled using Stream Depletion Factors View Model (SDFView) (Integrated Decision Support Group, 1999). SDFView uses stream depletion factors to determine the influence of groundwater pumping or groundwater recharge on the flow of a nearby river. For example, SDFView predicts the time and rate at which water diverted from the river to nearby recharge ponds will return to the river for the Tamarack projects.

Present Condition

The South Platte River Basin has a drainage area of about 24,300 square miles (Dennehy, 1991) and is located in parts of three states— Wyoming (6 percent of the Basin), Colorado (79 percent of the Basin), and Nebraska (15 percent of the Basin). The South Platte River originates in the mountains of central Colorado at the Continental Divide and flows about 450 miles northeast across the Great Plains to its confluence with the North Platte River at North Platte, Nebraska. Altitude in the Basin ranges from 14,286 feet at Mt. Lincoln on the Continental Divide to 2,750 feet at the confluence of the South Platte and North Platte Rivers.

In eastern Colorado, the South Platte River is a low-gradient plains river with substantial sediment loads. Annual flows are dominated by snowmelt runoff in the spring and early summer, as well as irrigation deliveries starting in spring and continuing through the summer. Hundreds of canals divert water to off-stream reservoirs or carry irrigation deliveries to farm fields, mostly in the Platte River Valley or on nearby bench areas. During the irrigation season, it is common for the river to be dry below main irrigation canal diversions and then to begin flowing again farther downstream as irrigation return flows enter the river.

Surface water in the South Platte River Basin is managed primarily to provide irrigation, municipal and industrial water, recreation, and flood control. Agriculture is the predominant water use, with approximately 2.0 million acre-feet (maf) per year used to irrigate 1.1 million acres in Colorado alone. An additional 880 kaf per year of groundwater is applied for irrigation, and 100 kaf of groundwater is used to meet municipal, domestic, livestock, industrial, and commercial needs (Colorado Water Conservation Board [CWCB], 2002 [South Platte Basin facts]). A portion of these demands are met by diversions of surface water from neighboring river basins—in particular, from the Colorado River Basin. During the 1990s, annual diversions from the Arkansas and Colorado Rivers into the South Platte River Basin averaged around 340,000 acre-feet (Hydrosphere, 2000). Transbasin diversions from the Colorado River Basin into the South Platte River Basin currently average about 430 kaf per year (Hydrosphere, 1999). There are no significant exports of water out of the South Platte River Basin.

Future South Platte River Basin Development and Colorado's Future Depletions Management Plan

Many urban areas and industrial operations in Colorado (and, to a much smaller extent, in Nebraska and Wyoming) obtain water supplies from the South Platte River Basin. Outside of the urban corridor along the Colorado Front Range, population densities are low and centered in small towns that are located along the principal streams. Most population is concentrated in the Front Range municipalities of Colorado, which are growing at a rapid rate, including the Denver metropolitan area, Boulder, Greeley, Loveland, and Fort Collins. Between 1990 and 2000, Colorado's population in the South Platte River Basin increased by 31 percent, to some 2,970,000 people (details and references for this analysis can be found in the *Water Resources Appendix* section, "Modeling Colorado's Plan for Future Depletions for the Platte River EIS" in volume 3).

In planning for any Platte Program, an important consideration is this rapidly expanding population and the corresponding demand for water. It is projected that approximately 1.1 million additional people will live in the South Platte River Basin in Colorado by the end of the Program's First Increment, relative to the 1997 baseline.

The effects of anticipated water development in the Platte River Basin during the Program's First Increment were analyzed in light of the plans made by each state and by the Federal Government to offset adverse effects of new depletions, as described in their corresponding Depletion Management Plans. Colorado's plan (Governance Committee Program Document: Attachment 5: Water Plan, Section 9: Colorado's Plan for Future Depletions) describes anticipated trends of water supply development in the South Platte Basin of Colorado during the Program's First Increment. Among the water use characteristics and anticipated trends described in that Plan are:

- The gross per-capita water requirement in the South Platte Basin is assumed to be 0.27 acre-foot/year.
- Of water supplied in the Basin, 35-percent consumptive use is assumed for municipal purposes, and 45 percent is assumed for agricultural irrigation purposes.
- Six sources of water supply are anticipated to serve population increase in the Basin, in the approximate proportions shown in table 4-WR-7.

Table 4-WR-7.—Water Supply Sources

Source	Northern Region	Central Region	Southern Region	Accretive (+) or Depletive (-) Effect
New transbasin imports	40 percent	30 percent	20 percent	64 percent
Nontributary groundwater	0 percent	10 percent	50 percent	68 percent
Agriculture to urban conversion	35 percent	5 percent	0 percent	10 percent
Conservation	5 percent	15 percent	10 percent	0 percent
Wastewater exchange/reuse	10 percent	25 percent	10 percent	-41 percent
Native South Platte flows	10 percent	15 percent	10 percent	-27 percent

➢ Monthly transit loss per-mile factors for the South Platte River are assumed to be those set forth in table 4-WR-8.

Table 4-WR-8.—Transit Loss Per Mile

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
.02 percent	.02 percent	.05 percent	.1 percent	.3 percent	.45 percent	.5 percent	.5 percent	.5 percent	.4 percent	.1 percent	.02 percent

➢ The cumulative effect of Colorado's population growth and new water supply development on the South Platte River at Julesburg for any annual period is expected to be a mix of net accretions during the fall, winter, and spring period, and seasonal depletions in the late spring to mid-summer period, resulting in an estimated total seasonal net depletive effect on an order of magnitude of less than 1,800 acre-feet per year for each 100,000 additional people in the South Platte River Basin in Colorado.

To evaluate the aggregate effect of meeting population-driven demands, the State of Colorado has developed an "illustrative tool" (Colorado, 1998 [tool]) to assess assumed population growth and assumed mixes of new water supply sources. Based on an accretive/depletive "signature" for each water supply source, the tool estimates monthly impacts to flow in the South Platte River. Under current projections, Colorado believes that, during the Program's First Increment, flow increases at the Nebraska State line during months of net accretion (generally, fall through spring) will outweigh flow reductions during months of net depletion (generally, the summer season) in average years. Colorado's plan for addressing future depletions in the South Platte River Basin therefore proposes creating and operating re-regulation facilities in the Lower South Platte River (Tamarack Project, Phase II) to divert and retime accretions to offset depletions (State of Colorado, 1998). The intent of this re-regulation is to ensure that, on average, there will be no net new depletions to South Platte Riverflows at Julesburg in any month of the year as a result of new water-related activities.

Effects on the Platte River of the Program's First Increment water development in the South Platte River Basin of Colorado were modeled by adjusting monthly inflows at the Julesburg, Colorado, gauge, for the Central Platte River model (CPR model) runs.

For all modeling, it was assumed that the basic assumptions articulated in Colorado's Depletion Management Plan (and incorporated into Colorado's "illustrative tool" [Colorado, 1998 {Tool}]) hold true through the Program's First Increment, with the possible exception of the mix and distribution of the six sources of water supply. A net population growth of 1.1 million was assumed between 1997 and 2020. It was further assumed that Colorado will fulfill its commitment to avoid creating any net new depletions to South Platte Riverflows at Julesburg in any month of the year on an average long-term basis.

To address concerns about potential impacts to peak flows in the Platte River, Colorado agreed that initial Endangered Species Act (ESA) coverage for Colorado projects under the Program will be limited with respect to the magnitude of new water supplies derived from sources that have the potential to impact peak flows. As described in the Colorado's Plan for Future Depletions:

"New water related activities would not be covered by this plan after the average annual water supply to serve Colorado's population increase from "Wastewater

Exchange/Reuse" and "Native South Platte Flows" exceeds 98,010 acre feet during the February-July period as described below. The 98,010 acre-feet figure represents gross water deliveries (supplies) to meet new demands for an average hydrologic year, and is not a consumptive use or diversion limitation. In analyzing proposed new water related activities that have supplies derived from the storage of native South Platte flows only those supplies resulting from diversions to storage or exchange/reuse during the period from February through July will be counted toward the 98,010 acre-feet. In the event that a new water related activity is not covered by Colorado's plan pursuant to this subsection I.H.1, Colorado and the activity's proponent can propose, as provided in Section E of the Program document, amendments that will allow Colorado's Plan to provide ESA compliance for the activity as provided in Section E of the Program document."

(Governance Committee Program Document:
Attachment 5: Water Plan, Section 9: Colorado's Plan for Future Depletions)

The period of February-July is specified because the Service identified these as the months of greatest concern from its perspective of potential impacts to the Program target species and habitat.

To evaluate potential impacts on peak flows within the "umbrella" of coverage described above, five South Platte Basin water-supply development components were conceptualized that are within this magnitude and are believed representative of the kinds of projects most likely to be implemented during the Program's First Increment. The likely fate of historic South Platte Riverflows (1947-1994) was analyzed assuming that these new water projects were in place. Several assumptions were adopted that err on the side of overestimating impacts to high flows.

From this analysis, estimated daily reductions in flow in the South Platte River at Julesburg, Colorado, associated with only these projects were aggregated into monthly estimated flow reductions. These reductions were then adjusted upward to reflect Colorado's commitment to maintain or increase long-term average flows at Julesburg in each month of the year. This includes the effects of other anticipated water transfer or development that was not explicitly modeled, but which would be accretive to South Platte Riverflows.

The product of the above steps was a new table of monthly flows for the South Platte River at Julesburg, adjusted from Present Condition flows. While long-term average flows at Julesburg were not reduced in any month of the year, the distribution of monthly flows over the 48-year modeled period changed, with many high-flow months manifesting reductions in flow, and most low-flow months showing increases (figure 4-WR-1). Differences between the Present Condition and the "Build-out" simulation reflect both projected Program's First Increment water development activities in Colorado, and Colorado's commitment to maintain long-term average flows at Julesburg in each month of the year through re-regulation or other means.

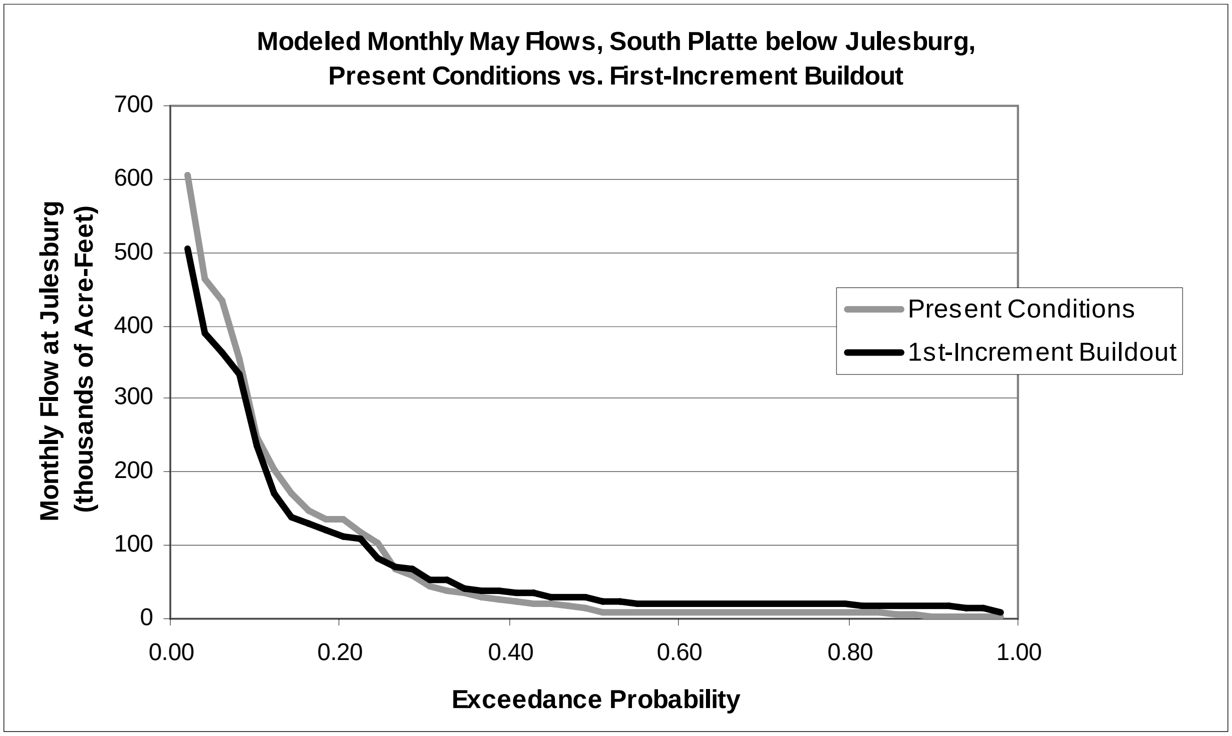


Figure 4-WR-1.—Modeled effect of projected water development on flows in the South Platte River at Julesburg in May, within the parameters of Colorado's Future Depletion Management Plan.

Reservoir Storage

Reservoir storage in the South Platte River Basin is crucial to irrigation, recreation, fisheries, and flood control. Current useable storage in this Basin in Colorado totals about 1,134,400 acre-foot (CWCB, 2002b).

Table 4-WR-9 displays average historic end-of-month storage in six South Platte reservoirs from 1950-1994. These six reservoirs are highlighted here because they are evaluated in this EIS to illustrate possible effects of water leasing under some alternatives. Actual leasing of water to a Program in Colorado, under some of the action alternatives, could occur from any number of reservoirs, depending upon willing participants. These reservoirs are described in more detail in the "Recreation" section in this chapter.

Table 4-WR-9.—Average End-of-Month Storage (kaf) Historic Values (1950-1994)*

Reservoir	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Julesburg (Jumbo)	18.5	17.8	19.6	19.5	19.4	19.4	14.2	10.0	7.8	11.9	15.9	16.8
North Sterling** (Point of Rocks)	46.7	46.3	57.8	53.5	54.9	48.8	27.3	12.7	6.8	20.1	33.6	45.7
Prewitt**	16.0	15.7	21.2	19.6	20.2	19.9	12.7	10.1	11.2	13.2	14.1	15.4
Jackson	27.1	29.2	31.1	32.0	32.0	30.8	24.2	15.5	11.0	12.4	18.9	23.8
Empire	21.4	24.2	28.9	28.9	26.7	27.0	17.4	9.7	9.5	8.6	12.6	18.3
Riverside	39.7	46.4	53.7	53.7	50.7	47.9	32.5	17.3	10.7	14.7	26.1	34.4

* Storage values were not available for all years during this period; these averages reflect only available years.

** North Sterling and Prewitt Reservoir averages are for 1970-1994.

Historic values, rather than values adjusted for the Present Condition, are illustrated in table 4-WR-10 and were used as the basis for evaluating the effects of water leasing. Most of these reservoirs are not explicitly incorporated into the South Platte EIS model; thus, the historic data provide the most straightforward and useful basis for evaluation. End-of-month reservoir contents might have differed if Present Condition adjustments had been made to the historic record. However, the relative differences in content as evaluated for this FEIS—with versus without Program water leasing—are expected to be essentially the same.

Table 4-WR-10 summarizes the storage capacity of other major reservoirs in the South Platte River Basin.

Table 4-WR-10.—Additional Major Storage Reservoirs in South Platte River Basin

Reservoir	Storage Capacity (Acre-Feet)
Horsetooth Reservoir	157,000
Carter Lake	112,200
Eleven Mile Canyon Reservoir	97,800
Cheesman Reservoir	79,064
Spinney Mountain Reservoir	53,873
Boyd Lake	52,438
Standley Lake	43,344
Aurora Reservoir	32,400
Gross Reservoir	41,811
Chatfield Reservoir	26,600
Antero Reservoir	25,618
Milton Reservoir	29,732
Marston Reservoir	19,795
Button Rock Reservoir	16,080
Horse Creek Reservoir	18,747
Cherry Creek Reservoir	13,226

Source: Colorado Water Conservation Board, 2002 (South Platte Basin facts).

Flow in the South Platte River

Flow in the Lower South Platte River in Colorado is lowest during the late irrigation season (July-September) and highest during the spring runoff (May-June), as shown in table 4-WR-11, which shows average estimated 1947 to 1994 flows at five South Platte River locations below the Cache La Poudre River confluence, as adjusted for the Present Condition.

The maximum flow ever recorded in the South Platte River at Julesburg was 37,600 cfs on June 20, 1965. The minimum recorded flow was zero, which has occurred on a number of occasions.

Table 4-WR-11.—Average Monthly Flows (cfs)* Under the Present Condition (1947-1994)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
South Platte at Kersey	755	795	849	878	2,028	2,798	756	537	599	791	856	763
South Platte Below Weldon Valley Diversion	667	661	509	615	1,579	2,125	753	590	677	563	503	537
South Platte at Balzac	574	577	416	487	1,391	1,845	536	419	495	292	295	403
South Platte at Cooper	619	645	492	530	1,433	1,906	559	435	528	330	309	433
South Platte at Julesburg	734	854	584	547	1,250	1,769	454	230	363	345	426	552
* cfs is cubic feet per second.												

Groundwater

The hydrogeology of the Lower South Platte River Basin is such that alluvial groundwater has a strong hydrologic connection with surface water in the river. Approximately 50,000 groundwater wells exist in the South Platte River Basin. The majority of these wells tap alluvial groundwater along the South Platte River and its tributaries. The alluvial aquifers range in thickness from a few feet to 200 feet, and in width from 1 mile to 10 miles. Where sand and gravel layers are thick and relatively free of fine materials, wells in these aquifers can be highly productive, capable of yielding 2,000 to 3,000 gallons per minute.

The proposed Tamarack projects' groundwater recharge would divert South Platte waters into recharge ponds or other facilities at some distance from the river. This diverted water would percolate into the alluvial aquifer and return to the South Platte River at times more beneficial to the species. It is anticipated that these projects primarily will be developed along the lowest reaches of the South Platte River in Colorado, but they could potentially extend as far upstream as Fort Morgan. The sandhills found along the edge of the valley are aeolian deposits consisting of fine to medium sand. Due to topography and high infiltration rates, there are several areas where waters diverted onto the lands from the river would return to the river through the alluvium over relatively predictable periods of time (Boyle Engineering, 1999).

CENTRAL PLATTE RIVER BASIN

From its confluence near North Platte, Nebraska, the Platte Riverflows eastward along an S-shaped course and empties into the Missouri River near Omaha, Nebraska. For this analysis, the Central Platte River (see description and maps in chapter 2) is simulated from the point of inflow to Lake McConaughy on the North Platte and where flow passes Julesburg on the South Platte. The simulation ends where the Platte River passes the gauge near Duncan, Nebraska. The modeled region therefore includes the entire "Big Bend" reach of the Platte River (and the Central Platte Habitat Area), which is the focal area of this endangered and threatened species recovery effort in central Nebraska. Using historic gains and losses, flows at Louisville, Nebraska, are also simulated.

Along this route, approximately 29,800 square miles are drained by the Platte and its major tributaries. Water in the Central Platte River Basin is primarily managed to provide irrigation water, hydropower generation, recreation, and flood control. A more detailed description of the Central Platte River water projects is found in *Major Facilities Likely to be Affected* in volume 2. The Central Platte environment most likely to be affected by the alternatives is Lake McConaughy, the river downstream to the confluence of the Missouri, the offstream canal and reservoir facilities (including irrigation delivery canals), and the agricultural operations that they serve.

West of the 100th meridian (approximately Cozad, Nebraska), the Central Platte River is in a drier climate zone, dominated by mixed-grass prairie. East of Kearney, Nebraska, the climate transitions to a wetter regime, where rainfall exceeds 20 inches annually, and the prairie changes to upland and lowland tallgrass. In the valley and bench areas along the river, the majority of the land is in agricultural production. In the area between Lexington and Chapman, Nebraska, 60 percent of lands are in crops or pasture.

Much of the river area and flood plain is now wooded with cottonwoods, mixed hardwood, and shrubs. The extent of forestation of the river channel diminishes downstream; downstream of Kearney, Nebraska, the river is more often bordered by wet meadows and fields.

Method of Analysis

The Central Platte River model was developed by Reclamation and the Service as a tool for evaluating management alternatives affecting flows in the Central Platte River in Nebraska. The Central Platte River model allows for the assessment of a wide variety of water management scenarios at monthly time steps. The model simulates river conditions based on inflows to, outflows from, and demands on the river system. The Central Platte River model allows alternatives to be compared in terms of estimated riverflows, power generation, irrigation diversions, reservoir storage and release, losses associated with reservoir evaporation and seepage, and other measures.

For analysis of the alternatives, especially the Governance Committee Alternative, the CPR model analysis uses certain assumptions about how Lake McConaughy and the NPPD and CNPPDs' canal and hydropower system would be operated. More details on the model and these assumptions are described in the Governance Committee Program Document: Attachment 5: Water Plan, Section 11: Water Plan Reference Materials, Appendix C: OPSTUDY Assumptions Regarding Water Operations for Diversions at Keystone and the Central District Supply Canal.

Present Condition

Modeling Nebraska's Future Depletion Management Plan for the Platte River Environmental Impact Statement

Future depletions in Nebraska were simulated by decreasing the reach gains/losses in the CPR model. The reach gains/losses were reduced by the amount specified by Nebraska in an attachment to an email from the Nebraska Department of Natural Resources (NDNR) (NDNR, 2005).

Nebraska's future Depletion Management Plan, which relies on many of the same projects that are in the Water Action Plan, was simulated in the CPR model by full implementation of the Water Action Plan, including the portions reserved by Nebraska to offset future depletions. Implementation of Nebraska's future Depletion Management Plan (Governance Committee Program Document: Attachment 5: Water Plan, Section 8, Nebraska's New Depletion Plan) resulted in no change in amount of time that target flows are met, but it did result in depletions to flows above target flows.

Lake McConaughy Reservoir Storage and Spills

Table 4-WR-12 displays average end-of-month storage and elevation under the Present Condition. Under the Present Condition, the average monthly elevation of Lake McConaughy would be 3,255 feet, with an average monthly storage level of 1,457 kaf. Other indicators are the number of years in which storage would be less than 500 kaf and the largest May-August drawdown.

Table 4-WR-12.—Lake McConaughy Average End-of-Month Content and Elevation Under the Present Condition (1947-1994)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
Average end-of-month content (kaf)	1,456	1,483	1,513	1,537	1,561	1,554	1,444	1,339	1,333	1,370	1,402	1,428	1,452
Average end-of-month elevation (feet mean sea level)	3255	3256	3257	3258	3258	3258	3254	3250	3250	3252	3253	3254	3255

Under the Present Condition (1947 - 1994), Lake McConaughy would have no years with storage less than 500 kaf ("low storage conditions"), and the largest May-August drawdown of the reservoir is 19.2 feet.

As described in the "Reservoir Storage and Spills" section for North Platte River Basin, spills can provide important downstream benefits, including flows which help mobilize and redistribute sediment within the river channel (also see the "River Geomorphology" section, later in this chapter). Spills include releases from Lake McConaughy to prevent violating maximum storage limits set by the Federal Energy Regulatory Commission (FERC). (FERC has set limits on how much water Lake McConaughy can store at various times of the year in order to prevent damage to the dam.) There were 29 years with spills, and an average spill of 280 kaf under the Present Condition (1947 - 1994).

Flows and Diversions

The Central Platte system consists of a large reservoir (Lake McConaughy), two large canals that divert riverflow to hydroelectric and thermal powerplants, a number of small reservoirs along the canal systems to help regulate flows, and many smaller canals that provide irrigation water to farms (see figure 4-I-2 Central Platte River schematic). In simple terms, waters are released from Lake McConaughy year round to support power generation at these hydroelectric powerplants and in the summer to deliver irrigation water. Table 4-WR-13 displays estimated monthly flows in the Central Platte River system under the Present Condition. Flows are estimated for eight locations on the North Platte, South Platte, and Platte Rivers. (For more information on desired flow levels, see "Water Habitat-Service Flow Targets" in chapter 3.)

Table 4-WR-13.—Average Monthly Flows Under the Present Condition (cfs)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
North Platte River at Keystone (below the Sutherland Diversion)	5	10	4	63	490	1,256	1,679	1,053	262	224	2	0
North Platte River at North Platte	347	390	423	422	716	1,324	1,507	1,015	442	564	393	371
South Platte River at Julesburg	734	854	584	547	1,250	1,769	454	230	363	345	426	552
South Platte River at Paxton (below the Korty Diversion)	304	426	280	286	883	1,317	293	73	136	199	183	209
Platte River at Maxwell (below the Tri-County Diversion)	322	379	216	290	1,104	1,983	1,237	582	203	233	174	201
Platte River at Overton	1,798	2,243	2,027	1,692	2,252	3,009	1,454	666	948	1,561	1,691	1,648
Platte River at Odessa	1,801	2,336	2,060	1,467	2,026	2,802	1,291	427	675	1,283	1,578	1,637
Platte River at Grand Island	1,656	2,310	2,305	1,794	2,274	2,997	1,558	576	747	1,437	1,576	1,521

Flow in the North Platte River Downstream of Keystone Diversion Dam

The flow in the North Platte River immediately below the Keystone Diversion Dam varies greatly by season. Flows tend to be low in the winter, increase in late spring, and reach their highest levels during the irrigation season (table 4-WR-13).

Downstream from Keystone Diversion Dam to the confluence with the South Platte and the Tri-County Diversion Dam, the North Platte River typically picks up considerable flow from groundwater, irrigation returns, and several perennial creeks. Flows from October-May near North Platte, Nebraska are, on average, approximately 300 to 400 cfs higher than below Keystone Diversion Dam.

Flow in the South Platte River

Flow in the Lower South Platte River in Colorado is lowest during the late irrigation season (July-September) and highest during the spring runoff (May-June), as shown in table 4-WR-13.

Flow in the Lower South Platte River in Nebraska, between the Korty Diversion Dam and the confluence with the North Platte River near the town of North Platte, is normally less than the flow at Julesburg. This is because much of the South Platte flow is diverted into the Sutherland Canal at the Korty Diversion Dam. Only in wet periods does the South Platte flow exceed the capacity of the Korty Diversion Dam.

Flow in Platte River Downstream of the Tri-County Diversion Dam

In the 60-mile-long Central Canal bypass portion of the Platte River, between the Tri-County Diversion Dam and the Johnson-2 return channel upstream of Overton, flow patterns are similar to those of the North Platte River downstream of the Keystone Diversion Dam: low at the upper reach with water increases occurring along the reach. Average monthly flows just below the Tri-County Diversion Dam also follow a seasonal pattern similar to flows downstream of the Keystone Diversion Dam. In the Brady to Cozad and Cozad to Overton reaches downstream of the Tri-County Diversion Dam, winter flows are low, averaging less than 200 cfs during some winter months (table 4-WR-13). In most years, however, winter flow accretion in the Brady to Cozad reach is large, typically averaging an increase of about 100 to 200 cfs from the Tri-County Diversion Dam to Brady. In contrast, irrigation season flows are relatively high because flows required for irrigation between Brady and Cozad are in excess of available Tri-County Supply Canal capacity.

Flow in Big Bend Reach of the Platte River

The Platte Riverflow downstream of the Johnson-2 return Channel has been simulated for the Overton, Odessa, and Grand Island gauges. Overton is the uppermost gauge of the reach known as the Big Bend reach. The Odessa gauge is in the middle portion of the reach within the bypass reach of the Kearney Canal diversion. The Grand Island gauge is at the lower end of the reach and downstream of the Kearney hydro return.

All three gauges show the general pattern of a small, late winter peak and a larger, late spring peak in flow (table 4-WR-13) that generally coincides with high South Platte Riverflow and spill from Lake McConaughy. Flows are lowest in the reach during late summer (August-September).

The Sutherland Canal is supplied with water from both Keystone Diversion Dam on the North Platte River and Korty Diversion Dam on the South Platte River. For the Present Condition, the minimum flow diverted at Keystone is 200 cfs. Diversion rates below 200 cfs at the Keystone Diversion Dam could lead to flows below 200 cfs at the Paxton Siphon. Such flows would increase the frequency of ice formation in the siphon under the South Platte River during the winter.

As shown in the “Sutherland and Tri-County Supply Canals” subsection in the “Water Resources” section in chapter 5, average flows by month during the nonirrigation season (October-April) for the Keystone diversions are all greater than 700 cfs.

The largest flows in the Tri-County and Sutherland Canals occur during the irrigation season .

Irrigation Deliveries

There are five canals in the Keystone-Sutherland reach: two canals in the Sutherland to North Platte reach and six canals in the Brady to Cozad reach. Irrigation deliveries are greatest for the Tri-County

Canal, followed by the six canals in the Brady to Cozad reach. The Kearney Canal has the least amount of irrigation deliveries.

The effect of each alternative on irrigation deliveries is assessed by projecting the number of years that irrigation deliveries fall short of a full irrigation supply to the various water districts in the Central Platte River Basin. Western Canal is the only district that experiences shortages in the Central Platte under the Present Condition. Under the Present Condition, there were 8 years with irrigation shortages, with an average irrigation shortage of 2 kaf for those years,[10] which is 8 percent of the annual irrigation demand.

NEW WATER USES IN EACH STATE

While water demand in each of the three states is expected to continue growing, the amount of water available to meet new uses in the Platte River Basin is limited. In fact, in some parts of the Platte River Basin, surface and/or groundwater supplies are already overappropriated. This section briefly describes the existing situation in each state with regard to available water supply from the Platte River and how new demands for water will be met. Chapter 5 will describe how the Program will or will not affect the process of obtaining new water use in each state.

Wyoming

The North Platte River Basin is the most densely populated area in Wyoming. Appropriation of water for irrigation began in the 1860s, and the dependable water supplies in the Laramie River were appropriated by 1910 and in the North Platte River by 1930. The Supreme Court North Platte Decree further limits the amount of water used by Wyoming from the North Platte River. The North Platte Decree limits irrigation in the State of Wyoming from the North Platte River and its tributaries above Guernsey Reservoir to 226,000 acres of land, exclusive of the Kendrick Project (Casper Alcova Irrigation District). Exclusive of Seminoe Reservoir, not more than 18 kaf of irrigation water may be stored in Wyoming from the North Platte River and its tributaries above Pathfinder Reservoir in any water year (October 1-September 30). The natural flow of the North Platte River from Guernsey Dam to the Tri-State Diversion Dam in Wyoming is annually divided: 25 percent to Wyoming and 75 percent to Nebraska during the irrigation season (May 1-September 30). Glendo Reservoir has a right to annually store 40 kaf of the natural flow of the North Platte River and its tributaries below Pathfinder Dam. The total amount of natural flow that may be held in Glendo Reservoir at any one time, including carryover storage, is 100 kaf. Wyoming is annually allocated 15 kaf of Glendo storage water for beneficial purposes within the North Platte River Basin in Wyoming. The remaining 25 kaf of Glendo storage water is annually allocated to Nebraska for beneficial purposes within the Platte River Basin in Nebraska.

Because of the existing senior water rights, those seeking new irrigation, municipal, or industrial water projects from the North Platte River cannot expect to obtain a reliable water supply with water rights with priority dates junior to July 1, 1997. These junior water rights would likely be subject to water right administration to meet the demands of the more senior water rights in average or dry years. Therefore, it is likely that the proponents of new projects will seek water right transfers in which they will secure senior water rights through the water marketing process.

[10] Average is calculated for years with shortages and does not include years with no shortage.

Colorado

Colorado, in the South Platte Basin, faces a situation of rapidly growing municipal population and limited new water supplies. The population in the South Platte Basin in Colorado is projected to increase by 65 percent from 2,985,600 in the year 2000 to 4,911,600 in 2030. Currently, the municipal water demand is 772,400 acre-feet, and it is expected to rise to 1,182,100 in 2030. “The plans for nearly all South Platte water providers (to meet this increased demand) include some component of agricultural transfers and the optimization of existing supplies through new storage and/or reuse and exchanges,” Update on Statewide Water Supply Initiative, South Platte Basin (Colorado Water conservation Board, 2004), page 6.

Currently, there are more than 1 million irrigated acres in the South Platte Basin, with more than 2.5 maf of diversions. “The greatest changes in agricultural water use are expected to occur in the Front Range as municipal and industrial (M&I) growth moves into agricultural lands and/or as water is transferred from agriculture to support growth,” (Update on Statewide Water Supply Initiative, South Platte Basin, page 3). Transfers from agricultural use to M&I are projected to reduce the acreage of irrigated agriculture in the South Platte by 133,000 to 226,000 acres by 2030 (Colorado Water Conservation Board, 2004).

The South Platte Basin in Colorado has been overappropriated (meaning more water rights have been decreed than there is water available to fill the decrees) for about 75 years. While there are some very limited opportunities for new native South Platte River appropriations during very high water events, Colorado does not expect extensive development of new native South Platte River water because undeveloped native flow is very expensive to develop and, due to its junior priority, does not provide reliable yields for municipal water systems.

Nebraska

In Nebraska, the most important influence on the development of new water uses is the recent passage of Legislative Bill 962 (LB 962) and the processes that it puts in place to manage surface and groundwater rights in an integrated fashion.

Shortly before the July 2004 effective date for Legislative Bill 962, the Nebraska Department of Natural Resources (NDNR) adopted a formal moratorium on new surface water uses in the Platte River Basin down to Columbus, Nebraska. On that effective date, most of the North Platte and all of the South Platte, Twin Platte, and Central Platte Natural Resources Districts were declared to be “fully appropriated” by operation of law. As a result, much of the area subject to the moratorium on new uses of surface water also became subject to stays on such new surface water uses, and stays were added on new uses of groundwater in much of the Platte River Basin above Columbus. Two months later, following a review of existing water rights, demands, and supply, the NDNR designated the Platte River Basin above the Kearney Canal Diversion; the North Platte River Basin, including Pumpkinseed Creek; and the South Platte River Basin, including Lodgepole Creek as “overappropriated.” The September 15 Order designating the overappropriated Basins includes a description of the geographic area within which the NDNR has determined that surface water and groundwater are hydrologically connected for purposes of those overappropriated designations and the criteria used to make that determination. As a result of the September 15 Order, some Platte River Basin lands that were not made subject to the stays on new groundwater uses because of the fully appropriated designations became subject to such stays in September 2004 (NDNR, 2004 [September 15 Order]).

Legislative Bill 962 also requires the NDNR to make an annual assessment of all other river basins in the state to determine if they are fully appropriated. That assessment is to be based on an analysis of the combined supply of surface water and hydrologically connected groundwater to determine whether that supply can support additional development. The first assessments are expected to be completed by January 2006. The 2006 assessment, or any subsequent assessment, could result in the designation as fully appropriated of additional Platte Basin area, including portions of the Tri Basin, Little Blue, and Upper Big Blue Natural Resource Districts that are upstream of Columbus. Following any such determination, the same kinds of stays that were described earlier would be applied to the newly designated area.

Whenever land area in Nebraska is designated as "fully appropriated" and/or as "overappropriated," the NDNR and each of the affected natural resources districts must jointly develop an integrated management plan (IMP) for surface and groundwater use. The goals and objectives of such a plan must have a purpose of "sustaining a balance between water uses and water supplies" for the area. Such plans also must be sufficient to "ensure that the state will remain in compliance with any formal state contract or agreement pertaining to surface water or groundwater use or supplies" (e.g., any agreement to implement the Platte River Recovery Implementation Program). Also, the controls and incentives adopted for implementation of an IMP for either a fully appropriated or overappropriated area must:

> *". . . protect. . . the surface water appropriators [and river recharge-dependent groundwater users. . . from streamflow depletion caused by surface water uses and groundwater uses begun after the date the river Basin, subbasin, or reach was designated . . .."*
>
> (LB962)

For the overappropriated areas (upstream of the Kearney Canal diversion), sustaining a balance between water use and water supply will not be possible without an increase in supply or a reduction in use. The long-term goal for those areas is to restore them to the fully appropriated status, but there is also a short-term Programs, First Increment goal for those areas. That short-term goal, which is for the first 10 years of the IMP, requires the NDNR and the natural resource districts in the overappropriated area, to address the impact of streamflow depletions caused by water uses initiated after July 1, 1997. Thus, for most of the Platte River Basin in Nebraska down to Columbus, new uses are now restricted. Even without a Platte River Program, most new uses of surface water and of hydrologically connected groundwater in this area likely will need to be based upon acquisition or transfer of existing uses.

RIVER GEOMORPHOLOGY

INTRODUCTION

This section describes the occurrence of braided river and the trends that affect this river plan form in the Central Platte River. Braided river is the river plan form that provides the most roosting habitat preferred by whooping crane, and the most nesting and rearing habitat preferred by the interior least tern and piping plover along the river today. Current trends affect this habitat. Significant factors affecting plan form in the Central Platte River are: the volume and occurrence of riverflows, the load of sediment being transported by the river, and suitability of the riverbanks. Topography of the flood plain (including natural features and manmade features) is the most influential factor of the riverbank stability factors.

INDICATORS

Impacts on the affected environment related to river geomorphology were evaluated through an analysis of the following indicators:

- **Flows**:
  - Mean annual flow
  - 1.5-year peak flow and sandbar height
- **Sediment Transport**:
  - Maximum and stable sediment transport rates
  - Deposition and erosion
- **Topography**:
  - Braided river
- **Plan Form**:
  - Width-to-depth ratio of the main channel
  - Widest water and open view width

METHODS

The FEIS chapter analyzes the factors that determine changes in indicators for all alternatives compared to the Present Condition. This description of the Present Condition of the Central Platte River is based on geomorphic theory and principles (Knighton, 1998 and Bridge, 2003), and the available data and data summaries, including:

- Land surveys of cross sections summarized in Holburn et al. (2006)
- United States Geological Survey (USGS) maps from 1896 to 1902 and USGS quadrangle maps from 1960 to 1962
- Infrared aerial photos from:
  - 1998 (Friesen et al., 2000)
  - 2003 and 2004 (Platte River EIS Office, 2004)
  - USGS aerial photos from 2000 (NDNR, 2000 [quads])
- Rating curves by Kircher (1983) and Simons and associates (2000) applied to USGS gauge flows at Grand Island as summarized by Randle and Samad (2003)
- Flows, as summarized by Randle and Samad (2003)
- USGS gauge data for Plum Creek near Smithfield, Nebraska 1946-1953, 1968-1975, and 1996-2002
- Profile of the Platte River (Gannett, 1901)
- Platte River bed material samples from the U.S. Army Corps of Engineers in 1931 (Corps, 1935), USGS (1980), and Reclamation (Holburn et al., 2006)
- Geologic and historical summary of the Platte River, as presented by Murphy et al., 2004
- Daily flows for the Central Platte River from Reclamation's flow management model (CPR model)
- A 1-dimensional sediment transport model (SEDVEG Gen3) that incorporates vegetation growth impacts on bank resistance (Murphy et. al, 2006)

PRESENT CONDITION

For a detailed consideration of the study area under the Present Condition, the river has been divided into 12 reaches (figure 4-G-1). These divisions are based on the Schumm classification of plan form ("River Plan Form" sidebar in chapter 2), as identified from 1998 infrared aerial photos. The plan form classifications are braided, anastomosed, meandering, and braided and anastomosed where the plan form alternates between the two classifications.

A braided plan form provides more of the habitat characteristics preferred by roosting whooping cranes and nesting and rearing interior least terns and piping plovers. A braided plan form provides more preferred river habitat for the endangered species than an anastomosed or meandering plan form with wider widths, larger width-to-depth ratios, and more prevalent sandbars. The Central Platte River has been divided into 12 reaches (see the "Geographic Markers" section in this chapter), based on plan form (table 4-G-1), and they are summarized here with respect to braiding potential and trends. Characteristics of a braided plan form in the Central Platte River under the Present Condition are:

- Flows conveyed in a single river corridor are greater than 25 percent of historic flows.
- The average number of channels in the cross section of a single river corridor is three or less.
- The width-to-depth ratio in the main channel is greater than 400 and increases with distance downstream.
- The slope of the riverbed profile is greater than 0.0008 foot per foot.
- Sediment transport in stable braided reaches is estimated at 585,000 tons annually.
- The river corridor width is 3,000 feet or less and/or is reduced by features such as remnant sandbars, bridge crossings, and gravel mining pits, which discourage the divergence of flows into multiple channels.
- At 400 cfs, the width of the braided river under the Present Condition is approximately 700 feet in sediment deficient reaches.
- At a flow of 1,000 cfs, the width of the braided river is approximately 1,000 feet in reaches with no sediment deficit.
- Mid-channel sandbars are nearly nonexistent in meander and anastomosed reaches, and mid-channel sandbars which protrude above the water surface are rare in braided reaches due to limited flow variation.
- The average difference in water surface elevation for mean annual flow and the 1.5-year peak flow in the Central Platte River is 0.9 foot.

Table 4-G-1 contains a summary of the plan form and the dominant processes of flow, sediment, and topography that determine the plan form and the shape of the river[11] in each of the 12 river reaches of the Cooperative Agreement study area.

[11]The shape of the river can be described by the plan form (width and length–as observed from an airplane), the cross section (width and depth–as a "slice" of the river), and the profile (the longitudinal slope of the riverbed).

Table 4-G-1.—Central Platte River Reaches, Plan Form and Dominant Process Affecting Plan Form

Reach	River Mile	Location	Plan Form	Dominant Process
	266	Near Cozad, Nebraska		
	255	Start of Cooperative Agreement study area		
1A	251	Lexington, Nebraska	Meandering	**Flow** (limited stream power)
1B	242	North Channel of Jeffrey Island	Meandering	**Flow** (limited stream power) possibly **Sediment** (head cut from Johnson-2 return)
2	247	Johnson-2 Return and South Channel of Jeffrey Island	Meandering	**Sediment** (degradation, slope reduction, and coarser grain size from Johnson-2 return)
3A	239	Confluence of North and South Channels, Jeffrey Island, and Overton, Nebraska	Anastomosed	**Sediment** (degradation and coarser grain size from Johnson-2 return) **Topography** (over-wide river corridor)
3B	230	Elm Creek near Kearney diversion	Braided	**Sediment** (degradation and coarser grain size from Johnson-2 return) **Topography** (river corridor reduced by levees)
3C	225	Near Odessa, Nebraska	Anastomosed	**Sediment** (degradation and coarser grain size from Johnson-2 return) **Topography** (overwide river corridor)
3D	215	Near Kearney, Nebraska	Anastomosed	**Topography** (overwide river corridor)
4A	212	Channel split at downstream end of Evans Island, begin Kilgore Island	Braided	**Topography** (more narrow river corridors) **Flow** (more flow concentrated in one of multiple river corridors)
4B	200	Near Gibbon, Nebraska, at channel confluence	Braided and anastomosed	**Topography** (overwide river corridor reduced by remnant bars or bridge) **Sediment** (aggradation)
4C	187	Wood River, Nebraska, at channel split	Braided	**Topography** (more narrow river corridors) **Flow** (more flow concentrated in one of multiple river corridors)
4D	180	Alda, Nebraska, at channel split	Braided	**Topography** (more narrow river corridors) **Flow** (more flow concentrated in one of multiple river corridors)
5	168	Grand Island, Nebraska, at channel confluence	Braided and anastomosed	**Topography** (overwide river corridor reduced by remnant bars or bridge)
	156	Near Chapman, Nebraska		
	154	End of Cooperative Agreement study area		

Reach 1A, **downstream of Lexington**, and reach 1B, the **North Channel of Jeffrey Island,** are primarily limited to meander channel due to insufficient flows to cause braiding. Degradation may occur in reach 1B, resulting from a headcut triggered by the Johnson-2 Return, but more data is needed to detect this process with any certainty.

Reach 2, in the **South Channel of Jeffrey Island**, is also meander channel due to insufficient flows, severe degradation, a reduced slope of 0.0008 foot per foot (the average for the Platte River from Lexington to Chapman is 0.0012 foot per foot), and coarser grain size. The degradation, slope reduction, and coarser grain size are due to the sediment shortage that results from operation of the Johnson-2 Return.

Reaches 3A and 3C, **between Overton and Kearney**, are anastomosed, and the bed is degrading due to the Johnson-2 return, but at a slower rate. The occurrence of a braided channel in these reaches is also limited by topography, since the river corridor width is greater than 3,000 feet. A few braided sections occur at bridge crossings and locations of protected gravel mining pits, where flows are diverted back to the main channel.

Reach 3B, **between Overton and Kearney downstream of Elm Creek**, is also degrading and has a river corridor width greater than 3,000 feet; however, the reach is braided due to the levees reducing river corridor width and consolidating flow for the Kearney Diversion.

Reach 3D, **downstream of Kearney**, is anastomosed due to a river corridor width greater than 3,000 feet.

Reach 4A, **from Kilgore Island to Gibbon**, and reach 4C and reach 4D, from **Wood River to Grand Island**, are island reaches with multiple river corridors. The main channel in each of these reaches conveys a majority of flow and is generally less than 2,000 feet wide, so they are predominantly braided. The downstream section of reach 4A is aggrading.

Reach 4B, **from Gibbon to Wood River**, and reach 5, **between Grand Island and Chapman**, alternate between braided and anastomosed plan form due to topography. The river corridor is greater than 3,000 feet, but remnant sandbars on the sides of the river corridor reduce the width of the historical flood plain and consolidate flows to cause braiding. The river is anastomosed between these remnant bars or between other features, which reduce river corridor width such as bridge abutments and gravel mining pits. The upstream half of reach 4B is presently aggrading. Reach 5 currently appears to be stable, but predictions from the sediment transport model, SEDVEG Gen3 (Murphy et al., 2006), indicate a degrading condition may develop in the future.

Additional detail on the flows, sediment, topography, and plan form indicators is presented in the following subsections.

Flow

Mean Annual Flow, Stream Power, and Plan Form

As presented in chapter 2, the mean annual flows upstream of Overton (figure 4-G-1) and in the north channel at Jeffrey Island are approximately one-fourth of the mean annual flows at the start of the 20th century. Lower flows equate to lower stream power, and as shown in “Stream Power and Plan Form” sidebar in chapter 2, the stream power of a river may drop below the threshold needed to maintain a braided plan form. When this occurs, a meandering plan form can develop and vegetation colonizes areas of the channel where the riverbed sands are no longer mobilized by annual floods. This shift in plan form is illustrated in figure 4-G-1 and the reduction in mean annual flows and stream power are believed to be the dominant factors for a meander plan form in reaches 1A and 1B (table 4-G-1).

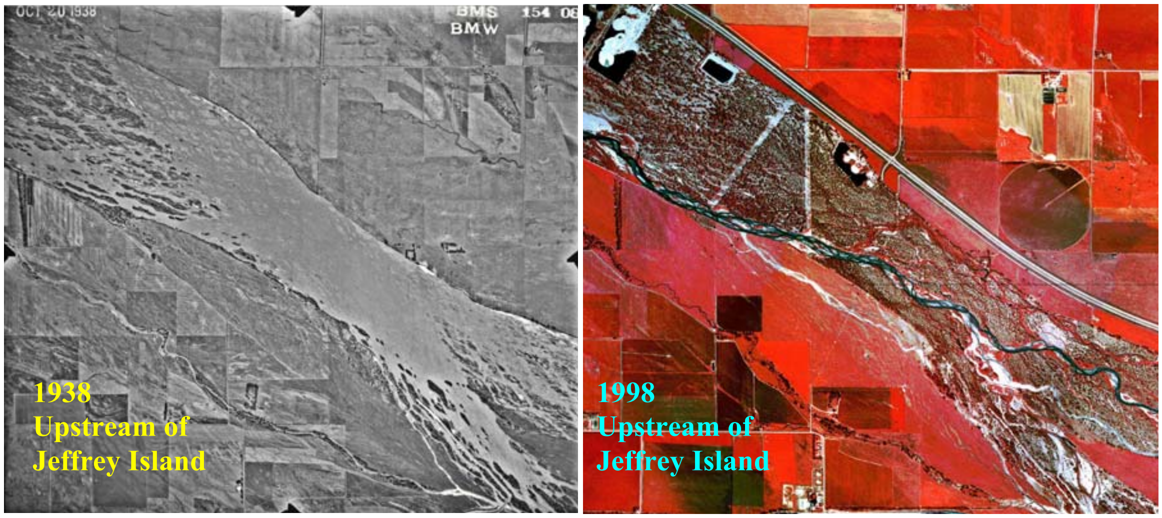


Figure 4-G-1.—Comparison of flows and plan form from 1938 to 1998 at location upstream of Jeffrey Island. Jeffrey Island appears in the lower right corner of each photo.

Riverflows upstream of Jeffrey Island are diverted to the north channel (figure 4-G-1), while flows from the Tri-County Supply Canal are discharged into the south channel of Jeffrey Island at the Johnson 2 Return. The south channel and north channel of Jeffrey Island convey approximately the same mean annual flow. At the confluence downstream of Jeffrey Island, and near Overton, the mean annual flows are approximately one-half the magnitude of the mean annual flows at the start of the 20th century (Simons and Associates, 2000). Between Overton and Grand Island, 71 miles downstream of Overton, riverflows are reduced by the Kearney diversion at Elm Creek and by groundwater seepage during dryer seasons. In this same reach, riverflow is increased by gains from groundwater seepage during the irrigation season and by gains from small tributaries such as Spring Creek, Elm Creek, North Dry Creek, and Dry Creek. Despite these changes, a comparison of mean annual flows indicates that flows at Grand Island are similar to those at Overton (see chapter 2). At approximately one-half the flows from the 1895-1909 period, there is sufficient stream power in the reaches between Overton and Chapman (reach 3A – reach 5) for a braided condition to develop if other factors are favorable.

High Flows and Sandbars

The ability of the river to build sandbars increases with increasing annual peak discharge and cumulative sand transport, and with the fineness of the bed-material grain size. Sandbar formation is also dependent on the type of plan form. Braided rivers have the greatest number of sandbars of the three classifications: braided, anastomosed, and meandering. In wider or more intensively braided rivers, which require high stream power, multiple channels produce a checkered pattern of unit bars across the width of the channel. At lower discharges the periodic flow will divide into anabranches that are similar to an anastomosed plan form, but because of inundation of the full channel width, bars within the active channel of the braid plain remain relatively free of vegetation. If there is sufficient bedload, meander and anastomosed channels can have sandbars, but these sandbars are more commonly found as point bars along the sides of the channel and rarely occur mid-channel.

Although there are braided reaches in the Central Platte River with many submerged sandbars apparent in the 1998 infrared aerial photos (Friesen et. al, 2000), very few of these sandbars protrude high enough to provide habitat for least terns and piping plovers during the summer nesting season. Sandbars form to the elevation of the water surface during high flow events, when the river is moving a significant bed load. The lack of suitable sandbar habitat is partially attributed to the current flow regime that does not have a sufficient difference between the water surface during frequently recurring high flows and the average water surface during the summer nesting season. There is an average difference of 0.9 foot between the water surface of a 1.5-year peak flow event (a flow that occurs in 2 of 3 years) and the water surface elevation of a mean annual flow event (see the "River Geomorphology" section in chapter 5 for a discussion of flows). Vegetation that has colonized the higher sandbars and islands is well established and reduces the quality of this habitat for most years.

Sediment

A geomorphic definition of dynamic equilibrium is that the rate of sediment entering a reach of river matches the rate of sediment exiting that reach (Mackin, 1948). When the rates do not match, the study reach is described as unstable. A reach is degrading when more sediment is transported out of the reach, and it is aggrading when more sediment is transported into the reach. The plan form, cross section, and profile of the river can be altered under either condition of instability.

Two methods for computing the annual sediment transport between the Johnson-2 return in the South Channel of Jeffrey Island (RM 247) and Chapman (RM 256) are shown in figure 4-G-2. Values for the first method (survey) are computed from rating curves at Grand Island (Randle and Samad, 2003) and repeat cross section surveys (Holburn et. al., 2006). These are average values for the period 1989 to 2002. Values for the second method are computed using a one-dimensional, numeric, sediment transport model, SEDVEG Gen3 (Murphy et al., 2006) and represent average transport over the next 48 years. Survey estimates of sediment transport have been adjusted down to 600,000 tons annually at Grand Island, while SEDVEG Gen3 estimates have been increased by a factor of 1.5 to match 600,000 tons of transport annually at Grand Island. See Murphy et al., 2006 for a description of these estimates.

The sediment rate is increasing in figure 4-G-2, either when the bed or banks of the river are eroding to supply sand or sediment (degradation) or when tributaries add sediment. Sediment transport decreases when a portion of the sediment load settles on the bed of the river channel (aggradation).

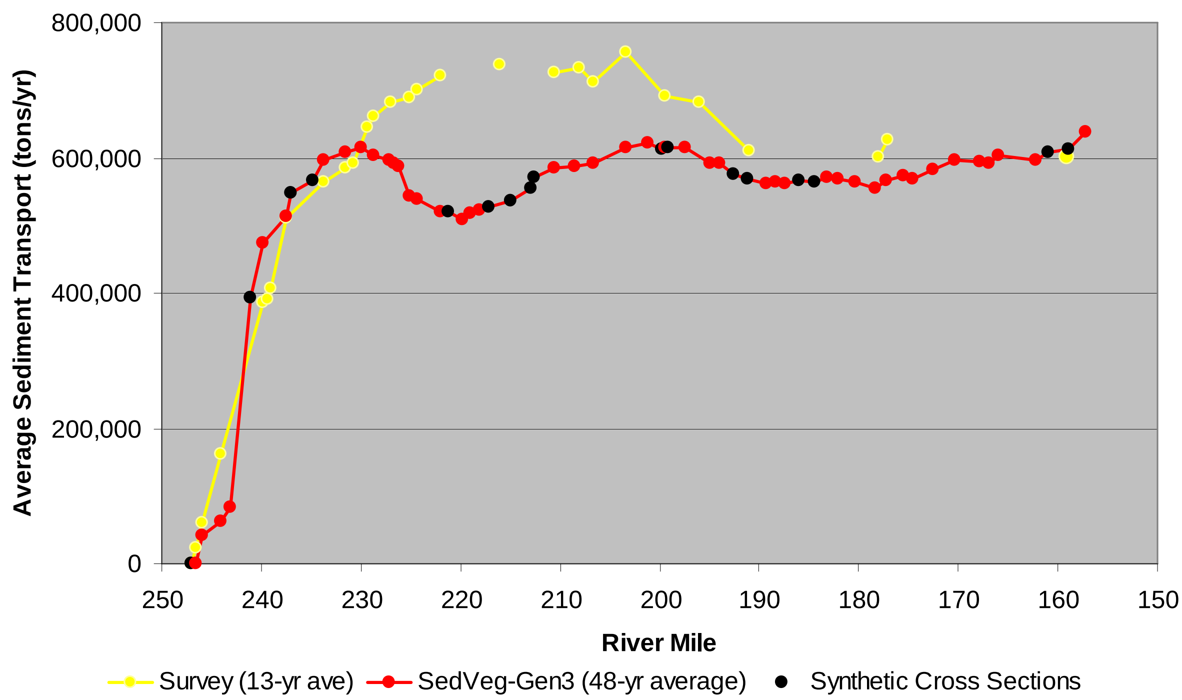


Figure 4-G-2.—Sediment transport estimates for the Central Platte River beginning at the Johnson-2 return in the South Channel of Jeffrey Island and continuing to Chapman. The first estimate (survey) was computed from sediment rating curves at Grand Island and repeat cross section surveys. The Grand Island transport from rating curves was reduced 25 percent. The second transport estimate (SEDVEG Gen3) was computed using a one-dimensional sediment transport model with values increased by a factor of 1.5.

Aggrading and Degrading Reaches

As described in chapter 2, there are two known reaches of instability between Lexington and Chapman under present conditions: a degrading reach between RM 247 and RM 230, and an aggrading reach between RM 204 and RM 191. There is a higher level of uncertainty associated with sediment transport between RM 222 and RM 211, due to an 11 mile gap in cross section data for both the Survey method and the SEDVEG Gen3 method. However, under the Present Condition, the erosive condition caused by clear water flows at the Johnson-2 Return appears to end near Kearney (RM 215). The plan form is meandering in reach 2 (RM 247 to RM 239), where there is also a flow affect, and the plan form is anastomosed in reaches 3A (RM 239 to RM 230) and 3C (RM 225 to 215). Reach 3B (RM 230 to RM 225) is braided due to the topography effects in this reach that also influence plan form.

Although not shown in figure 4-G-2, limited data indicates that although reach 1A is aggrading, downstream reach1B appears to be degrading. This would be true if bed level lowering at the confluence near Overton (from Johnson-2 Return flows) triggered a head cut up the North Channel at Jeffrey Island, which had not migrated upstream to Lexington and reach 1A by 1998. Additional data are needed to confirm or dispel this concern.

There is a large gap in data for the Survey method between RM 191 and RM 159, placing higher uncertainty on the Survey sediment transport estimate for this reach. The limited data available indicate that this reach is stable under present conditions. The SEDVEG Gen3 method has better cross section data between RM 191 and RM 159 and predicts that this reach will experience degradation over time, although the river is presently stable. All the reaches downstream of RM 210 are predominantly braided under present conditions, although short reaches of anastomosed channel occur due to topography effects.

Sediment Budget

A sediment budget for present conditions, based on the SEDVEG Gen3 estimate (adjusted by a factor of 1.5), shows in an average flow year:

- A maximum sediment transport value of 620,000 tons annually near RM 201
- A consistent rate of transport estimated to be 585,000 tons annually, based on the downstream reach between RM 189.3 and RM 160 near Chapman
- Net erosion is 220,000 tons from the bed and banks of the river between RM 246.5 (Johnson-2 return in south channel) and RM 160 near Chapman:
    - 285,000 tons are conveyed annually from the north channel of Jeffrey Island, with up to 100,000 tons from the bed and banks of this channel
    - 105,000 tons originate annually from tributaries
    - 60,000 tons are deposited annually between RM 201 and RM 189.3

Topography

The plan form from reach 3A at Overton downstream to reach 5 at Chapman is either braided or anastomosed. Because a braided reach provides better habitat for whooping cranes, interior least terns, and piping plovers, it is important to understand what triggers the formation of braided river in these reaches under the Present Condition. As introduced in chapter 2, braiding occurs in the central Platte River downstream of Overton when natural or manmade topographic features restrict the width of the pre-1900 flood plain.

River Corridor Width

The river corridor, as defined here, is the flood plain from 1900 or earlier that is discernable by vegetation that grows between the remnant river banks (figure 4-G-3). In the Central Platte River, anastomosed plan forms are often located within wide river corridors, while braided plan forms are generally located within narrower river corridors. One example is shown in figure 4-G-3, where the river transitions from braided to anastomosed downstream of RM 157, at an abrupt expansion in the river corridor width.

Downstream of RM 157, the plan form changes from braided to anastomosed as the river corridor widens. On the northwest riverbank, the levees constructed to protect the gravel bar ponds are also helping to restrict the overwide river corridor, extending the braided condition downstream of the abrupt change in river corridor width. The plot in figure 4-G-4 shows the width of the widest river corridor in reaches 3A through 5, with respect to the reach classification of braided or anastomosed river.

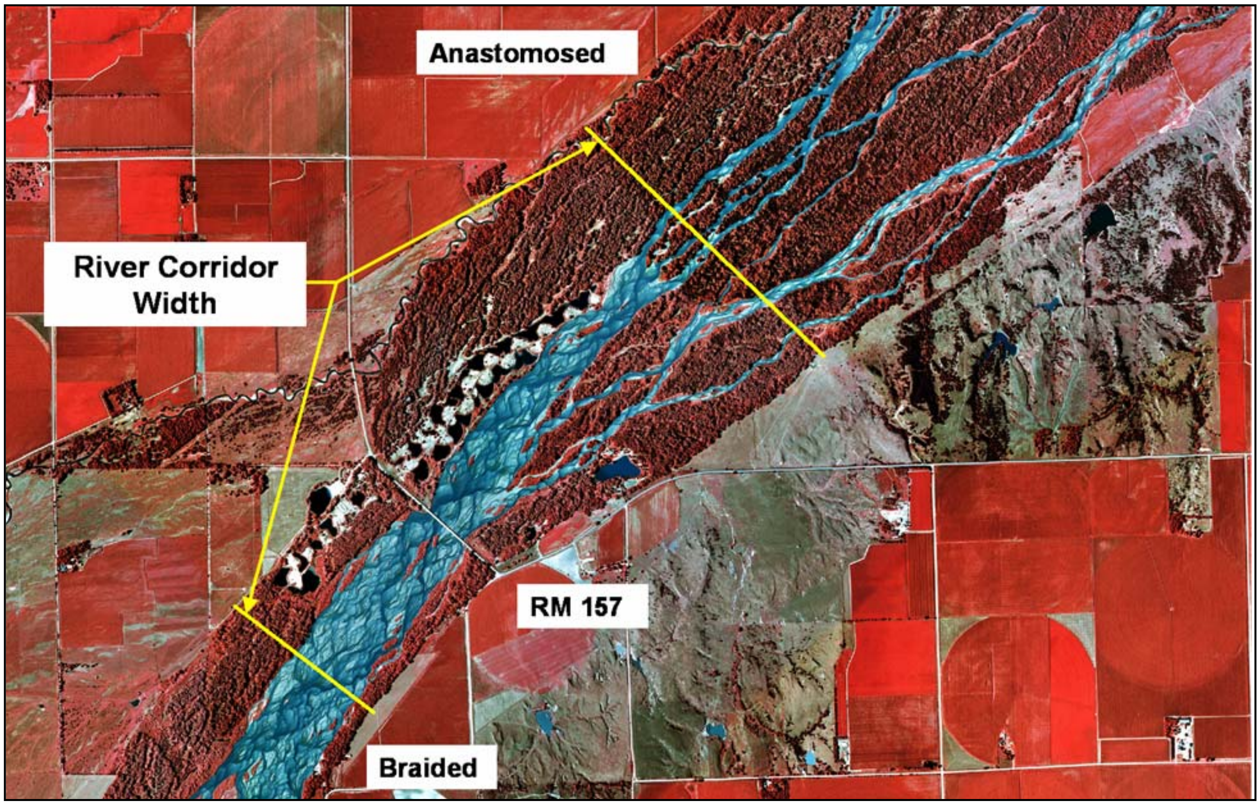


Figure 4-G-3.—1998 infrared photo illustrating river corridor, braided plan form, and anastomosed plan form and illustrating the effect of river corridor width on plan form.

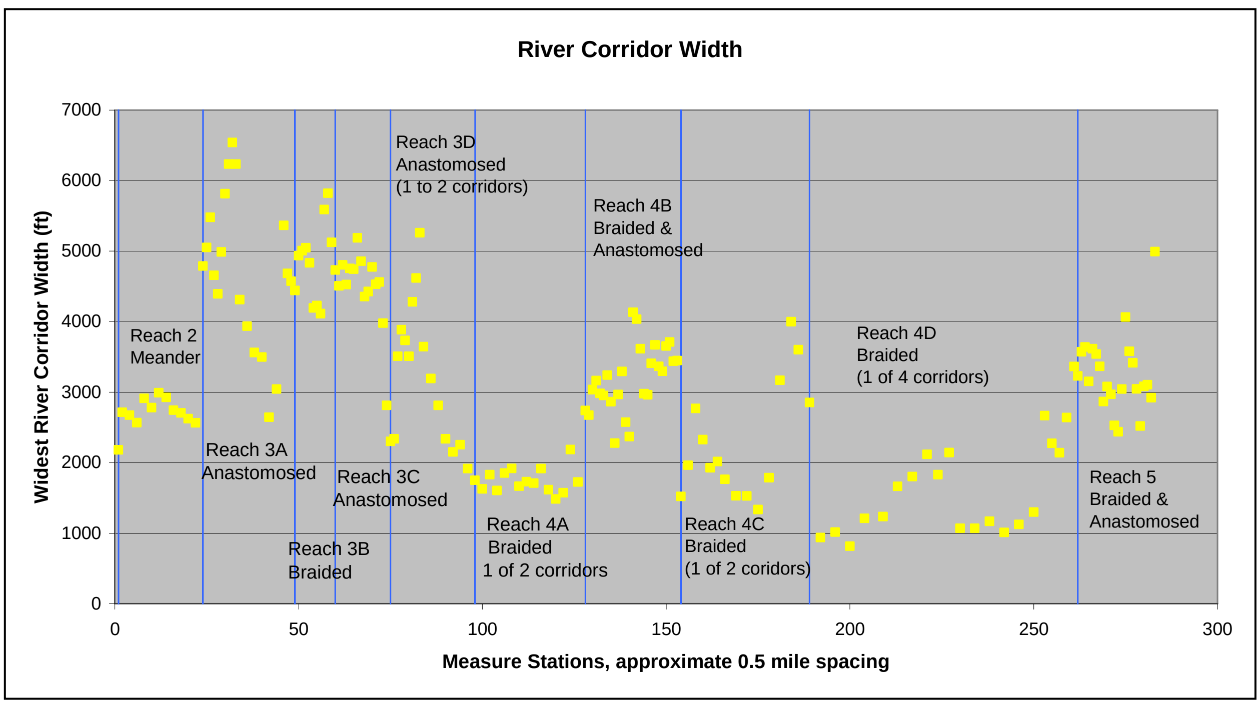


Figure 4-G-4.—Relation of the river corridor width to braiding and anastomosed plan forms.

The measurements were made at approximate one-half mile spacings from the Johnson-2 Return at Jeffrey Island (station 0) downstream to Chapman. It can be seen from figure 4-G-4 that a braided plan form occurs when riverflow is contained in a single river corridor less than 3,000 feet wide. At a river corridor width of 3,000 to 4,000 feet, the plan form alternates between braided and anastomosed. There are two to four parallel river corridors in reach 4A and reach 4C, with the widest corridor being less than 2,000 feet wide.

The link between river corridor width and anastomosed or braided plan form is assumed to be the remnant braid scars which remain from historic flows. These old channel scars can be accessed during high flow events. The braid scars or old channel swales are points of reduced bank stability that allow the flow to diverge from the main channel. Flow in the side channels may not converge again with the main channel for long distances if there is a wide river corridor (greater than 4,000 feet). When the majority of flow in a cross section is consolidated to a single main channel in the central Platte River downstream of Overton, the single channel has greater stream power ("Stream Power and Plan Form" sidebar in chapter 2) that is sufficient to produce braiding under present conditions.

The Island Reaches Impacts on River Corridor Width

Reach 4A, 4C, and 4D are island reaches where large islands divide flow into multiple river corridors. The upstream end of reach 4A is shown in figure 4-G-5. The river corridor for the Central Platte River splits into two narrower river corridors at river mile 211, downstream of Kearney. However, the flow is not evenly divided, and most of the flow is conveyed through the south channel, which is predominately braided, as shown in figure 4-G-5. Because nearly half of the historic flow is currently diverted into half the total width of the historic river corridor, there is less of a disparity under the Present Condition between river corridor width and existing flow in reach 4A. The majority of Present Condition flow appears to be diverted to the south channel for reaches 4C and 4 D. In the 1998 aerial photos, braided reaches that provide the preferred habitat for the target species are found predominantly in the narrower river corridors, but wide river, of the island reaches.

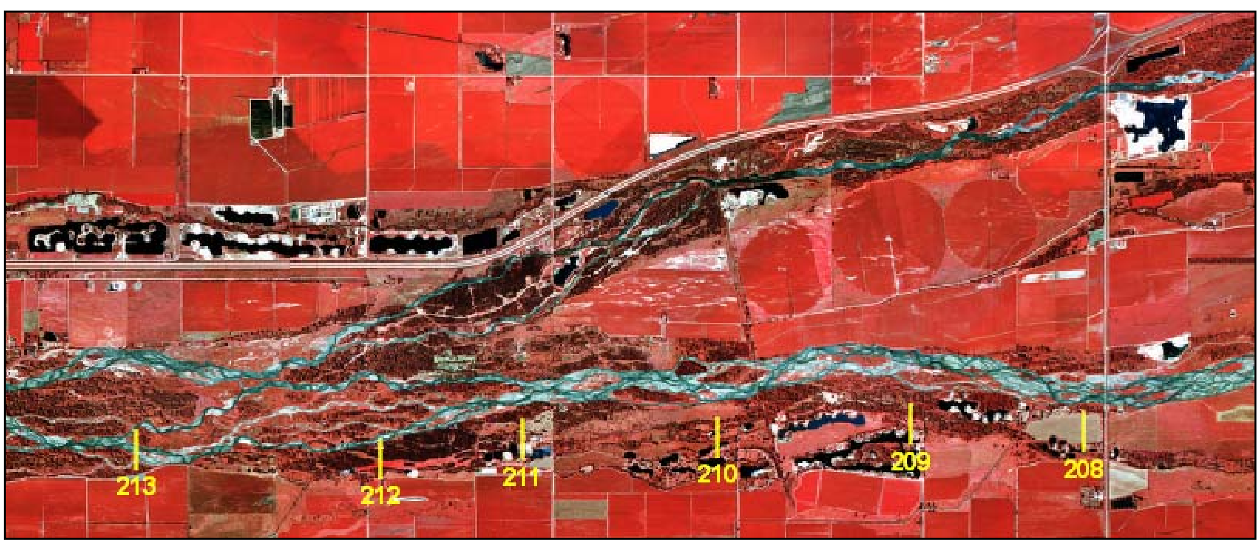


Figure 4-G-5.—River mile 211 downstream of Kearney.

Remnant Sidebars' Impacts on River Corridor Width

Reach 4B and reach 5 have alternating braided and anastomosed plan form. The 1998 aerial photo in figure 4-G-6 shows reach 5 between Grand Island and Chapman. There is a single river corridor throughout this reach that is sufficiently wide to allow side channel development at low flows. A braided plan form alternates with an anastomosed plan form. The river corridor width for these two reaches is generally greater than 3,000 feet, an apparent threshold for braiding; however, the river still braids in some sections of river. Braiding can occur at those sections where remnant sidebars, which formed during high flows from 1900 or earlier, reduce the width of the river corridor. These well-vegetated and elevated features consolidate or restrict flows to one side of the river corridor. Between the remnant bars where braiding occurs, the river unravels to anastomosed plan form.

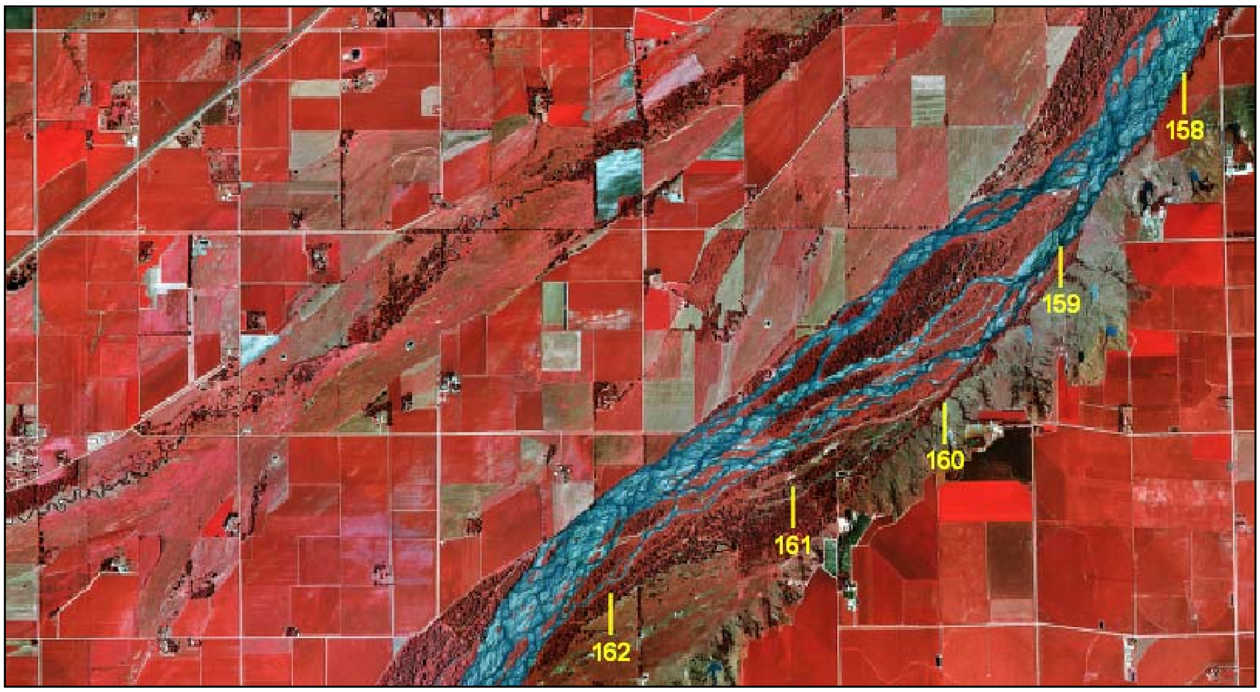


Figure 4-G-6.—Reach 5 located downstream of Grand Island, Nebraska.

Levee and Bridge Abutment Impacts on River Corridor Width

The river corridor width of reach 3B is more than 4,000 feet wide (figure 4-G-4), yet this reach is classified as braided. Braiding occurs not because of remnant sidebars, but due to levees constructed for the Kearney diversion that confine flows to the north side of the river corridor. The Kearney diversion is at the upstream end of reach 3B (RM 229 downstream of Elm Creek), and flows do not unravel to an anastomosed plan form until the downstream end of reach 3B near RM 225.

Bridge abutments and gravel mining pits also reduce the width of the river corridor, but they widen the river and trigger braided plan form by consolidating flows. Bridge abutments in the river corridor divert side channels back to the main channel. Short sections of braided plan form can be found within the anastomosed reaches, 3A and 3C, at the Overton bridge crossing, the Elm Creek bridge crossing, and the Kearney bridge crossing (figure 4-G-7). Here, the river corridor is wide and primarily anastomosed with multiple channels. At Kearney, the river corridor is reduced by levees protecting gravel pits and by the Kearney bridge abutments. A single braided channel forms at RM 215.4 in the narrowed river corridor. This view of bridge effects is a reversal from earlier studies (Becker, 1986; Simons and Associates, 1990 and 2000; and Murphy et al., 2004), which held that bridge abutments caused localized river narrowing due to flow constriction (see chapter 2). Removing bridges is not considered under the alternatives of this FEIS. The narrowing of the total river width from bridge abutments does not restrict potential channel width and, in fact, consolidates local flows. Although braided river in the immediate vicinity of the bridge is not considered good habitat due to the disturbance factor at the highway crossing, the braided plan form may persist upstream and downstream of the bridge beyond the limits for disturbance.

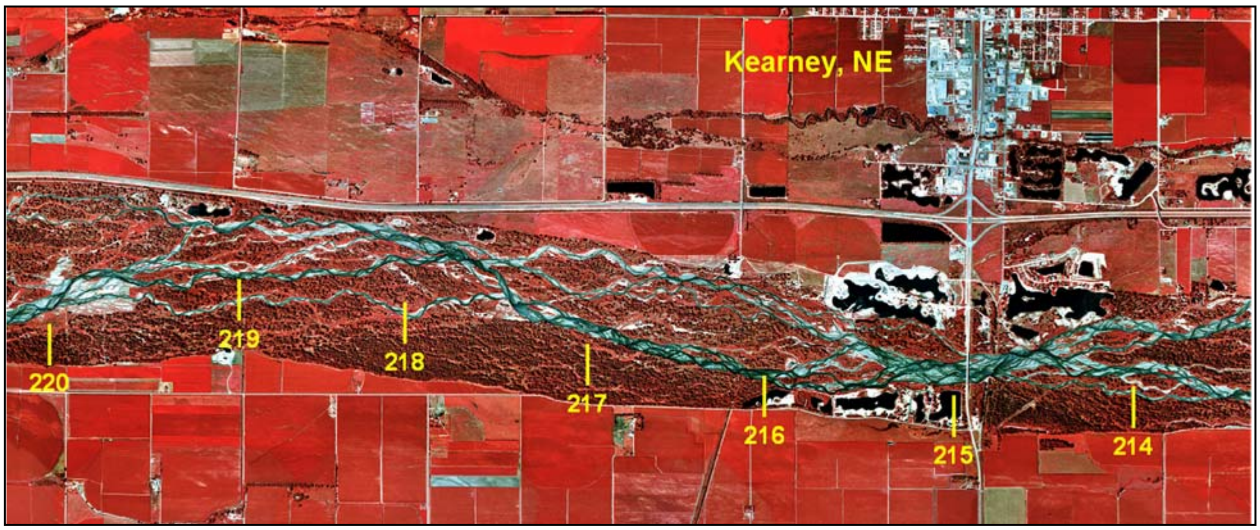


Figure 4-G-7.—Upstream of Kearney, Nebraska, reach 3C.

Plan Form

Plan form indicators presented here are:

- Wetted width of braided channel
- Width-to-depth ratio
- Number of channels in a river section

Wetted Width of a Braided Channel

A meandering or anastomosed plan form has narrower channel widths than a braided plan form, and a reach that is deficient in sediment has narrower width than a reach with stable transport. Measurements of the wetted width of braided river in the Central Platte River were made at locations where there were two or fewer side channels. The widths shown in figure 4-G-8 were measured from 1998 infrared aerial photos. The photos were taken on August 19, 21, and 24, and the flows reported at USGS gauges for those days are shown in table 4-G-2. The trend of increasing width of braided river in the downstream direction reflects the increase in flows between Kearney and Grand Island on August 19, 1998, but it also reflects sediment transport processes. A braided channel under the Present Condition in the Central Platte River has widths of approximately 700 feet at 400 cfs where the river is generally degrading and approximately 1,000 feet at 1,000 cfs where the river is relatively stable with respect to sediment transport.

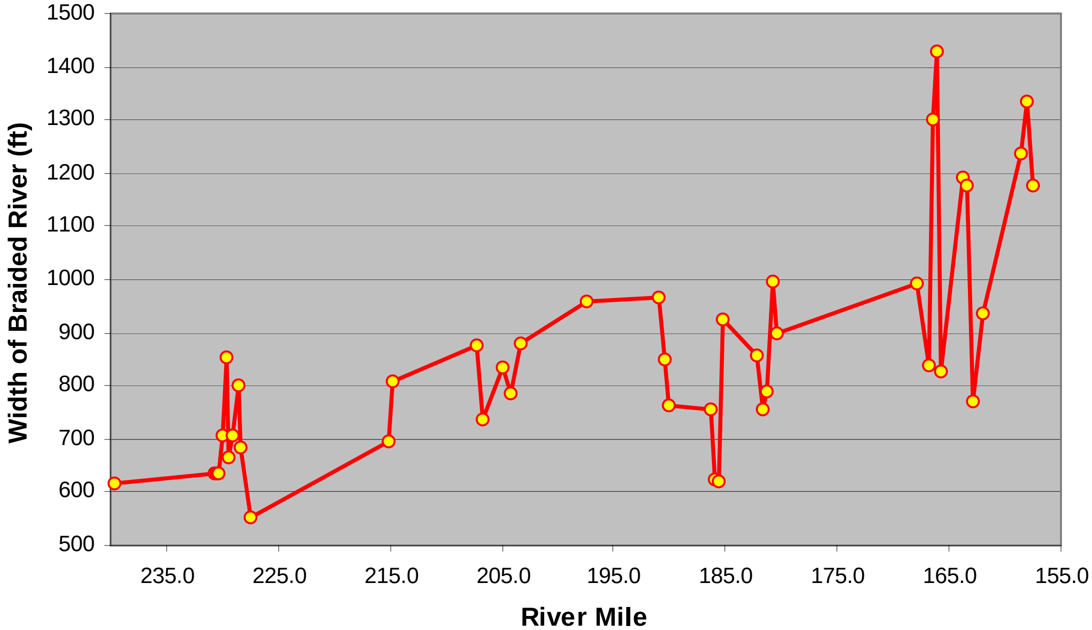


Figure 4-G-8.—Width of braided river measured from 1998 infrared aerial photographs.

Table 4-G-2.—Flows from USGS Gauge Data on Flight Days of 1998 Aerial Photographs (cfs)

Location of USGS Gauge	August 19, 1998 RM 238-157	August 21, 1998 RM 251-231	August 24, 1998 RM 251-(bs13)
Overton – RM 240	380 cfs	325 cfs	496 cfs
Kearney – RM 215	405 cfs	327 cfs*	400 cfs*
Grand Island – RM 168	1,030 cfs	767 cfs*	423 cfs*
* Not shown in aerial flights—no flights made.			

Width-to-Depth Ratio and Number of Channels

Two additional indicators of plan form are the ratio of the width-to-depth of wetted channel, and the number of channels in a cross section. The width-to-depth ratios for the main channel of the Central Platte River were calculated from 45 cross sections surveyed between 1985 and 1989. The width-to-depth ratio calculated here is the width of the wetted surface of the main channel at 2,000 cfs, divided by the average channel depth at that flow. Number of channels was computed from 1998 infrared aerial photos, at the same one-half mile spacing used for measuring the width of the widest river corridor. Braided rivers have the largest width-to-depth ratios, while anastomosed rivers have the greatest number of channels.

Figure 4-G-9 summarizes the river corridor width, the width-to-depth ratio, and the number of channels for the Central Platte River beginning in the south channel of Jeffrey Island at RM 247. The values presented in figure 4-G-9 are averages for the reach specified by river miles. To obtain the width-to-depth ratio values from the plot, multiply the y-axis by 100. To obtain the river corridor width, multiply the y axis by 1000. Data from present conditions (1989 to 1998) of the Central Platte River indicate that the braided plan form occurs at or less than an average river corridor width of 3000 feet, at or less than an average of three channels per section, and at greater than an average width-to-depth ratio of 400 for the main channel. The river corridor width shown here is the natural width based on terraces that were the high flow river banks in the Pre-Development period. The width of the river corridor between RM 231 and 225 is less than 3,000 feet when the constructed levees on the south side of the river are considered as boundaries of flow.

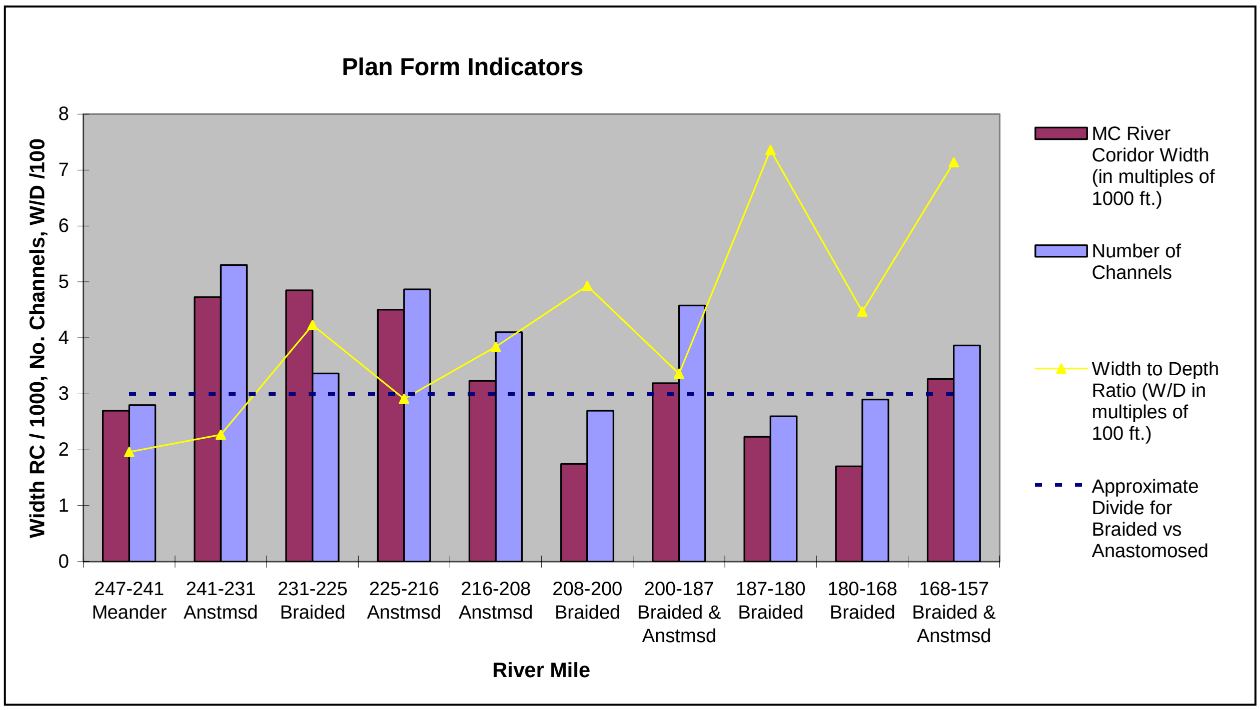


Figure 4-G-9.—Plan form indicators including the width-to-depth ratios of the main channel (width-to-depth in multiples of 100 feet), number of channels in the main flow corridor, and width of the main flow corridor (in multiples of 1000 feet) are shown for the Central Platte River, as averages of the reaches shown by river mile.

WATER QUALITY

INTRODUCTION

This section describes chemical, physical, and biological characteristics of the study area and their influence on river system water quality (more detailed information can be found in the *Water Quality Appendix* in volume 3).

Water quality indicators were selected that are important to the river reach being evaluated and that are likely to be affected by Program actions.

- **North Platte River Basin:**
  - Total dissolved solids (TDS)
  - Specific electrical conductance (EC)
- **South Platte River:** Specific EC
- **Lake McConaughy:** Water temperature in the release to Lake Ogallala
- **Central Platte:**
  - Water temperature
  - Turbidity: Sediment management and its effect on water quality
  - Metals: Sediment management
- **Groundwater mound:** Selenium

Special attention is paid to river reaches listed as impaired under the Clean Water Act, Section 303.

NORTH PLATTE RIVER (WYOMING)

Introduction

The main stem of the North Platte River, including main stem reservoirs, is included in the potentially affected environment in Wyoming. All of the action alternatives have the potential to affect reservoir levels and riverflows from Seminoe Reservoir down to the inflow to Lake McConaughy. This section provides a description of background water quality in the main stem of the North Platte, including Seminoe, Pathfinder, Alcova, and Glendo Reservoirs. Guernsey Reservoir is also located on the main stem of the North Platte River, but it is essentially dry during the nonirrigation season and would not be greatly affected.

Indicators

Indicators used in the water quality analysis:

- **Total Dissolved Solids.** As TDS is the water quality constituent most directly affected by changes in reservoir volume and residence time, this is the indicator used to evaluate effects of the alternatives on the North Platte Basin.

- **Electrical Conductance.** Another measure of TDS, as TDS equals approximately 0.65 * EC.

Methods

The water quality analysis was performed on the alternatives as defined in the June 2005 hydrologic simulations using the NPRWUMEIS. This analysis focuses on changes in the TDS of North Platte reservoirs due to the Program requirements for delivery of Program water to the Central Platte River in Nebraska. The significance of any changes will be documented.

Present Condition

The North Platte River in the vicinity of Casper and Glenrock, Wyoming, is listed as impaired for selenium (Wyoming Department of Environmental Quality [Wyoming DEQ] has given the reach a low priority [Wyoming DEQ], 2004). Because a source control program is underway that should take care of the selenium impairment, the DEQ has given the reach a low priority (Wyoming DEQ, 2004). There are currently no other listed sources of water quality impairment of the North Platte main stem in Wyoming.

The TDS data for the North Platte River from upstream of Seminoe Reservoir to just upstream of Lake McConaughy are summarized on figure 4-WQ-1. The figure also includes data on the other significant tributaries to Seminoe (the Medicine Bow River, referred to in the figure as “MB Sem”) and Pathfinder (the Sweetwater River, referred to as “Sw Path”) reservoirs. The generally increasing downstream trend for TDS is evident from the graph if the tributary data are ignored. The North Platte River upstream of Pathfinder (referred to as “NP Path” on figure 4-WQ-1) is also the Seminoe outflow and is a mix of the North Platte River and Medicine Bow inflows. The North Platte downstream from Seminoe shows only a slight increase in TDS despite the very high TDS concentrations in the Medicine Bow River. The reason is that the Medicine Bow only contributes about 10 percent of the Seminoe inflow.

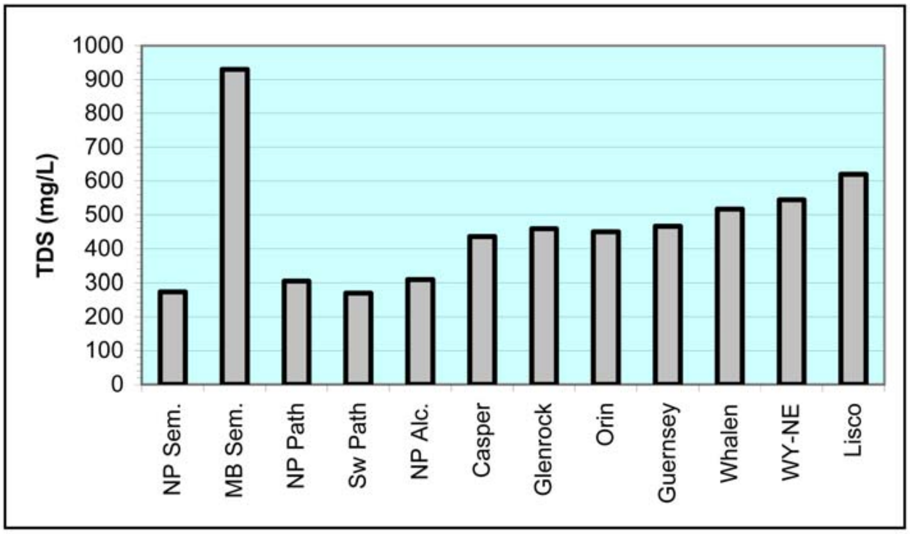


Figure 4-WQ-1.—TDS of the North Platte Basin upstream from Seminoe Reservoir, Wyoming, to upstream of Lake McConaughy, Nebraska.

Abbreviations:
NP Sem – North Platte River above Seminoe Reservoir
MB Sem – Medicine Bow River above Seminoe Reservoir
NP Path – North Platte River above Pathfinder Reservoir
Sw Path Sweetwater River above Pathfinder Reservoir
NP Alc –North Platte River near Alcova (downstream from Gray Reef Dam)
WY-NE – North Platte River at the Wyoming-Nebraska State line
Lisco – North Platte River at the Lisco gauge at Lisco, Nebraska

SOUTH PLATTE RIVER (COLORADO)

Introduction

For this analysis, the primary affected environment is the South Platte River in the vicinity of Julesburg, Colorado, which is expected to be most influenced by the alternatives. The diversion of water from the South Platte River upstream of Julesburg, and its subsequent return through groundwater recharge, has the potential to change the EC of the river at Julesburg by increasing the evaporation and, consequently, further concentrating its TDS. Water leasing in the South Platte River Basin, which is included in two alternatives, could also affect flows in the river.

The current 303(d) list for Colorado was prepared in April 2004 (Water Quality Control Division, 2004). Several reaches of the South Platte River are listed as impaired, but all of these are well upstream from the reach of the river potentially affected by the Program. However, the reach of the river that could be affected by Program alternatives is on the monitoring and evaluation list of suspected impaired waters (ibid.). The reason for the suspected impairment relates to its aquatic life use, but the cause is not specified.

There are several reaches of the South Platte River in Nebraska on the current state 303(d) list (NDEQ, 2004). The constituents of concern include polychlorinated biphenyls (PCBs), *Escherichia coli* (*E. coli*), pH, and selenium. Sutherland Reservoir itself is also listed as impaired because of PCBs. The reaches listed for selenium are near the state line and near the Keith-Lincoln County line.

Indicators

- **Specific EC.** The indicator used on the South Platte River is specific EC. EC is affected by changes in flow and return flows to the river, which affect the concentration of salts and dissolved solids. There has been a significant trend of increasing EC over the period of record at the Julesburg gauge. The EC data are plotted on figure 4-WQ-2. The trend is dominated by the EC data measured since the 1970s.

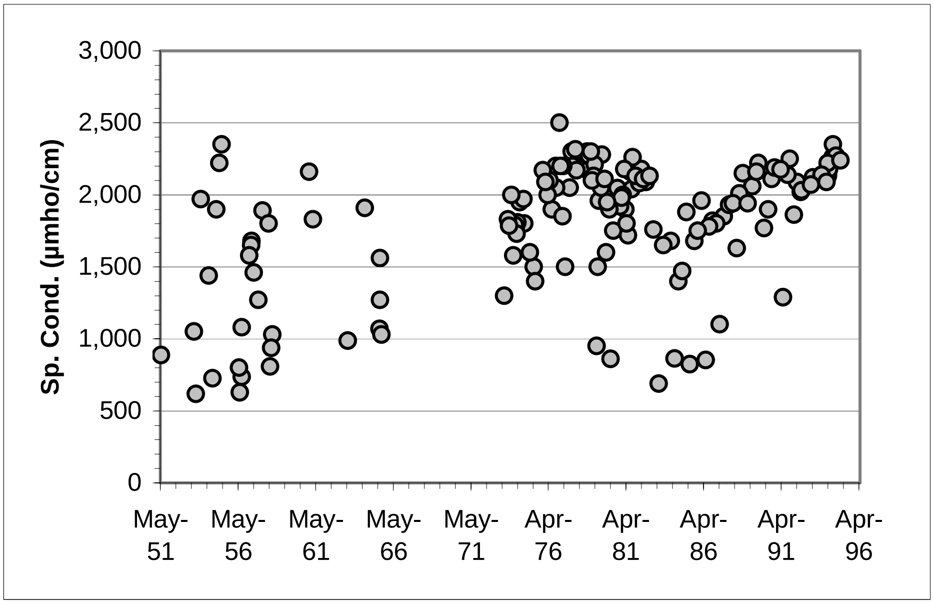


Figure 4-WQ-2.—Specific conductance data for the South Platte River at Julesburg for 1951-1995.

Methods

For this analysis, the historic EC record for the Julesburg gauge for the period of record of 1947-1994 was assumed to represent the existing environment. EC data for missing months in 1947-1994 were entered into the data set from a regression relationship with flow.

Burns (1985) modeled the groundwater at the Tamarack site to evaluate the effects of diverting river water for groundwater recharge to enhance the development of open-water sloughs maintained by seepage of groundwater adjacent to the river.

To evaluate the effects of the operation of the Tamarack project, the modeled accretions and depletions from Tamarack operations were used to adjust the flow at the Julesburg gauge. Where there was a net depletion in flow, due to the diversions for recharge, the EC of the river was not changed because Burns (1985) indicated that, during the diversion period, the river was changed from a gaining reach to a losing reach; hence, it was not influenced by return flows. The river became a gaining reach after pumping stopped and recharge to the river began to have a net effect. The gains (accretions or seepage) were assigned an EC based on a relationship developed by Burns (1985).

Present Condition

The South Platte River at the Julesburg gauge is relatively saline. The EC has averaged about 1,820 microSiemens per centimeter (µS/cm) (= µmho/cm) at the Julesburg gauge over the period of record used in the hydrologic models. For figure 4-WQ-3 shows a comparison between the historic mean monthly EC record for the Julesburg gauge with the full monthly record for the period 1947-1994. As can be seen, the added data make some differences in the mean monthly EC over the 48-year period. There is a decrease in EC in the late fall and winter months and an increase in EC during the summer (figure 4-WQ-3). The supplemented EC data set for the 48-year period of record of the Platte River model is used to represent the Present Condition.

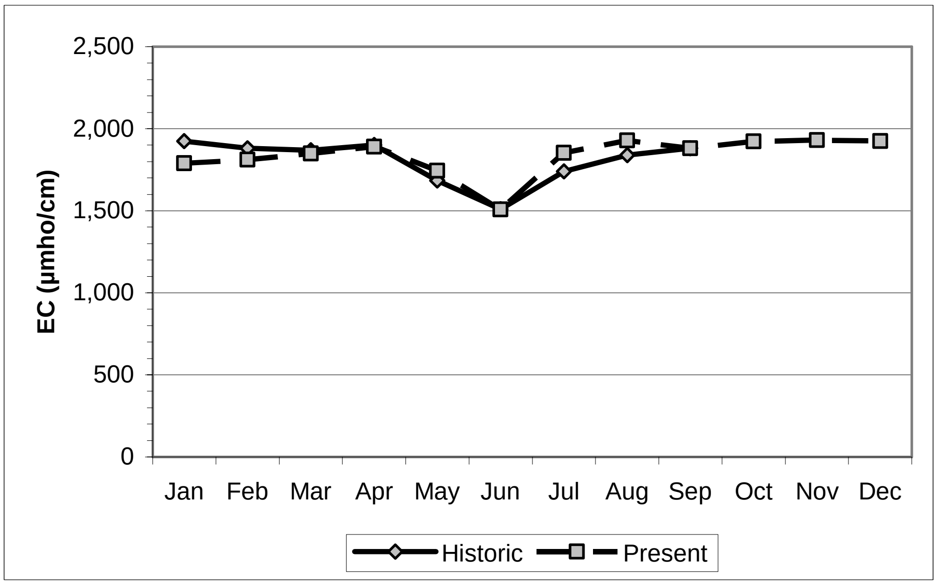


Figure 4-WQ-3.—Comparison between the mean monthly specific conductance for the historic record and the Present Condition as represented by the supplemented historic record.

NORTH PLATTE RIVER (NEBRASKA)

Introduction

Druliner et al. (1999) have characterized the water quality of the North Platte River from Whalen diversion dam, Wyoming, to Broadwater, Nebraska, based on data collected in 1995. Broadwater is located about 15 miles west of the Lisco water quality monitoring site and should be reasonably representative of water quality downstream from the North Platte Project.

The North Platte River in Nebraska has several main stem reaches on its current (2004) list of impaired waters (Nebraska Department of Environmental Quality [NDEQ], 2004). The pollutants causing the impairment or the parameters identified as impaired are *E. coli* (2 reaches), mercury (2 reaches), dieldrin (1 reach), temperature (1 reach), and PCBs (1 reach) (NDEQ, 2004). Total maximum daily loads (TMDL) have been developed for fecal coliform bacteria (NDEQ, 2003). *E. coli*. is a member of the fecal coliform group. The mercury impairment is included based on a fish consumption advisory. No TMDL is contemplated for mercury because the state feels that the source is airborne rather than a water quality problem. The dieldrin and PCB listings are also based on fish tissue data. However, neither dieldrin nor PCBs are currently being used, and the source is unknown.

Indicators

- **TDS.** TDS is the indicator used to evaluate effects of the alternatives on the entire North Platte River Basin upstream of Lake McConaughy.

Methods

The NPRWUMEIS does not include the Lisco water quality monitoring site, but it does include flows for the Lewellen gauge (about 26 miles downstream) in its output. The only water quality data for the Lewellen gauge consist of one set of suspended solids data collected in 1977. Alternatively, there is a large body of water quality data at the Lisco site. The water quality data for the Lisco site encompass the period from 1970 to 1994. For this analysis, statistical relationships derived for the Lisco site are assumed to apply to the Lewellen gauge as well.

Present Condition

Druliner et al. (1999) showed an increase in EC from around 680 µS/cm above Whalen diversion dam to between 800 and 940 µS/cm at Broadwater. The levels of EC near Broadwater are similar to those observed at Lisco. Druliner et al. (1999) observed higher EC in the late spring in drains and tributaries to the North Platte River than was present later in the summer. The decrease in EC was attributed to dilution by canal seepage and irrigation return flows, which diluted the salt contributed by saline groundwater flows.

Harmful concentrations of potentially toxic trace elements and organic compounds were not observed in the main stem of the North Platte River by Druliner et al. (1999). However, several main stem reaches are on the current Nebraska list of impaired waters (NDEQ, 2004).

LAKE MCCONAUGHY

All of the action alternatives have the potential to lower lake elevations in Lake McConaughy. This could affect the temperature and dissolved oxygen (DO) levels in the lake, which affect the quality of fish habitat, especially for trout in Lake Ogallala.

Indicators

- **Water Temperature to Lake Ogallala.** Water temperature in the release to Lake Ogallala is the indicator used for Lake McConaughy.

Methods

Yahnke (1990) modeled the temperature and DO regime in Lake McConaughy. In the modeling study, in addition to the delivery of water from what would be the equivalent of variously sized EAs, the effect of different water surface elevations in April on the ability of the lake to meet the trout criteria (less than 70 degrees Fahrenheit (°F) and DO greater than 3 milligrams per liter) in August was evaluated. There was a definable relationship. If the spring elevation of Lake McConaughy was at or above 3250 feet, the criteria were met in 4 out of the 4 years simulated. This dropped to 1 out of 4 years with a spring elevation of 3240 or 3230 feet, and 0 out of 4 years at 3220 feet. These April elevations will be used as benchmarks in comparing alternatives.

The April elevations were extracted from the end-of-month elevation table in the hydrology model runs for the various alternatives. The number of years in the total record of the hydrology model (48 years) that the reservoir elevation in April was projected to be at or above 3250 feet was enumerated, along with the number of years that the April elevation was between 3240 and 3250 feet, and the number of years that the April elevation was below 3240 and below 3230. The comparison of these counts against those of the Present Condition is used to indicate the change brought about by each of the alternatives.

Present Condition

Lake McConaughy was classified as meso-eutrophic (somewhat nutrient rich) by the U.S. Environmental Protection Agency (EPA) (1976) in their National Eutrophication Survey in 1974-75. Phosphorus loadings during the study were more than twice the eutrophic level calculated in accordance with Vollenweider and Dillon (1974). Over 90 percent of the estimated phosphorus loading came from nonpoint sources in the North Platte River Basin upstream of the reservoir (EPA, 1976).

The more critical water quality problem in Lake McConaughy relates to high temperature and low DO; the latter is symptomatic of eutrophy. When the reservoir becomes thermally stratified in the summer, the surface layer supports a warmwater fishery consisting of walleye, white bass, catfish, smallmouth bass, and striped bass (Van Velson, 1978). Cold water from the deeper layer is released to Lake Ogallala, where it supports a rainbow trout fishery. The low DO and high levels of biochemical oxygen demand in the releases represent a water quality problem and cause fishkills in Lake Ogallala.

The characteristics of Lake McConaughy with respect to temperature and DO at the different April water surface elevations in each of the 4 years simulated in the model study are summarized in table 4-WQ-1.

The physical basis for the effects shown in table 4-WQ-1 relates to the mass of water, its relation to heat gain and loss, and the consequent distribution of DO in the reservoir. Heat gain in the reservoir is primarily at the water surface. The surface layer is warmed, while the bottom water remains cool. The density of water depends on the temperature. Warm water is less dense than cooler water, as long as the water is warmer than about 39°F. This distribution of heat in the reservoir causes a density stratification that isolates the cool, denser bottom layer from the atmosphere. As long as the temperature-induced density stratification is present, the deeper water cannot be aerated. Consequently, the DO in the deeper layer cannot be replenished and is depleted by the decomposition of organic matter as the summer stratification persists.

Table 4-WQ-1.—Summary of August Minimum Habitat or "Worst Case" Combinations of Temperature and DO Related to Different April Water Surface Elevations

April Lake Elevation	August "Worst Case" Condition	Year			
		1974	1977	1978	1980
3250 feet	Minimum thickness (feet) of ≥ 70°F and ≤ 3 milligrams per liter layer	< 1½	8	20	< 1½
	Depth of < 70°F layer (feet)	Absent	53-61	25-45	51-52
	Depth of > 3 milligrams per liter layer (feet)	56	53-61	25-45	51-52
	Duration of temperature > 70°F (days)	1	0	0	0
	Duration of DO < 3 milligrams per liter (days)	0	0	0	0
	Maximum temperature (°F)	70.2	< 70	< 70	< 70
	Minimum DO (milligrams per liter)	3	> 3	> 3	> 3
3240 feet	Minimum thickness (feet) of ≥ 70°F and ≤ 3 milligrams per liter layer	0	0	15	0
	Depth of < 70°F layer (feet)	Absent	Absent	30-45	Absent
	Depth of > 3 milligrams per liter layer (feet)	Absent	Absent	30-45	Absent
	Duration of temperature > 70°F (days)	21	17	0	36
	Duration of DO < 3 milligrams per liter (days)	5	9	0	15
	Maximum temperature (°F)	71.6	71.2	< 70	71.4
	Minimum DO (milligrams per liter)	2.9	2.8	> 3	2.8
3230 feet	Minimum thickness (feet) of ≥ 70°F and ≤ 3 milligrams per liter layer	0	0	5	0
	Depth of < 70°F layer (feet)	Absent	Absent	43-48	Absent
	Depth of > 3 milligrams per liter layer (feet)	Absent	Absent	43-48	Absent
	Duration of temperature > 70°F (days)	36	30	0	45
	Duration of DO < 3 milligrams per liter (days)	20	16	0	21
	Maximum temperature (°F)	72.7	72.1	< 70	73.8
	Minimum DO (milligrams per liter)	2.5	2.7	> 3	2.7

Under the existing conditions, the Lake McConaughy water surface elevation in April is lower than 3250 feet in about 10 percent of the years. This means that in about 10 percent of the years, there is a chance that one or the other of the respective temperature or DO criteria would not be met, based on the years simulated. If the 4 simulated years represent a broad range of conditions, then the result could be translated to a probability. However, the model results make it reasonable to conclude that the probability that the criteria would not be met is somewhere between 0 and 75 percent in those 10 percent of the years out of 48 years that the April water surface elevation is less than 3250 feet.

LAKE OGALLALA

Introduction

Lake Ogallala is an afterbay downstream from Kingsley Dam. The afterbay is fed entirely by releases from the dam. Lake Ogallala supports a trout fishery, which depends entirely on cool releases from Kingsley Dam. If the temperature of releases from the dam are changed, then there would be changes in Lake Ogallala as well, possibly affecting the trout fishery in Lake Ogallala.

Lake Ogallala is listed as impaired on the Nebraska 303(d) list for not supporting its aquatic life and aesthetics designated uses. The causes of nonsupport are low DO and excessive nutrients (NDEQ, 2004). No TMDLs are currently scheduled (NDEQ, 2004).

Indicators

- **Water Temperature.** Water temperature was the indicator used for Lake Ogallala, due to its importance to trout habitat and its likelihood of being affected by changes in operation of Lake McConaughy.

Methods

Yahnke (1990) evaluated the effects of decreasing water surface elevations on the peak release temperature from Kingsley Dam. The projected release temperature data are shown in table 4-WQ-2. The same types of effects that were shown in table 4-WQ-1 (for Lake McConaughy) are shown in table 4-WQ-2 for the waters released from Lake McConaughy. Data indicate that the increased warming extends to the deepest layers of Lake McConaughy.

Table 4-WQ-2.—Comparison of Kingsley Dam Maximum Release Temperatures (°F) for Different Initial Water Surface Elevations in Each of Four Simulated Years*

April Water Surface Elevations	1974 Temperature		1977 Temperature		1978 Temperature		1980 Temperature	
	Peak	Date	Peak	Date	Peak	Date	Peak	Date
3260	66.6	September 9	67.1	September 13	66.0	September 11	66.0	September 8
3250	67.6	August 23	67.5	September 13	67.8	September 11	68.4	September 8
3240	70.9	August 23	71.2	August 26	68.2	August 28	70.2	August 25
3230	72.5	August 19	72.1	August 12	69.8	August 13-16	72.0	August 17
*Source: Yahnke, 1990.								

Lake Ogallala is a small reservoir. At full pool, the reservoir capacity is 2,500 acre-feet. Active storage in Lake Ogallala is usually between elevations 3123.5 and 3126 feet, the full pool elevation. The storage between the above elevations is 1,600 acre-feet and represents the normal regulatory capability of Lake Ogallala. Therefore, the residence time (the amount of time for inflows to completely replace storage) in Lake Ogallala is relatively short. Changing the releases from Kingsley Dam would change the residence time in Lake Ogallala. In cases where the release temperature is above that suitable for trout, adverse effects on the fish are possible in Lake Ogallala.

Present Condition

Table 4-WQ-3 summarizes data on the water quality of Lake Ogallala, which were collected on several dates from 1989 through 1991. The Secchi depth, a measure of water clarity, was relatively low, with a range of just under 3 feet (33 inches) to a little over 5 feet (64 inches). (For comparison purposes, Secchi

Table 4-WQ-3.—Summary of Present Condition Water Quality in Lake Ogallala

	Water Temperature (°C)	Secchi Disc Transparency (Inches)*	Specific Conductance (µmhos/cm at 25°C)	DO (Milligrams Per Liter)	DO, Percent of Saturation (Percent)
Minimum	1.0	33.0	550	8.2	86.3
Median	17.5	45.5	746	10.5	110.0
Maximum	19.5	64.0	843	20.5	160.2
Number of Observations	6	6	6	6	6
*Measure of light absorption characteristics of water and its dissolved and suspended particulate matter.					

depths of 40 meters (over 130 feet) have been recorded in extremely clear pristine waters, while Secchi depths of less than 3 feet are more characteristic of polluted water bodies [Cole, 1979].)

Historically, the DO in the inflow to Lake Ogallala was adequate, even when the water was drawn from the anoxic hypolimnion (the cold, deep layer of a stratified lake) of Lake McConaughy. However, with the introduction of a hydropower generation plant that drives power turbines with the outflow at Lake McConaughy, air entrainment has been greatly reduced (Stansbury et al., 2002 [WASP-5]). The water from the hypolimnetic origin in Lake McConaughy, although cool, has low DO and contains potentially toxic concentrations of ammonia and hydrogen sulfide, along with other oxygen-demanding substances (Stansbury et al., 2002 [WASP-5]). The effects of these problematic factors are further influenced by large beds of macrophytes downstream from the powerplant discharge, which are suspected of further depressing DO near the outlet gates (Stansbury et al., 2002 [WASP-5] and Dove et al., 2002). As a result, the fishery in Lake Ogallala has been under stress, and fishkills have been reported in August in the northeast corner of Lake Ogallala (Dove et al., 2002). An aeration system (Howell-Bunger valve) has been installed in the outlet of the hydropower facility, (ibid.), and aerators have been installed in the North Basin that inhibit stratification (Dove et al., 2002). In an attempt to understand the effects of the poor water quality on the fishery in Lake Ogallala, a series of studies was undertaken to better define the problem and develop solutions (Admiraal et al., 2003; Dove et al., 2002; and Stansbury et al., 2002 [WASP-5] and 2002[RMA-2]).

The temperatures of water released from Kingsley Dam are well within the trout habitat temperature criterion of 70°F (21 degrees Celsius [°C]) about 90 percent of the years during August, based on the monthly data. Because of the morphometry of Lake Ogallala, complete mixing does not occur. There is a current that flows through the lake, but the area of the lake away from the Kingsley Dam outlet is not greatly mixed. The unmixed area warms more than the area most affected by the current.

CENTRAL PLATTE RIVER

Introduction

The main focus of the Program is the Central Platte River Basin in Nebraska. The analysis for the Central Platte River Basin will evaluate the effect of water and sediment manipulation. The water manipulation will affect water quality. The sediment manipulation will affect the water quality and sediment quality. In addition, for some alternatives, nonirrigation season releases from Lake McConaughy would be diverted from the Platte River and stored in the groundwater mound; the water could then be extracted from the ground and used for irrigation in exchange for additional releases from Lake McConaughy.

There is one site in the Middle Platte River Basin on the state/EPA 303(d) list, Johnson Lake, which is listed for fecal coliforms and nutrients (NDEQ, 2004). TMDLs for nonpoint sources of coliforms and nutrients are scheduled for development in 2005 or 2006. None of the alternatives are expected to affect potential nonpoint sources to Johnson Lake.

Some of the alternatives involve moving river sand from islands back into the river channel. Any contaminants in the island sand and sediment could be mobilized when added to the river.

Limited sediment sampling during the Platte River National Water Quality Assessment report (Frenzel et al., 1998) indicated possible contamination of the sediments with selenium and mercury. To assess this possibility, sediment samples were collected by the Program during 2000 for analysis of contaminants at numerous sites in the Platte River from the confluence of the North and South Platte Rivers to Grand Island. A summary of the 2000 data is presented in table 4-WQ-4. The summary indicates that most of the sediment concentrations, including selenium and mercury, are below levels of concern, as indicated by screening levels (Upper Effects Threshold [UET]) shown in the last column of the table. Those elements that exceeded the UET were selected for further screening as potential indicators for the impact analysis. Four heavy metals in the Platte River sediments exceed their respective UET values and must be considered possible contaminants: copper, nickel, lead, and zinc (see table 4-WQ-5). The UET is based on levels above which toxicity is commonly, although not always, observed (National Oceanic and Atmospheric Administration [NOAA], 1999). Copper shows the greatest exceedance in that the median concentration in the sediments exceeds the UET by a factor of 9. In the case of the other possible contaminants, the median is less than the UET, but the maximum concentration exceeds the UET.

Table 4-WQ-4.—Summary of Platte River Sediment Chemical Analysis (ppm).

Element	Symbol	Number of Observations	Number Greater than Detection Limit	Minimum	Median	Maximum	UET*
Silver	Ag	43	2	< 0.8	< 0.8	1.8	4.5
Aluminum	Al	43	43	434	2,515	13,036	—
Arsenic	As	27	27	0.4	0.8	3.1	17
Barium	Ba	43	43	8	46	148	—
Beryllium	Be	43	36	< 0.1	0.2	0.9	—
Calcium	Ca	43	43	780	4,673	23,228	—
Cadmium	Cd	43	1	< 0.8	< 0.8	2.4	3.0
Cobalt	Co	43	41	< 0.6	3.1	10.5	—
Chromium	Cr	43	43	1.0	6.2	30.6	95
Copper	Cu	43	43	60	766	23,006	86
Mercury	Hg	27	0	< 0.019	< 0.020	< 0.040	0.56
Iron	Fe	43	43	1,227	5,589	28,037	40,000
Potassium	K	43	42	< 200	767	3,115	—
Magnesium	Mg	43	43	231	1,090	4,596	—
Manganese	Mn	43	43	24	152	815	1,100

Element	Symbol	Number of Observations	Number Greater than Detection Limit	Minimum	Median	Maximum	UET*
Molybdenum	Mo	43	1	< 2.0	6.9	6.9	—
Sodium	Na	43	43	25	151	469	—
Nickel	Ni	43	41	< 2	6	146	43
Lead	Pb	43	41	< 6	15	295	127
Antimony	Sb	43	0	< 4	---	< 4	3.0
Selenium	Se	27	5	< 0.4	< 0.4	0.7	2.5**
Silicon	Si	43	38	0	602	4,626	—
Strontium	Sr	43	43	4	24	107	—
Vanadium	V	43	43	1	11	69	—
Zinc	Zn	43	43	19	115	4,000	520

*Upper effects threshold (NOAA, 1999).

**No upper effects threshold. Concentration shown is that at which 10 percent of the fish and birds in a variety of aquatic systems show effects (National Irrigation Water Quality Program, [NIWQP], 1998).

Table 4-WQ-5.—Concentrations of Four Metals in Bed and Bank/Island Sediments in Samples Collected in 2000 in the Central Platte River in the Vicinity of Grand Island, Nebraska (ppm).

Source	Depth	Copper	Nickel	Iron	Zinc
Bed	Surface	491	4	13	86
Bank/island	0-inch depth	811	9	16	127
	1-inch depth	1,450	10	17	220
	2-inch depth	1,094	11	35	215

Indicators

Several indicators are used in the Central Platte:

- **Water Temperature.** Used to analyze impacts on water quality due to water manipulation.
- **Turbidity.** Used to analyze the effects of sediment manipulation on water quality.
- **Contaminants.**
  - **Selenium.** Used to evaluate the effects of groundwater storage.
  - **Metals.** Although copper appears to be the best indicator because the median copper concentration exceeds the UET, lead, nickel, and zinc were also considered and carried through the analysis, and they were used as the indicators of the effects of sediment manipulation on the concentrations of contaminants in bed sediments.

Methods

Water Temperature

There have been numerous fishkills in the Central Platte River. Most of these fishkills have been attributed to water temperatures in excess of 90°F, the Nebraska water quality standard for temperature in the Central Platte River. To better define the relationship between excessive temperatures and effects on forage fish for the least tern, the Service in Grand Island monitored riverflow and water temperatures at five sites in the Platte River from 1989 through 1995. The data from June, July, and August for the site at Mormon Island, near Grand Island, were used to develop frequency distributions of the water temperatures within different flow intervals. The temperatures within each of the flow intervals were compared to the temperature standard to calculate a frequency of exceeding the standard within each interval.

In the biological opinion for the FERC license for the hydroelectric plant at Kingsley Dam, the Service established a target flow of 1,200 cfs at Grand Island for the maintenance of whooping crane roosting habitat (Service, 1997). The Service also indicated that the 1,200-cfs target flow would be adequate to help meet the temperature standard, based on studies by Sinokrot et al., 1997. The effect of the alternatives on water temperature will also be evaluated by comparing the frequency that the flow at Grand Island meets the 1,200-cfs target flow with that of the Present Condition.

Turbidity

Turbidity was evaluated by developing a regression relationship with total suspended solids (TSS). There are no common TSS turbidity data available. Consequently, the process of developing the relationships was somewhat complex (see *Water Quality Appendix* in volume 3 for details). The regression relationship with TSS was used to estimate turbidity in the Platte River near Grand Island, based on the output from the SEDVEG model for each of the alternatives.

Contaminants: Selenium and Metals

The effects on concentrations of the various elements from the sediment chemistry data were evaluated by weighting the chemical concentrations in proportion to the deposition of sediment at augmentation sites as defined by the SEDVEG Gen3 model. The sources of sediments from bank and island clearing and leveling were evaluated in proportion to the suspended solids load. Based on the assumption that much of the suspended sediment is currently resuspended from the bed, and that any additional sediment added by the Program will enter the bed sediments in proportion to those in suspension, the change in sediment chemistry was based on weighting the concentrations of copper, nickel, lead, and zinc in proportion to the increase in suspended sediment. The modeled loss to the bed sediments was used to weight the sediment concentrations of copper, nickel, lead, and zinc to adjust concentrations in the bed sediments.

EPA (2004) has derived a series of logistic regression curves that can be used to estimate the probability of toxicity for a continuum of concentrations of each of the above-listed metals. The concentrations of the metals after the 13-year Program's First Increment and after the full SEDVEG Gen3 model study period, were used to develop estimates of the probability of toxicity for the sediments. The probabilities for each element were compared to those of the Present Condition.

The results of the above-described analysis should probably be considered more qualitative than quantitative. In other words, the changes relative to the Present Condition will be accurate insofar as there are increases or decreases, but the magnitude of the changes are not very precise.

Present Condition

Water Temperature

Table 4-WQ-6 shows the frequency of exceeding 1,200 cfs under the Present Condition. The totals included in table 4-WQ-6 represent the number of days in the 48-year simulated period (1947-1994) that the mean daily flow exceeded 1,200 cfs. Table 4-WQ-6 indicates that the target flow would be exceeded on 729 of the 1,440 days in June; 515 of the 1,488 days in July; and 138 of the 1,488 days in August during the simulation period. In other words, the flow is exceeded on a little over half of the days in June, decreasing to about one-third of the days in July, and less than one-tenth of the days in August under the Present Condition.

Table 4-WQ-6.—Summary of the Present Condition Relative to the 1,200 cfs Target Flows and the Probability of Exceeding the Nebraska Temperature Standard

Measure	June	July	August
Number of years that flow is greater than 1,200 cfs	729	515	138
Probability of exceeding 90°F	27 percent	33 percent	42 percent

Table 4-WQ-6 also indicates that there is nearly a 27-percent probability of exceeding the temperature standard in June. The probability increases to 33 percent in July, and to over 40 percent in August. The increased probability of exceeding the temperature standard is a reflection of the decreasing number of high flows as the summer progresses.

Turbidity

The re-created turbidity at Grand Island for the Present Condition was compared to the historic data on figure 4-WQ-4. The turbidity in the historic record ranged from 3 to 140 Jackson turbidity units (JTU). The re-created turbidity ranges from 1 to 42 JTU. This maximum in the Present Condition would be the 95th percentile in the historic record. In general, there is not a great deal of difference between the distributions of the historic and the Present Condition turbidity data sets shown on figure 4-WQ-4. The only real difference is near the maximum turbidity.

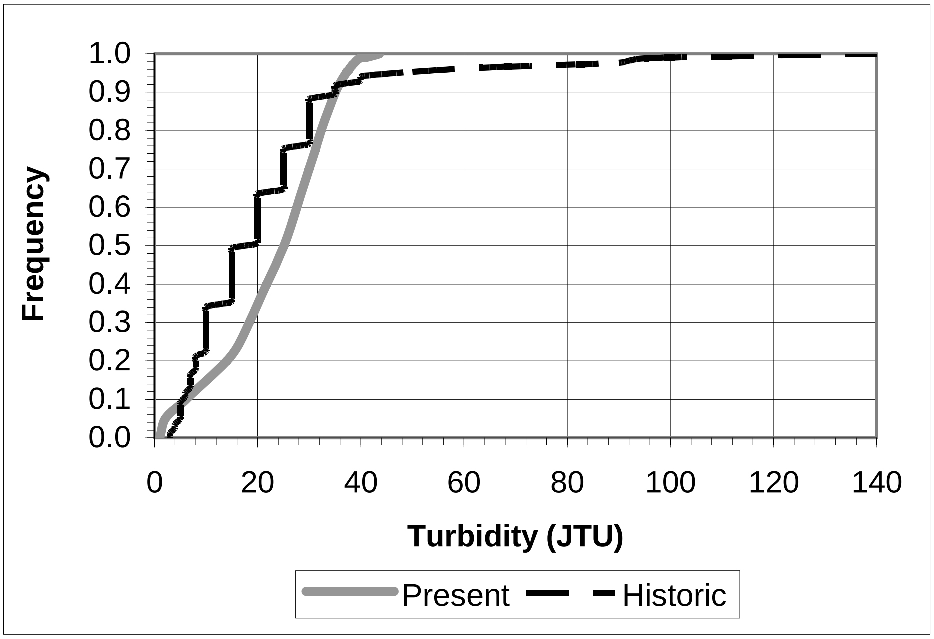


Figure 4-WQ-4.—Historic and Present Condition turbidity distributions.

Contaminants—Selenium and Metals

A breakdown of the concentrations of copper, nickel, lead, and zinc in the bed and combined bank/island samples is shown in table 4-WQ-5. In all cases, the concentrations of the four metals are higher in the bank/island samples than in the bed sediments. In the case of copper and nickel, the minimum bank/island concentration is about twice as high as the bed concentration. In addition, the concentration of each of the metals shows an increase from the surface to the 1-foot depth in the bank/island samples. Nickel and lead show a further increase from the 1-foot to the 2-foot depth in the bank/island samples, while copper and zinc show a decrease between those depths.

All of the copper concentrations in table 4-WQ-5 exceed the UET for copper. Alternatively, none of the nickel, lead, or zinc concentrations in the table exceed their respective UET concentration.

GROUNDWATER MOUND

Introduction

A large mound of groundwater has developed near the Platte River in south-central Nebraska near the study area. The mound is characterized by a rise of more than 50 feet in the groundwater surface elevation since the Pre-Development benchmark. The mound underlies most of Gosper, Phelps, and Kearney Counties, south of the Platte River and just north of the Republican River. Because of its proximity to the Platte River, it is a potential source of water for augmentation flows. This section evaluates the quality of the groundwater in the mound.

Indicators

- **Selenium.** A review of historic data (i.e., pre-1978) concerning wells in the groundwater mound showed very high concentrations of selenium (maximum greater than 100 micrograms per liter [µg/L]). Because there were no recent data on selenium in the groundwater mound, and some questions concerning the validity of the earlier selenium data, 28 wells in the groundwater mound, many of which were sampled in the earlier data set, were sampled in 2000. The more recent data also showed high concentrations of selenium, although the maximum was lower, at 31 µg/L. Because several of the configurations of the groundwater mound augmentation plan had the potential to add selenium to tributaries of the Platte River, and more than 40 percent of the well samples exceeded the aquatic life criterion for selenium, selenium was chosen as the indicator for the groundwater mound augmentation element.

Methods

The analysis for selenium is entirely non-numeric. The first part of the analysis was to identify if the facilities involved in the conjunctive use activity will be located in an area of seleniferous groundwater. The next step was to evaluate how the activities involved in the conjunctive use element would affect the chemistry of selenium in terms of either causing increases or decreases in the concentration in the groundwater mound (see the *Water Quality Appendix* in Volume 3).

Present Condition

The groundwater mound has areas of high selenium. The higher selenium groundwater is primarily in Phelps and Kearney Counties. Concentrations in samples collected during 1969-78 had a maximum selenium concentration of over 100 µg/L (figure 4-WQ-5). More recent samples had a peak selenium concentration of 31 µg/L. Although there are no selenium data on streams draining the groundwater mound, it seems likely that there is elevated selenium in Whisky Slough, Lost Creek, and North Dry Creek. Figure 4-WQ-5 shows selenium concentrations in part of the groundwater mound.

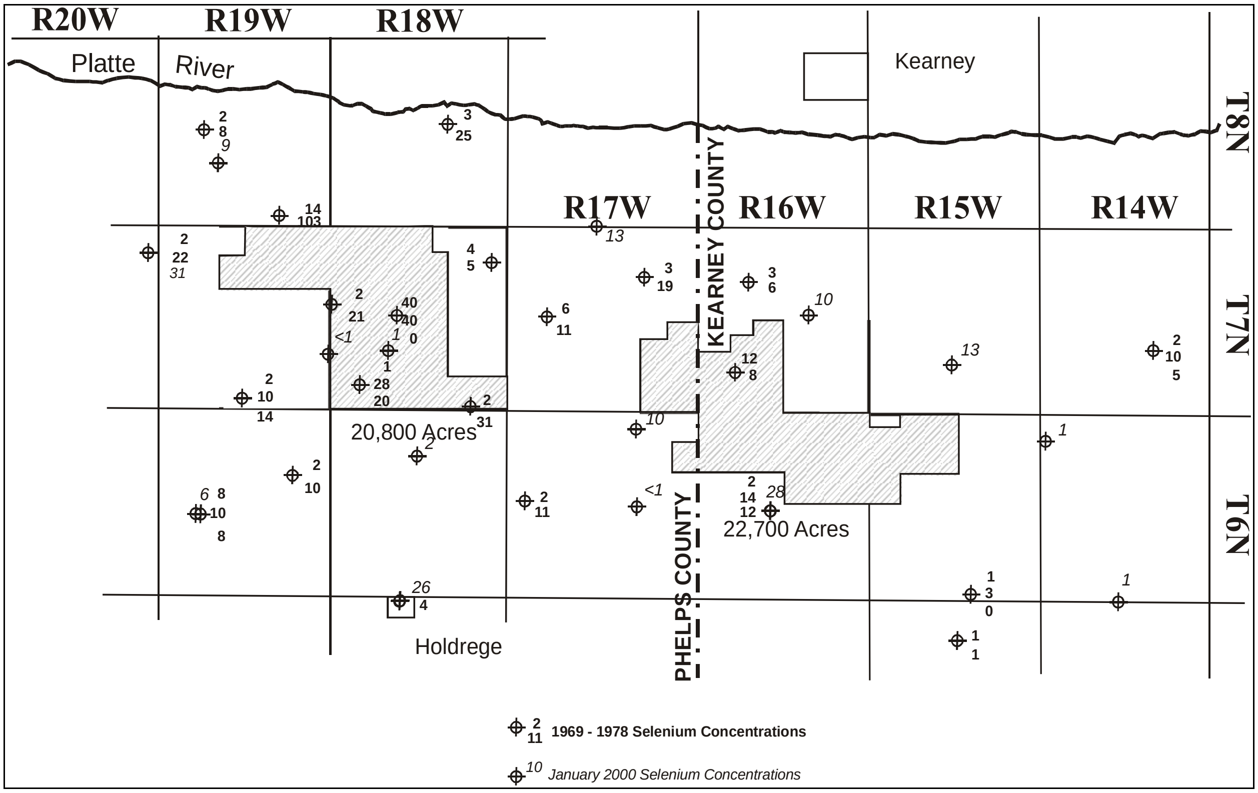


Figure 4-WQ-5.—Selenium concentrations (micrograms per liter) from sampled wells in the Phelps and Kearney Counties' segment of the groundwater mound and potential conjunctive use areas.

CENTRAL PLATTE RIVER TERRESTRIAL VEGETATION COMMUNITIES AND LAND USE TYPES

INTRODUCTION

Vegetation communities along the Central Platte River provide habitat for a variety of species. These vegetation communities will be affected by the land and water actions included in all action alternatives as riverine and wet meadow habitats are restored. This section of the FEIS describes the extent of the existing vegetation communities found in the land action area (Lexington to Chapman), as well as land use types and representative animal and bird species in each habitat type. A more detailed description of vegetation communities within the flood plain and within the channel are included in the "Wetland" section in this chapter.

INDICATORS

The Present Condition of terrestrial vegetation communities and land uses is described in relation to their topographic position within the study area and their representative plant and wildlife species.

Impacts to terrestrial vegetation communities will be measured by:

- ➢ Increase or decrease in acres of habitat types

METHODS

In 1998, Reclamation's Remote Sensing and Geographic Information Group classified and created a digital Geographic Information System (GIS) database representing land cover and land use in the 90-mile-long, 7-mile-wide habitat area between Lexington and Chapman. Twelve natural vegetation, seven agricultural land cover types, five surface hydrology, and fourteen land-use classifications were interpreted from 1998 color-infrared aerial photography and transferred into a GIS database (Friesen, et al., 2000). Figure 4-P-1 is an example of one of the GIS land cover, land use maps for a reach of the Central Platte from Kearney to Odessa. The legend of the map shows all of the land cover, land use classes used in the GIS classification.

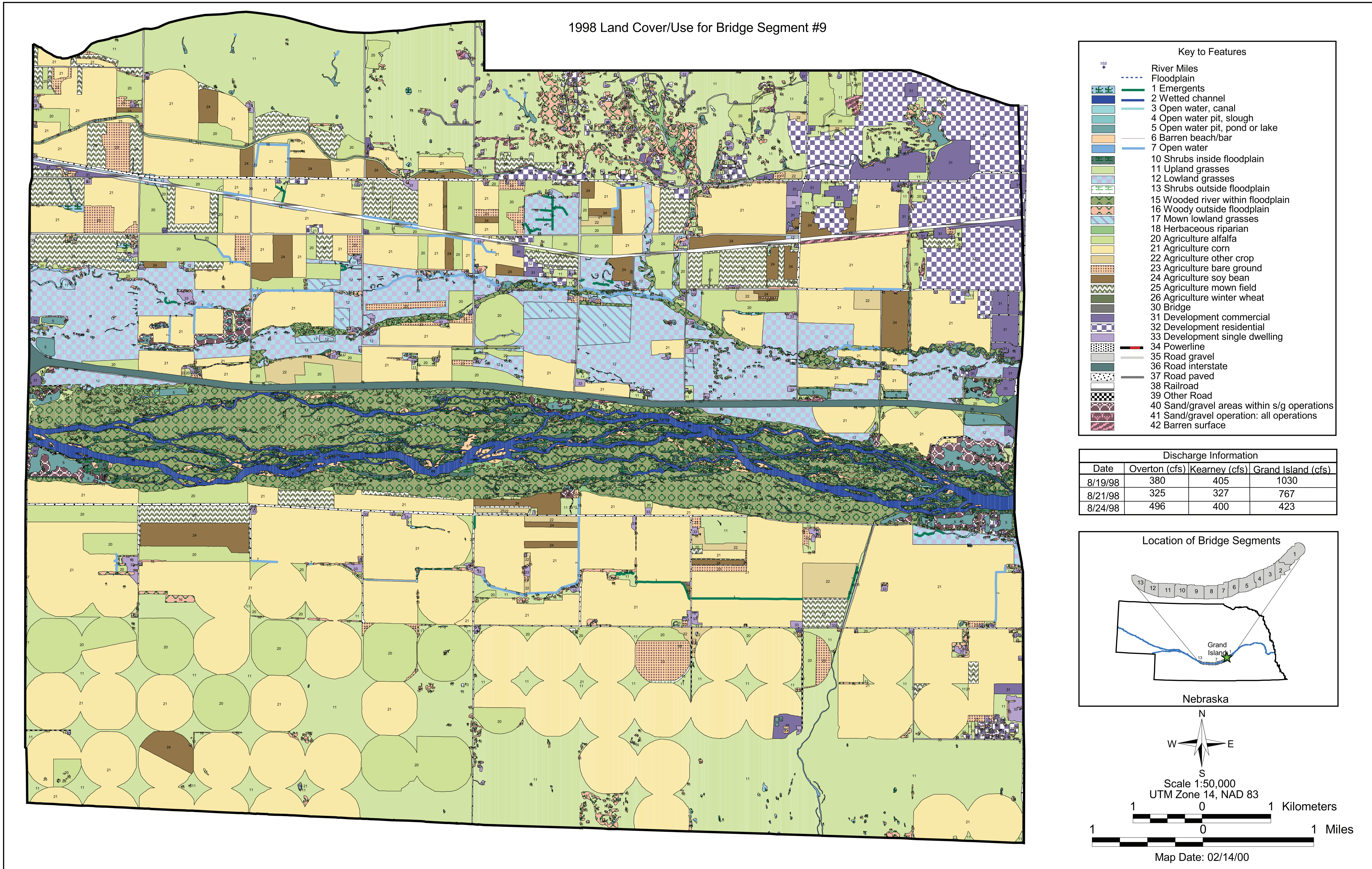
PRESENT CONDITION

Table 4-P-1 summarizes the most significant land cover types relating to species habitats.

Table 4-P-1.—Present Condition Central Platte Habitat Area Land Cover/Land Use Classification Summary

Land Cover/Land Use Type	Acres	Percent	Percent of Total
Inside Flood Plain			
Agricultural lands	29,517	34.4 percent	**20 percent**
Emergent wetlands	131	0.2 percent	
Herbaceous riparian	2,253	2.6 percent	
Lowland grasslands	18,605	21.7 percent	
Open water (pits, ponds, lakes)	1,499	1.7 percent	
Open water (canals)	11	0.0 percent	
Open water (slough)	116	0.1 percent	
Sand and gravel	956	1.1 percent	
Shrublands	2,048	2.4 percent	
Upland grasslands	3,082	3.6 percent	
Wooded	16,708	19.5 percent	
Other classes*	10,817	12.6 percent	
Totals	**85,743**	**100.0 percent**	
Inside Channel			
Agricultural lands	4,805	11.3 percent	**10 percent**
Barren beach/bar	665	1.6 percent	
Emergents	182	0.4 percent	
Herbaceous riparian	1,275	3.0 percent	
Lowland grasslands	10,497	24.8 percent	
Open water (pits, ponds, lakes)	348	0.8 percent	
Open water (canals)	0	0.0 percent	
Open water (slough)	56	0.1 percent	
Sand and gravel	140	0.3 percent	
Shrublands	3,210	7.6 percent	
Upland grasslands	255	0.6 percent	
Wetted channel	9,967	23.5 percent	
Wooded	10,326	24.4 percent	
Other classes*	641	1.5 percent	
Totals	**42,367**	**100.0 percent**	
Outside Flood Plain			
Agricultural lands	230,340	75.3 percent	**70 percent**
Emergents	1,092	0.4 percent	
Herbaceous riparian	375	0.1 percent	
Lowland grasslands	13,935	4.6 percent	
Open water (pits, ponds, lakes)	2,257	0.7 percent	
Open water (canals)	232	0.1 percent	
Open water (slough)	8	0.0 percent	
Sand and gravel	576	0.2 percent	
Shrublands	451	0.1 percent	
Upland grasslands	32,301	10.6 percent	
Wooded	7,930	2.6 percent	
Other classes*	16,591	5.4 percent	
Totals	**306,088**	**100.0 percent**	
Grand Totals	**434,198**		**100 percent**

*"Other classes" equals bridge, development commercial, development single dwelling, powerline, road gravel, road interstate, road paved, other road, and barren surface.



Date	Overton (cfs)	Kearney (cfs)	Grand Island (cfs)
8/19/98	380	405	1030
8/21/98	325	327	767
8/24/98	496	400	423

Figure 4-P-1.—GIS bridge segment map.

The following sections briefly describe vegetation cover types, as well as representative species in each classification.

Vegetation Communities Inside the Flood Plain

Lowland Grasslands/Wet Meadows

Lowland grasslands occupy about 10 percent of the study area on lower terraces of the Platte River valley from high, dry areas to lower, moist areas.

Lowland Grasslands/Wet Meadows Representative Plant Species

On drier sites, tall grass prairie communities support big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and western wheatgrass (*Pascopyrum smithii*). Moister sites are dominated by switchgrass (*Panicum virgatum*), prairie cordgrass (*Spartina pectinata*), redtop (*Agrostis* spp.), Kentucky bluegrass (*Poa pratensis*) and Indiangrass (*Sorghastrum nutans*).

The lowest and wettest sites within the lowland grasslands community type form a mosaic with the tall grasses mixed with wetlands occupying old channels, depressions, deep swales, cut-off oxbow, slow-flowing streams, and pond margins. These areas are commonly called "wet meadows." Wet meadows are a subset to the lowland grassland class and cannot be readily identified using aerial photography. The lowland grassland class includes the drier sites described above and wet meadows as described below. "Lowland Grasslands and Wet Meadows" in chapter 2 includes a description and illustration of the typical position of wet meadows on the landscape along the Platte River. Chapter 2 also discusses the hydrologic relationship of these meadows to the river and the adjacent groundwater, and sites at which some of the representative species can occur.

Wet meadows have a combination of wetland and upland plant species. Lower areas may contain sedges (*Carex* spp.), spikerushes (*Eleocharis* spp.), and smartweed (*Polygonum* spp.). Wetland species include both broad- and narrow-leaved cattails (*Typha latifolia* and *T. angustifolia*); softstem, river, and three-square bulrush (*Scirpus validus*, *S. fluviatalis*, and *S. pungens*); sedges; spikerush; reed-canarygrass (*Phalaris arundinacea*); and smartweed (*Polygonum* spp.). Often, a fringe of tall prairie grasses and wetland shrubs is present, which includes prairie cordgrass, switchgrass, sandbar and peachleaf willow (*Salix exigua* and *S. amygdaloides*), and leadplant (*Amorpha* spp.).

Lowland Grasslands Wildlife Use

In large tracts of lowland grasslands, bobolink and lark bunting are common inhabitants. In an average size and good conditioned grasslands, the dickcissel (*Spiza americana*), grasshopper sparrow (*Ammodramus savannarum*), song sparrow (*Melospiza melodia*), upland sandpiper (*Bartramia longicauda*), western and eastern meadowlark (*Sternella neglecta* and *S. magna*), ring-neck pheasant (*Phasianus colchicus*), red-winged blackbird (*Agelaius phoeniceus*), and marsh wren (*Cistothorus palustris*) are common. In addition, wet meadows are important habitats for loafing and foraging for whooping cranes and sandhill cranes. Mammals using these grasslands include the eastern cotton-tail (*Sylvilagus floridanus*), white-tailed deer (*Odocoileus virginianus*), striped skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), and various mice (*Mus* spp.) and voles (*Microtus* spp.).

Woodlands

Riparian woodlands are one of the most common habitats of the Central Platte River valley, occupying islands, terraces, and tributary drainages along the length of the corridor.

Woodlands Representative Plant Species

In mature riparian stands, eastern cottonwood trees 20 - 35 meters tall provide up to 60 percent of the cover. In a few stands, the mature eastern cottonwood trees were estimated to be nearly 50 meters tall. Shorter-statured green ash (*Fraxinus pennsylvanica*), eastern red cedar (*Juniperus virginiana*), peachleaf and black willow (*Salix amygdaloides* and *S. nigra*), slippery elm (*Ulmus rubra*), red mulberry (*Morus rubra*), hackberry (*Celtis* spp.), and Russian-olive (*Elaeagnus angustifolia*) trees form a subcanopy and contribute 30 to 60 percent additional ground cover.

Riparian woodland understory shrubs, ranging from 1 - 5 meters tall, include rough-leaved dogwood (*Cornus drummondii*), sapling eastern red cedar and green ash trees, chokecherry (*Prunus virginiana*), Arkansas rose (*Rosa arkansana*), false indigo (*Amorpha fruiticosa*), prickly ash (*Zanthoxylum americanum*), and coralberry (*Symphoricarpos orbiculatus*). They provide up to 50 percent of additional vegetation cover. The lianas, wild grape (*Vitis riparia*), and Virginia creeper (*Parthenocissus quinquefolia*) are also present in some locations.

Herbaceous riparian woodland understory species form a dense layer of up to 80-percent cover and include the following grasses: switchgrass, Kentucky bluegrass, smooth brome (*Bromus inermis*), Canada and Virginia wildrye (*Elymus canadensis* and *E. virginiana*), prairie cordgrass, redtop, orchardgrass (*Dactylis glomerata*), reed canarygrass, and the annual Japanese brome (*Bromus japonicus*). Common forbs and grasslike plants include sedges, Nuttall sedge (*Carex nutallii*), common and western ragweeds (*Ambrosia artemisiifolia* and *A. psilostachya*), field mint (*Mentha arvensis*), fog fruit (*Phyla lanceolatum*), smooth horsetail (*Equisetum laevigatum*), dandelion (*Taraxacum officianale*), northern bedstraw (*Galium aprine*), hemp (*Cannabis sativa*), catnip (*Nepeta cataria*), dogbane (*Apocynum cannabinum*), mullein (*Verbascum thapsus*), common curly dock (*Rumex crispus*), white avens (*Geum canadense*), stinging nettle (*Urtica dioica*), poison ivy (*Toxicodendrom rydbergii*), goldenrod (*Solidago* spp.), white and yellow sweetclover (*Melilotus alba* and *M. officianalis*), black medic (*Medicago lupulina*), marsh-elder (*Iva annua*), musk thistle (*Carduus nutans*), and showy milkweed (*Asclepias speciosa*).

Woodland Representative Wildlife Species

Common mammals occurring in woodland communities include white-tailed deer, raccoon, Virginia opossum (*Didelphis virginiana*), fox squirrel (*Sciurus niger*), eastern mole (*Scalopus aquaticus*), masked and northern short-tailed shrew (*Sorex cinereus* and *Blarina brevicauda*), striped skunk, and several species of mice. Many bird species also use these woodland habitats. Common birds include gray catbird (*Dumetella carolinensis*), orchard oriole (*Icterus spurius*), warbling vireo (*Vireo gilvus*), black-capped chickadee (*Poecile atricapillus*), American robin (*Turdus migratorius*), Swainson’s thrush (*Catharus ustulatus*), and hairy and downy woodpeckers (*Picoides villosus* and *P. pubescens*).

Shrublands

Shrublands are common on islands in the Platte River and along shorelines immediately adjacent to the river.

Shrublands Representative Plant Species

These shrublands are dominated by either sandbar willow or rough-leaf dogwood. Sandbar willow most often occupies newly exposed or recently deposited sand sites and forms fairly dense stands with little or no understory. Rough-leaf dogwood shrublands occur adjacent to, or intermixed with, woodlands and forests on drier sites. False indigo, black willow, peach-leaf willow, and American elm (*Ulmus americana*) can also be a component of the shrublands along the Platte River. Typically, these shrublands are characterized by a high density of tall and short shrubs. Saplings and small green ash, eastern cottonwood, and red mulberry trees are often a small, but conspicuous component of the canopy or subcanopy layer. Kentucky bluegrass is the most common understory herbaceous species.

Shrubland Representative Wildlife Species

Shrublands and woodlands share many species in common in Central Platte River riparian areas. Common mammals include white-tailed deer, raccoon, Virginia opossum, muskrat (*Ondatra zibethicus*), eastern mole, and masked and northern short-tailed shrews. Beaver (*Castor canadensis*) also use shrublands for bank dens and foraging. Common birds include gray catbird, American goldfinch (*Carduelis tristis*), brown thrasher (*Toxostoma rufum*), grasshopper sparrow, yellow warbler (*Dendroica petechia*), and willow flycatcher (*Empidonax traillii*).

Emergent Wetlands

Emergent wetlands occur throughout the study area in low areas and depressions adjacent to rivers and creeks or on seeps and springs.

Emergent Wetlands Representative Plant Species

Emergent wetlands range from saturated soils that support prairie cordgrass and three-square bulrush to inundated sites dominated by cattail. Other species in these emergent wetlands include reed canarygrass, foxtail barley (*Hordeum jubatum*), redtop, Kentucky bluegrass, intermediate wheatgrass (*Agropyron intermedium*), Arctic rush (*Juncus balticus*), spikerush, showy milkweed, western ragweed (*Ambrosia artemisifolia*), field horsetail (*Equisetum arvense*), sedges, curly dock, giant ragweed (*Ambrosia trifida*), and smooth brome.

Emergent Wetland Representative Species

Emergent wetland habitats are used by many birds, including yellow-headed blackbirds (*Xanthocephalus xanthocephalus*), red-winged blackbirds, green heron, great blue heron, great egret, snowy egret, American bittern (*Botaurus lentiginosus*), sora rail (*Porzana carolina*), and assorted sandpipers. Dabbling surface feeding ducks forage in these areas, and emergent wetlands are also used by sandhill cranes during migration.

Herbaceous Riparian Wetlands

Herbaceous riparian wetlands occur adjacent to the river and on vegetated islands. These areas are dominated by wetland grasses and forbs, which are present in very dense stands.

Herbaceous Representative Plant Species

Typically associated with these habitats are common reedgrass (*Phragmites australis*), reed-canarygrass, smooth brome, three-square bulrush, smooth horsetail, wild licorice (*Glycyrrhiza lepidota*), cocklebur (*Xanthium strumarium*), yellow- and white-sweetclover, and sandbar willow.

Herbaceous Riparian Wetland Wildlife Use

Many birds use riparian wetland habitats including American goldfinch, Baltimore oriole (*Icterus galbula*), orchard oriole, yellow-rumped warbler (*Dendroica coronata*), yellow warbler, American robin, brown thrasher, gray catbird, yellow-breasted chat (*Icteria virens*), eastern and western kingbirds (*Tyrannus tyrannus* and *T. verticalis*), red-headed woodpecker (*Melanerpes erythrocephalus*), hairy and downy woodpecker, belted kingfisher, eastern screech owl (*Otus asio*), green heron, great blue heron, great and snowy egret (*Ardea alba* and *Egretta thula*), American woodcock (*Scolopax minor*), and turkey (*Meleagris gallopavo*). Mammals include raccoon, Virginia opossum, white-tailed deer, striped skunk, beaver, coyote, red fox, fox squirrel, mice, and voles.

Open Water (Sloughs, Pits, Ponded Water)

Open Water Classification

The "open water" classification inside the flood plain includes open water sloughs and backwaters on the first terrace within the flood plain. These areas are generally water-filled channel scars, cut-off oxbow bends, or abandoned channel segments.

Open Water Wildlife Use

Many birds use these open water habitats including assorted waterfowl during migration, merganser, wood duck, teal, and pintail. Around ponds, common birds include belted kingfisher (*Ceryle alcyon*), great blue heron (*Ardea herodias*), green heron (*Butorides virescens*), and egrets, with cliff swallows (*Petrochelidon pyrrhonota*) using the ponds for foraging. Bald eagles, osprey (*Pandion haliaetus*), and American white pelican (*Pelecanus erythrorhynchos*) use larger lakes for foraging. Mammals that use open water habitats for a water source include raccoons and white-tailed and mule deer. Muskrats, beaver, and mink (*Mustela vison*) also use ponds and other open water habitats.

Sand and Gravel Operations

Sand and Gravel Location and Classification

Sand and gravel mines are usually located within the flood plain, on large islands and first terraces, and include the active area for equipment operation and piled material. These areas are usually represented by newly disturbed areas and areas undergoing recovery following sand and gravel extraction. This classification includes both active and inactive sand and gravel operations.

Sand and Gravel Representative Species

Open water associated with sand and gravel operations is used by double crested cormorants, bald eagles, assorted waterfowl, and killdeer (*Charadrius vociferus*). Mammals in these habitats include muskrat, beaver, raccoon, domestic feral cat, and domestic dog.

Vegetation Communities Within the Channel

Bare Sand

These areas are located within the active channel as islands and point bars.

Bare Sand Plant Species

Vegetation on these bare sand areas has less than 30-percent cover and can include many wetland grass and forb species, as well as seedling willows and cottonwoods.

Bare Sand Representative Wildlife Species

Bare sand within the channel is essential nesting habitat for both the interior least tern and piping plover. Other birds using bare sand habitats include foraging spotted sandpipers (*Actitis macularia*), killdeer, and cliff swallows (dabbing water and sunning). During migration, flocks of white-rumped (*Calidris fuscicollis*), Baird's (C.. *bairdii*), least (C.. *minutilla*), and semipalmated (C.. *pusilla*) sandpipers use bare sand habitats. Although mammals that cross the river are often found on bare sand, no mammals are known to consistently use bare sand as permanent habitat.

Shrubbed and Wooded Islands

Shrubbed and wooded vegetation communities occur on islands within the channel. These communities are similar to those described for woodland and shrubland communities within the flood plain.

Vegetation Communities Outside the Flood Plain

Agricultural Lands

Almost 60 percent of the land within the land action area is irrigated agricultural land. Much of the irrigated agricultural land in the land action area would be classified as prime farmland by the Natural Resources Conservation Service. Prime farmlands are lands that have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. The land must also be available for these uses. Prime farmland has the soil quality, growing season, and moisture supply needed to economically produce sustaining high yields of crops when treated and managed, including water management, according to acceptable farming methods. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding (USDA Handbook No. 18, October 1993).

The Program has potential to temporarily or permanently convert irrigated agricultural lands that may be prime farmland to lowland grasslands and/or wet meadows through habitat restoration activities in the Central Platte Habitat Area. In addition, the Program contemplates an off-channel reservoir near the Central Platte River that may inundate some farmlands.

Agricultural Crops

The majority of agricultural lands are irrigated row crops, including corn (*Zea mays*) and soy beans (*Glycine max*). Smaller acreages in the agricultural lands classification are used to irrigate alfalfa (*Medicago sativa*) and non-native grasses for hay and dry-farmed winter wheat (*Triticum aestivum*).

Agricultural Lands Wildlife Use

Whooping cranes, sandhill cranes, Canada geese, and snow geese use agricultural fields for foraging during migrational stopovers. Other birds using these areas include wintering horned-larks and ring-neck pheasant, with most usage occurring after harvest of corn. Raccoons, white-tailed deer, striped skunks, a variety of mice, and voles also use agricultural fields during the growing season as cover and shelter, and after harvest as forage, although raccoons consume corn ears near harvest time.

Upland Grasslands

Upland grasslands occupy the highest terraces along the Platte River and account for less than 10 percent of the study area. These grasslands are a combination of mixed-grass prairie growing on loess soils and tall-grass prairie growing on sandy ridges and sandhills.

Upland Grasslands Plant Species

Grasses in these communities include western wheatgrass and buffalograss (*Buchloë dactyloides*) in swales and shallow depressions, and blue grama (*Bouteloua gracilis*), needle-and-thread grass (*Stipa* *comata*), little bluestem, threadleaf sedge (*Carex filifolia*), and sand dropseed (*Sporobolus* spp.) on drier sites. Sandy ridges and hills are dominated by sand bluestem (*Andropogon hallii*), prairie sandreed grass (*Calamovilfa longifolia*), sandhills muhly (*Muhlenbergia pungens*), sand dropseed, purple threeawn (*Aristida purpurea*), blowout grass (*Redfieldia flexuosa*), and Indian ricegrass (*Oryzopsis micrantha*). A few scattered shrubs are often present in upland grasslands including soapweed yucca (*Yucca glauca*), wild buckwheat (*Eriogonum* spp.), prickly-pear cactus (*Opuntia* spp.), and sand sagebrush (*Artemisia filifolia*).

Upland Grasslands Wildlife Use

Common bird species using these upland grasslands include western and eastern meadowlarks, horned larks (*Eremophila alpestris*), foraging red-tail hawks (*Buteo jamaicensis*), great horned owls (*Bubo virginianus*), harriers (*Circus cyaneus*), and other raptors. Mammals include white-tailed deer, eastern cotton-tail, black-tail jackrabbit (*Lepus californicus*), thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*), coyote, red fox, mice, and voles.

Open Water (Ponds, Lakes, and Other)

Open Water Habitats

Open water habitats outside the flood plain include excavated or dammed water storage structures that provide livestock water, fisheries habitat, and recreation. Many of these structures are old gravel pits. Fringes of these open water habitats often have emergent vegetation similar to those described for emergent wetland and herbaceous riparian communities as described below

Open Water Wildlife Use

Open water within the flood plain has similar wildlife use as described in the "Open Water Wildlife Use" section in the previous section.

Woodlands

Naturally occurring upland woodlands are rare in the study area.

Woodland Plant Species

These woodlands are dominated by eastern red cedar, which are present in scattered stands with some dense pockets of trees. These stands occupy low hills, ridges, and the margins of ephemeral drainages or draws, and they are typically distributed on north-facing aspects. Included in the upland woodlands are stands of trees planted as shade trees or windbreaks around farmsteads and within agricultural fields. These stands often include eastern cottonwood (*Populus deltoides*), boxelder (*Acer negundo*), and green ash, but may also have introduced species including Russian-olive, Siberian elm (*Ulmus pumila*), Lombardy popular (*Populus lombardii*), ponderosa pine (*Pinus ponderosa*), blue spruce (*Picea pungens*), weeping willow (*Salix babylonica*), apple (*Malus* spp.), cherry (*Prunus* spp.), and honey locust and black locust (*Gleditsia triacanthos* and *Robinia pseudoacacia*).

Woodland Wildlife Use

The wildlife use for woodlands outside the flood plain are similar to those described for woodlands inside the flood plain.

Invasive Plant Species

Purple Loosestrife

Purple loosestrife (*Lythrum salicaria*) is an herbaceous perennial of Eurasian origin. It became established in the estuaries of northeastern North America by the early 1800s. By the late 1800s, it had spread throughout the northeastern United States and southeastern Canada. Purple loosestrife is an aggressive invasive species and can be found scattered across Nebraska in marshes, along rivers, ditches, and wet meadows. The largest infestations are along the Platte River in central Nebraska and along the Missouri River above Gavins Point Dam. Other infestations can be found along the Niobrara River and in ornamental settings. It is extremely difficult to control, and concentrated efforts are necessary to keep it from spreading (NRCS [Plants], 2005). Purple loosestrife is listed as a noxious weed in Nebraska (Nebraska Department of Agriculture, 2005).

Tamarisk

Saltcedar (*Taramix ramosissima*), also known as tamarisk, is an invasive weed introduced from Eurasia and found in Nebraska's wetland habitats in all soil types. It is a perennial deciduous or evergreen shrub or small tree from the tamarisk family that reproduces both by seeds and perennial structures such as taproot and stem. As of January 1, 2005, salt cedar is on Nebraska's noxious plant list (Nebraska Department of Agriculture, 2005).

WETLANDS

INTRODUCTION

This section describes the methods of analysis and the current extent and character of wetlands in the Central Platte Habitat Area, where river channel and land restoration activities will be undertaken by the Program. Potential impacts to wetlands are described in chapter 5.

INDICATORS

The U.S. Army Corps of Engineers (Corps, 1987) guidelines require examination of wetland characteristics of habitats under consideration for modification or restoration. The GIS Land Cover/Land Use database was analyzed based on the Cowardin Deepwater Habitats Classification (Cowardin et al., 1979) as well as the presence of other wetland determinants–hydrophytic vegetation, hydric soils, and hydrology sufficient to support hydrophytic vegetation and soils.

Impacts to wetlands will be measured by:

- ➢ Increase or decrease in acres of wetlands

METHODS

The programmatic wetland analysis for this FEIS uses the Level 1 Routine Wetland Determination method (onsite inspection unnecessary), which uses the extensive remote sensing and other information developed in support of this FEIS. Based on Corps guidelines (Corps, 1987), the Level 1 Routine Wetland Determination method may be employed when the information already obtained is sufficient for making a wetland determination for the study area. This approach is appropriate for a programmatic analysis of likely consequences to wetlands, where the specific location of habitat restoration activities cannot be known until Program implementation begins and individual landowners offer lands for sale or lease. As discussed in the "Wetlands," section in chapter 5 more detailed field studies will be undertaken when specific Program lands are acquired. Habitat restoration actions that involve dredge and/or fill activities in wetland areas will be subject to permitting through Section 404 of the Clean Water Act.

Hydrophytic Vegetation

In order to determine the presence of hydrophytic vegetation, wetland plant communities are examined for dominant species. The following sources were used to investigate the presence of hydrophytic vegetation in the Central Platte River valley vegetation communities:

- ➢ **GIS Land Cover/Land Use Database**. Accuracy assessment field data (Friesen et al., 2000)
- ➢ **Vegetation Community Classification.** Community classification field data (Butler, 2001)
- ➢ **National Wetland Inventory (NWI) Digital Maps** (Service, 1987 [Wetlands]).

NWI mapping for the study area was considered for this analysis. However, NWI mapping was conducted between May and September 1981, using 1:58,000 scale infrared photography. The GIS Land Cover/Land Use digital database was developed from 1998 using 1:12,000 infrared aerial photography. In addition, field data was collected on dominant plant species in the Central Platte River valley in 1999 in support of the accuracy assessment and vegetation community classification for the GIS land cover/land use database. Since the GIS land cover/land use database is at a larger scale and more detailed than NWI mapping, the GIS land cover/land use database and community classification (Butler, 2001) were used in this analysis of wetland community types.

Hydric Soils

The Soil Survey Geographic Database (SSURGO) (NRCS, 2005) was used to determine the types of soils present in vegetation communities in the Central Platte River Basin. Soil surveys in the SSURGO database (NRCS, 2005) for the study area include a digital map layer delineating "hydric soils," "partially hydric soils," "not hydric," and "unknown soils." Dates of soils surveys for the counties included in the study area. The digital information also includes the soil map unit name, as well as flooding and drainage characteristics within each of these classifications. The digital soils layer was overlayed on the GIS Land Cover/Land Use digital maps, and acreages of each soil map unit within each vegetation community type were calculated.

Wetland Hydrology

To determine the hydrology supporting vegetation community types in the Central Platte River Basin, the wetland analysis used:

- **CPR Model**: This model was used to simulate flows for Present Condition and the proposed alternatives.
- **Sed/Veg Sediment Transport and Vegetation Model (SEDVEG Gen3):** This model was used to determine in-channel island inundation, duration, and average depth to groundwater for island vegetation communities.
- **Qualitative hydrologic information available for the study area:** Qualitative hydrologic information was used to determine wetland hydrology outside the active channel, focusing on such factors as subirrigation, surface water contributions, and depth to groundwater.

Cowardin Wetland Classification

Using the information above, each undeveloped vegetation cover type in the GIS land cover/land use database was classified using the Cowardin Wetland and Deepwater Habitat Classification system as in sidebar 4-WT-1.

Sidebar 4-WT-1.—Cowardin Wetland and Deepwater Habitat Classification System, Wetland Classifications

Riverine: The riverine system includes all wetlands and deepwater habitats contained within a channel, with two exceptions:

(1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens
(2) habitats with water containing ocean-derived salts in excess of 0.5 percent

A channel is "an open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of standing water" (Cowardin et al., 1979).

Upper Perennial: The gradient is high and the velocity of the water fast. There is no tidal influence and some water flows throughout the year. The substrate consists of rock, cobbles, or gravel with occasional patches of sand. The natural DO concentration is normally near saturation. The fauna is characteristic of running water, and there are few or no planktonic forms.

Palustrine: The palustrine system includes all nontidal wetlands dominated by trees, shrubs, or persistent emergents:

- **Emergent:** Characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens, and vegetation is present for most of the growing season in most years.
  - **Persistent:** Dominated by species that normally remain standing at least until the beginning of the next growing season.
  - **Nonpersistent:** Dominated by plants which fall to the surface of the substrate or below the surface of the water at the end of the growing season so that, at certain seasons of the year, there is no obvious sign of emergent vegetation.
- **Scrub-Shrub:** Dominated by woody vegetation less than 6 feet tall. The species that dominate these areas include true shrubs, young trees, and trees or shrubs that are small or stunted due to environmental conditions.
  - **Broad-Leaved Deciduous:** Dominated by alders, willows, and red osier dogwood.
- **Forested:** Dominated by woody vegetation that is 20 feet tall or taller.
  - **Broad-Leaved Deciduous:** Common dominants in forested wetlands in the southern and eastern U.S. include red maple, American elm, ashes, black gum, tupelo gum, swamp white oak, overcup oak, and basket oak. Wetlands in this subclass generally occur on mineral soils or highly decomposed organic soils.
- **Open Water:** Characterized by surface water of less than 6 feet in depth for a portion of the growing season.

Based on Cowardin et al., 1979.

Methods Used to Assess Potential Impacts to Wetlands

- **GIS Land Plans:** Illustrative land plans were developed using the GIS Land Cover/Land Use mapping to estimate potential land restoration activities and potential impacts to wetlands in the study area. Since it cannot be determined what lands will be available and acquired, these land plans are for analysis purposes only and are not intended to represent actual land parcels that will be acquired. Habitat restoration activities are evaluated based on conversion of land cover types (i.e., wetted channel to bare sand).

PRESENT CONDITION

Table 4-WT-1 shows the results of the hyrophytic vegetation, wetland soils, and wetland hydrology analyses. In addition, this summary includes the Cowardin classification and codes of the GIS database categories in the study area that could be affected by habitat restoration activities.

Table 4-WT-1.— Central Platte River Study Area Summary of Land Cover/Land Use Classifications, Cowardin Classifications, and Wetland Determination Criteria

Land Cover Classifications	Cowardin Classifications	Cowardin Code	Hydric Vegetation	Hydric Soils	Wetland Hydrology	Acreage*	Percent
Inside Flood Plain							
Emergent wetlands	Palustrine, emergent, persistent	PEM	Yes	No	Yes	131	
Herbaceous riparian	Palustrine, emergent, persistent	PEM	Yes	Yes	Yes	2,253	
Lowland grasslands	Palustrine, emergent, persistent	PEM	Yes	No	Yes	18,605	
Open water	Palustrine, open water	POW	Yes	Yes	Yes	1,526	
Shrublands	Palustrine, scrub-shrub, broad-leaved deciduous	PSS				2,048	**53 percent**
	Higher islands		Yes	Yes	No		
	Lower islands		Yes	Yes	Yes		
Woodlands	Palustrine, forested, broad-leaved deciduous	PFO	No	Yes	No	16,708	
Totals						**41,271**	
Inside Channel							
Bare sand	Palustrine, emergent, persistent/non-persistent	PEM	Yes	Yes	Yes	665	
Emergent wetlands	Palustrine, emergent, persistent	PEM	Yes	No	Yes	182	
Herbaceous riparian	Palustrine, emergent, persistent	PEM	Yes	Yes	Yes	1,275	

Land Cover Classifications	Cowardin Classifications	Cowardin Code	Hydric Vegetation	Hydric Soils	Wetland Hydrology	Acreage*	Percent
Lowland grasslands	Palustrine, emergent, persistent	PEM	Yes	No	Yes	10,497	**47 percent**
Shrublands	Palustrine, scrub-shrub, broad-leaved deciduous	PSS				3,210	
	Higher islands		Yes	Yes	No		
	Lower islands		Yes	Yes	Yes		
Wetted channel	Riverine, upper perennial, unconsolidated bottom	R3UB	No	Yes	Yes	9,967	
Woodlands	Palustrine, forested, broad-leaved deciduous	PFO	Yes	Yes	No	10,326	
Totals						**36,122**	
Grand Total						**77,393**	**100 percent**
*Vegetation acreages within the channel and within the flood plain are generally flow-dependent. Acreages of each land cover/land use class are based on 1998 aerial photography (Friesen et al., 2000) when flows in the study area ranged from 325 to 1030 cfs.							

WHOOPING CRANES

INTRODUCTION

This section describes whooping crane habitat resources along the Platte River, including the river area and bottomland formally designated under the ESA as critical habitat that may be affected by the action alternatives. It also describes the Present Condition of the biological resources that occur under the existing water operations and management of lands along the river.

Platte River above Lexington, Nebraska, Including the North and South Platte Rivers

The migrational path of the Aransas-Wood Buffalo whooping crane population crosses the Basin in central and western Nebraska and eastern Colorado (see *Target Species Appendix* in volume 3). The distribution of crane sightings indicates that some whooping cranes also cross the North Platte River Basin in eastern Wyoming (Austin and Richert, 2001).

Along the Platte River, whooping crane observations have been confirmed as far west as Mitchell, Nebraska, near the Wyoming border on the North Platte River; in rare instances in the South Platte River Basin of Colorado and as far east as Chapman, Nebraska, on the Central Platte River. The east-west distance spans more than 400 miles.

The primary migrational pathway of the Aransas-Wood Buffalo population overlies a reach of the Platte River that is approximately 140 miles long, stretching from near North Platte, Nebraska, to near Grand Island, Nebraska. Records from the early 20th century indicate whooping crane stopovers formerly occurred throughout this range, with sightings most frequent at the middle of the range, near Odessa (Lingle, 1987). Allen (1952), Black (1934), Kennedy (1934), and Swenk (1933) describe historic whooping crane sightings occurring near Lewellen, Ogallala, and North Platte on the North Platte River; from Gothenburg; "Ranch 96" near Gothenburg; between Cozad and Brady Island; Brady Island in Lincoln County; between Brady and Maxwell; and between Darr and Lexington on the Platte River.

Though whooping crane migrations through the western range (i.e., generally west of Lexington, Nebraska) are less common, the infrequent sightings in the upper Platte region since the mid 1900s are likely due, in large part, to deteriorated river habitats provided by the narrow anabranched channels on the North Platte River, South Platte River, and Platte River upstream of Overton, Nebraska.

Under the Present Condition, the widest river channels above Lexington are only a few hundred feet wide and are generally unsuitable as whooping crane habitat. "History of Habitat Use and Habitat Trends for Target Species" in chapter 2 describes the transformation of the Platte River characteristics during the early to mid-1900s. The development of dense woodlands within the former river channel has been most pronounced in the upper reaches of the Platte River system, extending from lower portions of the North Platte and South Platte rivers, downstream on the Platte River through much of the Central Platte Habitat Area.

During 1975-2005, only 7 of 122 confirmed whooping crane sightings on or along the Platte River mainstem (including the North and South Platte Rivers) have occurred upstream of Lexington, Nebraska (Service, 2005 [wc sightings]).

- No use of the river channel or valley has been documented in the 50-mile river reach between Lexington and the city of North Platte.
- Five sightings (two confirmed uses of the river channel) occurred along the North and South Platte Rivers between the cities of North Platte and Ogallala.
- Two sightings occurred along the North Platte River above Ogallala (one at the inflow to Lake McConaughy and another near Oshkosh).

Under the Present Condition, whooping cranes may stop over in the Upper Platte River reaches but would likely continue to be relatively infrequent visitors. Therefore, this area of whooping crane habitat is not evaluated further in this FEIS.

Central Platte River (Lexington to Chapman, Nebraska)

The Central Platte River, a 90-mile reach, contains a 54-mile reach designated as critical habitat for the whooping crane. Out of 122 sightings, 115 were in the Central Platte River. This is the Central Platte Habitat Area where all the habitat recovery activities will occur under any of the action alternatives. Therefore, the analysis in this FEIS is focused solely on this 90-mile reach.

INDICATORS AND METHOD

In this analysis, three primary elements of whooping crane habitat are evaluated:

- **Channel roost habitat:** The river channel is primarily used by whooping cranes for roosting at night, as well as some loafing during the day. The roosting habitat of the river channel is considered to be the primary attraction for migrating whooping cranes. Shallow water to stand in, with wide open views and expanse of water, provide the birds secure resting and roosting habitat.
- **Out-of-channel habitat:** These cropland and wet meadows near the river channel habitats, often within 1 to 2 miles of roosts, are used for feeding and loafing during the day. They provide food items (e.g., frogs, small fish, snails, earthworms, beetles, plant tubers, and small grains) and water for the physiological and nutritional needs of the species.
- **Security and protection from disturbance:** Protection of both channel and out-of-channel habitats from disturbance and human intrusion**.** Generally, whooping cranes in migration are secretive and highly sensitive to disturbances from perceived threats, such as humans, predators, dogs, and vehicles. A human on foot can quickly put a whooping crane to flight at distances over one-quarter mile.

These three elements are also designated as constituent elements of critical habitat for the species and are important to the physiological, behavioral, ecological, and evolutionary requirements of the species conservation and recovery. These three factors were evaluated for both the quantity and quality of conditions at the end of the Program's First Increment.

During the Program and over the long term, the Platte River's ability to sustain wide channel and subirrigated grasslands habitat for whooping cranes depends on an adequate sediment supply and channel-forming processes (see chapter 2, "History of Habitat Use and Habitat Trends for the Target Species" and "River Geomorphology" in chapter 4). Therefore, a primary consideration for both the channel roosting habitat and wet meadow habitat evaluations is how well the processes that have contributed to ongoing degradation of river habitats are avoided and reversed. The long-term sustainability of channel and riparian meadow habitats for the Present Condition and for the action alternatives was evaluated using the SEDVEG Gen3 model (Murphy et al., 2004) and hydrological data for channel forming peak flow events.

PRESENT CONDITION

Channel Roost Habitat

Whooping cranes seen at stopover locations in migration are usually found at or within short flight distances of lakes, palustrine wetlands, or large rivers. The cranes use submerged sandbars in rivers and the shallows of lakes and palustrine wetlands for nightly roosting. Use of these areas for roosting appears to be one of the major factors in habitat selection of stopover sites by migrating cranes. For this reason, roost habitat was selected as a necessary and focal element for analyzing the migrational habitat value of the Platte River.

Three separate but complementary procedures were used to evaluate the effects of the action alternatives on whooping crane roost habitat:

- **Wide channel availability:** Because most whooping crane observations on the Platte River occur in wide channels with open views, the first procedure simply estimates the amount and the distribution of wide channels within the affected area. Changes in open channel area that would result from the action alternatives, due to tree clearing and island leveling on project lands, were similarly evaluated.

- **Wide channel characteristics:** The second procedure assesses the availability of open channel and aquatic characteristics within the channel using a hydraulic model, Physical Habitat Simulation Methodology (PHABSIM).

- **Wide channel sustainability:** The third procedure evaluates the effects that the water and land management have on river system geomorphologic processes that sustain open channel habitat. This determines the likelihood that the Program activities contribute to the long-term goal of avoiding habitat degradation and simultaneously achieving habitat recovery.

The three evaluation procedures are described in more detail below.

Distribution of channel habitat is important to the functional value of the Platte River habitat. Whooping cranes cross the Platte River throughout a wide migration corridor and, based on presently available information, crane biologists generally believe that to best serve as stopover habitat, open channel areas must be distributed within a few miles of their flight path across the river (Service, 1990 [biology work group] and Lutey, 2002). Conversely, reduced distribution of habitat over significant portions of the cross-over river reach would diminish their stopover opportunities.

Wide Channel Availability

The extent and locations of wide river channels were evaluated using a GIS from 1998. The Platte River study area was divided into short segments separated by bridge crossings. In this report, these are termed "bridge segments." There are 13 such bridge segments in the study area—the 6-mile river reach between the Alda Bridge and Highway 281 bridge near Grand Island is one example (see "Geographic Markers" in chapter 4).

A statistical routine was developed to compute the amount of open channel, which ranges from 170 feet wide (the narrowest channel where whooping crane roosting has been observed) to channels greater than 1,000 feet wide. Greatest emphasis was placed on channel areas greater than 500 feet wide because the information currently available indicates that most recorded crane uses have occurred in these areas (see the *Target Species Appendix*), and the limited information available from the Cooperative Agreement monitoring protocol indicates that crane using the Platte River select these wide channels in disproportion to their limited availability (WEST Inc., 2005). By contrast, few crane observations have occurred in narrower channels even though narrower channels are far more abundant.

The Present Condition was compared to the channel management contemplated in each action alternative. The GIS land cover/land use database (Friesen et al., 2000) was used to estimate the area of wide channels that would result from each action alternative, due to mechanical tree clearing and/or island leveling. The change in the amount of wide channels from the Present Condition was computed for each segment of river between bridges in the Central Platte Habitat Area.

Under the Present Condition (i.e., the 1998 GIS), roughly 3,020 acres of open channel greater than 500 feet wide exist. The wide channels are primarily distributed in GIS river segments 1 to 7, in a 40-mile segment of the 90-mile long study reach downstream of Fort Kearney. (Likewise, about 85 percent of recent crane sightings in the study area have occurred within these river reaches.) Figure 4-WC-1 shows the spatial distribution of wide channels that existed in 1998 in the 13 bridge segments.

Channel widths fluctuate to some degree, based on predominating channel forming flows. Under the present variable flows, segments of the river predominated by narrow channels seem to have stabilized (Johnson, 1994). These river segments, however, have little or no recorded whooping crane use (WEST, Inc., 2004 and Service, 2005 [wc sighting]) and are believed to have no (or severely limited) habitat value. Wider channels that remain in the downstream sections of the Central Platte Habitat Area have continued to contract during episodes of low flows (Johnson, 1997; Currier, 1995; and Murphy et al., 2004).

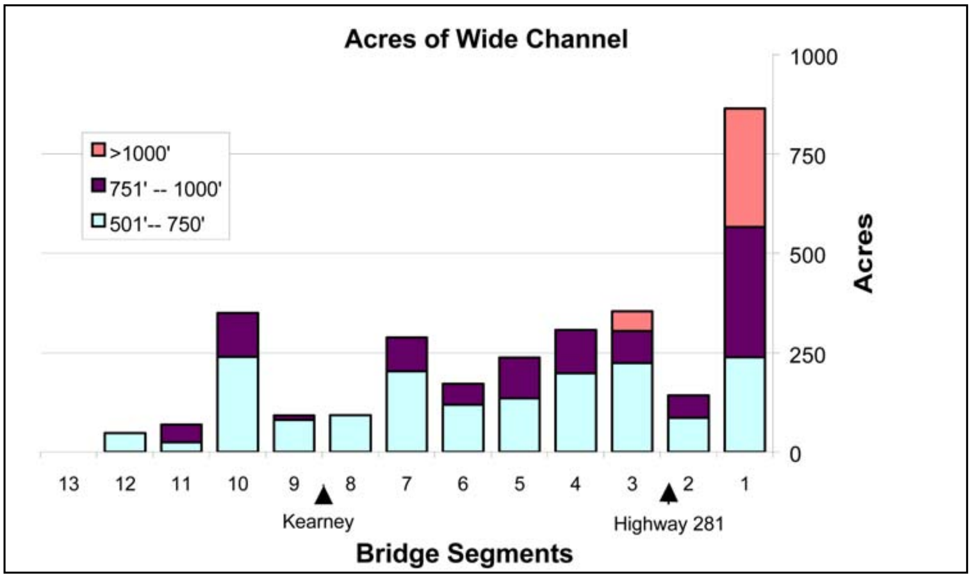


Figure 4-WC-1.—Distribution of wide channels in the Central Platte River Habitat Area under the Present Condition. The GIS bridge segments are displayed from right to left, or west to east.

Wide Channel Characteristics

The combined effect of the channel widening and aquatic habitat characteristics within the channel were evaluated using the concepts and principles of PHABSIM.[12]

PHABSIM consists of detailed measurements of channel geometry and hydraulics that have been surveyed throughout the 90-mile-long study area. These field surveys enable simulation of river channel characteristics at a range of riverflows.

Even as detailed understanding of the whooping crane habitat needs continues to be investigated, the information gathered at stopover sites over several decades has led crane experts to identify general characteristics for habitat management. Essential characteristics for Platte River habitat are described by whooping crane authorities (Service, 1987 [crane expert responses] and [crane workshop] and Lutey, 2002):

- Wide channel with open views and an expanse of water
- Shallow areas for cranes to stand
- No disturbance features in the surrounding area

For comparative evaluation of alternatives, this PHABSIM analysis focuses on the changes in three channel variables:

[12]The hydraulic model (Reclamation, 1987) for the Platte River Management Joint Study for analyzing various Platte River habitat relationships, and it is based on the concepts and principles of PHABSIM (Bovee, 1984).

- Amount of wetted area occurring in channels greater than 500 feet wide
- Wide channel area having a minimum shallow width of 100 feet
- Wide channels having an absence of disturbance features (road, bridges, housing, or commercial development) within one-quarter mile

Initially, the PHABIM model views the channel geometry as having a fixed shape measured in the field. However, under the alternatives, the Program would acquire properties along the river to manage as crane habitat. At specific locations, multiple, narrow, anabranched channels would be converted to single, wide, open channels that are more suitable for crane use. In these cases, the model must be modified to mathematically simulate the wide channels that would be produced instead of the narrow channels originally surveyed. To simulate future channel modifications, a length of wide channel was substituted, mathematically, in place of the habitat/flow function of poorer habitat (narrow channel).

The second step of this process incorporated the flow scenarios of the alternatives with the channel configuration. In this way, the CPR model hydrologic data are used to produce a 48-year series of channel characteristics for each of four hydrologic segments in the study area for each action alternative.

Figures 4-WC-2 and 4-WC-3 show the combination of wetted area and the channel area having a minimum of 100-foot shallow width during April, and October and November, respectively, over the 48 years of analysis. These represent channels wider than 500 feet. The corresponding average values for each month of the crane migration season are provided in table 4-WC-1.

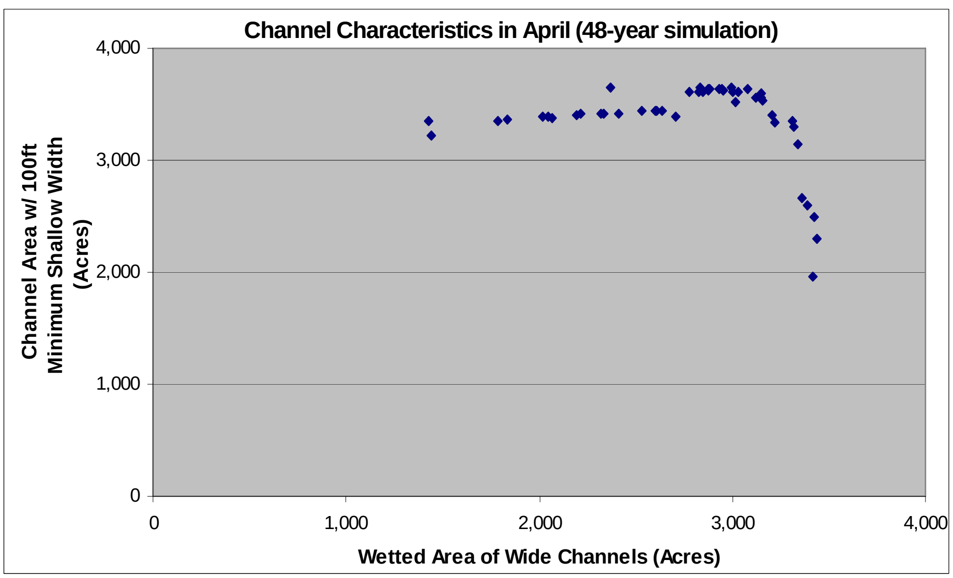


Figure 4-WC-2.—Characteristics of wide channels (>500 feet) for the Present Condition during April, a primary month of whooping crane migration.

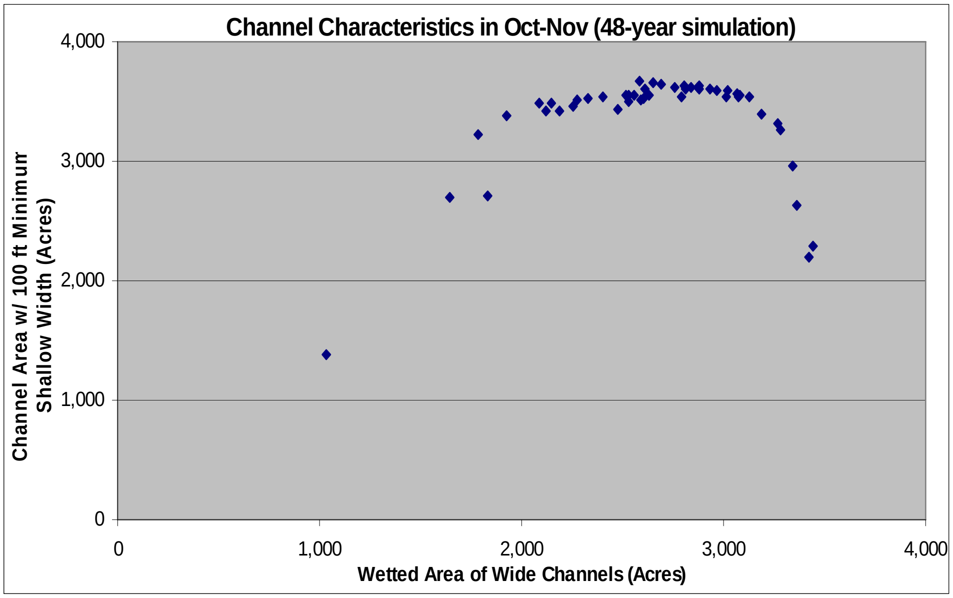


Figure 4-WC-3.—Characteristics of wide channels (>500 feet) for the Present Condition during October and November, primary months of whooping crane migration.

Table 4-WC-1.—Average Channel Characteristics (Acres) of Wide Channels (>500 feet) Under the Present Condition in the Central Platte River

Channel Variable	March	April	May	Oct	Nov
Wetted area	3,091	2,758	2,601	2,516	2,786
Channel area with 100-foot minimum shallow width	3,355	3,375	3,118	3,265	3,464

Wide Channel Sustainability

Computations of open channel from the GIS and the modeled channel habitat characteristics, above, quantify habitat in an immediate, or contemporary, sense. They do not, however, indicate future trend. So in the computations, it is assumed that the river channel geometry—in those sections not managed under the action alternatives—either does not change, or fluctuates but remains in "dynamic equilibrium." In other words, the GIS and PHABSIM computations do not account for future channel characteristics of a changing river system under either the Present Condition or the action alternatives. These trends are driven by channel forming processes of the river—primarily vegetation scouring and sand transport by periodic high flows, discussed elsewhere in this FEIS.

The inability to address channel forming processes is a critical limitation of these analytical methods used alone to predict future conditions. As described in "River Geomorphology" in chapter 4 the Platte River between Lexington and Kearney continues to undergo bed erosion, leading to reductions in channel width and deepening of the channel (decreased elevation and width-to-depth ratio) (Murphy et al., 2004). In some reaches downstream of Kearney, available field survey data from the 1980s and 1998 support the model projections of long-term channel change (i.e., bed incision and width reduction) (Murphy et al., 2004). However, additional long-term data is required to better define the complete scope of change. The loss and fragmentation of habitat that are presently occurring upstream of Kearney, and the potential future change at specific locations downstream of Kearney, pose continuing adverse impacts to habitat recovery. This factor is one of the greatest risks to conservation and recovery of Platte River whooping crane habitats.

Though the action alternatives state that Program lands should be managed to maintain wide channel habitat, Program lands under all of the alternatives constitute a very small portion of the migrational crossing in the affected habitat area, and less than 10 percent of the Central Platte Habitat Area. The effect of the alternatives on channel geomorphology in the rest of the river must also be assessed to evaluate potential overall effects of any alternative on whooping crane habitat. Continuing or accelerated channel degradation could further impair existing wide channels, as well as compromise Program channel management activities.

Vegetation scouring and sand transport are associated with peak flows (Johnson, 1994 and Murphy, et al., 2004). This analysis evaluated the influence of the Program by examining changes in the peak flow regime. The SEDVEG Gen3 model (Murphy et al., 2006) was also used as one tool for this evaluation. The model estimates the sediment supply and rate of transport at the location of transects (cross sections) in the river and the vegetation growth that responds to the channel forming factors. Using SEDVEG Gen3, ongoing trends in the width of open channel were simulated for 62 cross-channel transects spaced throughout the Central Platte Habitat Area. (For more details on this analysis, see Murphy et al., 2006). Under the Present Condition, no channels are modified by Program management.

Sand Balance

For the Present Condition, the sand load transported by the river at Lexington is estimated to be roughly 30 to 35 percent of the amount transported near Gibbon and about 40 to 50 percent of the load transported from the Habitat Recovery segment at Chapman. The deficit, or difference, within the Habitat Recovery must be made up from other sources, either inflows or erosion of the channel bed. For the Present Condition the latter is believed to be the major source (Murphy et al., 2004).

Channel Bed Elevations

Channel surveys indicates channel bed elevations in the upper habitat area are degrading (i.e., incising), owing to net removal of sand from the channel bed under present conditions (Murphy et al., 2004). Over a 15-year interval, degradation of approximately 2 feet has been measured near Overton and about one-half foot near Gibbon. Concurrently, little or no change in channel bed elevations, and no general trend, was detected at the 5 sites (24 transects) surveyed from the vicinity of the Shelton bridge, downstream.

Bed Material Particle Size

The particle size of channel bed material influences the mobility of the channel bed, important for processes of vegetation scouring and maintaining and active alluvial channel bed. Coarsening of the bed material has occurred from the 1930s to the present time (Kinzel et al., 2000). SEDVEG Gen3 indicates that bed material will continue to coarsen under the Present Condition.

Out-of-Channel Habitat

During migration, whooping cranes are observed to feed and loaf in grain fields (especially in fall) and in native pastures and wetlands near their roosts. What migrating whooping cranes eat is not well known. The species is considered omnivorous and, during migration, likely uses grains, plants, tubers, soil macroinvertebrates (e.g., earthworms, snail shells, beetles, and other insects), and vertebrates (e.g., fish, snakes, frogs, and rodents). Diet may vary by age, season, and location. The life history of whooping cranes on wintering, breeding, and migrating is closely associated with wetland habitats. Whooping cranes' foraging habits are generally considered to be more closely associated with wetlands than sandhill crane's foraging habits.

In the Platte River valley, whooping cranes probe the soil for food material in the habitat types used by, and often alongside, sandhill cranes. Probing occurs in cornfields, wet meadow and other pastured grasslands, and occasionally in the river. Sandhill cranes that stage on the Platte River derive nearly all of their energy requirements from waste corn, but spend much of their time foraging for soil invertebrates in native pastures and meadows (Reinecke and Krapu, 1986). Protein food material and nutrients that are found in meadows are not readily available from other habitats. Sparling and Krapu, 1994, concluded that, based on time spent relative to availability, grassland and haylands were preferred over other habitats. Information obtained through monitoring may modify the understanding of whooping crane feeding habits and biology.

Riparian grassland habitats support flora and fauna suitable as whooping crane food resources. In these grasslands, the measure of biodiversity[13] is generally associated with soil moisture regimes (Seibert, 1994 and Whiles and Goldowitz, 1998).

Wet meadows are particularly productive and diverse systems, subirrigated by a high groundwater level. Prey foods available in the Platte River wet meadows include snails, small fish, snakes, frogs and frog egg masses, crayfish, earthworms, beetle and beetle larvae, grasshoppers, crickets, and other insects. Many of these organisms depend on aquatic moisture regimes or seasonally moist or saturated soils for all or part of their life cycle. The cranes also forage on cereal grains in surrounding cultivated fields and on tubers and other vegetative parts of plants.

Chapter 2 discusses various impacts that have affected the quality of wet meadow habitats. Landscape variables that influence whooping crane habitat value include the size, location, juxtaposition with complementary (i.e. roosting) habitat and juxtaposition with disturbance features. Though these characteristics can potentially be mapped using GIS, a detailed GIS model for analyzing out-of-channel whooping crane habitat has not been developed at this stage.

Other qualitative factors for out-of-channel habitat are not determinable from GIS land cover/land use themes presently developed. At a local scale, soil types and ground- and surface-water hydrology, for example, would likely influence the productivity and biodiversity of wet meadow flora and fauna. On a temporal basis, annual and seasonal management practices could change habitat value; for example, the stature of tall grasses not grazed or hayed could preclude crane use.

The analysis assumed that the characteristics of existing grassland, as part of the baseline, would uniformly apply to all action alternatives, and that the lands acquired by the Program under each action alternative would contain similar physical attributes (e.g., soils, topography, proximity to channel, avoidance of disturbance). These assumptions narrowed the focus of the FEIS alternative evaluation to

[13] Diversity of organisms in the biological communities.

the differences in the size and general distribution of Program-acquired lands, and to differences in river hydrology that would potentially impact existing native wet meadows.

Extent and Location of Lowland Grasslands and Wet Meadows

Types of grasslands, their biological communities and characteristics, and their hydrologic characteristics are not distinguished in the GIS database. Therefore, in this report, lowland grasslands are only generally characterized as acreages with grassland cover of the valley bottom within 3-½ miles of the river channel—the maximum distance cranes typically move from the channel during the stopovers in the Platte River valley.

The amount of bottomland grasslands in the affected area, by bridge segment, is presented in figure 4-WC-4. The GIS river segments are displayed right to left or west to east. The total lowland grassland acreage (39,000 acres) comprises about 9 percent of the study area.

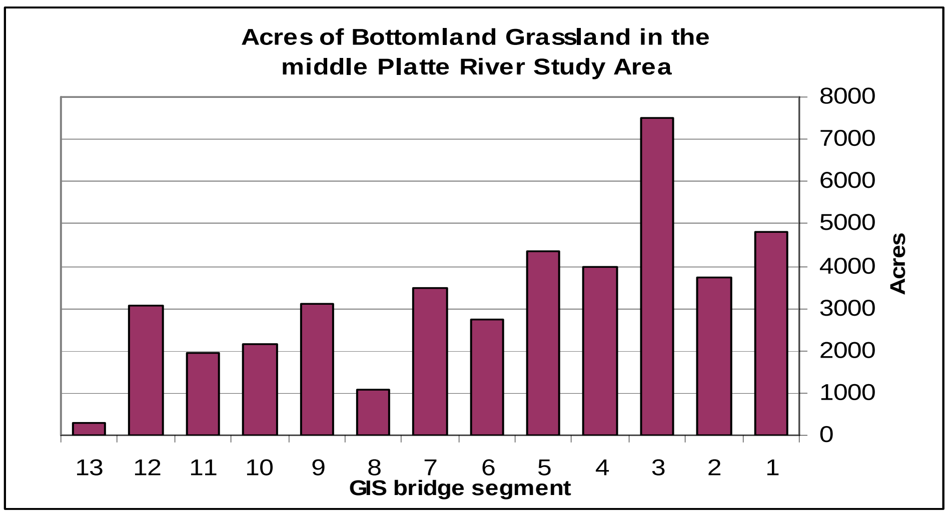


Figure 4-WC-4.—Amount (acres) and distribution of grassland along the Central Platte River bottomlands.

Wet Meadow Hydrology

Two types of riverflow effects are believed to be important influences on the maintenance and integrity of wet meadow biological communities. Each process provides differing benefits to the ecological maintenance of the riparian wetland systems.

First, episodes of surface flows are believed to contribute to wetland hydrology by providing for (re)introduction and (re)distribution of wetland organisms among wet meadow communities (Seibert 1994). Overland flows provide surface interchange in the lowest depressions for fish, snails, and amphibians. Figure 4-WC-5 is an aerial photograph of the wet meadow complex at Crane Meadows, Morman Island, Nebraska, during spring high flows (approximately 6,000 cfs, backed up by ice damming). Extensive overland flow is seen in the lower rills and channels which make up the wet

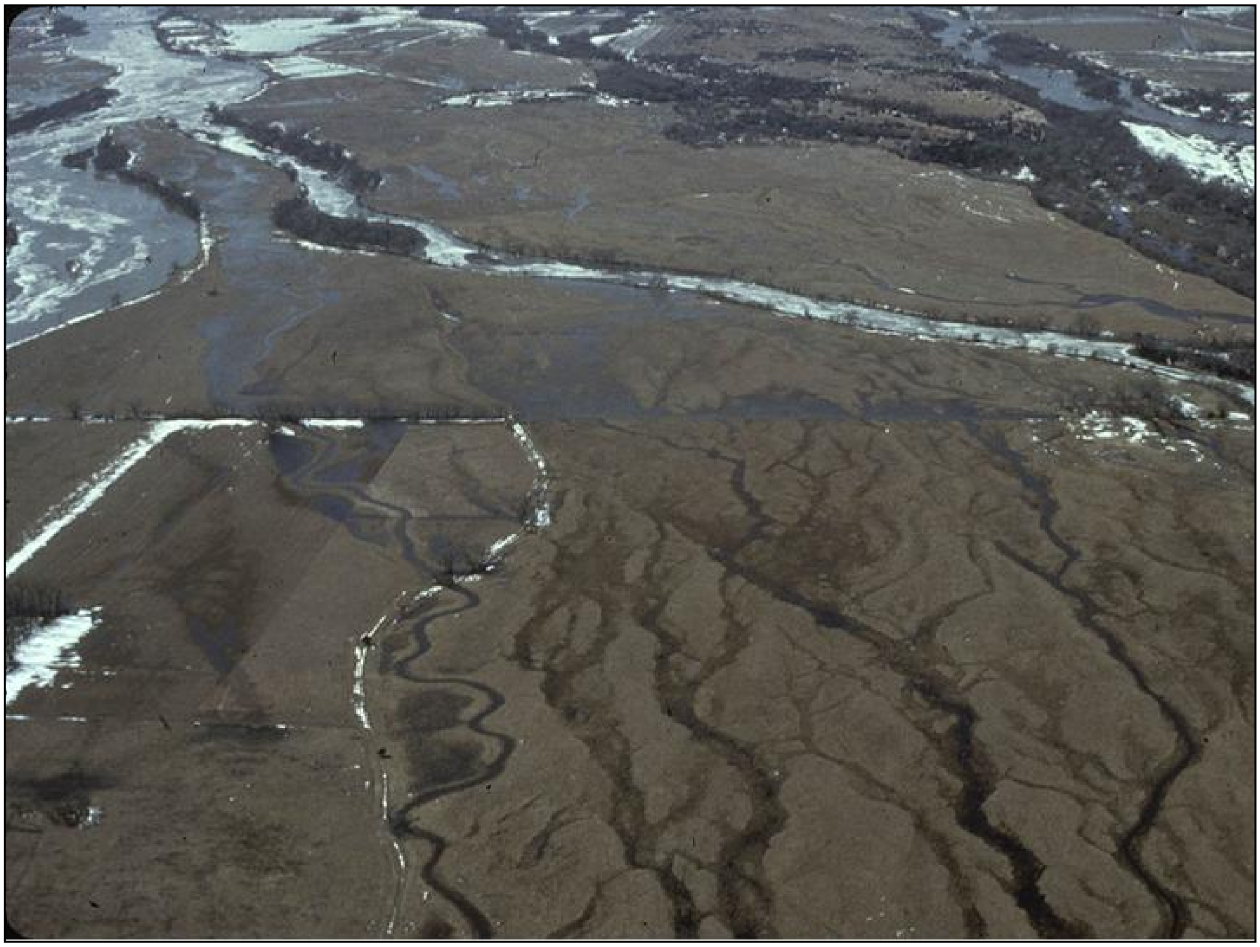


Figure 4-WC-5.—Overbank flow of the Platte River at Mormon Island Crane Meadows near Grand Island, Nebraska, during peak flow event, March 1993.

meadow complex, illustrating the interconnectedness of the river channel and adjacent meadows. The survey transect used as the basis for the wet meadow cross-section figure in chapter 2 is located within the boundaries of this photograph (though not surveyed on this particular date).

Second, groundwater hydrology is considered to be a controlling factor of riparian wetlands and wet meadow grasslands. Groundwater seeps into sloughs and swales help support aquatic habitats for fish, frogs, snails, and aquatic insects (Whiles and Goldowitz, 1998 and Whiles and Goldowitz, 2005). At transitional elevations, saturation of surface soils and subsoils for extended periods of a week to several weeks creates anaerobic, or reduced oxygen conditions that favor hydrophytic, or wetland, biological communities (Mitsch and Gosselink, 1993 and Henszey et al., 2004). At the same time, the soil surface and aerated soils near the surface of sandy loam soil provide a moist oxygenated environment that supports organisms like beetles and earthworms (Seibert, 1994; Davis and Vohs, 1993; and Nagel and Harding, 1987). Along the Platte River, high river surface elevations during spring (in combination with precipitation) are believed to help sustain the elevated groundwater levels of these riparian meadows (Henzey and Wesche, 1993 and Wesche et al., 1994).

The procedure used to evaluate the effect of action alternatives on wet meadow hydrology addresses the changes in the magnitude, frequency, and duration of springtime riverflows and river stage. Consistent with the recommendations of the National Research Council (2005), two periods of the year were evaluated that correspond with the "normative" or natural high flow regime of the Basin: from mid-February to mid-March, and from mid-April to mid-July. These are the periods when wet meadow organisms are likely to be active and at important life stages.

Exceedance values of flow and stage would probably best characterize an effective period of continuous soil saturation. However, future exceedance values cannot be reliably depicted with available hydrologic tools. For the purpose of these analyses, a 30-day mean flow was used as an indicator of respective exceedance values. It is assumed that 30-consecutive-day means are reliable indicators for comparing the effect of the flow alternatives. A daily flow model was to evaluate certain short-term flow characteristics of each alternative (see the *Water Resources Appendix* in volume 3).

Emphasis was placed on years with above-normal flows, as these are believed to have the greatest controlling influence of long-term sustainability of wetland systems and have the greatest importance to wet meadow rejuvenation. The highest flows provide both overland flow and saturate the soil profile. The exceedance values for the entire 48-year period are given in the *Water Resources Appendix* in volume 3.

Short-Term Flow Events

The annual frequency of hydrologic events under the Present Condition that are believed to most directly contribute to maintenance of wet meadows through surface connections of overland flow are given in table 4-WC-2.

Table 4-WC-2.—Maximum Annual 1-Day and 7-Day Running Average Peak Flow Events (at Grand Island) During Spring for the Present Condition (measured in cfs)

	April 16 - July 15	
	Maximum 1-Day	**Maximum 7-Day**
0-percent exceedance	28,172	25,201
10-percent exceedance	14,099	12,006
20-percent exceedance	9,963	8,617
30-percent exceedance	5,962	5,219
40-percent exceedance	5,147	3,771
50-percent exceedance	4,498	3,421

Longer-Term Flow Events

The annual frequency of longer-term hydrologic events under the Present Condition that are believed to most directly contribute to maintenance of wet meadows through elevated groundwater levels and soil saturation are presented in table 4-WC-3.

Table 4-WC-3.—30-Consecutive-Day Peak Flow Events at Grand Island During the Early Spring and Late Spring Periods for the Present Condition (cfs)

	February 15 - March 16	April 16 - July 15
0 percent exceedance	4,368	22,839
10 percent exceedance	3,652	9,524
20 percent exceedance	3,026	4,679
30 percent exceedance	2,775	3,785
40 percent exceedance	2,504	2,397
50 percent exceedance	2,280	2,132
60 percent exceedance	1,959	1,836
70 percent exceedance	1,713	1,434

Finally, changes in channel morphology, such as changes in channel width or channel bed elevations, would ultimately influence river stage produced by the sustained pulse flows described above. To analyze the changes that would result from action alternatives (see chapter 5, "Environmental Consequences"), the water surface elevations computed by the SEDVEG Gen3 model were used. The water surface elevations output from SEDVEG Gen3 account for both the riverflow and changes in the river channel morphology, which may, in turn, affect the river stage/discharge relationship.

Again, the analysis of water surface elevations examines the maximum 30-consecutive-day elevation in early spring and in late spring. Because most meadows adjacent to the main river channel are located downstream of Highway 10 (RM 208), the analysis focuses on the SEDVEG Gen3 cross sections from Highway 10 to Chapman.

Grain Fields

Waste grains gleaned from agricultural croplands near the river are a high-energy food source used by migrating sandhill cranes. Migrating whooping cranes are often observed to probe in cornfields, and corn and small grains are also thought to be a significant food source. All program-acquired lands would be in rural settings and would likely have corn and other small grains close to the restored channel habitat. Agricultural land in corn production comprises about 205,000 acres, or nearly one-half of the land use in the study area.

Despite the abundance and broad distribution of grain fields, the availability of waste corn as a food source has dwindled in recent decades in the Central Platte Habitat Area. Available waste corn in early spring has decreased by roughly 60 percent, and in late spring by as much as 96 percent, from the amounts found available in similar surveys during the 1970s (Krapu and Brandt, 2001). Diminished availability of waste grain is apparently due to increased farm harvest efficiency and competition among large populations of migratory waterfowl.

Though once spread over a much larger area, very large populations of migrating sandhill crane and geese have concentrated within a much smaller area of suitable river habitat along the Platte River (Krapu and Brandt, 2001). Goose migration (in some years, geese winter on the Platte) is followed by a 4-to-6 week period of sandhill crane staging. Both geese and sandhill cranes concentrate in river segments with broad channels to roost, and rely on nearby cornfields for feeding. In the 1970s, waste corn was sufficiently abundant and no adverse effects on the sandhill cranes' physiological conditions were found.

Daily movements of sandhill cranes from river roosts to feeding areas has increased since the 1970s, and fat storage of larger sandhill cranes (*Grus Canadensis rowani* and *G.c. tabida)* has declined (Krapu, 2003). This is likely due to reduced corn availability and decreased foraging efficiency. These river segments of wide channels are the same reaches that whooping cranes most frequently use later in the spring. Whooping cranes store a higher proportion of fat on the wintering grounds than do sandhill cranes, but presumably replenish fat reserves at migration stopovers. Reduced fitness of the larger sandhill cranes subspecies suggests whooping cranes may also be less able to replenish fat storage during Platte River stopovers.

Security and Protection From Disturbance

The Platte River's location within the migrational pathway provides stopovers with roosting, loafing, and foraging habitat that is secure from disturbances. The river environment provides wide channel roosting areas with rural wet meadows and cropland feeding areas nearby. Recreation, traffic on roads, bridges, and, to a certain extent, farm machinery and activities adversely influence crane use. Lights and noise (e.g., shooting) are other disturbance factors that affect crane use of particular habitat parcels.

The wide channels, expanse of water, and remote feeding sites contribute to the cranes' isolation and protection. Distance from potential disturbances (e.g., roads, bridges, human occupations, etc.) and buffers provide protection from intrusive human activities.

Detailed models to evaluate spatial relationships to crane use have not yet been developed for the Platte River Basin; however, certain simple variables are useful indicators of land acquisition strategies. Two indicators used to compare relative protection are:

- **Bank length:** Length of channel managed for crane protection
- **Area:perimeter ratio:** Configuration of managed lands represented by the area-to-perimeter

Bank Length

In Nebraska, ownership of the river channel itself is often determined by ownership of lands abutting the channel. Thus, ownership (or management rights) of the riverbank generally affects the ability to control access to the river, as well as the ability to directly manage river habitat.

Protection of the river channel habitat is provided by ownership of lands on the riverbank. When the riverbank is owned, ownership generally extends to the midpoint of the main channel. Currently, of the 280 miles of riverbank of primary channel in the 140-mile-long river reach between Hershey and Chapman, Nebraska (North Platte and Platte Rivers), about 37 miles (12 percent) are managed for controlled access and crane habitat conservation. This includes about 9 miles of channel having both banks controlled through either fee-title or conservation easement and about 16 miles with a single managed bank. About 33 miles of riverbank (18 percent) of the Platte River from Lexington to Chapman are owned by organizations that manage for crane habitat. Though cranes may use other river sections, the remaining channels are not managed for crane habitat and often contain land uses that render those reaches unsuitable for crane use.

The Program *Habitat Guidelines* identify the objective to achieve management of both river banks (see “Habitat Complexes” in chapter 3 and the Governance Committee Program Document, Attachment 4: Land Plan). This analysis distinguishes between the biological value of managing both banks and the biological value of a single bank. When both banks are not managed for habitat purpose, managers have encountered these limitations:

➢ Control of a single bank may interfere with habitat conservation when the river shifts course due to the natural dynamic natural alluvial processes. Over a period of years, the active river channel−which occupies only a small portion of the floodplain−can migrate from one side of the floodplain to the other, thus disabling the ability to perform channel habitat improvements;

➢ Various residential, recreational, industrial, or commercial developments on the opposing bank may result in disturbances that impair habitat value and nullify the investments in habitat improvements, and;

➢ Inability to manage the opposing riverbank can prevent access to the channel for research and monitoring on habitat areas. Likewise, a change in ownership or management on the opposing bank may prevent access to established, long-term, monitoring and research sites.

Bank length owned or protected is a useful indicator but, in itself, is not synonymous with total site security, as land uses nearby may affect whooping crane use. For example, length of protected bank does not account for the quality of the channel habitat or for the width of buffer along the river property. In cases where a single bank is owned or managed, it does not protect from land use changes or disturbance features on the opposing channel bank that would compromise the channel’s value for crane use. Watercraft could also continue to use the river.

Bank length of river channel properties owned or managed for crane habitat conservation were computed using the Reclamation GIS (Friesen et al., 2000). Results for the Present Condition are given in table 4-WC-4.

Table 4-WC-4.—Approximate Length of Bank of the Platte River and North Platte River Primary Channel That Are Owned or Controlled for Crane Habitat Conservation in 1997

Segment	Miles of Riverbank		Entities
	Single Bank	Both Banks	
Platte River			
Chapman to highway 34	0	0	
Highway 34 to highway 281	0	0	
Highway 281 to Alda	4.0	1.8	PRT
Alda to Wood River	3.0	1.4	PRT/TNC
Wood River to Shelton	1.1	0.6	PRT/TNC/NGPC
Shelton to Gibbon	1.6	0	PRT
Gibbon to highway 10	2.2	2.0	NAS
Highway 10 to Kearney	3.2	0.5	TNC/WWDC
Kearney to Odessa	0	0	
Odessa to Elm Creek	0.6	1.6	PRT/TNC/NGPC
Elm Creek to Overton	0	0	
Overton to Lexington	0	1.0	CNPPD
Lexington to North Platte	0	0	NGPC
Subtotals for Platte River	**15.7**	**8.9**	
North Platte River			
North Platte to Hershey	0	1.0	TNC
Totals	**15.7**	**9.9**	

Note: PRT = Platte River Whooping Crane Habitat Maintenance Trust; TNC = The Nature Conservancy; NGPC = Nebraska Game and Parks Commission; NAS = National Audubon Society; WWDC = Wyoming Water Development Commission; and CNPPD = Central Nebraska Public Power and Irrigation District.

Area:Perimeter Ratio

The area:perimeter ratio is an indicator of the potential exposure that a parcel of habitat will have and its ability to function in providing protection and security. The boundary of a linear property or several smaller properties would have greater exposure to disturbances from the adjoining lands than a single contiguous land parcel of equal size. Types of disturbance that may increase as the boundary area increases include:

- New development or land use changes on adjoining properties
- Disturbance from nearby hunting or trespass by humans
- Intrusions from domesticated animals (tame and feral)

In practice, the consideration of area:perimeter ratio would likely be balanced with consideration of the site-specific habitat functions that the individual parcel is intended to serve.

Currently, about 11,400 acres along the main channel of the river are buffered or held in habitat conservation to avoid disturbance or intrusion. Area, perimeter, and area:perimeter ratio of habitat parcels on the main channel owned or managed for crane habitat were computed using GIS. Adjacent parcels owned for the same purpose by different agencies are measured as a single contiguous unit. Results are given in table 4-WC-5.

Table 4-WC-5.—Area, Perimeter, and Area:Perimeter Ratio of Habitat Parcels on the Main Channel Owned or Managed for Crane Habitat in 1997.

River Segment	Area (Acres)	Perimeter (Miles)	Area:Perimeter Ratio (Acres per Mile)
Platte River			
Chapman to highway 34	0	0	0
Highway 34 to highway 281	0	0	0
Highway 281 to Alda	4,711	16.4	287
Alda to Wood River	2,496	16.6	150
Wood River to Shelton	0	0	0
Shelton to Gibbon	0	0	0
Gibbon to highway 10	1,603	11.7	137
Highway 10 to Kearney	1,184	10.5	112
Kearney to Odessa	0	0	0
Odessa to Elm Creek	1,325	7.7	172
Elm Creek to Overton	0	0	0
Overton to Johnson-2 Return Channel	0	0	0
Overton to Lexington	80	3	26
Platte and North Platte Rivers			
Lexington to Hershey	0	0	0
Overall	**11,399**	**65.9**	**173.2**

In addition to long-term habitat conservation described above, some individual landowners have undertaken activities to improve channels for waterfowl or other wildlife benefits. Often, these channel and wetland improvement activities are undertaken as habitat enhancement projects by cooperators in the Service's federally funded Private Lands Program. The level of effort/funding that would exist at year 13 and long-term continuity of those efforts are not determinable, but for the purpose of comparative analysis the activities are assumed to be nearly the same for the Present Condition and each of the action alternatives.

PIPING PLOVERS AND INTERIOR LEAST TERNS

INTRODUCTION

Piping plovers (plovers) are migratory shorebirds that spend approximately 3 - 4 months using northern breeding habitat before moving to wintering sites along beaches in the Gulf of Mexico or Atlantic Coast. The Northern Great Plains population of piping plovers uses suitable breeding habitat along prairie rivers and on alkali wetlands from Alberta to Manitoba, and south to Nebraska (Haig et al., 1988). Plovers generally arrive for the nesting season along the Platte River between early April and early May, with nest initiation beginning from early to mid-May, to mid-June (Bent, 1929; Tout, 1947; and Faanes, 1983).

Interior least terns (terns) are also migratory and historically used suitable nesting sites along the Missouri, Arkansas, Mississippi, Ohio, and Rio Grande river systems (Sidle and Harrison, 1990). Terns also arrive for the nesting season along the Platte River between early April and early May, with nest initiation beginning in mid-May to mid-June (Bent, 1929; Tout, 1947; and Faanes, 1983).

Both species use sediment deposits—exposed sand and/or gravel bars—and sometimes other sites to which the birds respond as if they are sediment deposits (e.g., beaches, parking lots, roof tops, etc.) for nesting. Potential nest sites support no or sparse vegetation at nest initiation and are usually close to surface water. In Nebraska, plovers and terns have been reported nesting on sand/gravel spoil piles (generally waste material remaining from floodplain aggregate mining operations—these sites are known as “sandpits”) and on exposed sandbars in the Missouri, Niobrara, Elkhorn, and North, South, and Platte Rivers; on sandbars on the Loup River; and on beaches at Lake McConaughy (Haig et al., 1988 and Sidle and Harrison, 1990).

Selected recent (1992-2004) plover and tern nesting information is provided in tables 4-PT-1 and 4-PT-2 to provide examples of relative use of nesting sites within the area of the proposed action. Note that these data are presented for illustration only—they come from several sources and were collected with a variety of methods for a variety of purposes (Lingle, 2004 and CNPPID and NPPD, 2005). These data do indicate, however, that channel nest sites in the Platte River between Lexington and Chapman produce fewer fledged plovers and terns than do other sites within the study area.

Data in table 4-PT-1 in the column, "Central Platte Islands" were collected primarily from managed islands within the channel between Lexington and Chapman. Lingle (2004) indicates the last recorded nesting on naturally formed and maintained sandbars in the Central Platte River occurred in 1989 (least terns) and 1990 (piping plovers). However, a 1992 record of piping plovers nesting on natural river habitat at RM 162 exists (Service, 1992 [plover nest]). In addition, after Lingle's report was compiled, a report was received of piping plovers nesting on naturally formed and maintained channel sandbars near the Audubon Rowe property at least as recently as 1996.[14] Nevertheless, the hydrology and sediment supply under the Present Condition no longer create sandbars that currently support successful nesting in the Central Platte River channel.

[14]Nebraska Game and Parks Department, 1996, personal communication, M. Humpert Wildlife Diversity Program Manager, and Service, 1996, personal communication, K. Dinan, State Coordinator, Partners For Fish and Wildlife Program, K. Schroeder, Assistant State Coordinator, Partners For Fish and Wildlife Program, and M. Tacha, Fish and Wildlife Biologist.

Table 4-PT-1.–Piping Plover Nest Data from Selected Sites in Central Nebraska, 1992 -2004

	Lake McConaughy		South Cozad Pit		Central Platte Islands		Central Platte Pits		Lower Platte Channel		Lower Platte Pits	
YEAR	No. Nests	No. Fledged	No. Nests	No. Fledged	No. Nests	No. Fledged	No. Nests	No. Fledged	No. Nests	No. Fledged	No. Nests	No. Fledged
1992	66	71	2	4	0	0	7	5	---*	---	---	---
1993	83	110	4	1	8	0	6	13	---	---	---	---
1994	50	65	4	8	7	1	21	8	27	28	9	8
1995	37	6	3	6	7	3	17	14	0	2	22	24
1996	60	37	6	6	13	3	10	16	6	0	20	0
1997	40	17	3	8	3	6	12	20	20	0	32	35
1998	25	13	4	4	5	1	8	17	1	2	29	8
1999	34	24	4	0	3	2	9	10	---	---	15	8
2000	33	74	3	5	2	3	10	23	9	5	45	22
2001	51	112	2	1	0	0	10	23	9	13	22	25
2002	69	132	3	0	0	0	20	28	---	---	---	---
2003	118	205	1	3	0	0	18	24	19	17	23	20
2004	183	371	0	0	---	---	---	---	---	---	---	---
Totals	849	1237	39	46	48	19	148	201	91	67	217	150
Total fledged/total nests		1.5		1.2		0.4		1.4		0.7		0.7
* "---" equals no data												

Table 4-PT-2.–Interior Least Tern Nest Data from Selected Sites in Central Nebraska, 1992 -2004

	Lake McConaughy		South Cozad Pit		Central Platte Islands		Central Platte Pits		Lower Platte Channel		Lower Platte Pits	
YEAR	No. Nests	No. Fledged	No. Nests	No. Fledged	No. Nests	No. Fledged	No. Nests	No. Fledged	No. Nests	No. Fledged	No. Nests	No. Fledged
1992	14	13	13	7	0	0	31	4	---	---	---	---
1993	10	6	12	4	4	5	29	49	---	---	---	---
1994	5	1	13	15	0	0	73	49	216	130	59	19
1995	4	4	12	4	14	16	55	41	5	23	109	16
1996	5	8	3	7	13	16	32	46	48	0	59	0
1997	7	11	8	10	10	13	35	49	120	0	116	81
1998	7	5	10	4	4	1	31	18	19	0	85	8
1999	3	5	6	5	3	0	24	23	---	---	---	---
2000	2	4	4	4	0	0	21	30	52	11	178	79
2001	8	13	4	6	0	0	27	45	64	52	95	26
2002	12	20	4	3	0	0	53	59	---	---	---	---
2003	14	19	2	1	0	0	67	49	109	109	84	87
2004	19	26	5	5	---	---	---	---	---	---	---	---
Totals	110	135	96	75	48	51	478	462	633	325	785	316
Total fledged/total nests		1.2		0.8		1.1		1.0		0.5		0.4
* "---" equals no data												

Data in tables 4-PT-1 and 4-PT-2 could be interpreted as indicating that other sites (e.g., Lake McConaughy and sandpits) provide adequate nest resources for plovers and terns. While important, nonchannel sites do not produce enough young birds to meet population recruitment needs. For example, piping plovers in the Northern Great Plains declined 15 percent from 1991 to 2001, while Nebraska plovers declined 25 percent during the same period (National Research Council, 2005). The National Research Council reviewed existing information on plover and tern populations in the Northern Great Plains and Nebraska, and commented on the importance of channel nesting in the Central Platte River:

> *"The committee [Committee on Endangered and Threatened Species in the Platte River Basin] also concluded that suitable habitat characteristics along the central Platte River are essential to the survival and recovery of the piping plover and interior least tern. No alternative habitat exists in the central Platte that provides the same values essential to the survival and recovery of piping plovers and least terns. Although both species use artificial habitat (such as shoreline areas of Lake McConaughy and sandpits), the quality and availability of sites are unpredictable from year to year."*
>
> (National Research Council, 2005, page 203)

The Platte River channel between Lexington and Chapman will be the focus of impact assessment for both plovers and terns. This reach is the focus of analysis because, as potential nesting habitat, it exhibits indications (e.g., lower numbers of young when compared to other sites) that nesting conditions are less favorable here than at other sites. Less favorable nesting conditions within this reach are believed to be linked to an altered hydrograph, reduced flows, reduced sediment supply, and other issues as discussed in chapter 2 and, more specifically, in "River Geomorphology" in chapter 4.

As discussed below, other areas and/or issues will also receive attention during impact assessment to ensure that potential alternative effects are documented. These areas include Lake McConaughy, the Platte River between North Platte and Lexington (river channel and sandpits), and the Platte River (river channel and sandpits) between Chapman and the confluence with the Missouri River.

Modifications to Original Indicators

Several impact indicators for both plovers and terns were evaluated in the draft Environmental Impact Statement (DEIS). Those indicators and their treatment in the DEIS generated considerable comments during the review process. The review process and subsequent analyses have resulted in a reorganization of indicators to focus the analysis on the river channel between Lexington and Chapman. Some of the original indicators were dropped from further analyses, or received further analyses and were moved to other sections within this FEIS, and some additional issues were addressed. Affected indicators are briefly discussed below.

Channel Width, Channel Stability, and Sediment Transport

Historic accounts and contemporary studies indicate that plovers and terns that nest within stream channels generally do so on dry sandbars—with less than 25-percent vegetative cover—that are located near midstream in wide, open channels (Faanes, 1983; Schwalbach, 1988; and Ziewitz et al., 1992). The natural occurrence of (as opposed to mechanically maintained) bare sandbars with little or no vegetation implies an abundant sediment supply and flows high enough to retard vegetation development through periodic inundation and restructuring of sediment deposits that are not anchored with large woody vegetation. It is assumed that peak or high flows in the preregulation hydrograph (see the "Changes in Riverflows" section in chapter 2 for examples), and significant postregulation spills from Lake McConaughy (see the "Lake McConaughy Reservoir Storage and Spills" section in chapter 4 for an example) provided the dynamic interaction of sediment and hydraulic energy necessary to periodically restructure sediment deposits into sandbars that are subsequently used by plovers and terns within the Central Platte and Lower Platte Rivers.

As discussed in chapter 2 and elsewhere, the dynamic interactions between flow and sediment have been altered in the Platte River system over the last 65 to100 years. Parameters linked to channel dynamics such as channel width, stability, and sediment transport were used as indicators for plovers and tern nesting in the FEIS. Channel width would be mechanically manipulated under various alternatives, and channel stability and sediment transport are inherent considerations of the SEDVEG Gen3 model. These are important impact indicators and are addressed in depth in other sections of this FEIS; therefore, those analyses need not be repeated here. This section characterizes channel dynamics by referencing issues addressed in depth under other sections. For example, channel stability and sediment transport are treated in detail in the "River Geomorphology" section of chapter 4. Change in the frequency and magnitude of spills from Lake McConaughy will be treated in "Channel Resources" in this section.

Water Quality

The DEIS addressed selenium, turbidity, and water temperature as possible issues of concern for plovers (selenium may bioaccumulate and cause reproductive impairment) and terns (change in turbidity may affect vulnerability of forage fish, and high water temperature may adversely affect forage fish).

Selenium is a naturally occurring, semimetallic trace element with biochemical properties similar to sulfur. Portions of the Republican River Basin south of the Platte River are underlain with deposits of Cretaceous marine shales containing selenium. Selenium from soils derived from shales, or groundwater containing selenium, can enter surface waters through natural runoff and/or through constructed pathways such as irrigation return flows. Historically, most selenium issues in Nebraska were restricted to the Republican River Basin. The groundwater mound south of the Platte River has created conditions that now make seleniferous groundwater potentially available to the Platte River Basin. The Platte River receives some selenium from the South Platte River, and a smaller portion from the North Platte River, but the majority of selenium comes from the groundwater mound south of the Platte River (see the *Water Quality Appendix* in volume 3).

Selenium is an essential trace nutrient necessary for normal metabolic functions. One of the interesting features of selenium is the narrow margin between nutritionally optimal and potentially toxic dietary exposure concentrations for vertebrates (National Irrigation Water Quality Program [NIWQP], 1998). The toxic effects result from the incorporation of selenium—rather than sulfur—in amino acids, and the subsequent alteration of protein structure and impaired enzymatic function (Amweg et al., 2003). Effects of selenium toxicity (selenosis) range from hair/feather loss to death, with reproductive impairment a common concern in wildlife studies.

Selenium is an important consideration in fish and wildlife studies because of bioaccumulation. Bioaccumulation results when a substance such as selenium accumulates in a living organism. Selenium is usually acquired through a diet, however, it can enter through the gills or skin. See Hamilton, 2004. The largest "step" in the bioaccumulation process occurs when selenium concentrations go from parts per billion (ppb) in water to parts per million (ppm) in plants and invertebrates. As additional layers, or trophic levels, of fish and wildlife feed on lower food-chain levels, selenium may bioaccumulate and can reach concentrations resulting in reproductive impairment or death.

Birds exhibit rapid accumulation and loss patterns for selenium (Heinz, 1996). Because of these patterns, selenium concentrations in eggs are good representations of local selenium levels. The embryo is also the most sensitive stage of a bird's life cycle to selenium. Therefore, selenium concentrations in eggs are a sensitive measure for evaluating selenium risks to birds. Extensive selenium studies over a range of conditions and locations have permitted the development of probable effect levels tied to various selenium concentrations. For example, Heinz (1996) reviewed numerous laboratory and field studies and concluded that a reproductive toxicity threshold occurred for bird eggs with selenium concentrations of about 10 ppm dry weight (dw). At this level, egg viability (hatchability) would begin to be reduced. However, for black-necked stilts, the threshold level is 6 ppm dw (Skorupa, 1998). The NIWQP Guidelines recommend that 3-6 ppm dry weight (dw) be considered a "level of concern" and greater than 6 ppm be considered a "toxicity threshold level" (NIWQP, 1998).

Reclamation scientists evaluated contaminants in plover (n = 64) and tern (n = 38) egg data collected between 1991 and 1993, and provided by the Service (see the *Water Quality Appendix* in volume 3 for details). Selenium concentrations in plover eggs ranged from a minimum of 2.7 ppm dw to a maximum of 15.0 ppm dw (median = 5.3 ppm). Tern eggs ranged from 1.1 ppm dw selenium to a maximum of 7.8 ppm dw (median = 4.9). The egg viability threshold for plovers or terns has not been identified, but both plover and tern egg median selenium concentrations fall within the NIWQP level of concern for bird eggs, and some eggs would have exceeded the toxicity threshold level.

If Heinz's (1996) conclusions—that egg concentrations reflect local food-chain levels of selenium—are correct, then aquatic invertebrates (plover food) and fish (tern food) in the Central Platte River may be bioaccumulating selenium. No selenium concentration data for invertebrates were found, but Reclamation scientists did evaluate fish data (1983-1997) provided by the Nebraska Department of Environmental Quality (see the *Water Quality Appendix* in volume 3 for details). The wet weight concentrations of selenium in these samples ranged from a minimum of 0.52 ppm to a maximum of 4.73 ppm (median = 1.41 ppm). (Note that the conversion of wet weight concentrations to dry weight would result in a higher dry weight concentration). Although there was a trend for increasing selenium concentrations with time, the fish were all large (the smallest was about 5 inches), rather than the small fish (~ 1.5 inches) terns eat, and there was a trend for more recent samples to be processed as fillets rather than whole body samples (whole body concentrations would likely be higher). Therefore, these sample data cannot be used directly to evaluate selenium bioaccumulation risk to terns on the Central Platte River. However, the presence of selenium concentrations in both tern and plover eggs within the level of concern, and higher, indicate the need for targeted sampling and selenium concentration analyses of plover and tern food in future studies.

Turbidity was also addressed in the FEIS as it relates to forage fish. The treatment of turbidity is addressed in "Channel Resources" in this section.

Invertebrate Food

The DEIS addressed invertebrate food as a possible issue of concern for piping plovers using channel nesting sites in the Platte River reach between Lexington and Chapman. The significance of invertebrate food as a limiting factor for nesting plovers has been re-examined.

Piping plovers are sight feeders that obtain food on or near the surface substrate (they do not probe) or from wave wash. Definitive food-habit studies that actually identify prey items taken by plovers are limited. Plovers appear to consume the same types of invertebrates in the same proportions that are available at feeding sites (Haig and Elliott-Smith, 2004). Most studies observe feeding plovers and then try to determine what is available as potential food. For example, Corn and Armbruster (1993 [Prey]) sampled surface and subsurface sites at various distances from water at both channel and sandpit locations frequented by feeding plovers along the Central Platte River. Adult life stages of terrestrial insects dominated both channel and sandpit surface samples, with channel sample sites producing a greater diversity and abundance of terrestrial insects. Investigators speculated that terrestrial insects flew into or were blown into channel and sandpit sites from surrounding uplands. Channel sites may also have exhibited greater diversity and abundance of insects because of more diverse juxtaposed vegetation than that supported by or near sandpits. In addition, channel sites also generally supported more surface area of moist sediment edge (e.g., dry sand—moist edge—water) and may have thus attracted more insects than did sandpit conditions. Subsurface sediment samples produced few potential food items. Some insect larvae and annelid worms were recovered from fine (e.g., silt), near-bank, channel sediment deposits (and such sites may have been the source of some terrestrial adults such as dipteran flies), but few potential food items were recovered from subsurface channel sand deposits regardless of the distance to water.

No indication that food limits adult plovers (reviewed by Haig and Elliott-Smith 2004) or young in channel nesting situations was found in the piping plover literature. Mechanical restructuring of the channel at some sites under some proposed action alternatives may remove some vegetated islands that support some insects, but other sources of terrestrial insects would remain. In addition, the mechanical restructuring of channel sites may increase the attractiveness of such sites to terrestrial insects by increasing the area of moist sediment edge. Because of these considerations, the abundance of invertebrates as food for piping plovers has been eliminated from further analysis.

Selenium and its potential to bioaccumulate within the plover's food chain is a potential issue with invertebrates as food for piping plovers that warrants further study in the Program's First Increment. As discussed in the subsection on water quality above, plovers and terns have exhibited median egg selenium concentrations within the NIWQP's level of concern. It is highly likely that selenium sources are local and that bioaccumulation occurs in plover eggs through invertebrate prey. Aquatic invertebrates were less abundant than terrestrial insects in samples collected by Corn and Armbruster (1993), but aquatic invertebrates (e.g., insect larvae) are the likely link between water and, perhaps, sediment selenium concentrations and selenium levels in plover eggs.

As discussed above, the *Water Quality Appendix* in volume 3 provides recommendations for a selenium monitoring effort designed to address both potential food-chain bioaccumulation and potential reproductive toxicity thresholds in plovers and terns should be implemented. Selenium concentrations within their respective food chains may be a factor limiting the reproductive potential of some plovers and terns nesting in the Central Platte River (e.g., selenium egg concentrations > 10 µg/g). However, a change in selenium concentration in Platte River water is not among the potential effects of the proposed action addressed in this FEIS.

Forage Fish

No indication was found in the literature that food currently limits least terns from nesting on channel sandbars in the Central Platte River between Lexington and Chapman. However, no definitive studies have been conducted that evaluated the link between prey abundance and nesting success. Obviously, no flow (i.e., a dry channel) or very low flow conditions would affect forage fish and, thus, least terns if such a flow event occurred during the nesting season. Currently, predicting no-flow events is problematic, but temperature thresholds can be identified and used as indicators of potential lethal or no-flow events as described below.

Forage fish are an important resource to nesting terns. Forage fish are treated in depth in the "Central Platte Fisheries" sections in chapters 4 and 5. Forage fish are also treated here as a component of tern channel nesting habitat and occur under the indicator "Channel Resources" discussed below.

INDICATORS AND METHODS

The indicators addressed here for both piping plovers and interior least terns include:

- Flow potential to build sandbars
- Fledging days[15]
- Nonchannel nest sites
- Channel resources

This analysis relied heavily on output from the SEDVEG Gen3 model and the CPR model. SEDVEG Gen3 model output for analysis of fledging days was manipulated postprocessing with spreadsheet routines developed by Reclamation scientists (Stroup, 2005).

The DEIS evaluated flow potential to build sandbars at two time intervals: a 1-year interval and a 3-year interval. The analysis in the FEIS relies on a 1.5-year peak flow. A detailed analysis is presented in the "River Geomorphology" sections of chapters 4 and 5. Only summary information is presented here.

Hydrology data from the CPR model was evaluated, and data distributions were determined to be non-normal. Statistical analyses were therefore performed on CPR model output using the Mann-Whitney U test with an $\alpha = 0.10$.

Flow Potential to Build Sandbars

For nesting plovers and terns use exposed sediment deposits (sandbars) in the river channel that provide some elevation protection from minor increases in flow during the nesting season. Potential nest sites generally support no, or very sparse, vegetative cover at nest initiation. Sandbars require frequent disturbance, such as overtopping or restructuring by higher riverflows, to remain both free of vegetation and high enough to prevent nest inundation.

The indicator used here to represent flow potential to build sandbars is used in comparisons of mean annual flow flows and 1.5 year flows (see the "River Geomorphology" sections in chapters 4 and 5 for additional details of the indicator). Basically, the indicator evaluates the difference in water surface elevation between the mean annual flow and the 1.5-year peak flow events for each alternative. The assumption here is that the greater the difference, the greater the potential to overtop sandbars and, possibly, to deposit new sediments and/or scour any annual vegetation that may have developed during the previous growing season. The "River Geomorphology" section of chapter 5 provides data for four river reaches:

[15] "Fledging" references the developmental attainment of flight by young birds and is used to identify the beginning of independence from parental care. Fledging days are the number of consecutive days beyond average nesting cycle for which successful fledging would be possible for piping plovers and least terns.

- Reach 1—Jeffrey Island to Elm Creek
- Reach 2—Elm Creek to Gibbon
- Reach 3—Gibbon to Wood River
- Reach 4—Wood River to Chapman

The percent changes from the Present Condition are presented here. See the "River Geomorphology" section in chapter 5 for a detailed treatment of flow-sediment transport issues.

The reader should note that the difference between annual mean flows and 1.5-year peak flow events is not linked directly to existing sandbars or channel nest sites. The value serves as an index to flow potential to build sandbars with limited vegetation and suitable elevation for nesting. This index is useful in comparing relative differences between alternatives.

The index values were obtained by postprocessing manipulations of some portions of the SEDVEG Gen3 model output. It was assumed that management activities—both flow and mechanical channel restructuring—would occur throughout the 13 years of the Program's First Increment. Therefore, mean values for indicators during this period would not accurately capture conditions in place at the end of the Program's First Increment. For these reasons, data from the 48-year post alternative implementation period were used in all analyses. This period better represents conditions with alternatives in place.

Fledging Days

The remaining requisite for successful channel nesting—if sandbars of adequate height and limited vegetation are available (above indicators)—is a period of reasonably steady or even declining flow without the danger of inundation. If suitable channel sites are available, plovers and terns may nest on exposed sediments in close proximity to the water surface level. However, their nests are at constant risk from rising water levels. If the water surface level rises to or above the elevation at which the nest is located, the nest and its eggs and/or young would be lost.

Piping plovers may begin nest initiation as early as May 1 and require at least 53 days before the young fledge. Least terns may begin nest initiation as early as May 20 and need at least 46 days until the young fledge. Fledging days are the number of inundation-free consecutive days in excess of those days needed for plover or tern nests to successfully fledge young. This analysis assumes that the longer this period lasts, the higher the probability of successful nesting.

The fledging-day value is calculated within the period May 1 (plovers) or May 20 (terns) through August 15. The value itself is the 48-year annual mean number of days in excess of the minimum needed for fledging, with water surface elevations continuously less than the elevation on the day the count begins. For example, the count for plovers would begin on May 1 and compare the water surface elevation on that day with each subsequent day's surface elevation. If water surface elevations remain less than those elevations on May 1 until the end of 53 days, the count of fledging days would begin and continue until the water surface elevation exceeds the elevation on May 1 or until August 15 is reached. The count is restarted at any time after May 1 when a day's water surface elevations exceed the elevations of the start date. Multiple restarts are possible as long as a 53-day interval remains before August 15. The procedure for terns is identical, except for a May 20 start date and a 46-day nesting cycle.

This analysis begins counting nesting days and tracking water elevations on May 1 for plovers and May 20 for terns. Obviously, plovers and terns may not elect to initiate nests on these dates, and current information from sandpit nests, and current and historic hydrographs,[16] indicate that nest initiation may often occur later than these dates. The count-restart mechanism mimics renesting attempts and allows the identification of an inundation-free period regardless of where it occurs within each of 48 potential nesting seasons.

There are limitations with the approach. For example, water elevations used to develop the fledging day value are not linked directly to existing sandbars or channel nest sites. Because of these limitations, the fledging day value serves best as an index to potential fledging success and is useful in comparing relative differences between the Present Condition and other alternatives.

The index values were obtained by postprocessing manipulations of portions of the SEDVEG Gen3 model output. Transect outputs were grouped to facilitate evaluations of different management options and river reaches. These groupings included all transects, managed transects, nonmanaged transects, transects above Kearney, and transects below Kearney. Most groupings are self-explanatory, except perhaps for the Kearney division. There are indications that the channel may function differently above Kearney than below Kearney (see “River Geomorphology” in chapter 4 for details).

Nonchannel Nest Sites

This indicator addresses potential effects from proposed alternatives on beach nesting at Lake McConaughy and nesting at sandpits within the Lexington to Chapman reach of the Central Platte River.

Beaches at Lake McConaughy have become important nesting areas for piping plovers and least terns, especially during the recent regional drought (tables 4-PT-1 and 4-PT-2). The May end-of-month elevations for Lake McConaughy are used as an index to show the beach area available for use by plovers and terns. May was selected because most inflow would be in storage, and plovers and terns would be initiating nests on exposed beaches. This assessment assumes that mean lake surface elevations less than the Present Condition would represent an increase in beach area. As in the above analysis, this value is not linked directly to the suitability of existing nesting areas, and, thus, the value serves only as an index to potential use by plovers and terns. The value is useful in comparing relative differences between the Present Condition and other alternatives.

In the short term, managed sandpits can provide conditions that support successful plover and tern nesting (tables 4-PT-1 and 4-PT-2). Some sandpits are currently actively managed for plover and tern nesting habitat along the Central Platte River from the Lexington to Chapman reach. Managed sandpits are generally postmining operations sites where vegetation is controlled. Some sites are also protected by some type of predator control. Some alternatives propose to increase the acreage of sandpits managed for plover and tern nesting. An increase in area of managed sandpit suitable nesting habitat is assumed to benefit plovers and terns. However, the National Research Council, 2005, states that several studies have concluded that artificial habitats such as sandpits cannot provide the full complement of essential habitat requirements for piping plovers over the long term and, therefore, cannot substitute for riverine habitat.

Areas of managed sandpits were obtained from the Platte River GIS database. No statistical comparisons were performed.

[16]See the “Changes in Riverflows” section in chapter 2 for examples of hydrographs.

Channel Resources

This indicator spans a rather diverse group of resources and measures that are generally indirectly tied to plover and tern habitat in the Central Platte River. Specifically, they address the frequency and magnitude of spills from Lake McConaughy, annual flow volume at Cozad, water quality parameters between Lexington and Chapman (for forage fish), and median July flows at Grand Island. The selection rationale and description of each member of this group are provided below.

Lake McConaughy Spills

River regulation, such as the construction and operation of dams and reservoirs, generally alters the pattern of seasonal streamflow by flattening periods of high flows and increasing flows during periods (e.g., summer) that historically experienced low or no flows (see "Water Resources" section in chapter 4 for details). Reservoirs also trap sediments. The loss of high flows reduces the dynamic process that would otherwise periodically restructure the channel and create sediment deposits (sandbars) of various elevations and longevity. Dam spills, or the unscheduled release of water, provide a reduced-scale function similar to historic high flows, in that they serve to restructure the regulated channel with its remaining sediments.

Lake McConaughy spills are important in maintaining the current character of the Central Platte River channel and any nesting habitat value the channel provides. Future frequency and magnitude of spills from Lake McConaughy were evaluated for change from the Present Condition. Frequency, magnitude, and graphical displays were developed from output from the CPR model.

Annual Flow at Cozad

Plovers and terns make some use of the river and adjacent sandpits between North Platte and Lexington. Tables 4-PT-1 and 4-PT-2 provide one example of sandpit use within this reach. This example is the largest site—in terms of nests and continuous data—within the reach, but other examples of more limited use also occur.

The purpose for evaluating annual flow at Cozad is linked to the observation that the river channel is currently providing resources such as food for both plovers (adults and young often move to the channel to feed postnesting) and terns (the channel likely provides a more diverse and, therefore, potentially more suitable fish prey base than found at most sandpits). The annual flow volume at Cozad, along with the frequency and magnitude of spills from Lake McConaughy, provide indices of channel maintenance processes at work within this reach. It is assumed that these indices reflect conditions that currently support resources (e.g., food) used by nesting plovers and terns between North Platte and Lexington. Deviations from current conditions may affect these resources.

Water Quality Parameters and Forage Fish

Numerous factors affect the habitat suitability for fish in the Central Platte River. Many of these factors are addressed in detail in the "Water Quality" and the "Central Platte Fisheries" in chapters 4 and 5. A subset of those parameters—water temperature and turbidity—is discussed here for least terns.

Water temperature is addressed fully in the "Water Quality" and the "Central Platte Fisheries" sections in chapters 4 and 5. The probability of July temperatures exceeding 90ºF at Grand Island is used as an index to the more detailed analyses occurring in other sections. July was selected because forage needs should be high during this month as tern young hatch. The temperature (90ºF) is a state water quality parameter.

Turbidity is also treated in detail in "Water Quality" and "Central Platte Fisheries" sections in chapters 4 and 5. In this section, median and maximum JTUs are used as an index to the more detailed analyses occurring in other sections.

July Flows at Grand Island, Nebraska

Plovers and terns nest on sandbars in the Platte River between Chapman and the river's confluence with the Missouri River (tables 4-PT-1 and 4-PT-2). It is assumed that the Present Condition within the channel (i.e., flow and sediment transport) supports resources that permit successful plover and tern nesting in the lower river. Most channel nesting in the lower river occurs between Columbus and the Missouri River (Sidle et al., 1993 and Kirsch 1996) and would likely be most influenced by the Loup River. It is unlikely that plover and tern nests located in the channel below the Loup River would be affected by actions associated with alternatives proposed in this FEIS. However, this assumption was explored by evaluating median July flows at Grand Island.[17]

The Grand Island gauge was selected because it best represents the reach between Grand Island and Columbus, near where the Loup River joins the Platte River, and it should be the last stream gauge to represent Program effects. This analysis assumes that any significant increase in July flows may represent adverse effects to sandbar nest sites in the lower river. July was selected because it represents a time period when sandbar nesting should be well underway, and it is unlikely that nests lost during July would be replaced by renesting attempts.

PRESENT CONDITION

Values for the impact indicators under the Present Condition are presented below.

Flow Potential to Build Sandbars

The Present Condition serves as the standard against which action alternative values are compared. Two stream gauges provide data for the Present Condition. At Overton, the mean annual flow is 1,751 cfs, and the 1.5-year peak flow event would average 3,696 cfs. Comparable values at Grand Island are 1,746 cfs (mean annual flow) and 4,609 cfs (1.5-year peak flow). See the "River Geomorphology" sections of chapters 4 and 5 for further details.

Fledging Days

Piping plovers may begin nest initiation as early as May 1 and require at least 53 days before the first young fledge. Least terns may begin nest initiation as early as May 20 and need at least 46 days until the

[17] The inclusion of flow data from the Duncan, Nebraska, gauge just upstream from the Loup River would have been beneficial to this analysis, but these data for alternative flows are unavailable.

first young fledge. Under the Present Condition between Lexington and Chapman (as represented by 62 SEDVEG Gen3 transects), plovers currently have an average of the 53 required days, plus an additional 6.2 days in which young could fledge before flows again reach the surface elevation of May 1, or of any subsequent restart date. Terns currently have an average of 7.4 additional days (46 + 7.4) in which their young could fledge.

When only transects that would be managed under the action alternatives are evaluated, plovers have 6.4 additional days to fledge young. Transects that would not be managed under the action alternatives also produce 6.1 additional fledging days. Transects above Kearney produce 5.5 fledging days, and transects below Kearney produce 6.7 additional fledging days for plovers.

When only transects that would be managed under the action alternatives are evaluated, terns have 7.7 additional days to fledge. Transects that would not be managed under the action alternatives also produce 7.3 fledging days. Transects above Kearney produce 6.5 fledging days, and transects below Kearney produce 8.0 additional fledging days for terns.

Nonchannel Nest Sites

The mean May end-of-month elevation for Lake McConaughy under the Present Condition is 3258.3 feet. It is assumed that this mean elevation is associated with some level of nesting activity at Lake McConaughy. Readers should note that the average nesting activity is most likely less than that depicted in tables 4-PT-1 and 4-PT-2. Lake McConaughy, like many western reservoirs, has experienced drought-related, reduced elevations in recent years. These reduced elevations—and the accompanying increases in beach area—may provide favorable nesting conditions for plovers and terns.

There are 16 sandpits currently surveyed for plover and tern use (Platte River Executive Director's Office, 2005). Of these 16 sandpits, 6 received some type of management. Management actions include singularly or in combination: electric fencing, predator control, and pre-emergent herbicide application. No acreage values are available for these sandpits.

Channel Resources

Channel resources address the frequency and magnitude of spills from Lake McConaughy, annual flow volume at Cozad, water quality parameters between Lexington and Chapman (for forage fish), and median July flows at Grand Island.

Lake McConaughy Spills

Of the 48 years of hydrology record used in this study, 29 years experienced some level of spill from Kingsley Dam. Under the Present Condition, the average annual volume of spills is 169,100 acre-feet, with March (28) and April (27) having the highest numbers of spills, and with June having the highest average volume of spills (54,900 acre-feet). For the 7 years in which June spills occurred, the average spill was 376,315 acre-feet. The highest spill of record occurred in June 1983 at 600,900 acre-feet.

Annual Flow at Cozad

The median annual flows at Cozad are 287,300 acre-feet. It is assumed that these flows result in conditions that support habitat resources (e.g., food for plovers and terns using the Platte River between North Platte and Lexington).

Water Quality Parameters and Forage Fish

The probability of July water temperatures exceeding 90 ºF in July at Grand Island is 0.329 under the Present Condition. The median and maximum JTU under the Present Condition are 25 (median) and 44 (maximum), respectively.

July Flows at Grand Island, Nebraska

Median July flows at Grand Island equal about 858.6 cfs. It is assumed that these flows result in conditions that play a part in supporting habitat resources, such as food and nest sites, for plovers and terns using the Platte River between Chapman and the Missouri River.

PALLID STURGEON

INTRODUCTION

The pallid sturgeon occurs in the Lower Platte River, within the area affected by the alternatives. Most captures and study observations have occurred in the area below the upstream edge of Two Rivers State Park (RM 41), just above the confluence of the Elkhorn River (RM 32) to the mouth of the Platte River (Service, 1997 and University of Nebraska, 2005, personal communication, E. Peters). This section of river can generally be characterized as being considerably more turbid than many developed plains rivers; it contains significant instream structure (e.g., sandbar complexes, large woody debris, islands, and side channels); and, although substantially impacted by upstream water development, it exhibits some properties of the Pre-Development seasonal hydrograph. These habitat features give the Lower Platte River considerable importance in its habitat value to native plains fishes such as the pallid sturgeon and sturgeon chub (Service, 1997).

Flows in the Lower Platte River consist primarily of water from three upstream subbasins: the upper reaches of the Platte River, the Loup River, and the Elkhorn River. The Shell and Salt Creek watersheds provide smaller, but significant flows to the Lower Platte River. The remaining Lower Platte River water supply comes from ungauged minor tributaries and groundwater inflow (Nelson and France, 1983).

The Basin above the confluence with the Loup River encompasses 59,300 square miles. The upper Platte River Basin contributes an average of over 1.2 maf of water each year. The greatest volume of water delivered to the Central Platte River comes in the form of snowmelt from the east slope of the Rocky Mountains in Wyoming and Colorado.

The Loup Basin encompasses more than 14,320 square miles (USGS, 2005). Much of the Basin is fed by seeps and springs that drain the Ogallala aquifer underlying the Nebraska sandhills region. The unconsolidated sands and gravels comprising the sandhills absorb some of the runoff, snowmelt, and rainfall in the area, which forms an underground storage reservoir that slowly releases water into small tributary streams draining into the Loup River. As a result, the natural flow of the Loup River, while it does exhibit seasonal hydrology associated with runoff, does not experience dramatic year-to-year changes between wet and dry cycles Nelson and France, 1983).

The Elkhorn River rises just east of the sandhills region of Nebraska, drains approximately 5,870 square miles, and carries nearly 1 maf of water each year (Grier, 1983). In addition to draining part of the sandhills, it also drains a considerable area in the more humid and less permeable loess hills region of northeastern Nebraska. Summer thunderstorms provide localized runoff events in the rolling hills of the Lower Elkhorn watershed, resulting in substantial variability in flows and silt load at Waterloo, Nebraska (Nelson, 1983).

The Shell and Salt Creek watersheds drain a physiographic region similar to the loess hills of the Lower Elkhorn Basin. Shell Creek enters the Platte River near North Bend, Nebraska, and Salt Creek enters the Platte River just downstream from Ashland, Nebraska.

In addition to upstream development of water in the Basin, a substantial level of municipal and industrial (M&I) water development affects the Habitat Area. Currently, the Fremont and Lincoln well fields pump several hundred acre-feet of water per month and 5,850 acre-feet of water per month, respectively. Downstream of the Louisville gauging station, but within the habitat area, the Omaha Metropolitan

Utilities District and Allied Chemical Company well fields pump a combined total of 6,760 acre-feet of water per month. Agricultural uses consume an additional unmeasured quantity of water from the Lower Platte River itself.

Sediment transport within the Basin is directly related to instream flow. As a consequence, water development within all areas of the Basin directly reduces the rate of sediment transport. The resulting reduction in both riverflow and sediment transport, in turn, reduces maintenance of instream habitat, such as sand and gravel bars, and also affects turbidity levels that have been linked to pallid sturgeon feeding efficiency (Service, 1993).

INDICATORS

The primary indicator used to identify the effects of alternatives on pallid sturgeon in the Lower Platte River is riverflow at the Louisville, Nebraska, gauge, located at approximately the midpoint of the pallid sturgeon habitat area in the Lower Platte River. The specific timeframes and riverflow conditions examined, and the pallid sturgeon life requisites associated with them, are as follows, as well as nonflow indicators that were examined.

Pallid Sturgeon Spawning Period

The April-June period is identified as the critical spawning period for pallid sturgeon. The exceedance intervals specifically examined within this period are the years in the wettest sixth of the data set, second wettest sixth, and third wettest (0 through 16.7 percent, 16.7 through 33.3 percent, and 33.3 through 50 percent).

Based on capture records, runoff patterns, and water temperature patterns, opportunity for pallid sturgeon to spawn in the Platte River probably occurs between April and June. Initiation of pallid sturgeon spawning migrations has been associated with seasonal spring flow (Peterman, 1977 and Zakharyan, 1972; both cited in Gilbraith et al., 1988). Since 1979, 19 of the 23 captures of pallid sturgeon in the Platte River or Missouri River near the Platte confluence occurred between April and June. The remaining four captures were in July and September of 1999. Twenty of the 23 captures correspond with years when May-June flows in the Lower Platte River were above normal for the recent period (Service, 1997). Pallid sturgeon do not spawn every year (Keenlyne and Jenkins, 1993). Intervals between spawning for females are estimated to be 3 to 7 years or more (Service, 2003, personal communication, H. Bollig). Environmental conditions are among the factors believed to play a part in intervals between spawning (Service, 1993). For these reasons, the wettest three-sixths of April to June of the 48-year period of record are considered to be the most critical.

Pallid Sturgeon Habitat Creation/Maintenance and Food Base Production Period

February to July is identified as the period in which habitat-creating and maintenance flows most frequently occur, as well as constituting the primary production period for the prey base for the pallid sturgeon. The exceedance intervals specifically examined within this period are the years in the wettest sixth of the data set, second wettest sixth, and third wettest sixth for pallid sturgeon habitat formation and maintenance (0 through 16.7 percent, 16.7 through 33.3 percent, and 33.3 through 50 percent), and the wettest third, the middle third, and the driest third for the pallid sturgeon food base (0 through 33.3 percent, 33.3 through 66.7 percent, and 66.7 through 100 percent).

Studies in the Platte River and elsewhere have found significant pallid sturgeon use of inchannel structure, principally the downstream edges of sand and gravel bars, and submerged dunes (Snook, 2001; Bramblett, 1996; and Hurley, 1996). Formation of these inchannel structures occurs primarily at the elevated flow levels most often seen in the February to July period in the Lower Platte River. The wetter years would be expected to play a greater role in maintenance and formation of inchannel structure.

The diet of the pallid sturgeon is made up of small fish and aquatic invertebrates. Multiple studies have stressed the role of flood plain connectivity in fish and aquatic invertebrate production (Crance, 1988; Schlosser, 1985; Killgore and Baker, 1996; and Fisher, 1999). This connectivity occurs most often in the February to July period in the Lower Platte River. The greatest potential for habitat formation and maintenance occurs at higher flows; as a result, more focus is placed on the wettest sixth for this factor. The greatest production of small fish and aquatic invertebrates could be expected with higher spring flows, but increases in flow rates during the driest years could still be expected to increase the more limited production occurring in those years.

Summer Period

June, July, and August are identified as the period most impacted by low water and high temperature events. Avoidance of low flows at this time of year is important for pallid sturgeon prey base survival and may be of significant importance in pallid sturgeon young-of-the-year survival. The exceedance intervals specifically examined for this period are the years in the driest sixth of the period of record, second driest sixth, and third driest sixth (50 through 66.7 percent, 66.7 through 83.3 percent, and 83.3 through 100 percent).

High water temperature events, coupled with frequent fluctuations in Lower Platte Riverflows, due to hydropower cycling releases out of the Loup Power Canal, can be moderated by the presence of greater summer base flows. Temperature effects on pallid sturgeon have not been investigated, but adult pallid sturgeon have been located in water with temperatures of up to 34.7˚C and are quite capable of moving to avoid dewatering under normal circumstances. As a result, direct effects of these fluctuations on adult pallid sturgeon would be expected to be minimal. Effects of these fluctuations on the larval and young-of-the-year pallid sturgeon and food base for the pallid sturgeon could be more substantial. Years with the lowest summer flows would be considered the most impacted; therefore, the driest three-sixths are considered to be the most important intervals.

Fall and Winter Periods

The importance of the period from September-January for pallid sturgeon in the Platte River is not well understood. As a result, at this time, the September-January period is examined by month, but lower emphasis is placed on the period until such information is available that would warrant otherwise. The intervals specifically examined for the months in this period are each of the driest three-sixths, as with the June-August period, above.

Sediment Transport

Sediment transport directly affects habitat formation and maintenance in the Lower Platte River, along with flow rate. Simply put, both sufficient sediment and flows sufficient to move and arrange that sediment are necessary to build the sandbars and islands that create river habitat used by pallid sturgeon.

Reclamation's SEDVEG Gen3 model calculates the rate of sediment transport at a number of transects in the Central Platte River. At this point in time, the model does not extend to the Lower Platte River. As a result, it cannot calculate the timing distribution−or rate at which−Central Platte River sediment reaches the lower river, only the amount that passes the last Central Platte transect (RM 162.2).

The majority of sediment is transported during high flow events; as a result, the average daily flow rate reflects these high flow events. Given the seasonal flow patterns in the Platte River, it is difficult to define "typical" river conditions. The median daily sediment transport rate is used by this analysis to represent somewhat more "typical" river conditions, because this statistic is less influenced by high flow events. The two basic statistics must be viewed together to gain an adequate view of sediment leaving the Central Platte area.

METHODOLOGY

Hydrology model runs for the pallid sturgeon are analyzed by comparing changes in riverflows at the Louisville gauge. Monthly flows for the Present Condition and the alternatives at Louisville are calculated by the CPR hydrology model, then adjusted for transmission loss as determined by the "potential to affect flows in the Lower Platte" analysis (Service, 2002 [flow]). This analysis provides a range of transmission loss factors so that, when applied, the output is an anticipated high-to-low range of monthly flow at Louisville for an analyzed alternative. The flow values for the Present Condition and the flow range for the alternative are then ranked in order of exceedance (ranked from highest to lowest flow). In this manner, the range of flows under different scenarios can be examined for a range of periods (e.g., monthly, yearly, seasonally) and compared using this common frame of reference.

The data, as organized above, are divided into distinct periods important to the pallid sturgeon and ranked as described above. Within these periods, the ranked data are specifically examined by exceedance intervals. An exceedance interval is a specified percent range of flows for the period of record (e.g., the highest 16.7 percent of flows). Generally, for the purpose of this analysis, the 48-year period of record was examined by thirds (wettest third of years in the period of record, middle third, driest third of years) or sixths (following the same pattern as before, but in sixths).

Analysis of SEDVEG Gen3 model runs is somewhat more straightforward, yet more limited in its informational value. The mean, median, and total are calculated for the daily sediment transport values at the lowest transect for the period of record. The limitations in this type of analysis are discussed above, in analyses indicators.

PRESENT CONDITION

Nelson (1983) calculated the proportional contribution of different water sources to average annual flow at the Louisville gauge for the period from 1950 to 1980. He determined the approximate contributions of the individual basins on an average annual basis:

- 25 percent - upper Platte Basins (above Loup)
- 41 percent - Loup Basin
- 21 percent - Elkhorn Basin
- 8 percent - Salt Creek Basin
- 6 percent - Shell Creek, groundwater, other tributaries

Sediment Transport

The SEDVEG Gen3 estimates the rate of sediment transport at various points in the Central Platte River. While an estimate cannot be made of the exact proportion of sediment transported out of the Central Platte River that arrives at the pallid sturgeon and sturgeon chub habitat area in the Lower Platte River, this model remains the most powerful tool available to estimate the sediment contribution of the upper Basin to the Lower Basin. The model estimates that from 1947 - 1994, a total of roughly 10.5 million tons of sediment were transported past the downstream end of the Central Platte River. The bulk of this sediment was transported during high-flow periods. This means that an average daily rate of sediment transport for the period was 1,121 tons per day. Again, the bulk of sediment transport takes place during high peak flows that occur over a relatively short period in a typical year. As a result, this 1,121-ton-per-day average does not truly represent a typical day, but it is a useful figure for the comparison of alternatives in subsequent sections of this document. The median daily sediment transport for this period was 405 tons per day (median sediment load). This more closely represents typical conditions but is less representative of overall effects on sediment transport. As a result, the mean and median values are used in conjunction to give a more complete picture of the effects of an alternative on sediment transport.

Current rates of sediment transport are not available for the Loup River, Elkhorn River, or Salt Creek. However, as discussed above, the Loup River appears to be less impaired in terms of sediment transport than the Central Platte River, and the Elkhorn River appears to be even less impaired. No estimate of current levels of sediment transport can be made for Salt Creek or other tributaries.

Due to this relative lack of data, we cannot determine the level of impairment of sediment transport in the Lower Platte River directly caused by water development in the upper Basin cannot be determined.

Water Quality and Daily Hydrograph

As in the Central Platte River, high temperature water events have been recorded in the Lower Platte River (Yu, 1996 and Fessel, 1996). It is likely that these events are of lower magnitude and frequency than those in the Central Platte River, due to higher relative summer flows in the Lower Platte River. Unfortunately, unlike the Central Platte River, no large data set is available for water temperatures in the Lower Platte River. Fishkills have been reported, and, undoubtedly, some are due to elevated water temperatures, but a definitive link to high water temperature has not been established. Some indication has been made that many of the fishkills may be linked to rapid change in flow rates (University of Nebraska, 2000, personal communication, E. Peters). Operation of water projects in the Loup and Lower Platte Basins causes frequent and rapid changes in flow rate. These fluctuations occur on an hourly daily basis, resulting in exposure and reflooding of large areas. This has particular importance for immobile plant and animal species and delicate reproductive life stages that cannot avoid dewatering (Peters et al., 1989). Although this effect is not caused by upper Basin water development, an incidental benefit of increasing summer flows in the Central Platte River would be to moderate this effect. In essence, when base flows are sufficient to wet the majority of the channel width, any fluctuations in flows above that level have a smaller incremental effect on wetted area.

Pallid Sturgeon Spawning Period

As mentioned previously in the discussion of pallid sturgeon "indicators," the timeframe examined for the pallid sturgeon spawning period is April-June, and the intervals examined are the three wettest sixths of the period of record. During this timeframe, the mean flow values for the entire timeframe for the three wettest sixths of the period of record are roughly 19,800 cfs, 12,300 cfs, and 9,600 cfs, respectively. The mean flow during the highest flow month of the timeframe for the wettest three-sixths of the period of record is roughly 28,700 cfs, 16,200 cfs, and 13,400 cfs, respectively.

Pallid Sturgeon Habitat Creation/Maintenance and Food Base Production Period

As mentioned previously in the discussion of pallid sturgeon "indicators," the timeframe examined for the pallid sturgeon habitat creation and maintenance and food base production is February-July, and the intervals examined are the three wettest sixths of the period of record for habitat creation/maintenance and all three thirds of the period of record for food base production.

For habitat creation/maintenance during this timeframe, the mean flow values for the entire timeframe for the three wettest sixths of the period of record are roughly 16,900 cfs, 11,200 cfs, and 9,200 cfs, respectively. The mean flow during the highest flow month of the timeframe for the three wettest sixths of the period of record is roughly 33,100 cfs, 18,400 cfs, and 15,100 cfs, respectively.

For food base production during this timeframe, the mean flow value for the entire timeframe for the three thirds of the period of record are roughly 14,000 cfs, 8,400 cfs, and 5,800 cfs, respectively. The mean flow during the highest flow month of the timeframe for the three thirds of the period of record is roughly 25,800 cfs, 13,800 cfs, and 8,600 cfs, respectively.

Summer Period

As mentioned previously in the discussion of pallid sturgeon "indicators," the timeframe examined for the summer period is June-August, and the intervals examined are the three driest sixths of the period of record. During this timeframe, the mean flow values for the entire timeframe for the three driest sixths of the period of record are roughly 3,000 cfs, 4,300 cfs, and 5,300 cfs, respectively. The mean flow during the lowest flow month of the timeframe for the driest three sixths of the period of record is roughly 1,300 cfs, 2,000 cfs, and 2,700 cfs, respectively.

Fall and Winter Periods

As mentioned previously in the discussion of pallid sturgeon "indicators," the five remaining months (September, October, November, December, and January) are examined individually, and the intervals examined are the three driest sixths of the period of record, shown in table 4-S-1.

Table 4-S-1.—Mean Flow Values for the Entire Timeframe for the Three Driest Sixths of the Period of Record (cfs).

September	October	November	December	January
1,500 cfs 2,100 cfs 2,700 cfs	2,400 cfs 3,200 cfs 3,500 cfs	3,300 cfs 4,200 cfs 4,700 cfs	2,600 cfs, 3,500 cfs 4,200 cfs	2,700 cfs 3,500 cfs 3,900 cfs

OTHER FEDERALLY LISTED SPECIES AND DESIGNATED CRITICAL HABITAT

INTRODUCTION

In addition to the target species, other federally listed species and designated critical habitat may be present in the North, South and Central Platte River Basins and may be affected by the action alternatives. These species and critical habitats are shown in table 4-FL-1. This section of this FEIS describes other federally listed species, Federal candidate species, and designated critical habitat that may be present in the action area, and the species' status, habitat, and distribution in Wyoming, Colorado and Nebraska.

The action area in Wyoming, Colorado, and Nebraska includes the North Platte River Basin from its headwaters in Colorado to its confluence with the South Platte River; the South Platte River Basin downstream of Greeley, Colorado, to its confluence with the North Platte River; and the main stem Platte River Basin from the confluence of the North and South Platte Rivers to its confluence with the Missouri River. A short reach of the Missouri River downstream of the confluence is included in the action area.

Table 4-FL-1.—Other Federally Listed Species and Designated Critical Habitat in the Action Area of the North Platte River, South Platte River, and Platte River Basins

Common Name	Scientific Name	Status	State
Threatened and Endangered Species/Critical Habitat			
American burying beetle	*Nicrophorus americanus Olivier*	Endangered	Nebraska
Bald eagle	*Haliaeetus leucocephalus*	Threatened	Wyoming Colorado Nebraska
Black-footed ferret	*Mustela nigripes*	Endangered	Wyoming Colorado
Canada lynx	*Lynx canadensis*	Threatened	Wyoming Colorado
Colorado butterfly plant	*Gaura neomexicana spp. Coloradensis*	Threatened	Wyoming Colorado Nebraska
Eskimo curlew	*Numenius borealis*	Endangered	Nebraska
North Park phacelia	*Phacelia formosula*	Endangered	Colorado
Preble's meadow jumping mouse	*Zapus hudsonius preblei*	Threatened	Wyoming Colorado
Ute ladies'-tresses orchid	*Spiranthes diluvialis*	Threatened	Wyoming Colorado
Western prairie fringed orchid	*Platanthera praeclara*	Endangered	Nebraska
Wyoming toad	*Bufo baxteri*	Endangered	Wyoming
Designated Critical Habitat			
Colorado Butterfly Plant	*Gaura neomexicana spp. Coloradensis*	Threatened	Wyoming
Preble's Meadow Jumping Mouse	*Zapus hudsonius preblei*	Designated	Wyoming

INDICATORS AND METHODS

The indicator for potential impacts that may result form the proposed action alternative is:

- ➢ The locations of known species under consideration.
- ➢ Potential impacts to these habitats under the alternatives.

Where elements of the action alternatives occur in these locations, an examination is undertaken of the potential to adversely affect those species.

Species status, species description, and habitat descriptions are reported below by State. If the species occurs in more than one State, these descriptions are not repeated. However, a general description of species' distribution is provided for each State. The following descriptions also include designated critical habitat in the action area.

PRESENT CONDITION

Other Federally Listed Species

American Burying Beetle—Nebraska

American Burying Beetle Introduction

The American burying beetle (*Nicrophorus americanus Olivier*) is one of 11 species of burying beetles found in Nebraska (Ratcliffe, 1996). It was listed as endangered on August 14, 1989 (*Federal Register* [FR] 54 [133]: 29652-55). These beetles locate small, dead vertebrates, and then one male and one female beetle work together to bury the carrion. The female lays her eggs at the site, and then both stay with the developing larvae until the grubs pupate. Both the adults and young feed on the buried carcass (Ratcliffe, 1996).

The species has been found in wet meadows, streams, and wetlands and in association with relatively undisturbed, semi-arid, sandhill and loam grasslands. The American burying beetle is generally recognized as a habitat generalist, whose limitation in conservation

- ➢ Less optimally sized carrion
- ➢ More vertebrate scavengers, resulting in more competition for carrion
- ➢ More competition from other species of the Nircrophorus genus

In Nebraska, American burying beetle populations are known to occur in Antelope, Blaine, Boone, Brown, Cherry, Custer, Dawson, Frontier, Gosper, Holt, Keya Paha, Lincoln, Loup, Rock, Thomas, and Wheeler Counties.

In the action area in Nebraska, the American burying beetle occurs in Dawson, Frontier, Gosper, and Lincoln Counties. The range of the species appears to be concentrated in the highly dissected uplands (loess hills) south of the Platte River near Gothenburg, Nebraska, although individuals have been observed in grasslands adjacent to the Platte River (Ratcliffe, 1990; Jameson and Ratcliffe, 1991; Ratcliffe, 1996; Bedick et al., 1999; and Peyton, 2003). Peyton (2003) stated that the beetle does not appear to be common in other habitats, such as open grassland and riparian forests. Peyton (2003) estimated the loess hills population size at approximately 3,000 beetles, based on a mark recapture study. This exceeds the recovery goal of 500 individuals per population recommended by the Service (1991 [Beetle]) and identifies the population in the loess hills as one of the largest in the U.S.

American Burying Beetle Indicators

Any affects to the American burying beetle would occur with the conversion of irrigated acres to grassland as a result of water leasing that is present in all action alternatives. Water leasing from croplands south of central the Platte River in Dawson, Frontier Gosper, and Lincoln Counties is anticipated to increase the presence of birds and mammals that could serve as carcasses for American burying beetle egg laying. For analysis purposes, it is anticipated that land cover changes from the Present Condition would vary little by alternative within the Program's First Increment.

Bald Eagle—Wyoming, Colorado, and Nebraska

The bald eagle (eagle) was first listed as endangered under the Endangered Species Protection Act of 1966 on March 11, 1967 (32 FR 4001). On February 14, 1978 (43 FR 6233), the species was listed as endangered under the ESA of 1973 in 43 states (omitting Washington, Oregon, Minnesota, Wisconsin, and Michigan, where it was listed as threatened). One cause of population decline was impaired reproduction caused by tissue accumulation of pesticide residues ingested from contaminated prey. The population and the number of occupied nesting territories have increased throughout much of the U.S. over the past two decades, and the eagle was down-listed from endangered to threatened in all 48 coterminous states on July 12, 1995 (60 FR 36000). Recovery of the eagle continues to progress, and the Service published a proposed rule to remove the eagle in the lower 48 states from the list of endangered and threatened wildlife (64 FR 36454) on July 6, 1999.

The bald eagle is the only species of sea eagle native to North America. Female eagles usually weigh 10 to 14 pounds in the northern sections of the continent and are larger than the male, which weighs 8 to 10 pounds. Birds nesting in the north are larger and heavier than birds of the south with the largest birds nesting in Alaska and Canada and the smallest birds nesting in Arizona or Florida. The wings span 6 to 7 feet.

Colorado and Nebraska fall within the Northern States Recovery Region, and Wyoming is within the Pacific Recovery Region (Service, 1983 [eagle] and Service, 1986 [eagle]). The primary objective in these recovery regions is to re-establish self-sustaining populations of eagles in suitable habitat. The eagles' southward migration begins as early as October, and the wintering period extends from December-March. Loss of suitable habitat, mortality from shooting, trauma, poisoning, diseases, electrocution, and other causes, as well as reduced reproduction caused by environmental contaminants are the most important problems that have decreased eagle populations. Additionally, many eagles nest from mid-February through mid-August. Disturbances within 0.5 mile of an active nest or within line-of-sight of the nest could cause adult eagles to discontinue nest building or to abandon eggs. Human disturbances and loss of eagle wintering habitat can cause undue stress, leading to cessation of feeding and failure to meet winter thermoregulatory requirements. These effects can reduce the carrying capacity of preferred wintering habitat and reproductive success for the species.

Wyoming Bald Eagle Distribution

In Wyoming, the bald eagle is found along the North Platte River, most commonly above Seminoe Reservoir for nesting and brood-rearing, with several communal roosts from Seminoe to the Nebraska state line. Surveys conducted by Wyoming Game and Fish Department during April of 2004 found 13 active, occupied nests in the upper North Platte above Seminoe Reservoir (WG&F, 2005, personal communication, Andrea Cerovski, non-game biologist). Active, occupied nests located upstream of Seminoe Reservoir in Carbon County, Wyoming during the 2004 surveys include the following sites identified by WG&F: Seminoe Backwaters, Scout Island, Savage Meadows, Lunt, Rochelle, Baggot Rocks, 1 Bar 11, Monroe, A-A South, Bennett Peak, Rattlesnake Pass, Irving, and Pass Creek at Bryant Slough. Two historical nest sites also exist along the North Platte River downstream from Casper, Wyoming.

A large number of bald eagles winter along the North Platte River from November - March. They concentrate in historically used roosts at night and forage opportunistically over central Wyoming during the day. They make extensive use of the North Platte River and its reservoirs to hunt fish and waterfowl, but also range widely over the sagebrush grasslands in search of winter-killed big game and livestock to scavenge. Foraging on the North Platte River and reservoirs in winter is restricted by availability of open water.

Bald eagles in Wyoming will use Seminoe Reservoir until ice-up and are known to frequent Kortes Reservoir just downstream. The river reach between Kortes Dam and the headwaters of Pathfinder Reservoir is known as the Miracle Mile reach of the North Platte River. Bald eagles use this river reach extensively during the winter and commonly are observed perched in cottonwood trees. A major bald eagle winter roost is located in the Pedro Mountain area in close proximity to Pathfinder Reservoir: Pathfinder having the highest concentration of wintering bald eagles of any reservoir USBR manages along the North Platte River (Reclamation, 1981, [eagle]).

The North Platte River from Gray Reef Dam to Glendo Reservoir supports one of the largest wintering concentrations of bald eagles in Wyoming and has been designated by the Service as very high value nationally for wintering and nesting bald eagles (Service, 1988 [values]). According to the Midwinter National Wildlife Federation Bald Eagle Survey, the North Platte River supports fifty percent or more of the total wintering bald eagle population in Wyoming. Cottonwood trees along the river are important perch sites and are used as night roosts. Communal bald eagle roosts near the river include Boxelder Creek, Jackson Canyon, Little Red Creek, and Pine Mountain. Roost counts conducted by the Bureau of Land Management found use of these roosts peaked in the winter of 1984-85, with an average of 43 eagles per count, and a maximum of 70 eagles counted on December 20, 1994 (all roosts combined) (Bureau of Land Management, 1999, personal communication, William Fitzgerald, biologist). Eagles using these roosts hunt for fish and waterfowl along the river and associated reservoirs, hunt in the desert for small game, and scavenge in the desert for winter-killed big game and livestock (Reclamation, 1981 [limnology]). Bald eagles have nested along the river at Edness K. Wilkins State Park and near Caryhurst, although neither of these nests has been active in recent years.

Bald eagles winter in the area of Glendo Reservoir, using the cottonwood trees adjacent to the reservoir for perching and preying on the abundant fish and waterfowl. Bald eagles are common winter residents prior to ice-up in the North Platte River from Glendo Dam to Guernsey Reservoir. The also are common winter residents from Guernsey Dam to the Nebraska state line, feeding on fish and abundant wintering waterfowl in the area (Reclamation, 1981 [limnology]), and the area is recognized for its high resource value by the Service (Service, 1988 [values]).

Colorado Bald Eagle Distribution

Within the South Platte River drainage, annual midwinter bald eagle surveys are conducted from Denver to the Nebraska State line. Between 1987 and 2002, midwinter survey counts have ranged from a low of 112 eagles in 1988 to a high of 253 eagles in 1994. During the 2002 midwinter survey, 238 eagles were counted (Colorado Division of Wildlife [CDOW], 2002).

In Colorado, eagles breed in both the upper North Platte River and South Platte River drainages. A nesting pair has been documented on the Lower South Platte River downstream of Prewitt Reservoir for the 2003 breeding season (Jerry Craig, CDOW, 2005, personal communication, Kirstie Bay, Biologist). In 2001, there was one occupied nesting territory on the upper North Platte River (in Jackson County, Colorado) that fledged two young (CDOW, 2002). Nesting in the South Platte River drainage increased from 1 nest in 1990 to 13 occupied nests in 2001. In 2001, the 13 occupied nests fledged 11 young (CDOW, 2002).

Communal eagle night roosts have been documented at nine locations within the South Platte River drainage in Colorado. The largest roost, located on the Rocky Mountain Arsenal, may be used by as many as 80 eagles. Eagle use of most roosts varies from 6 to 40 eagles (CDOW, 2002). Most roosts are in old growth cottonwoods along the South Platte River and some reservoirs. These habitats are endangered by urbanization and expanding gravel mining operations.

Nebraska Bald Eagle Distribution

In the past, nesting chronology has not been well documented for Nebraska because of the lack of a nesting population. In 1991, an active eagle territory was discovered on the Lower Platte River near Valley (Farrar, 1991). This was the first nesting territory recorded for Nebraska in approximately 100 years. Although the lone adult hatched one young, the eaglet did not successfully fledge. The first documented successful nesting and fledging of young eagles in Nebraska since the late 1800s occurred in Sherman County in 1992. By 2004, the number of active nests in Nebraska had increased to 35 and were located in 13 counties. Monitoring was sufficient to document the outcome of 32 out of the 35 active nests. These 32 nests fledged 60 young. Since 2004, 208 young have been fledged in Nebraska.

Nesting birds located within the North Platte, South Platte, and Platte River Basins include a nesting pair on Lake Alice in Scottsbluff County. Lake Alice and the surrounding uplands are protected as part of the North Platte National Wildlife Refuge (NWR) complex. The lakes of the North Platte NWR are fed by the Interstate Canal, whose flows are managed by Reclamation. Additional eagle nests potentially affected by the Program include a nest on the North Platte River near the Bayer Bridge in Morrill County and seven active nests along the Lower Platte River. A nest near Odessa in Buffalo County collapsed and was destroyed.

Studies of wintering eagles and their habitat use over the past 20 years have documented the use of the Platte River Basin, especially the Central Platte, as a major wintering area for eagles (Vian, 1971; Reclamation, 1981; Lingle and Krapu, 1986; and Stalmaster and Associates, 1990). Three segments known for concentrations of roosting eagles include:

- The North Platte River, Keystone to Lewellen area, including Lake McConaughy and Lake Ogallala
- The North and South Platte Rivers, Maxwell to the Lincoln/Keith County line, including Sutherland Reservoir

- The Platte River, Darr to Elm Creek area, including Johnson and Elwood Reservoirs.

During 1980 to 1996, no other area in Nebraska (with the exception of Harlan County Reservoir) supported more eagles on an average than the 30-mile stretch of the Platte River between Darr and Elm Creek (i.e., including Johnson and Elwood Reservoirs, the Johnson-2 return channel and powerplant, and associated canal system). In 1992, the Nebraska Game and Parks Commission observed 152 eagles in the North Platte, 65 in the South Platte, and 202 in the Central Platte Rivers, respectively.

The importance of the Basin (North Platte, South Platte, and Platte Rivers) in Nebraska to eagles during the 1980-1998 period is evidenced by the fact that an average of 27 percent (170 birds) of the total State-wide wintering population were found in the Basin. During the abnormally cold winter of 1978-1979, 65 percent (131 birds) of the total State-wide wintering population used the Basin.

From mid-October through early December, eagles can be found anywhere between Lexington and Grand Island. Normally, the weather is somewhat mild and the river is ice-free during this period. However, beginning in late December of most years, the weather becomes more severe and the river often freezes between Kearney and Grand Island. Eagles then move to a stretch of ice-free river located downstream from the point where Johnson-2 return channel flows enter the river.

A study by the Service (1981) found that the six communal night roosts on the Platte River between Darr and Elm Creek averaged 60 eagles per night. Currently, there are at least eight communal night roosts on the Platte River between Brady and Grand Island.

Bald Eagle Indicators

Because of the abundance of wintering eagles along the North Platte, South Platte, and Platte Rivers, selected gauges (table 4-FL-2) were used to determine action alternative impacts to flows along these river systems. The months of December-February were identified as the wintering months for the eagle.

Table 4-FL-2.—Average Monthly Flows Under the Present Condition (1947-1994) (cfs).

	Dec	Jan	Feb
Above Lake McConaughy	1,317	1,206	1,285
North Platte River at Keystone (below the Sutherland Diversion)	0	5	10
North Platte River At North Platte	371	347	390
South Platte River At Julesburg	552	734	854
South Platte River at Paxton (below the Korty Diversion)	209	304	426
Platte River at Maxwell (below the Tri-County Diversion)	201	322	379

The Service has identified instream target flows for the months of December though January as important for wintering eagles and their prey. Reduction of these target flow shortages, compared to the Present Condition, would be beneficial to eagles.

Because of the high occurrence of both nesting and wintering eagles along the Lower Platte River (below the Loup confluence), food base production for that reach of the river was analyzed for the months of

February-July. For food base production during this timeframe,[18] the mean flow values of the wettest third, middle third, and driest third for the period of record are roughly 14,000 cfs, 8,400 cfs, and 5,800 cfs, respectively. The mean flow during the peak flows of the timeframe for the three thirds of the period of record is roughly 25,800 cfs, 13,800 cfs, and 8,600 cfs, respectively. The change in eagle wintering flows for the months of December and January is also evaluated. During this timeframe, the mean flow values for the three driest sixths of the period of record are roughly 3,300 cfs, 4,200 cfs, and 4,700 cfs, respectively, for November and 2,600 cfs, 3,500 cfs, and 4,200 cfs, respectively, for December.

Improvements to active channel and wet meadow habitats would be beneficial for eagle prey items. Wetted channel is the selected index for channel habitat which represents 9,968 acres for the Present Condition in the Central Platte River. Bottomland grassland is the selected index for wet meadow habitat, which represents 43,035 acres for the Present Condition in the Central Platte River.

Black-Footed Ferret—Wyoming and Colorado

The black-footed ferret *(Mustela nigripes*) is a member of the Mustelid or weasel family; has a black face mask, black legs, and a black-tipped tail; is nearly 60 centimeters (2 feet) in length; and weighs up to 1.1 kilograms (2.5 pounds). It is the only ferret species native to North America.

The Service listed black-footed ferrets as endangered in 1967 (32 FR 48, March 11, 1967) under a precursor to the ESA of 1973. By the 1970s , although several ferret sightings were reported, the only documented population had been found in South Dakota in 1964. In 1974, the remnant wild population of ferrets in South Dakota abruptly disappeared (Henderson et al., 1969; updated 1974). As a result, the species was presumed extinct. Then in 1981, a small population of ferrets was discovered near Meeteetse, Wyoming. The population increased from 1981 through 1984. At its peak in 1984, nearly 130 ferrets were counted at Meeteetse. However, in 1985 to 1986, the Meeteetse population declined to only 18 animals, due to an outbreak of sylvatic plague and canine distemper (Service, 1988 [ferret]).

Today, the captive population of juveniles and adults annually fluctuates between 300 and 600 animals, depending on time of year, yearly reproductive success, and annual mortalities. Sixty-five to 90 ferrets are located at several field-based, captive-breeding sites in Arizona, Colorado, Montana, and New Mexico.

The first reintroduction project occurred in Wyoming in 1991, and subsequent efforts have taken place in South Dakota and Montana in 1994, Arizona in 1996, a second effort in Montana in 1997, Colorado and Utah in 1999, a second site in South Dakota in 2000, and Mexico in 2001.

Black-Footed Ferret Wyoming Distribution

The only known population in Wyoming is a reintroduced population in the Shirley Basin located in the northwest corner of Carbon County.

[18] See the "Pallid Sturgeon" section in this chapter for a thorough description of these indicators.

Black-Footed Ferret Colorado Distribution

As part of ongoing efforts to reintroduce the black-footed ferret to its historic range, there have been five releases to date, in 2003, in the remote White River region of northwest Colorado (CDOW, 2003 [ferret]). A total of 58 black-footed ferrets have been released in the U.S. Bureau of Land Management's (BLM) Wolf Creek Management Area, southeast of Dinosaur National Monument. These areas are outside the study area.

Black-Footed Ferret Indicators

No indicators were identified because the species is found in isolated, reintroduced populations far removed from areas potentially considered for water leasing (refer to the "Other Listed Species" section in chapter 5).

Canada Lynx—Colorado and Wyoming

Canada Lynx Introduction

The Canada lynx (*Lynx canadensis*) was listed by the Service as threatened on March 24, 2000 (65 FR 58). No critical habitat has been designated for the threatened population of lynx in the contiguous United States.

Within the contiguous United States, the lynx's range extends into different regions that are separated from each other by ecological barriers consisting of unsuitable lynx habitat. These regions are the Northeast, Great Lakes, northern Rocky Mountain/Cascades, and the Southern Rocky Mountains. In the contiguous United States, lynx populations occur at naturally low densities. The Northern Rockies/Cascades supports the largest amount of lynx habitat and the strongest evidence of persistent occurrence of resident lynx populations. Lynx continue to persist in the remaining geographic areas but are considered rare (Service, 2000).

In response to the emerging awareness of the uncertain status of lynx populations and habitat in the coterminous United States, and the onset of the listing process, an interagency Canada lynx coordination effort was initiated in March 1998. The Service, U.S. Forest Service, BLM, and National Park Service (NPS) have participated in this effort. Three products that are important to the conservation of the lynx on federally managed lands have been produced:

- "Scientific Basis for Lynx Conservation" (Ruggiero et al. 1999)
- "Lynx Conservation Assessment and Strategy" (Ruediger et al., 2000)
- Lynx Conservation Agreements between the Service and various land management agencies

The NPS is currently developing a conservation agreement with the Service for Canada lynx that was completed in draft form in the second quarter of 2000. That agreement will promote the conservation of Canada lynx and its habitat in the national parks and identify actions the NPS agrees to take to reduce or eliminate potential adverse effects or risks to lynx and their habitat. The "Lynx Conservation Assessment and Strategy" (Ruediger et al., 2000) provides a consistent and effective approach to conservation of lynx on Federal lands.

Canada Lynx Wyoming and Colorado Distribution

Colorado represents the extreme southern range of the lynx. The southern boreal forests of Colorado and southeastern Wyoming are isolated from boreal forest in Utah and northwestern Wyoming by the Green River Valley and the Wyoming Basin (Findley and Anderson, 1956, as cited in McKelvey et al., 2000 [distribution]). These areas likely reduce or preclude opportunities for genetic interchange with the Northern Rocky Mountains/Cascade region and Canada, effectively isolating lynx in the Southern Rocky Mountain Region (Halfpenny et al., 1982; and Koehler and Aubry, 1994).

A majority of lynx occurrence records in Colorado and southeastern Wyoming are associated with the "Rocky Mountain Conifer Forest" type. The occurrences in the Southern Rockies were generally at higher elevations than were all other occurrences in the West (McKelvey et al., 2000 [distribution] and [population]).

In Colorado, a state-wide lynx verification program conducted from 1978-80 by CDOW concluded that viable, low-density lynx populations persisted in Eagle, Pitkin, Lake, and Clear Creek Counties (Halfpenny and Miller, 1981). Because Summit County is sandwiched between three of those counties, it is likely that lynx existed there as well. In addition, the program provided evidence of lynx occurrence in Grand and Park Counties. Lack of evidence from other portions of the state was likely a consequence of survey effort, rather than lack of lynx.

Lynx were confirmed in Eagle County as late as 1991 and in Summit County (Gore Range) as late as 1993. Evidence has continued to indicate lynx occupancy of the central and possibly northern mountains throughout the 1990s. This evidence includes a sighting by a Forest Service biologist in July 1998 in the Flattop Wilderness Area, in northwestern Colorado, and tracks in Larimer County, north of Rocky Mountain National Park. The CDOW found evidence of lynx in Eagle County and in Grand County. Radio tracking in 2000 of lynx translocated to Colorado indicated that a few individuals spent time in the Gore Range. In July 2001, CDOW reported a collared lynx in the Flattops Wilderness Area (CDOW, 2001, personal communication, Tanya Shenk).

Canada Lynx Indicators

No indicators were identified because the species is found in isolated, high-elevation populations far removed from areas in the North Platte River Basin potentially considered for water leasing (refer to the "Other Listed Species" section of chapter 5).

Colorado Butterfly Plant—Wyoming, Colorado, and Nebraska

On October 18,2000, the Colorado butterfly plant (Gaura neomexicana ssp. coloradensis) was designated as threatened throughout its entire range under the Endangered Species Act (Act) (65 FR62302). Critical Habitat was designated for the Colorado butterfly plant in 2005 (70 FR 1940.1970 January 11, 2005).

The Colorado butterfly plant is a shortlived perennial herb that lives for several years before bearing fruit once and then dying. The plant has one to several reddish, pubescent stems are 50 to 80 centimeters tall and branch primarily from below the middle of the plant. The lance-shaped leaves average 5 to 10 centimeters long and have smooth or wavy-toothed margins. The flower, located above the leaves, consists of numerous branches that continue to grow throughout the flowering season. Individual flowers are 1-1.5 centimeters long with four reddish sepals and four white petals that turn pink or red with age (Fertig, 2000).

The Colorado butterfly plant occurs on subirrigated, alluvial (stream deposited) soils on level or slightly sloping flood plains and drainage bottoms at elevations of 1524-1951 meters (5000 to 6400 feet). Colonies are often found in low depressions or along bends in wide, active, meandering stream channels a short distance upslope of the actual channel. The plant requires early- to mid-succession riparian (riverbank) habitat. The plant occurs on soils derived from conglomerates, sandstones, and tuffaceous mudstones and siltstones of the Tertiary White River, Arikaree, and Ogalalla Formations (Love and Christiansen, 1985). These soils are common in eastern Colorado and Wyoming.

Colorado Butterfly Plant Colorado and Wyoming Distribution

The Colorado butterfly plant is a regional endemic historically found from Boulder, Douglas, and Larimer Counties in Colorado, Laramie County in Wyoming, and western Kimball County in Nebraska. Based on surveys conducted by the Service during 2004 and 2005, extant populations appear restricted to Laramie and Platte Counties in Wyoming and to Weld and Larimer Counties in northern Colorado—all locations are within the North and South Platte River watershed. Approximately ninety percent of known occurrences in Wyoming are on private lands, and almost ten percent on state lands. Two populations in Wyoming occur on F.E. Warren Air Force Base located in Cheyenne.

Recent surveys revealed populations of the Colorado butterfly plant in two locations in Colorado, both currently owned by the City of Fort Collins: the Meadow Springs Ranch in northem Weld County where the plant has been known historically; and a new population that was discovered in 2005 in northern Larimer County on the Soapstone Prairie Natural Area.

Colorado Butterfly Plant Nebraska

While the Colorado butterfly plant was known to occur historically in western Kimball County, Nebraska, surveys conducted by the Service during 2004 did not find any extant populations nor any suitable habitat. However, one unconfirmed report during 2004 by Nebraska Natural Heritage Program indicates that a small population may still exist in Oliver Reservoir Recreational Area. Surveys conducted by the Service at Oliver Reservoir during 2005 failed to locate any plants.

Colorado Butterfly Plant Indicators

No indicators were used because of the unknown details of water leasing (refer to the “Other Listed Species” section in chapter 5).

North Park Phacelia—Colorado

North Park Phacelia Introduction

The endangered North Park phacelia (*Phacelia formosula*) was federally listed as an endangered species in 1982 (Service). It was first discovered on August 6, 1918, by the Colorado botanist, George Osterhout (Service 1986). Other sites were not identified until 1981. The recovery plan was published in 1986 (Service 1986).

North Park phacelia is a Colorado endemic; it is found only in North Park in Jackson County (Service, 1986). Within the North Park region, the species is found from Michigan Creek west to the North Platte River. Eight populations are known, with a total of less than 8,000 individuals and annually fluctuating population sizes (NatureServe, 2003). Only two of the sites appear to support significant numbers (Service, 1986, NatureServe 2003). One of these major populations and six smaller populationss are located along the North Platte River. Land managers include the BLM, private landowners, and the State of Colorado.

North Park Phacelia Indicators

No indicators were used because no actions or effects are anticipated in the North Platte River headwaters where phacelia are found (see the "Other Listed Species" section in chapter 5).

Eskimo Curlew—Nebraska

Eskimo Curlew Introduction

On March 11, 1967, the Eskimo curlew was designated as endangered in the entire range of its known occurrence. This species is historically known to occur in Alaska, Kansas, Montana, North Dakota, Nebraska, Oklahoma, South Dakota, Texas, Canada, and Central and South America.

Although once abundant throughout its range, the curlew is now among the rarest bird species in the western hemisphere (Faanes and Senner, 1991). During 1981 to 1984, visits to historical nesting grounds uncovered no evidence of breeding (Gollop et al., 1986).

Eskimo Curlew Distribution

No known populations of the Eskimo curlew currently occur in Nebraska.

Eskimo Curlew Indicators

No indicators were used because the species is thought to be extirpated from Nebraska (see the "Other Listed Species" section in chapter 5)

Preble's Meadow Jumping Mouse—Wyoming and Colorado

Preble's Meadow Jumping Mouse Introduction

The Preble's meadow jumping mouse was listed as a threatened species on May 13, 1998 (63 FR 26517). Preble's is a small rodent in the family Zapodidae and is 1 of 12 recognized subspecies of the species Zapus hudsonius, the meadow jumping mouse. Preble's is native only to the Rocky Mountains-Great Plains interface of eastern Colorado and southeastern Wyoming. Critical habitat was designated for Preble's on June 23, 2003 (65 FR 3725-37332).

The Preble's is a relatively small rodent with an extremely long tail, large hind feet, and long hind legs (Krutzsch, 1954 and Fitzgerald et al., 1994). The Preble's is found along the foothills in southeastern Wyoming, southward along the eastern edge of the Front Range of Colorado to Colorado Springs, El Paso County (Hall, 1981; Clark and Stromberg, 1987; and Fitzgerald et al., 1994).

Krutzsch (1954), Quimby (1951), and Armstrong (1972) agree that across its range, Preble's occurs mostly in low undergrowth consisting of grasses, forbs, or both; in open wet meadows and riparian corridors; or where tall shrubs and low trees provide adequate cover. In addition, Preble's prefers lowlands with medium to high moisture over drier uplands. Tester et al. (1993) suggested that proximity to water may be the most important factor influencing habitat selection and use by Preble's. It has been speculated that Preble's may need an open water source to fulfill dietary water requirements. Shenk and Sivert (1999) noted the use of both perennial and intermittent tributaries adjacent to capture sites. Armstrong et al. (1996) reported that trapping success in ephemeral drainages decreased notably in late summer after flow ceased.

Preble's Meadow Jumping Mouse Wyoming Distribution

In Wyoming, capture locations of mice confirmed as Preble's, and locations of mice identified in the field as Preble's and released, extend in a band from the town of Douglas southward along the Laramie Range to the Colorado border, with captures east to eastern Platte County and Laramie County.

Preble's Meadow Jumping Mouse Colorado Distribution

The Preble's is largely a riparian species found within the 100-year flood plain and nearby uplands of the South Platte River, the Arkansas River, and their tributaries, from the Wyoming border south to El Paso County. In Colorado, the Preble's has been trapped since the mid-1990s in a number of sites in Larimer, Weld, Boulder, Jefferson, Douglas, Teller (at the Douglas County line), Elbert, and El Paso Counties. In Colorado, the distribution of the Preble's forms a band along the Front Range from Wyoming southward into El Paso County, with eastern marginal captures in western Weld County, western Elbert County, and north-central El Paso County. Critical habitat has been designated in Larimer, Jefferson, and Douglas Counties. These areas are upstream of the areas in the South Platte Basin that may be affected by Program alternatives.

Preble's Meadow Jumping Mouse Indicators

No indicators were used because of the unknown details of water leasing (refer to "Other Listed Species" in chapter 5).

Ute Ladies'-Tresses Orchid—Wyoming and Colorado

The Ute ladies'-tresses orchid (*Spiranthes diluvialis*) was listed as a threatened species on January 17, 1992 (57 FR 2053). This orchid is found in moist soils near wetland meadows, springs, lakes, and perennial streams. It occurs generally in alluvial substrates along riparian edges, gravel bars, old oxbows, and moist to wet meadows at elevations from 4200 to 7000 feet. The orchid colonizes early successional riparian habitats such as point bars, sandbars, and low-lying gravelly, sandy, or cobbly edges, persisting in those areas where the hydrology provides continual dampness in the root zone through the growing season. The species occurs primarily in areas where the vegetation is relatively open and not overly dense, overgrown, or overgrazed (Coyner, 1989 and 1990 and Jennings, 1989 and 1990). Plants usually occur as small scattered groups and occupy relatively small areas within the riparian system.

The orchid is a perennial herb with stems 20 to 50 centimeters tall that arise from thickened roots. Its narrow leaves are about 28 centimeters long at the base of the stem and become smaller in size going up the stem. Flowers consist of few to many small, white, or ivory flowers clustered into a spike arrangement at the top of the stem. The species is characterized by whitish, stout, gaping-mouthed flowers (57 FR, 1992 12:2048-2054). The Ute ladies'-tresses orchid typically blooms from late July-August (in some cases, through September), with blooms recorded as early as late June and as late as early October (Sheviak, 1984; Coyner, 1990; and Jennings, 1989).

Ute ladies'-tresses orchid is currently known in northwestern Nebraska, eastern Wyoming, north-central and northwestern Colorado, northeastern and southern Utah, east-central Idaho, southwestern Montana, and north-central Washington (Moseley, 1998).

The orchid is believed to be extirpated from most of its historical range due to alterations of stream hydrography and hydrology. Flow timing, flow quantity, and water table characteristics influence riparian vegetation (Pague and Grunau, 2000 [NCC]). Specific levels of change in hydrology, and how they affect this orchid, are not well understood, but Auble et al. (1994) demonstrated significant vegetation changes after losses greater than 0.5 meter in groundwater levels. Channelized and depleted streams are no longer capable of creating the semi-open habitats or maintaining the hydrologic conditions that sustain damp rooting zones throughout the growing season.

Ute Ladies'-Tresses Orchid Wyoming Distribution

In Wyoming, this species is known to occur at the southern extent of the North Platte River drainage in Converse, Goshen, Laramie, and Niobrara Counties. Other Wyoming populations are located in the southern Powder River Basin and in the Niobrara River Valley.

Ute Ladies'-Tresses Orchid Colorado Distribution

The Colorado populations occur in Boulder County along South Boulder Creek, Boulder Creek and its tributary Fourmile Creek, St. Vrain Creek, and Left Hand Creek; Jefferson County along Clear Creek; and Larimer County near the Cache La Poudre River/Claymore Lake. In western Colorado, populations occur along the Green River in Moffat County. Potential habitat is known to exist at a historical location for the species in Weld County, along the South Platte River near the mouth of Crow Creek (Service, 2002 [Ute ladies'-tresses]).

Ute Ladies'-Tresses Orchid Nebraska Distribution

The species is only known to occur in association with the Niobrara River in Sioux County.

Ute Ladies'-Tresses Orchid Indicators

No indicators were developed because of the unknown details and locations of water leasing actions (refer to the "Other Listed Species" section in chapter 5).

Western Prairie Fringed Orchid—Nebraska

On September 28, 1989, the western prairie fringed orchid *(Planthera praeclara*) was designated as threatened throughout its range. This orchid is known to occur in Iowa, Kansas, Minnesota, Missouri, North Dakota, Nebraska, Oklahoma, and Canada (Manitoba).

The western prairie fringed orchid is a smooth, erect, 2- to 4-foot-tall perennial species of terrestrial and palustrine communities in the North American tallgrass prairie biome. It is most often found on unplowed calcareous prairies and sedge meadows, but it has been observed at disturbed sites in successional communities (e.g., roadside ditches, borrow pits, and old fields). The two to five elongated leaves are hairless and thick. The open, spike-like inflorescence bears up to two dozen showy, 1-inch-wide, white flowers (Service, 1996).

Habitat dewatering and conversion to cropland are primary factors adversely affecting the western prairie fringed orchid throughout its range. Hydrologic alterations that draw down the water table near the root zone are associated with decreased flowering and increased plant mortality. Because Platte River discharge and stage are dominant factors influencing groundwater levels in the Platte River valley (USGS, 1964; Hurr, 1983; and Henszey and Wesche, 1993), depletions during the spring contribute to reduced frequency and duration of saturated soil conditions. Depletions contribute cumulatively to flow reductions during the pulse flow season (May and June). This, in turn, influences the frequency and duration of soil saturation. As a result of reduced flows, low-lying prairies and wet meadows near the Platte River have become drier. Conversion, fragmentation, and dewatering of low grassland and wet meadow habitats may adversely affect the western prairie fringed orchid by: (1) eliminating habitat; (2) reducing its potential range and distribution; (3) preventing or retarding expansion, colonization, or recolonization; and (4) decreasing the resilience of isolated populations to environmental stochasticity.

Western Prairie Fringed Orchid Nebraska Distribution

Numerous populations of the western prairie fringed orchid were known to occur along the Platte River. Historic populations from the late 1800s and early 1900s were observed in Cass, Dodge, and Kearney Counties. Recent sightings, from the 1990s to present, are located in a wet meadow on the Mormon Island Crane Meadows in Hall County and in prairies near the Lower Platte River in Sarpy County. The Mormon Island Crane Meadows site is owned and managed by the nonprofit Platte River Whooping Crane Maintenance Trust, Inc. The number of plants found in the Mormon Island population during recent surveys has been declining. No flowering or vegetative plants were found during 2001, 2002, 2003, and 2004 orchid surveys. Surveys from 1994 -1999 identified three new orchid populations in upland sites near the Platte River. Floodplain habitats along the lower Platte River provide suitable sites for the western prairie fringed orchid, although no orchids have been observed. (NGCP, 2005, personal communication, Gary Steinaur, Botanist).

Western Prairie Fringed Orchid Indicators

Short-term peak flows provide surface water connections to and within riparian meadows that provide for hydrologic conditions required for survival and reproduction. The annual frequency of hydrologic events under the Present Condition that are believed to most directly contribute to maintenance of required hydrologic conditions in wet meadows from overland flow are given in table 4-FL-3.

Table 4-FL-3.—Maximum Annual 1-Day and 7-Day Running Average Peak Flow Events (at Grand Island) During Spring for the Present Condition (cfs)

	April 16 - July 15	
	Maximum 1-Day	**Maximum 7-Day**
0-percent exceedance	28,172	25,201
10-percent exceedance	14,099	12,006
20-percent exceedance	9,963	8,617
30-percent exceedance	5,962	5,219
40-percent exceedance	5,147	3,771
50-percent exceedance	4,498	3,421

Peak flows during late spring, from mid-February to mid-March, occur when plants and animals that inhabit riparian wetlands and backwaters are initiating spring growth and activity. The peak flows during early spring elevate groundwater levels and thaw soils and are believed to promote orchid germination and growth.

The annual frequency of longer-term flows under the Present Condition believed to most directly contribute to maintenance of wet meadows through elevated groundwater levels and soil saturation are presented in table 4-FL-4.

Table 4-FL-4.—Maximum Annual 30-Day Running Average Peak Flow Events (at Grand Island) During the Early Spring and Late Spring Periods for the Present Condition (cfs)

	February 15 - March 16	April 16 - July 15
	Maximum 30-Day	**Maximum 30-Day**
0-percent exceedance	4,368	22,839
10-percent exceedance	3,652	9,525
20-percent exceedance	3, 026	4,680
30-percent exceedance	2,775	3,786
40-percent exceedance	2,504	2,398
50-percent exceedance	2,280	2,132

Finally, changes in channel morphology, such as changes in channel width or channel bed elevations, would ultimately influence river stage produced by pulse flows. To analyze the changes that would result from the action alternatives (see chapter 5, "Environmental Consequences"), the water surface elevations computed by the SEDVEG Gen3 model were used. The SEDVEG Gen3 model outputs account for changes in the river channel shape and resulting changes in the river stage/discharge relationship, in addition to changes in hydrology.

Again, the analysis of water surface elevations examines the maximum 30-consecutive-day elevation in early spring and in late spring. Because most meadows adjacent to the main river channel are located downstream of Highway 10 (RM 208), the analysis focuses on the SEDVEG Gen3 model cross-sections from Highway 10 to Chapman. See "Whooping Crane" and "Wet Meadow Hydrology" subsection earlier in this chapter for a thorough description of these indicators.

Wyoming Toad—Wyoming

In January 1984, the Wyoming toad (*Bufo baxteri*) was listed as endangered by the Service (Service, 49 FR 1992), with a recovery priority of 1 (high degree of threat and high recovery potential). The Wyoming toad is a medium-sized true toad (Family *Bufonidae*).

Endemic to Albany County, the Wyoming toad was historically found along the flood plain of the Laramie River, from the town of Bosler upstream to near Woods Landing; along the flood plain of the Little Laramie River, from its confluence with the Laramie River upstream to near Centennial; and in isolated lakes and wetlands on the Laramie plains. Today, the species occurs only at Mortenson Lake and in captive breeding facilities. Because its status is extremely tenuous, almost any adverse effect to the species may jeopardize its continued existence.

The Wyoming Toad Recovery Plan (Service, September 11, 1991) requires the establishment of five new secure populations in the Laramie Basin before down-listing to threatened. A self-sustaining population has not been established to date. Actions that would hinder the establishment of new populations and preclude down-listing may also jeopardize the toad's continued existence by maintaining its tenuous status.

Wyoming Toad Wyoming Distribution

The Wyoming toad was recently introduced to a small research project site on the Laramie Plains and on private land in Centennial, Wyoming, as a result of a Safe Harbor Agreement developed in August, 2004.

Wyoming Toad Indicators

No indicators were developed because of the unknown details and locations of water leasing actions (see the "Other Listed Species" section of chapter 5).

Designated Critical Habitat

Colorado Butterfly Plant: Designated Critical Habitat—Wyoming

Colorado Butterfly Plant Designated Critical Habitat

Critical habitat for the Colorado butterfly plant in Wyoming was designated on January 11, 2005 (70 FR 1940-1970).

Unit 1: Tepee Ring Creek, Platte County, Wyoming

Unit 1 consists of 2.4 kilometers (1.5 miles) of Tepee Ring Creek, bounded by the western edge of Sec. 2, T. 21 N., R. 68 W., extending downstream including S2S2 of Sec. 2; downstream to SW4SW4 Sec. 1, bounded by the southern line of Sec. 1.

Unit 2: Bear Creek East, Laramie County, Wyoming

Unit 2 consists of 8 kilometers (5 miles) of the South Fork of Bear Creek. Includes T. 19 N., R. 67 W., NW4 Sec. 25; NE4 Sec. 25; downstream into T. 19 N., R. 66 W., S2SW4 Sec. 19; N2SE4 Sec. 19; NW4 Sec. 20; SE4SW4 Sec. 17; SE4 Sec. 17; NE4SW4; N2SE4 Sec. 11; N2SW4 SEc. 12.

Unit 3: Bear Creek West, Laramie County, Wyoming

Reach 1 consists of 4.7 kilometers (2.9 miles) of an unnamed south tributary of North Bear Creek, in the valley between North Bear Creek and the North Fork of the South Fork Bear Creek. Includes T. 18 N., R. 68 W., N2 SW4 Sec. 8; downstream to NW4NW4SE4 Sec. 8; SE4NE4 Sec. 8; NW4NW4 Sec. 9; SE4SW4 Sec. 4; S2SE4 Sec. 4.

Reach 2 consists of 4.2 kilometers (2.6 miles) of the North Fork of the South Fork Bear Creek, upstream of Nimmo Reservoir No. 9. Includes T. 18 N., R. 68 W., SE4SW4 Sec.17; downstream to N2SW4SE4 Sec.17; NW4SE4SE4 Sec.17; S2NE4SE4 Sec.17; NW4SW4 Sec.16; SE4NW4 Sec.16; S2NE4 Sec.16.

Reach 3 consists of 2.8 kilometers (1.7 miles) of the South Fork Bear Creek. Includes T. 18 N., R. 68 W., N2N2SE4 Sec. 21; downstream to S2NW4 Sec. 22; NW4SW4NE4 Sec.22; SE4NW4NE4 Sec.22; W2NE4NE4 Sec. 22.

Unit 4: Little Bear Creek/ Horse Creek, Laramie County, Wyoming

Reach 1 consists of 16 kilometers (10 miles) of Little Bear Creek, which includes approximately 5 miles (8 kilometers) of the Paulson Branch tributary. Little Bear Creek includes T. 18 N., R. 68 W., NW4NW4SW4 Sec. 35; downstream to N2 Sec. 35. T. 18 N., R. 67 W., N2SW4 Sec.32; NE4 Sec. 32; NW4NW4NW4 Sec. 33; S2 Sec. 28; NW4SW4 Sec. 27; S2 SE4NW4 Sec. 27. Paulson Branch includes T. 18 N., R. 68 W., N2SW4 Sec. 2; downstream to S2NE4 Sec. 2; N2 Sec. 1; T. 18 N., R. 67 W., NW4NW4 Sec. 6; SE4SW4 Sec. 31; SE4 Sec. 31.

Reach 2 consists of 2.7 kilometers (1.7 miles) of an unnamed tributary to Horse Creek on the far eastern end just east of, and parallel to, Indian Hill Road. Includes T. 17 N., R. 66 W.,W2SW4 Sec. 2; NE4 Sec. 10.

Unit 5: Lodgepole Creek West, Laramie County, Wyoming

Unit 5 consists of approximately 20.4 kilometers (12.7 miles) west along Lodgepole Creek from state highway 85. Includes T. 16 N., R. 67 W., N2SW4 Sec. 21; W2 SE4 Sec. 21; N2NE4 Sec. 28; W2NW4 Sec. 27; N2S2 Sec. 27; SW4NE4 Sec. 27; S2 Sec. 26; S2SW4 Sec. 25; N2NE4 Sec. 36; T. 16 N., R. 66 W., N2 Sec. 31; downstream to SW4NW4 Sec. 32; SW4 Sec. 32; S2 SE4 Sec. 32; SW4SW4 Sec. 33; SE4SE4 Sec. 33; S2SW4 Sec. 34; T. 15 N., R. 66 W., N2N2 Sec. 4; downstream to NE4NW4 Sec. 3; N2NE4 Sec. 3; NW4 Sec. 2; SE4 Sec. 2.

Unit 6: Lodgepole Creek East, Laramie County, Wyoming

Unit 6 consists of 8.4 kilometers (5.2 miles) of Lodgepole Creek from approximately 3.2 kilometers (2 miles) northeast of the town of Hillsdale on the west end of the reach, downstream to approximately 0.4 kilometers (0.25 miles) east of State highway 213, approximately 3.2 kilometers (2 miles) north of the town of Burns. Includes T. 15 N., R. 63 W., N2SW4 Sec. 29; SE4SE4NW4 Sec. 29; S2NE4 Sec. 29; S2 Sec. 28; S2S2 Sec. 27; N2N2 Sec. 34; N2N2 Sec. 35; S2 SE4SE4 Sec. 26; T. 15 N., R. 62 W., N2NW4 SW4 Sec. 32.

Unit 7: Borie, Laramie County, Wyoming

Reach 1 consists of 10.5 kilometers (6.5 miles) along Diamond Creek west of F.E. Warren Air Force Base and other smaller tributaries merging from the north. Includes T. 14 N., R. 67 W., N2 Sec. 33; upstream to NW4SW4 Sec. 33; S2NE4 Sec. 32; E2SE4 Sec. 32; SW4 Sec. 32; SE4 Sec. 31; T. 13 N., R. 67 W., N2N2NE4 Sec. 5.

Reach 2 consists of 1.7 kilometers (1.1 miles) of Lone Tree Creek. Includes T. 13 N., R. 67 W., NW4 Sec. 31; downstream to NE4SW4 Sec. 31.

Colorado Butterfly Plant Designated Critical Habitat Indicators

No indicators were developed because of the unknown details and locations of water leasing actions (see the "Other Listed Species" section of chapter 5).

Preble's Meadow Jumping Mouse: Designated Critical Habitat—Wyoming

Preble's Meadow Jumping Mouse Designated Critical Habitat

Critical habitat for Preble's meadow jumping mouse in Colorado and Wyoming was designated on June 23, 2003 (68 FR 3723S-27332). Critical habitat in Colorado is outside the action area.

Preble's Meadow Jumping Mouse Designation of Critical Habitat in Wyoming

The following critical habitat units are located in Wyoming:

Unit SP1: Lodgepole Creek and Upper Middle Lodgepole Creek, Laramie County, Wyoming

Unit SP1 encompasses approximately 265 hectares (654 acres) on 20.8 kilometers (13.0 miles) of streams within two subunits in the Lodgepole Creek watershed, Lodgepole Creek, and the Upper Middle Lodgepole Creek. The Lodgepole Creek subunit includes Lodgepole Creek from Horse Creek Road (County Road 211) upstream beyond the confluence of North Lodgepole Creek and Middle Lodgepole Creek up to 2300 meters (7000 feet) elevation on both creeks. The subunit consists of almost entirely private lands. The Upper Middle Lodgepole Creek subunit includes Middle Lodgepole Creek from the eastern boundary of the Pole Mountain Unit of the Medicine Bow-Routt National Forest upstream to about 2400 meters (7750 feet) elevation, including the North Branch of Middle Lodgepole Creek. The unit consists of public lands, including portions of the Medicine Bow-Routt National Forest.

Unit NP1: Cottonwood Creek, Albany, Platte, and Converse Counties, Wyoming

Unit NP1 encompasses approximately 924 hectares (2,284 acres) on 43.3 kilometers (26.9 miles) of streams within the Cottonwood Creek watershed. It includes Cottonwood Creek from Harris Park Road upstream to 2100 meters (7000 feet) elevation. Tributaries include North Cottonwood Creek and Preacher Creek. The unit includes both public and private lands, including a small portion on the Medicine Bow-Routt National Forest.

Unit NP3: Chugwater Creek, Albany, Laramie, and Platte Counties, Wyoming

Unit NP3 encompasses approximately 2,912 hectares (7,194 acres) on 137.2 kilometers (85.3 miles) of streams within the Chugwater Creek watershed. It extends from several miles downstream of the town of Chugwater, upstream on Chugwater Creek and its tributaries to approximately 2100 meters (7000 feet) elevation. Major tributaries within the unit include Middle Chugwater Creek, South Chugwater Creek, Ricker Creek, Strong Creek, and Shanton Creek. The unit consists of both public and private lands.

Preble's Meadow Jumping Mouse Designation of Critical Habitat Indicators

No indicators were developed because of the unknown details and locations of water leasing actions (see the "Other Listed Species" section in chapter 5).

STATE-LISTED AND SPECIES OF SPECIAL CONCERN

INTRODUCTION

This section of this DEIS describes the occurrence and status of State-listed threatened, endangered, and species of special concern that could occur in the action areas of Wyoming, Colorado, and Nebraska. Table 4-SL-1 is a summary of these species and their status in each State.

Table 4-SL-1.—Wyoming, Colorado, and Nebraska State Listed Threatened, Endangered, and Species of Special Concern

Common Name	Scientific Name	Status
Wyoming		
Amphibians		
Western boreal toad	*Bufo boreas boreas*	Species of special concern
Wood frog	*Rana sylvatica*	Species of special concern
Birds		
American white pelican	*Pelecanus erythrorhynchos*	Species of special concern
American bittern	*Botaurus lentiginosus*	Species of special concern
Black tern	*Chlidonias niger*	Species of special concern
Black-crowned night heron	*Nycticorax nycticorax*	Species of special concern
Caspian tern	*Sterna caspia*	Species of special concern
Common loon	*Gavia immer*	Species of special concern
Forster's tern	*Sterna forsteri*	Species of special concern
Lewis' woodpecker	*Melanerpes lewis*	Species of special concern
Snowy egret	*Egretta thula*	Species of special concern
White-faced ibis	*Plegadis chihi*	Species of special concern
Yellow-billed cuckoo	*Coccyzus americanus*	Species of special concern
Fish		
Flathead chub	*Platygobio gracilis*	Species of special concern
Hornyhead chub	*Nocomis biguttatus*	Species of special concern
Suckermouth minnow	*Phenacobius mirabilis*	Species of special concern
Mammals		
Vagrant shrew	*Sorex vagrans*	Species of special concern

Common Name	Scientific Name	Status
Colorado		
Amphibians		
Boreal toad	*Bufo boreas boreas*	State endangered
Northen cricket frog	*Acris Crepitans*	State special concern
Northern leopard frog	*Rana pipiens*	State special concern
Plains leopard frog	*Rana blairi*	State special concern
Wood frog	*Rana sylvatica*	State special concern
Birds		
American peregrine falcon	*Falco peregrinus anatum*	State special concern
*Bald eagle	*Haliaeetus leucocephalus*	Federal threatened, state threatened
Burrowing owl	*Athene cunicularia*	State threatened
Ferruginous hawk	*Buteo regalis*	State special concern
Greater sage grouse	*Centrocercus urophasianus*	State special concern
Greater sandhill crane	*Grus Canadensis tabida*	State special concern
*Least tern	*Sterna antillarum*	Federal endangered, state endangered
Long-billed curlew	*Numenius americanus*	Species of special concern
Mountain plover	*Charadrius montanus*	State special concern
*Piping plover	*Charadrius melodus circumcinctus*	Federal threatened, state threatened
Plains sharp-tailed grouse	*Tympanuchus phasianellus jamesii*	State endangered
Western snowy plover	*Charadrius alexandrinus*	State special concern
Western yellow-billed cuckoo	*Coccyzus americanus*	State special concern
*Whooping crane	*Grus Americana*	Federal endangered, state endangered
Fish		
Common shiner	*Luxilus cornutus*	State threatened
Brassy minnow	*Hybognathus hankinsoni*	State threatened
Iowa darter	*Etheostoma exile*	Species of special concern
Lake chub	*Couesius plumbeus*	State endangered
Plains minnow	*Hybognathus hankinsoni*	State endangered
Stonecat	*Noturus flavus*	Species of special concern
Suckermouth minnow	*Phenacobius mirabilis*	State endangered
Mammals		
Black-tailed prairie dog	*Cynomys ludovicianus*	State special concern
*Black-footed ferret	*Mustela nigripes*	Federal endangered, state endangered
Northern river otter	*Lontra canadensis*	State endangered
*Preble's meadow jumping mouse	*Zapus hudsonius preblei*	Federal threatened, state threatened
Swift fox	*Vulpes velox*	State special concern
Reptiles		
Common garter snake	*Thamnophis sirtalis*	State special concern
Yellow mud turtle	*Kinosternon flavescens*	State special concern

Common Name	Scientific Name	Status
Nebraska		
Birds		
*Least tern	*Sterna antillarum*	Federal endangered, state endangered
*Piping plover	*Charadrius melodus circumcinctus*	Federal threatened, state threatened
*Whooping crane	*Grus Americana*	Federal endangered, state endangered
Insects		
*American burying beetle	*Nicrophorus americanus*	Federal endangered, state endangered
Platte River caddisfly	*Ironoquia plattensis*	State special concern
Fish		
Finescale dace	*Phoxinum neogaeus*	State threatened
Lake sturgeon	*Acipenser fulvescens*	State threatened
Northern redbelly dace	*Phoxinus eos*	State threatened
Pallid sturgeon	*Scaphirhyncus albus*	Federal endangered, state endangered
Sturgeon chub	*Macrhybopsis gelida*	State endangered
Mammals		
River otter	*Lutra canadensis*	State endangered
Plants		
*Western prairie fringed orchid	*Platanthera praeclara*	Federal threatened, state threatened
Saltwort	*Salicornia rubra*	State endangered
Reptiles		
Massasauga rattlesnake	*Sistrurus catenatus*	State endangered
*Also federally listed. See "Other Federally Listed Species and Designated Critical Habitat" in chapter 4.		

METHODS

Although the State of Wyoming does not have listed threatened and endangered species, it did supply a list of species of special concern that have the potential of occurring in the areas of the proposed action alternatives. The States of Colorado and Nebraska supplied lists of state endangered and state threatened species that have the potential of occurring in the areas of the proposed action alternatives.

PRESENT CONDITION

Wyoming

The State of Wyoming does not have a list of threatened or endangered species, but it does list species of special concern. The following species of special concern may occur in the North Platte River Basin in Wyoming.

Amphibians

Western Boreal Toad

Boreal toads (*Bufo boreas borea*) typically occur between 2420 and 3420 meters (8000 and 11,000 feet) in elevation, in spruce-fir (*Picea* and *Abies* spp.) forests and in meadows (Burger and Bragg, 1946; Smith et al., 1965; Baxter and Stone, 1985; and Hammerson, 1989). They also may be found as low as 2100 meters (7000 feet) in elevation, in willow (*Salix* spp.) dominated riparian areas surrounded by sagebrush (*Artemisia* spp.) or grassland and as high as 4000 meters (12,900 feet) in elevation, in alpine habitats (CDOW, 1996).

In surveys conducted from 1999-2005, boreal toads were found in seven locations within the upper North Platte River Basin, Wyoming: French Creek Basin; Ryan Park; the North Fork of the Little Laramie River; the South Fork of Bird Creek; Sourdough Creek; Foxpark; and upper Snowy Range, White Rocks. All of these locations occur in either Carbon or Albany County within the Medicine Bow National Forest.

Wood Frog

In Wyoming, the wood frog (*rana Sylvatica*) is found in the Medicine Bow Mountains from the Colorado-Wyoming State line north to at least Long Lake, Carbon County. Another population occurs in the Big Horn Mountains. The wood frog inhabits beaver ponds, slow-moving streams, and small lakes in the montane zone. The wood frog's diet includes a variety of small invertebrates, mostly insects. The wood frog breeds from mid-June to early July, shortly after the ice has melted from ponds and small lakes, at an elevation of 9800 feet in the Snowy Range and the Medicine Bow Mountains. Breeding is earlier at lower elevations. Adults congregate along the northern, sunlit margins of the breeding habitat, usually breeding at the same time and place with the boreal toad. Eggs develop rapidly at relatively low water temperatures and, in Wyoming, transformation of the larvae is usually completed by early August (adapted from Baxter and Stone, 1980).

Birds

American Bittern

American bitterns (*Botaurus lentiginosus*) in Wyoming are classified as uncommon summer residents, with confirmed or probable breeding recorded in 9 of 24 latilongs. Bitterns are typically solitary nesters in marsh habitat, making censusing difficult. Bitterns nest on dry ground or above water or mud in tall emergent vegetation, building a scanty nest of sticks and emergent vegetation. Nests contain separate entrance and exit paths and may be partially covered by vegetation arch. Diet of the bittern is varied and includes any prey item that can be caught, including fish, aquatic invertebrates, small vertebrates, and insects. Young are fed regurgitant (adapted from Oakleaf et al., 1996).

In Wyoming, American bitterns have been documented at seven different sites since 1984.

American White Pelican

American white pelicans (*Pelecianus erythrorkynchos*) are classified as a common summer resident in Wyoming and, although pelicans can be observed Statewide, confirmed breeding has only been documented in 4 of Wyoming's 28 latilongs.[19] Causes of population decline have included illegal shooting, probable decline from the widespread use of the pesticide diehlorodiphenyltrichloroethane (DDT), habitat loss due to human activities, and excessive human disturbance at breeding colonies and foraging sites. White pelicans forage at depths of less than 3 feet from the surface of water, and fish comprise the majority of their diet.

Pelicans nest in colonies, often associated with double-crested cormorants. Pathfinder Reservoir Bird Island colony was first active in 1984. The island became a peninsula in 1989 due to low water conditions resulting from drought; this condition continued throughout 1995. Pelicans have failed to fledge any young from this colony since 1990, due to continued low water levels resulting in increased predation on the colony, and have not even attempted to nest at this site since 1992. The Wheatland Reservoir No. 3 site was first active in 1993. In past years, the site was not surveyed because of the lack of suitable breeding habitat—partially due to disturbance from anglers along the shoreline. The suitability of this site for nesting pelicans is currently unknown (Oakleaf et al., 1996).

Black Tern

In Wyoming, the black tern (*chlidonias niger*) is classified as a common summer resident; however, confirmed or suspected breeding has only been recorded in 7 of 26 latilongs in which it has been documented. Black terns nest in dense stands of emergent vegetation (cattails and bulrushes), often on a muskrat house. Nests are typically loose, floating mats of dead vegetation that keep eggs raised just above the water's surface. Black terns feed on insects, aquatic invertebrates, and small fish (adapted from Oakleaf et al., 1996).

This species has been documented at six different sites in Wyoming from 1982 through 1994.

Historically, population declines were caused by loss of wetland habitat due to water diversion projects and intentional draining of wetland habitats, as well as agricultural chemical use in the Midwest that resulted in greatly reduced hatching success. Currently, the primary threats to populations are the degradation and loss of suitable wetland breeding habitat due to human disturbance and unfavorable weather conditions (Oakleaf et al., 1996).

Black-Crowned Night Heron

In Wyoming, the black-crowned night heron (*Nycticorax nycticorax*) is classified as an uncommon summer resident, with confirmed breeding recorded in 10 of 26 latilongs in which the species has been documented. Night herons nest in colonies that can range greatly in size, and they feed primarily on minnows, crayfish, and aquatic invertebrates. Loose nests of sticks, twigs, or cattail stems are built in emergent vegetation or in shrubs near the water's edge. Main threats to night heron populations include loss of suitable nesting wetland habitat due to human activities, excessive human disturbance of nesting colonies, and drought-related habitat changes in suitable nesting sites (Oakleaf et al., 1996).

In Wyoming, night herons have been documented breeding at 16 different sites from 1982 through 1994.

[19]A ***latilong*** encompasses a rectangle covering 1 degree of latitude by 1 degree of longitude.

Caspian Tern

In Wyoming, the Caspian tern (*Sterna caspia*) is classified as an uncommon summer resident, and confirmed or probable breeding has only been recorded in 4 of 22 latilongs in which the species has been documented. Caspian terns nest on the ground in small colonies along coasts and inland lakes, rivers, and marshes. Nests consist of scrapes in rocks or sand and are located close to water. Fish are the main food source for Caspian terns, which they take by diving underwater, often from a hovering position. Aquatic invertebrates, such as crustaceans, are also taken.

In Wyoming, the species has been documented nesting at four different sites since 1983, including Pathfinder Reservoir (Oakleaf et al., 1996).

Common Loon

The common loon (*Gavia immer*) is classified as an uncommon summer resident in Wyoming; confirmed or probable breeding has been documented in 4 of Wyoming's 28 latilongs, and loons have been observed in an additional 22 latilongs. In Wyoming, loons nest on lakes greater than 10 acres in size and at elevations between 5900 and 7900 feet. Large lakes with adequate nesting islands and abundant populations of small and mid-sized fish, aquatic invertebrates, and amphibians are preferred. Lakes also should be clear enough for loons to see their prey, deep enough to prevent winterkill of fish (greater than 6 feet), and must remain ice-free for a minimum of 4 months for successful fledging of young. Escape cover for adult loons is deep, open water, whereas young loons and their attending adults will use emergent shoreline vegetation as cover when disturbed (adapted from Oakleaf et al., 1996).

Loons exhibit a high fidelity to nesting lakes. The most important factors that determine nest locations are well protected sites on small islands, if available, in close proximity to open water . Nests are built of aquatic vegetation at or near the water's edge and may be concealed by surrounding aquatic vegetation. In Wyoming, nesting typically begins in early to mid-May, and hatching occurs in early to mid-June. The breeding territory also includes an area with shallow water, protected bays, aquatic vegetation, and abundant small fish for brood rearing.

Primary threats leading to decline of loons include loss of nesting habitat, increased human disturbance, and increased predation due to shoreline developments; nest desertion or increased egg predation due to human disturbance; flooded or stranded nests due to water level fluctuations; direct mortality or loss of prey base from exposure to environmental contaminants; and, possibly, excessive human-induced mortality during migration and on wintering grounds (Oakleaf et al., 1996).

Forster's Tern

In Wyoming, the Forster's tern (*Sterna forsteri*) is classified as a common summer resident, and confirmed breeding has only been recorded in 4 of 26 latilongs in which it has been documented. Forster's terns nest in colonies in marshes and aquatic areas. They nest on the ground, close to water, in depressions made in the mud or grass, or they build deeply hollowed platform nests out of emergent vegetation. This species feeds primarily on fish taken by diving underwater and insects taken while flying over marshes. They also feed on aquatic invertebrates and dead fish (adapted from Oakleaf et al., 1996).

This species has been documented breeding at eight different sites in Wyoming since 1982 (Oakleaf et al., 1996).

Lewis' Woodpecker

In Wyoming, the Lewis' woodpecker (*Melanerpes lewis*) is classified as an uncommon summer resident, and confirmed or probable breeding has only been recorded in 18 of 26 latilongs in which the species has been documented. In Wyoming, this species is known to nest in a variety of habitats below 9000 feet, including cottonwood-riparian, aspen, ponderosa pine savannah, and mixed pine-juniper. Because this species prefers open areas for nesting, coniferous forests the Lewis' woodpecker uses that have been disturbed by burning or logging. Lewis' woodpeckers build cavity nests in snags, poles, or dead stubs of live trees. A nest site may be reused in successive years, and the pair bond may be permanent. Diet of this species consists primarily of insects caught in the air, although nuts, pine seeds, fruit, and berries also are eaten. Hulled acorns and other nuts are cached in natural crevices for use in the nonbreeding season (adapted from Oakleaf et al., 1996).

Snowy Egret

In Wyoming, the snowy egret (*Egretta thula*) is classified as an uncommon summer resident, with confirmed or probable breeding recorded in 7 of 23 latilongs. Snowy egrets nest in mixed colonies and build flat, flimsy stick nests in emergent vegetation or in shrubs on islands. Primary food items include aquatic invertebrates, fish, insects, and small vertebrates. Primary threats to snowy egret populations include loss of suitable nesting wetland habitat due to human activities, human disturbance of nesting colonies, habitat changes in suitable nesting sites due to drought, and pesticide contamination, especially in the Western U.S. where breeding populations may be accumulating DDT and dichlorodiphenyldichloroethylene (DDE) on their wintering grounds in Mexico (adapted from Oakleaf et al., 1996).

In Wyoming, snowy egrets have been documented nesting at nine different sites from 1982 through 1994. However, the only site where snowy egrets have consistently nested over the past 13 years is Bamforth Lake (Oakleaf et al., 1996).

White-Faced Ibis

In Wyoming, the white-faced ibis (*Plegadis chihi*) is classified as an uncommon summer resident, and confirmed or probable breeding has only been recorded in 5 of 26 latilongs in which it has been documented. This species nests primarily in bulrush stands, making a deeply cupped platform nest from emergent vegetation and sticks. Individuals feed primarily on aquatic and moist-soil invertebrates, crustaceans, and earthworms

In Wyoming, the white-faced ibis has been observed breeding at six sites from 1982 through 1994.
.
Historical causes of population decline throughout their range include loss of suitable wetland habitat from water diversion projects, intentional draining of marshes, and, possibly, pesticide and herbicide contamination, especially dieldrin and DDT. Changing habitat conditions, such as drought and flooding, at nesting colonies can cause western breeding populations to fluctuate in size and location, and human disturbance of nesting colonies during nest site selection, nest building, and incubation periods may cause partial or total desertion of the colony. Of the six breeding sites used in Wyoming, five are on the margin of the species' breeding range and are extremely susceptible to habitat alterations during periods of drought, making them unreliable and unsuitable breeding sites in some years (Oakleaf et al., 1996).

Yellow-Billed Cuckoo

In Wyoming, the yellow-billed cuckoo (*Coccyzus americamus*) is classified as an uncommon summer resident, and confirmed or probable breeding has only been recorded in 5 of 20 latilongs in which the species has been documented. This species primarily nests in large stands (100 to 400 meters or 312 by 1,312 feet) of cottonwood-riparian habitat below 7000 feet in elevation and in urban areas—the only known areas in Wyoming to provide such habitat are in isolated stands along the Bighorn, Powder, and North Platte Rivers. Yellow-billed cuckoos feed primarily on terrestrial invertebrates. Young are fed insect regurgitant. Breeding often coincides with outbreaks of insects, and prey abundance may increase egg production and lead to brood parasitism of nests (Oakleaf et al., 1996).

Fish

Flathead Chub

The flathead chub (*Platy gobio gracilis*) inhabits large, turbid rivers and is known to occur in the North Platte Basin. This species spawns late in the summer, when the rivers are lower and warmer and where the bottom is more stable. The flathead chub is omnivorous, feeding mainly on aquatic invertebrates, some terrestrial invertebrates, and vegetation. This species likely provides forage for large, predatory species and is sometimes used for bait (adapted from Baxter and Stone, 1995).

Hornyhead Chub

The hornyhead chub (*No comis biguttas*) is a native fish of the North Platte Basin in Wyoming, once common in tributaries of the Laramie River in Platte County, but now very rare. This species inhabits clear, gravel-bottomed streams where it builds a gravel nest during spawning. The hornyhead chub diet includes insects, crustaceans, and mollusks (adapted from Baxter and Stone, 1995).

The hornyhead chub was collected in the North Laramie River during 1993.

Suckermouth Minnow

The suckermouth minnow (*Phena cotius mirabilis*) is a native fish of the North Platte Basin in Wyoming, found rarely in tributaries of the North Platte River in Goshen County and common in lower Horse Creek. The suckermouth minnow is a riffle fish that prefers clear water and sand, gravel, or rubble substrate. Spawning occurs throughout the summer, and its diet includes aquatic insects and other bottom-dwelling invertebrates (adapted from Baxter and Stone, 1995).

Mammals

Vagrant Shrew

The vagrant shrew (*Sorex vagrans*) occurs in riparian shrub, moist meadow grasslands, bogs, and riparian or marsh habitats with moist soil in a variety of habitat types, from sagebrush grassland and mixed shrubland to conifer forest. It prefers areas with accumulated leaf litter and rotting logs. Currently, the documented distribution indicates that the vagrant shrew's range includes all of Wyoming, except the eastern tier of counties, those east of the Bighorn Mountains and Laramie Mountains. The suspected range includes the Medicine Bow, Bridger-Teton, Targhee, Wasatch, Bighorn and Shoshone National Forests, and all BLM resource areas in the State (adapted from NatureServe, 2004).

Colorado

Amphibians

Boreal Toad

The boreal toad (*Bufo boreas boreas*) has warty skin with a light stripe along the middle of its back (most prominent in mature females). Mature males have a dark patch on the inner surface of the innermost digit on the forefeet during breeding season. The toad typically lives in damp conditions in the vicinity of marshes, wet meadows, streams, beaver ponds, glacial kettle ponds, and lakes interspersed in subalpine forest (lodgepole pine, Englemann spruce, subalpine fir, and aspen). They eat a wide variety of invertebrates, including grasshoppers, various beetles, mosquitoes, crane flies, stink bugs, damsel bugs, water striders, backswimmers, alderflies, moths/caterpillars, black flies, deer flies, muscid flies, ants, wasps, bees, mites, daddy longlegs, spiders, and snails.

This mountain toad is restricted to the southern part of the Rocky Mountains. The elevational range is mainly 8500 to 11,500 feet (2,600 to 3,500 meters), with higher and lower occurrences in some areas (Campbell, 1970).

Northern Cricket Frog

The northern cricket frog (*Acris crepitans*) typically has a triangular mark between its eyes, large webs between its hind toes, and whitish marks on its upper lip. Its dorsum is usually grayish white with small, irregular, dark marks; its eardrum is small and indistinct, and it has a dark stripe on the rear of its thigh. Mature males have a yellowish (or dusky) throat. The innermost digit of its forefeet has a thickened pad on the inner side during breeding season. The northern cricket frog has an expanded vocal sac that is evenly rounded, and its breeding call is an accelerating, then decelerating, "gick-gick-gick," lasting up to 30 seconds and sounding like stones being tapped together. Larvae: dorsum is olive to brown with black mottling; eyes are dorsolateral, slighting inside the outer margin of its head when viewed from above. Cricket frogs eat various small invertebrates obtained on shore or in the water. Typical food items in Kansas and Nebraska include beetle, beetle larvae, midge larvae, water boatmen, flies, leaf hoppers, and other bugs (Jameson, 1947 and Burkett, 1984).

In Colorado, the northern cricket frog occurs along the sunny, muddy, or marshy gently sloping edges of permanent or semipermanent ponds, reservoirs, and streams, and along irrigation ditches, in pastures, and in sandhill country. It is known from the North Fork and South Fork of the Republican River in Yuma County (at about elevation 3500 to 3,600 feet [1,070 to 1,100 meters]) and perhaps also from the South Platte River drainage in Weld and Morgan Counties.

Northern Leopard Frog

The northern leopard frog (*Rana pipens*) is a green or brown frog, with large rounded or oval spots, that breeds in shallow, quiet areas of permanent water bodies. Typical habitats include wet meadows and the banks and shallows of marshes, ponds, glacial kettle ponds, beaver ponds, lakes, reservoirs, streams, and irrigation ditches. Breeding sites typically contain vegetation, mats of algae, and fairly clear water. Usually, leopard frogs are found at the water's edge, but they may roam far from permanent water in wet meadows or during mild, wet weather.

The northern leopard frog occurs throughout Colorado, excluding most of the southeastern and east-central portions of the state. Elevational range extends from below 3500 feet in northeastern Colorado to above 11,000 feet in southern Colorado.

The formerly abundant northern leopard frog has become scarce in many areas of Colorado. Some populations have disappeared due, at least in part, to change in habitat. Breeding sites, such as those along streams and in mountain glacial kettles, change in suitability in response to climatic variation and flooding; though some sites may become unusable, other sites may be created by these events.

In some lowland areas, reduced or extirpated leopard frog populations are associated with the presence of the increasingly abundant bullfrog (Hammerson, 1982 [amphibian/reptile]), the larvae and adults of which may negatively impact leopard frogs. Northern leopard frogs are now greatly outnumbered by bullfrogs in many streamcourses, ponds, reservoirs, and wetlands in eastern Colorado.

Plains Leopard Frog

The plains leopard frog (*Rana blairi*) has a brown dorsum, with large rounded or oval dark spots that usually have a light border. Their skin is somewhat rough or nodulated, with an eardrum that is usually a distinct light spot. Their hind toes have extensive webbing. Mature males have swelling at the base of the innermost digits of the forefeet during breeding season. The plains leopard frog's breeding call is a series of short "clucks," followed by a few low chuckling or grunting sounds, which together usually last less than two seconds. The diet of the leopard frog includes various invertebrates and, probably, occasional small vertebrates. Known predators include western terrestrial garter snakes or blackneck garter snakes. The larvae are vulnerable to predation by fishes such as centrarchids (adapted from Kruse and Francis, 1977).

The plains leopard frog inhabits the margins of streams, natural and artificial ponds, reservoirs, creek pools, irrigation ditches, and other bodies of water in plains grassland, sandhills, stream valleys, or canyon bottoms. The plains leopard frog occurs in southwestern South Dakota south to central Texas; east through Iowa, Missouri, and Illinois to west-central Indiana; southeast along the Mississippi River to southeastern Missouri; and west to eastern Colorado, New Mexico, and (disjunctly) southeastern and north-central Arizona (Clarkson and Rorabaugh, 1989; Conant and Collins, 1991; and Brown and Morris, 1990). This species occurs in northeastern Colorado at elevations principally below 5000 feet (1525 meters).

Wood Frog

The wood frog (*Rana sylvatica*) can be distinguished by the dark "mask" on each side of its face. Wood frogs usually have a light mid-dorsal stripe with relatively smooth skin. The base of the innermost digit on its forefeet is swollen on mature males, and they average slightly smaller in size and are darker than adult females. The breeding call is a rapid series of 1 to 8 (usually 3 to 5) rough clacking notes (a chorus sounds somewhat like a group of softly quacking domestic ducks). Bagdonas (1968) reported that the wood frog diet in Colorado includes small insects, worms, and spiders. Known predators on larvae and metamorphosed individuals include diving beetle (*Dytiscus*) larvae, brook trout (*Salvelinus fontinalis*), rainbow trout (*Oncorhynchus mykiss*), brown trout (Salmo trutta), smallmouth bass (*Micropterus dolomieu*), and the western terrestrial garter snake (adapted from Bagdonas, 1968).

Wood frogs in Colorado inhabit subalpine marshes, bogs, pothole ponds, beaver ponds, lakes, stream borders, wet meadows, willow thickets, and forests bordering these mesic habitats. This frog ranges farther north than any other North American amphibian, extending from Alaska to Newfoundland, and south to Virginia, Georgia, Alabama, and Arkansas in the east and to Montana, Wyoming, and northern Colorado in the Rocky Mountains. The wood frog occurs in Colorado from about elevation 7900 to 9800 feet (2400 to 3000 meters).

Birds

American Peregrine Falcon

Breeding pairs of the American peregrine falcon (*falco peregrinus anatum*) primarily nest on cliffs and forage over adjacent coniferous and riparian forests. Migrants and winter residents occur mostly around reservoirs, rivers, and marshes but may be seen in grasslands, agricultural areas, and other habitats. Rare spring and fall migrants are found in western valleys, foothills, lower mountains, mountain parks, and on eastern plains. It may also be a rare winter resident at Monte Vista National Wildlife Refuge and very rare in western valleys and on eastern plains near foothills. It is also a rare summer resident in foothills and lower mountains (adapted from CDOW, 2006 [falcon]).

Burrowing Owl

The burrowing owl (*Athend cuniculavia*) is a small, ground-dwelling bird that is highly visible to humans. This brown, long-legged owl can frequently be seen in the daytime, bobbing up and down while perched on a fencepost or the mound of a prairie dog burrow. Contrary to what their name implies, these little owls do not dig their own burrows, but will instead use an abandoned rodent burrow, usually from a prairie dog. Burrowing owls are small, about 9 inches in height, with a short tail and long legs. They have yellow eyes, no ear tufts, and their face is framed in white with a black collar. Burrowing owls are primarily found in grasslands and mountain parks, usually in or near prairie dog towns. The burrowing owl also uses well-drained steppes, deserts, prairies, and agricultural lands. Burrowing owl food includes rodents, small birds, eggs, nestlings, reptiles, and insects. They will hunt for food at any time, day or night.

The owls breed from Canada's southern prairie provinces south throughout the Western U.S. to southern California and Texas. Burrowing owls are resident in central and southern Florida. In Colorado, burrowing owls are a migratory species and can be found almost anywhere there are prairie dog burrows from late March or early April-October. During winter, Colorado owls migrate to Mexico and Central America.

The burrowing owl is listed as threatened in Colorado. Habitat has been lost to housing, suburban development, and agriculture activities along the Front Range. There is also concern about the loss of burrowing owl habitat in areas where sylvatic plague occurs in prairie dog colonies. If prairie dogs are absent, burrowing owls will eventually collapse, due to lack of homes.

Ferruginous Hawk

The ferruginous hawk (*Buteo regalis*) is the largest of all the North American buteos that feed nearly exclusively on medium-sized mammals such as rabbits, prairie dogs, and ground squirrels. Unlike other hawks, ferruginous hawks do not require trees or similar elevated structures for hunting or nesting. Optimum habitat consists of vast expanses of ungrazed or lightly grazed grassland and shrubland with varied topography, including hills, ridges, and valleys (adapted from Ensign, 1983). For nest sites, ferruginous hawks use trees or similar structures, when available, but they readily nest on the ground. They typically place ground nests on hilltops that provide a panoramic view.

Endemic to the Great Plains and other grassland and shrub-steppe areas of Western North America, ferruginous haws occupy the smallest breeding range of any North American buteo. They breed in Saskatchewan, southern Alberta, eastern Washington, and south to northwestern Texas, central New Mexico, and northern Arizona. Conversion of prairie to cropland, and the war on prairie dog towns in eastern Colorado, has affected their numbers. Conversion of grassland and moderately grazed rangeland to cropland and urban development poses significant threats to ferruginous hawk populations through much of its range.

Greater Sage Grouse

The greater sage grouse (*centro cereus urophasianus*) inhabits sagebrush shrublands in northwestern Colorado during the summer. They occur in native or cultivated meadows, grasslands, aspen, and willow thickets adjacent to or interspersed with sagebrush.

This grouse is a fairly common local resident in northwestern Colorado, including Jackson and Larimer Counties (CDOW, 2005, personal communication, Kirstie Bay, Biologist).

Greater Sandhill Crane

In Colorado, greater sandhill crane (*Crus Canadiensis tobida*) migrants occur on mudflats around reservoirs, in moist meadows, and in agricultural areas. Breeding birds are found in parks with grassy hummocks and watercourses, beaver ponds, and natural ponds lined with willows or aspens (Ellis et al., 1996).

Abundant spring and fall migrants are found in the San Luis Valley, and abundant fall migrants occur on staging grounds in the Hayden area (Routt County). This crane is an irregular, common to abundant migrant, primarily in spring, in western valleys from Montrose County northward and east to Eagle and Gunnison Counties. They are rare summer residents in the parks of the Elkhead Mountains and Park Range in eastern Moffat, northern Routt, and western Jackson Counties, and there are a few south to northeastern Rio Blanco and northwestern Grand Counties. It is casual in mid-winter.

Long-Billed Curlew

Long-billed curlews (*Numenius americanius*) are the largest of the North American shorebirds. They are a brown shorebird with flashy cinnamon underwings and decurved bills up to 8-3/4 inches long. They nest mostly on shortgrass prairie. During migration, especially postbreeding, long-billed curlews feed along the shorelines of prairie reservoirs. At the height of nesting in May and June, adults noisily fly to reservoir shorelines to drink and feed. As soon as the young can fly, family groups gather on lake edges close to their natal sites.

The current range of the long-billed curlew is smaller that it was historically, due to habitat loss. Conversion of prairies to agriculture caused much of the decline, and their size and taste made them popular for hunting (CDOW, 2005, personal communication, Kirstie Bay, Biologist).

Mountain Plover

The mountain plover (*Charadirius montenus*) is a rare to fairly common summer resident locally on eastern plains. The greatest numbers occur in northern Weld County (Graul and Webster, 1976), and smaller numbers occur locally in El Paso and Pueblo Counties, along the northern edge of the Arkansas Valley in Crowley and Kiowa Counties, and in Cheyenne and Baca Counties. It is a common to abundant fall migrant locally in Weld County and in the lower Arkansas Valley in Crowley, Bent, and Kiowa counties. However, it is a rare spring and fall migrant elsewhere on eastern plains (primarily fall). At the same time, it is a casual migrant (three spring records and four fall records) in northwestern and west-central valleys and in the San Luis Valley (three spring records). The species is a casual fall migrant in the Barr Lake area (adapted from Andrews and Righter, 1992).

Plains Sharp-Tailed Grouse

The plains sharp-tailed grouse (*Tym-. panuchus phasiunelli usjamesil*0 is a bird of Colorado's eastern grasslands. Sharp-tailed grouse closely resemble prairie chickens, except that sharp-tails have a pointed tail, and the air sacs on the neck of the male are purple. The birds are 15 to 20 inches in length. They are resident from Alaska east to Hudson Bay and south to Utah, northeastern New Mexico, and Michigan. In Colorado, plains sharp-tailed grouse formerly nested over much of the northern two-thirds of the eastern prairie, but the present population consists of only a few hundred birds in Douglas County (adapted from CDOW, 2000 [grouse]).

The plains sharp-tailed grouse is listed as endangered in Colorado. The decline is the result of overgrazing, the conversion of grassland to cropland, and, more recently, to housing developments. What remains of Colorado's population is now severely threatened by proposed land developments in the area between Denver and Colorado Springs.

Western Snowy Plover

Snowy plovers (*Charadrius alexandrinius*) nest in temperate regions of all continents except Antarctica. The first Colorado record came from Denver in 1939. Based on the Colorado Breeding Bird Atlas (2001), snowy plovers nest in the lower Arkansas River Valley and the San Luis Valley. They also nested about 12 years at Antero Reservoir in South Park. Snowy plovers have adapted to changing habitat quality by colonizing new sites when old ones became unusable. Snowy plovers may have moved into Colorado because of disturbance to nest colonies elsewhere, perhaps in the panhandle of Oklahoma or southwestern Kansas.

Snowy plovers breed in sandy ocean beaches, dry salt flats, dredge spoils, and river bars. Inland, they breed in natural habitats such as ephemeral alkali playas and alongside manmade sewage and evaporation ponds (Page et al., 1995). In southeastern Colorado, they breed only in manmade habitats: reservoir edges. Early migrants, male snowy plovers arrive on territory the first week of April. Females choose from displaying males almost as soon as they return, a few days later. They place their nests up to 500 feet from water. The nests are simple scrapes in the ground.

Western Yellow-billed Cuckoo

The western tellow-billed cuckoo (*Coccyzus americanus*) inhabits lowland riparian forests and urban areas with tall trees in Colorado. It is a rare spring and fall migrant and summer resident on eastern plains west to Morgan and Otero Counties, and rare west to foothills. It is an uncommon local summer resident in western valleys, primarily from Mesa County southward. It occurs in mountain parks (four records) and in foothills and lower mountains (four records). Numbers of this species fluctuate widely from year to year. Historically, the yellow-billed cuckoo bred throughout much of North America. Available data suggests that within the last 50 years the species' distribution west of the Rocky Mountains has declined substantially. Loss of streamside habitat is regarded as the primary reason for the population decline (Service 2006 [cuckoo]).

Fish

Brassy Minnow

The brassy minnow (*Hybog nathus hankin soni*) is a small (3 inches long), brassy-colored minnow often confused with the plains minnow, which is larger (5 inches long). While this species can be found in the South Platte River, the river is believed to act as a conduit for connecting tributary stream populations. Habitat for the brassy minnow includes cooler, flowing waters or pools with sand to gravel substrate and aquatic vegetation most often found in smaller tributary streams. This species was considered common in Colorado in the early 1900s, but it was also considered to be at the southern periphery of its range. Distribution data show the brassy minnow has declined in distribution since 1985. Populations remain in the South Platte River Basin in the St. Vrain River, Cache la Poudre River, Lonetree Creek, Pawnee Creek, and Lower South Platte River east of Sterling. While loss of brassy minnow populations may be common due to natural or man-caused degradation in stream habitats, recolonization and expansion can occur rapidly when more favorable habitat conditions are restored (CDOW 2003 [minnow]).

Common Shiner

The common shiner (*huxi lus cornutus*) is bright silver and stout bodied, with a distinct stripe down the midline of the back. The tail fin is deeply forked. Males develop tubercles, or bumps, on the head, back, and fin rays during breeding, and blue coloration of the head, with pink-colored fins and body. The common shiner is currently rare in Colorado and occurs only in the upper South Platte tributary system and the St. Vrain River drainage. Habitat requirements of common shiner are streams of moderate gradient with cool, clear water and gravel substrates shaded by overhanging riparian bushes and trees. The common shiner is known to be intolerant of silt-predominated habitat and, therefore, is adversely affected by habitat changes due to siltation. The historic distribution data indicate a clear declining trend in the South Platte River Basin. The common shiner appeared well distributed in the Front Range, transition zone streams in the 1900-1978 time period. Decline in distribution appears most evident in the last decade. Due to the apparent declines and the vulnerability of its Front Range stream habitats to modification, conservation efforts are focusing on expanding its distribution into protected habitats (CDOW, 2003 [minnow]).

Iowa Darter

The Iowa darter (*Etheo stoma exile*) is a small darter, a northern species ranging from central Canada south to New York and west to Nebraska and Colorado. The species is native to Colorado (Ellis, 1914), although now the species has limited distribution in Colorado. Populations are found in some plains streams in northeastern Colorado, Plum Creek, single locations on the St. Vrain and Big Thompson Rivers (Propst, 1982), and Eleven Mile Reservoir in South Park. Iowa darters have been introduced to the upper Colorado River Basin (Shadow Mountain Reservoir).

Iowa darters prefer cool, clear water over a sand or organic matter substrate (Trautman, 1957). The darters in Colorado are found in lakes, over mats of rooted aquatic plants, and in streams with vegetation along the streambank that extends into the water (CDOW, 2006 [darter]). Stream specimens are collected from undercut banks, and the species is absent in reaches lacking undercut banks.

The species is a northern, coolwater species and may never have been common in Colorado. Reduction in habitat through dewatering, channelization, etc., has further reduced distribution.

Lake Chub

The lake chub (*Covesis plumbeus*) has a long, stout body that is 4 to 6 inches in length, with a dark olive back merging into silvery sides and a dusky white underside. Males may show reddish orange near the head during spawning. Lake chubs are known to occupy lake habitats and migrate into streams to spawn. Historically, the lake chub was known to occur in the St. Vrain and Boulder Creek watersheds.

This species was thought to be extirpated from Colorado until it was rediscovered in the St. Vrain River drainage in 1989. Populations have since been discovered in two reservoirs in Clear Creek County and two reservoirs in the upper Cache la Poudre River drainage. As a glacial relict in Colorado, the lake chub has likely always been rare, so recovery goals, when developed, will be correspondingly modest. Recovery actions for this species include establishment of self-sustaining populations in secure habitats (CDOW, 2003 [minnow]).

Plains Minnow

The plains minnow (*Hybog nathus hankinsoni*) is another slender minnow (5 inches long) that is very similar to the brassy minnow described above, although the plains minnow is somewhat larger (the brassy minnow is 3 inches long). The plains minnow lives in the main channels of plains rivers with some current, turbid water conditions and sandy bottoms. Spawning is associated with high and receding flows in the spring, usually under turbid conditions. Historically, the plains minnow inhabited the main stem channels of Colorado's eastern plains rivers. In the South Platte River, early identification of this species was confused with the brassy minnow, but records from the early 1900s indicate the plains minnow occupied at least the Lower South Platte River reaches. However, it is clear that this species has been rare in Colorado since the early 1900s. Records from the 1980s, and as recently as 1994, indicate the plains minnow has persisted in the South Platte River between Fort Morgan and Sterling.

If this species was ever common to the South Platte River, those populations likely diminished rapidly with water and land use development. Elimination of highly variable water levels, unstable streambeds, and fluctuating water temperatures can contribute to the decline of short-lived fish species like the plains minnow, which has adapted to highly unstable plains rivers. It is likely that water depletion, diversions, and barriers could interfere with the downstream dispersal of eggs and young fish and the upstream dispersal and recruitment of juvenile fish into adult populations inhabiting upstream river reaches and tributaries (CDOW, 2003 [minnow]).

Stonecat

The stonecat (*Noturus flavus*) is a small, slender catfish that is yellow-brown in color and has a dusky strip through the center of the tail fin. Stonecats are found in the north-central U.S. from Montana to New York, south to Alabama through Oklahoma (Miller and Robison, 1973). Colorado is on the western edge of the stonecat's natural range. The species' Colorado distribution is not well known. Stonecats in Kansas are found in fast water riffles and runs of streams, hiding under rock, woody debris, or along sandbars during the day (Cross and Collins, 1975). The retiring nature of the species may be the reason so few stonecats have been collected in Colorado.

The eastern plains streams of Colorado, with low flows, silt, and frequent dewatering, do not provide an ideal habitat for the stonecat.

Suckermouth Minnow

The suckermouth minnow (*Phena cobius mirabilis*) is a slender minnow with a conspicuous dark spot at the base of the tail fin. It now inhabits clear, shallow, riffle areas with gravel and year-round flow. This minnow feeds on insect larvae and invertebrates and spawns in late spring to early summer. The suckermouth minnow has declined significantly in distribution and abundance in the South Platte River system since the early 1900s. Early distribution data indicate the presence of the species was well documented in the main stem of the South Platte River.This species is now extremely uncommon in Colorado, based on recent inventories. Only a very small population now remains in the Lodgepole Creek drainage of the South Platte River (CDOW, 2003 [minnow]).

Mammals

Black-Tailed Prairie Dog

Black-tailed prairie dogs (*Cynomys ludovicianus*) are reddish cinnamon in summer to more reddish in winter, and their underparts are generally a paler buffy brown, yellow, or white. Albino individuals are not uncommon. The tail is long compared to that of other prairie dogs and is conspicuously tipped with black to brownish black hairs. As with many mammals in Colorado, its summer pelage is short and rather coarse. Its winter pelage is longer and more lax. Measurements are: total length 336 to 410 millimeters; length of tail 60 to 93 millimeters; length of hindfoot 48 to 68 millimeters; length of ear 8 to 14 millimeters; weight 525 to 1,350 grams. Black-tailed prairie dogs form large colonies or "towns" in shortgrass or mixed prairie, and can consume large quantities of annual forbs and native grasses (Bonham and Lerwick, 1976; Gold, 1976; Hansen and Gold, 1977; Klatt, 1971, Klatt and Hein, 1978, and Uresk, 1984). Grasses and sedges are preferred. Western wheatgrass, buffalo-grass, grama, Russian-thistle, pigweed, and ragweed are common food items. During late fall, winter, and spring, these prairie dogs frequently dig and eat roots of forbs and grasses.

Black-tailed prairie dogs are not uncommon in most of the counties of the eastern plains, especially those immediately along the Front Range. Some of the highest densities presently found in Colorado are on lands held by developers adjacent to or within urban areas such as Denver, Boulder, and Aurora.

Northern River Otter

The northern river otter (*Contra canadiensis*) is the longest of our weasels, ranging from 3 to 4-1/2 feet; the powerful, cylindrical tail (which thickens toward the base) comprises about one-third of the body. Webbed toes and water-resistant fur suit the animal to a life spent largely in water. Otters sometimes paddle, but the force for swimming comes mostly from eel-like movements of the body and tail. They are rich brown in color, with silver brown beneath. The otter is about twice as long and five times as heavy as mink, and it is the only other aquatic carnivore in the Rockies.

Otters live in riparian habitat, where aquatic animals like crayfish, frogs, fish, young muskrats, and beavers are favored foods. Otters usually live in bank dens abandoned by beavers. They are active mostly at dawn and dusk and appear to spend large amounts of time just playing; sliding on ice, snow, and mud; and swimming gracefully for no apparent reason beyond swimming.

Otters breed in spring. Embryo implantation is delayed until the following winter, and one to four young are born in early spring. While the female is nursing one litter, mating occurs again (CDOW, 2006 [river otter]).

Once, otters probably occurred in major streams statewide in Colorado, although they apparently have never been abundant. With settlement, subsequent water pollution, and control of streamflows, otters disappeared from the state by the early part of this century. In the 1970s, however, the CDOW began to restore populations to several drainages in Colorado, including the Upper Colorado, the Dolores, and the upper South Platte Rivers.

Swift Fox

The swift fox (*Vulpes velex*) is small and slender. The dorsal coat ranges from yellowish to buffy gray, with the underfur tan and interspersed with multicolored guard hairs so that the overall dorsal color is fairly dark. The ventral pelage ranges from white to yellow. Conspicuous black marks are present on either side of the snout, and the tail is always tipped with black. The black facial marks clearly separate the species from young coyotes. Swift foxes are almost entirely carnivorous, preying on a variety of small rodents, lagomorphs, birds, and similar quarry (Cutter, 1958b). Studies over much of their range indicate that jackrabbits compose the bulk of their diet, supplemented by ground squirrels, prairie dogs, and many species of ground-nesting birds.

The swift fox is an animal of grasslands. It occupies shortgrass and midgrass prairies over most of the Great Plains, including eastern Colorado. In northeastern Colorado, the swift fox appears to be most numerous in areas with relatively flat to gently rolling topography (Cameron, 1984 and Loy, 1981). However, habitat occupied on the Pinon Canyon Maneuver Site in southeastern Colorado is more diverse (Rongstad et al., 1989). It appears that the density of swift foxes in certain areas on the eastern plains of Colorado is high (Cameron 1984; Loy 1981; Rongstad et al., 1989; and CDOW, 2006 [swift fox]).

The most commonly cited reasons for the swift fox decline include: loss of native prairie habitat from conversion to agriculture and urban and rural development, predator control campaigns, rodent and predator control programs, unregulated trapping and hungint, and competition and predation by coyotes (Rongstad et al., 1997; Kilgore, 1969; Samuel and Nelson, 1982; FaunaWest; 1991, Covell, 1992; Kahn et al., 1997; and Kitchen 1999). Kahn et al., 1997, pointed out that land conversion is not the only form of habitat loss. Land ownership, rangeland and cropland management practices, habitat fragmentation, limited movement corridors, and changes in wildlife composition that occur as a result of prairie conversion all play an important role in limiting swift fox distribution and abundance.

Reptiles

Common Garter Snake

The common garter snake (*Thamnophis sirtalis*) is found throughout much of North America, from southern Canada to southern California; central Utah; Chihuahua, Texas; the Gulf Coast; and southern Florida (Stebbins, 1985 and Conant and Collins, 1991). It is absent from most of the Great Basin and arid Southwest. Although it is fairly common along the South Platte River, the species occurs only along this river and its tributaries at elevations below 6000 feet in northeastern Colorado (Hammerson, 1982 [amphibian/reptile]).

The species' coloration varies geographically; it is recognized, in part, by keeled scales on the back, pale lateral stripes on the second and third scale rows, red blotches between stripes on the back, and an adult total length of 16 to 26 inches (Conant and Collins, 1991 and Smith and Brodie, 1982).

Throughout its range, the common garter snake inhabits virtually any type of wet or moist habitat, including marshes, ponds, and stream edges. The species is largely restricted to aquatic and riparian habitats along the flood plains of streams. Unlike the plains garter snake, this species is seldom found away from water or at isolated ponds (Hammerson, 1982). When inactive, the common garter goes underground, in or under surface cover, or in other secluded sites.

Common garter snakes emerge from hibernation in March and April. The annual period of activity generally ends in September or October. They are usually most active on sunny days but are probably also active at night during hot weather (Hammerson, 1982). The common garter usually gives birth from late July-September; litter sizes of 3 females from Boulder County ranged from 19 to 24 (Hammerson, 1982). They mature sexually in 1 to 2 years.

Common garter snakes prey chiefly on various fishes, earthworms, frogs, toads, and salamanders; less regularly on slugs, leeches, small mammals, and birds; and rarely on insects, spiders, and small snakes (Fitch, 1980).

Yellow Mud Turtle

The yellow mud turtle (*Rinosternon flavescens*) has a smooth, hard shell that is oval shaped, sometimes with extensive attached algae. It has a yellow throat, with several nipple-like barbells, and all toes are webbed. Mature males have a slightly concave shell, and two patches of conspicuous, rough scales on inner surface of each hind leg. Their thick tail is tipped with a horny nail and extends well beyond the rear edge of the carapace, usually curled to one side. The males grow to a larger size than females and have a relatively larger head and claws that are longer and more curved. These turtles eat annelid worms, leeches, flatworms, nematodes, insects, various crustaceans, centipedes, millipedes, spiders, a wide variety of insects, snails, amphibian larvae, fishes (usually dead or dying), animal carcasses, and plant material (which may be ingested incidental to feeding on animal prey) (Punzo 1974b andErnst et. al., 1994). Predatory fishes and water snakes probably prey on small mud turtles. Adults likely are attacked occasionally by the usual assortment of larger predatory animals.

Typical habitat in Colorado includes permanent and intermittent streams, permanent ponds, isolated temporary ponds and rain pools far from permanent water, irrigation ditches, soggy fields, and the surrounding grasslands and sandhills in eastern Colorado river drainages at elevations below 5000 feet (1525 meters).

Nebraska

Insects

Platte River Caddisfly

The Platte River caddisfly (*Ironoquia plattensis*) is a new species first described in 1999 (Whiles et al., 1999). This caddisfly is known to occur in an intermittent palustrine sloughs and side channels that are subirrigated by Platte Riverflows. Caddisfies provides nutrients and energy to a wetland food web by shredding coarse particulate organic materials which is a function unique to wetland communities in North America (Whiles and Goldowitz, 2005). Current studies conducted in 2005 indicated that species range is constrained to a 50- to 60-mile reach of the Platte River between Gibbon and Central City (Whooping Crane Trust, 2005, personal communication, Beth Goldowitz, Aquatic Ecologist). Distribution surveys were conducted on similar habitats in the Elkhorn and Loup River Basins, which resulted in no observations at these sites. Therefore, the Platte River caddisfly seems restricted to the Platte River (Goldowitz, personal communication).

Fish

Finescale Dace and Northern Redbelly Dace

The finescale dace (*Phoxinus neogaeus*) and the northern redbelly dace (*Phoxinus eos*) are both protected as threatened species by the Nebraska Nongame and Endangered Species Conservation Act. These fish are usually found together in Nebraska; therefore, these species will be discussed together in this section. Habitat for these two dace includes clear brooks, ponds, and marshes sustained by springs and seeps. Threats to the species focus on habitat loss and include groundwater pumping, dams, fertilizer runoff, and stream diversion (Madsen, 1985). Habitat degradation through increased turbidity from livestock and agricultural cultivation up to the streambank without the use of protective buffers can also render the habitat unsuitable. Stocking and introduction of predaceous and non-native species threaten the native dace with range restrictions and elimination from some streams.

Spawning for both species takes place from April to June, with the northern redbelly continuing to spawn into August. The northern redbelly dace releases eggs into filamentous algae, while the finescale dace releases its eggs over the stream substrate. Female dace can produce up to several thousand eggs in the spawning season. Eggs hatch in 4 to 10 days, and the young that survive into adulthood reach sexual maturity in 1 to 2 years.

The finescale dace has a short intestine, which typifies a carnivorous species, and is a stout-bodied fish with a large mouth. Diet studies have confirmed the finescale dace as being carnivorous, consuming relatively large, hard prey such as fingernail clams, snails, and other invertebrates. The northern redbelly dace, on the other hand, is largely herbivorous, feeding primarily on algae and, to a lesser degree, insects and zooplankton.

Identification can be difficult since these species are very similar in appearance, and hybridization further complicates identification. The NGPC data show that hybrids are in greater abundance than either of the parental species, and reproductive status of hybrids is not well understood.

Isolated populations have been documented in the North Platte River. Both species have been found in the North Platte River, from Kingsley Dam to the city of North Platte, Nebraska, both historically and in recent years. Due to their specific habitat preferences, connection of the river to spring-fed backwaters and side channels may be important to both species. The alternatives would provide access to these types of habitats, as well as an access corridor between habitats. The Present Condition for the two dace species is represented by monthly average volume of water passing the North Platte gauge along the North Platte River (see the "Water Resources" section in this chapter for a discussion and table of monthly average volume).

Lake Sturgeon

The lake sturgeon (*Acipenser fulvescens*) is primarily an inhabitant of large, moderately clear rivers and lakes. The lake sturgeon is most often found over firm, silt-free substrates of sand, gravel, or rock. In Nebraska, this species is listed by the state as threatened, and can be found in the Missouri River and the lower reaches of the Platte River. Spawning occurs in late spring, and a single female may lay more than 500,000 eggs, although females do not spawn every year. Lake sturgeon are very slow growing and do not reproduce before they are 20 years old. Overharvest appears to have been largely responsible for population declines at the turn of the century (Pflieger, 1997). Lake sturgeon spawning generally takes place from April to June, during high water. Habitat preference tends toward slower velocity habitats, and the availability of these habitats would be facilitated by high spring flows that build sandbars and submerged "dunes" that would serve as velocity breaks in the Platte River. For these reasons, both the April-June flows (table 4-SL-2) and February-July flows (table 4-SL-3) have been examined. The April-June flows are broken out into sixths for the period of record, and only the three wettest sixths are examined, because these higher flows are the most likely to provide significant spawning cues. The same is true for the February-July habitat formation flows.

Table 4-SL-2. —Average and highest monthly flows at Louisville, Nebraska from April to June (cfs)

		Average Flow	Highest Flow Month
Present Condition	Wettest sixth	19,800	28,700
	Second wettest sixth	12,300	16,200
	Third wettest sixth	9,600	13,000

Table 4-SL-3.—Average and Highest Monthly Flows at Louisville, Nebraska,
from February to July (cfs)

		Average Flow	Highest Flow Month
Present Condition	Wettest sixth	16,900	33,100
	Second wettest sixth	11,200	18,400
	Third wettest sixth	9,200	15,100

Sturgeon Chub

The sturgeon chub (*Macrhybopsis gelida*) is classified as an endangered species in the state of Nebraska. Nebraska is one of only five states where sturgeon chub have recently been collected. Sturgeon chubs have also been observed on the Missouri River, just downstream of the confluence with the Platte River. The Lower Platte River continues to provide turbidity and discharge levels suitable for the sturgeon chub and may play a prominent role in the recovery of the species. The Platte River is one of the largest tributaries of the Missouri River, and the only one below Gavins Point Dam that carries spring snowmelt from the Rocky Mountains into the Lower Platte River Basin area.

Water temperature (Cross 1967 and Werdon 1992) and increased flows (Service, 1993 [chub]) are believed to regulate spawning. Collections of ripe fish suggest spawn timing varies across the species range (Stewart, 1981; Werdon, 1992; and Service, 1993 [chub]). Despite the existence of a small population in the Lower Platte River, infrequent and small collections have made it impossible to produce a population estimate or gather information on the movements of adults or juveniles. Sturgeon chub feed primarily on aquatic insects.

Within Nebraska, only two of the six rivers with historical records have maintained populations. Three fish were collected in the Lower Platte River between 1987 and 1991.

Habitat alteration and destruction are the primary factors leading to the decline of the sturgeon chub. The authorization of the Flood Control Act in 1944 spurred the construction of over 105 reservoirs on rivers and streams in the Missouri River Basin. These and other reservoirs flooded riffle habitats, altered flow and temperature regimes, and reduced turbidity; all of which are environmental conditions the sturgeon chub evolved with and is particularly suited to handle. Additional pressure is likely due to predation resulting from the stocking of piscivorous sport fish and the alteration of water quality by industrial and agricultural pollutants (Service, 1993 [chub] and Hesse, 1994).

The historic population trend of the sturgeon chub population in the Lower Platte River appears to be stable, with the maintenance of a very small population. Under the Present Condition, it is unlikely that this trend would change. The population is likely driven by the availability of turbid sandbed habitat with moderate to high current velocities, and by the high spring flows that cycle nutrients in the Platte River, which, in turn, drives the aquatic ecosystem. Flows during the February to July period were examined for the 48-year period of record modeled with the Reclamation CPR model. The average flow and peak flow, within the February-July time period, were organized into thirds (wettest, middle, and driest third of the record) (table 4-SL-4).

Table 4-SL-4.—Average and Highest Monthly Flows at Louisville, Nebraska (in cfs), from February to July

		Average Flow	Highest Flow Month
Present Condition	Wettest third	14,000	25,800
	Middle third	8,400	13,800
	Driest third	5,800	8,600

Mammals

River Otter

The river otter (*Lutra canadensis*) is native to Nebraska and the Platte River, although unregulated trapping led to its disappearance from Nebraska sometime in the early 1900s. For approximately the next 75 years there were few sightings. Then, in 1977, an otter was confirmed along the Republican River in Furnas County, Nebraska. Infrequent reports of river otters from the Republican River Basin continued, and these otters are believed to have been transients rather than from an established population. In 1986, the river otter was listed as a threatened species under the Nongame and Endangered Species Conservation Act for the State of Nebraska.

The NGPC management goal for this species is to restore a self-sustaining, state-wide population. Between August 1986 and March 1991, wild caught otters from thriving populations in other states were released at seven locations in Nebraska, including the North Platte River above Lake McConaughy and the Platte River near Kearney. With legal protection as a State threatened species and continued availability of habitat, river otters are expected to expand into their former range throughout Nebraska.

The habitat of the river otter along the North Platte and Platte Rivers consists of forested rivers and streams with sloughs and backwaters. Marshes and beaver ponds are also frequented. Otters are denning animals, but they rarely dig their own dens and typically use those of beaver and other animals. River otter are opportunistic, and will forage on a variety of animals, although the majority of their food is in the form of fish and some crayfish. The slower swimming, rough fish are taken more readily than faster game fish. As a result, the diet of river otters in the Central Platte Habitat Area likely consists largely of common carp (*Cyprinus carpio*) and channel catfish (*Ictalurus punctatus*).

River Otter Discharge Parameters in the North Platte Basin

Several discharge parameters were evaluated in the North Platte River Basin:

- Percent change in average seasonal flows above Lake McConaughy during October-March – 1,363 cfs for the Present Condition.
- Percent change in average seasonal flows above Lake McConaughy during April-September – 1,438 cfs for the Present Condition.
- Months average monthly flows above Lake McConaughy – less than 500 cfs for the Present Condition. The Present Condition estimates that 29 months within the 48-year period will average less than 500 cfs at the Lewellen Gauge.

The months of October-March represent the winter seasonal flow period while April-September represent the summer seasonal flow. It is anticipated that flows that fall below 500 cfs in the reach above Lake McConaughy will impact the otter's forage fishery.

River Otter Parameters for the Platte River

High water temperature events associated with fishkills are significantly more likely to occur at flow rates below 1,200 cfs in the Central Platte River (Service, 1997), depleting the prey base for the otter. For the 48 years modeled under the Present Condition at the Grand Island flow gauge, it is estimated that 744 days will fall below the 1,200-cfs threshold.

Backwaters are partially separated from the main channel by bars or islands and have low or no current velocities. Studies have shown that backwaters generally support greater species richness and diversity than main channel habitats (O'Shea et al., 1990 and Patton and Hubert, 1993). Side channels are departures from the main channel, which continue to have current during normal river stages; a braided channel has many active side channels. Both side channels and backwaters provide unique habitat parameters that support different fish species during their seasonal life cycle requirements (Patton and Hubert, 1993). Therefore, any management action proposed must be evaluated for potential effects in sediment transport, channel morphology, and changes in fish assemblages. Currently, a Present Condition baseline for backwaters and side channels is not known because of the ephemeral nature of these habitats as a result of interannual and intra-annual flows.

Channel incision and habitat changes that result may lead to a shift in fish species, where species adapted to shallow, turbid waters become displaced by non-native species adapted to lentic conditions (Patton and Hubert, 1993).

Plants

Saltwort

Saltwort (*Salicornia rubra*) is listed as endangered by the State of Nebraska due to its limited range in the state and continuing threats to existing populations. Saltwort is a small, annual, succulent wetland plant characteristic of mudflats with high salinity and poor soil aeration. Few other species can tolerate these conditions, and locations with supporting saltwort are usually otherwise unvegetated. In Nebraska, all but one documented occurrence of this species were in the saline flood plain wetlands of Salt Creek and Little Salt Creek. One small population (less than 20 plants) was identified in a sparsely vegetated alkali flat within a Phelps County wet meadow in 1997, but this population has not been documented since. Since this species is an annual, conditions required for seed germination may not be present every year.

Reptiles

Massasauga Rattlesnake

This species is listed as endangered in the State of Nebraska due to low population numbers and habitat loss. Massasauga (*Sistrurus catenatus*) are medium-sized rattlesnakes associated with natural marsh habitats. Adult massasauga rattlesnakes range from 18 to 26 inches long, not including the rattle. This species is typically active from April-October and spends considerable time is spent basking on sunny spring days (Johnson, 1992). In spring, massasauga rattlesnakes typically move from moist prairie habitats into drier upland areas.

This snake is primarily diurnal but becomes nocturnal during hot summer months. Its diet consists of mice, voles, shrew, frogs, and an occasional lizard or snake (Stebbins, 1985 and Johnson, 1992). Sexual maturity is reached at approximately 3 to 4 years, and female massasaugas reproduce every other year. The size of the female dictates the number of young produced per clutch, and an average clutch is 4 to 10 eggs (Johnson, 1992).

In Nebraska, this species is found in the southeastern part of the state, near the town of Rogers in Colfax County. The population in Colfax County is in wet meadow and native pasture within the Platte River flood plain.

This species is generally restricted to marshes and moist prairie habitats in close proximity to large flood plains, and the trend toward flood plain development and channelization has resulted in range-wide habitat loss and population decline.

Flood plain connectivity and flood plain wetland subirrigation is driven by the spring peak hydrograph in the Lower Platte River. For this reason, flows during the February to July period were examined for the 48-year period of record modeled with the Bureau of Reclamation CPR model. These were organized into thirds (wettest, middle, and driest third of the record) and examined by highest flow month between February and July (table 4-SL-5).

Table 4-SL-5.—Highest Monthly Flows at Louisville, Nebraska (in cfs), from February to July

		Highest Flow Month
Present Condition	Wettest third	25,800
	Middle third	13,800
	Driest third	8,600

SANDHILL CRANES

INTRODUCTION

The North Platte and Platte Rivers, and adjacent lands in central Nebraska, provide important spring habitat resources for sandhill cranes migrating from southern wintering sites to northern breeding grounds. Approximately 500,000 cranes (recent 2000-2003 estimates for the Lexington to Grand Island reach range from 486,000 to 552,000 [Kinzel et al., in press]), which is most of the midcontinent population (> 95 percent) and about 80 percent of all cranes in North America, spend from 4 to 6 weeks each spring (February-April) along portions of the North Platte and the Platte Rivers. Sandhill cranes use this traditional stopover to prepare themselves physiologically for continuing their migration and participating in the subsequent breeding season. Cranes build lipid reserves and obtain important proteins by feeding in harvested corn fields and lowland grasslands and alfalfa fields near river channel roost sites (Krapu et al., 1985; Reinecke and Krapu, 1986; and Tacha et al., 1987). Harvested cropland and lowland grasslands also provide secure sites for pair-bond formation and courtship. In contrast to spring use, cranes appear to use the rivers in fall as a nontraditional stopover site (i.e., opportunistically if inclement weather is encountered or some other factor dictates an overnight or short multi-day stop). Spring habitat resources are, therefore, the focus of this analysis.

Spring migration habitat for sandhill cranes consists of three main components (Armbruster and Farmer, 1981):

- Secure roost sites within the active river channel
- Feeding sites where cranes obtain waste grain (primarily corn from harvested fields)
- Feeding sites where cranes obtain invertebrate food (from wet meadows, alfalfa fields, grazed pastures, and hay fields)

Cranes generally roost in the channel, standing in shallow water, away from wooded banks and islands. They leave their roost sites at first light and move to nearby feeding areas. Midday activities include loafing, sleeping, and courtship. The afternoon feeding period ends at dusk when cranes move to roost sites for the night (Krapu et al., 1984; Iverson et al., 1987; and Folk and Tacha, 1990).

Historically (before water development began in the late 1800s), cranes used the Central Platte River valley from Sutherland to Grand Island, Nebraska (Krapu, 1999). Sandhill cranes no longer use the North Platte and Platte Rivers between North Platte and Lexington, Nebraska. In the areas still occupied on the Platte River, crane use has shifted eastward during the past 45 years. Approximately 60 percent of crane use occurred between Lexington and Kearney in 1957, with about 9 percent of the use between Kearney and Chapman (Faanes and LeValley, 1993). By 1989, 5 percent of cranes occupied the Lexington to Kearney reach, and 81 percent of cranes used the Kearney to Chapman reach (see table 4-SC-1 for recent estimates of use).

Table 4-SC-1.—Sandhill Cranes Daylight and Roosting Use Estimates by Bridge Segments for the Lexington to Chapman Study Area, Averages of 2000-2003 Data

Bridge Segment (River Reach)	Segment Number	Diurnal Distribution	Roosting Distribution	
		Percent Cranes*	Percent Cranes*	Percent Roosting Area
Lexington-Overton	12	1.6	0.0	1.2
Overton-Elm Creek	11	2.9	0.1	0.8
Elm Creek-Odessa	10	6.7	0.7	5.4
Odessa-Kearney	9	6.0	1.6	2.2
Kearney-Highway 10	8	7.9	6.0	6.0
Highway 10-Gibbon	7	12.9	22.5	22.5
Gibbon-Shelton	6	17.7	3.9	9.3
Shelton-Wood River	5	12.3	19.0	15.0
Wood River-Alda	4	9.6	15.4	13.9
Alda-Highway 281	3	14.8	18.0	12.9
Highway 281-US 34	2	5.9	11.8	10.9
US 34-Chapman	1	2.2	1.1	

*Source: Platte River Whooping Crane Maintenance Trust <http://www.whoopingcrane.org>.

The subpopulation of sandhill cranes using the North Platte River has not experienced the same research interest as birds using the Central Platte River. This observation may be linked to the perceived importance of the Central Platte River for whooping cranes. Folk and Tacha (1991) documented what they believed to be substantial reductions in sandhill crane use of the North Platte River Valley between 1980 and 1989. These researchers believed reductions in use were highly associated with declining habitat quality.

This analysis focuses on sandhill crane habitat and spring use at three sites within the study area along the:

- North Platte River at the upper end of Lake McConaughy (from Clear Creek Wildlife Management Area west approximately 2 miles)
- North Platte River between Sutherland and North Platte, Nebraska
- Platte River between Lexington and just east of Grand Island, Nebraska

INDICATORS AND METHODS

Sandhill cranes are gregarious during migration, and most habitat resource use occurs in flocks of varying sizes, from a few birds to aggregations of several thousand individuals. This gregarious behavior—at a traditional use site—is the factor used to formulate our concept of resource use for this species. Basically, that concept is: the greater the abundance of habitat resources, the greater the number of sandhill cranes that can be accommodated at any unit area of interest. Abundance is used here as an index to availability. Availability would consider, among other things, the complex relationships between crane habitat and human disturbance, and potential competition with geese and ducks for food, and possibly roost sites. Such considerations are however beyond the scope of this assessment. Although the focus on resource abundance is a simplistic approach, information generated can be readily modified as new knowledge accumulates through the adaptive resource management process.

This evaluation of sandhill crane spring habitat and its use in the Central Platte River Valley is focused on the abundance of suitable conditions (i.e., depth and width) for roosting within the channel and the abundance of waste corn and invertebrate food—specifically, roosting suitability at the site, bridge segment, and system scale, and potential food abundance at the bridge segment scale (see *Sandhill Crane Appendix* in volume 3).

Roosting Depth Abundance

Cranes use roosting sites that provide suitable water depth. Sandhill crane researchers have speculated that optimal water depth for roosting ranges from 4 to 8 inches, with depths greater than 14 inches believed unsuitable for sandhill cranes (Armbruster and Farmer, 1981). Research indicates that depths up to about 8 inches are commonly used for roosting, with use decreasing rapidly at deeper sites (Latka and Yahnke, 1986; Folk and Tacha, 1990; and Norling et al., 1990). Latka and Yahnke (1986) speculated that—because velocities are closely correlated with depth in the Platte River—flow velocity greater than 1.3 feet per second, or channel bed instability at deeper sites with higher velocities may influence use of sites for roosting.

A depth range of 3 to 9 inches was selected to represent suitable roosting depth. Flows and channel morphology have been the subject of numerous studies in the Central Platte River Valley (reviewed by Simons and Associates, Inc., 2000). Permanent channel transects have been established for various purposes and used to collect data over the years. Subsets of these data, plus additional data, are used to document transect length in the 3- to 9-inch depth range. The indicator for roosting suitability at the site scale is roosting depth abundance as measured by transect length (in feet) within the 3- to 9-inch depth range. Both PHABSIM and SEDVEG Gen3 modeling methodologies were used to evaluate roosting depth abundance.

Physical Habitat Simulation Methodology

Components of the PHABSIM (Bovee and Milhous, 1978; Bovee, 1982; and Milhous et al., 1984) were used as one of two approaches to estimate roosting depth abundance. Habitat transect data collected from sites established by the Service and Reclamation in the mid-1980s (Reclamation, 1989) were manipulated and analyzed to identify the abundance of depths suitable for roosting sandhill cranes. About 16 sites, each supporting from 3 to 9 transects, and believed to represent from 3 to over 16 miles of channel per site, constitute the original source of data (Reclamation, 1989 [Prairie Bend]). Each site was sampled several times at various flows. A subset of these data—a single sampling event at eight sites (representing about 41.5 channel miles)—was selected to represent the relationships between flow and roosting depth. The reader should note that although the data presented below were collected between 1984 and 1986, the eight sites have been resurveyed more recently (1998-2001). Although changes have occurred at these sites, the basic relationships between discharge and roosting depth—to be discussed below—remain for those sites located downstream from Kearney where most cranes roost (table 4-SC-1) (see *Sandhill Crane Appendix* in volume 3 for details).

A discussion of PHABSIM is used to familiarize the reader with the concept of how roosting depth abundance within the 3- to 9-inch depth range changes with changes in flow. This concept is then represented by median March flows as an analysis tool. Actual estimates of transect length within the 3- to 9-inch depth range are derived from the SEDVEG Gen3 model methodology discussed below.

SEDVEG Gen3 Model Methodology

The PHABSIM discussed above is useful in gaining an understanding of the relationship between discharge and roosting depth abundance at different sites between Lexington and Chapman. The approach is appropriate under the Present Condition, since PHABSIM assumes a reasonably stable channel—a channel in dynamic equilibrium— throughout the period of analysis.

However, some proposed action alternatives contain provisions for island leveling, and such activities would radically alter channel morphology at some sites in some bridge segments. Island leveling would likely lead to channel restructuring and may nullify the assumption of channel stability and limit the usefulness of the PHABSIM approach for future impact assessment. To address this uncertainty, a second technique, employing the SEDVEG Gen3 model (Murphy et al., 2006), was also used at the site scale to evaluate the Present Condition and the alternatives for roosting depth abundance.

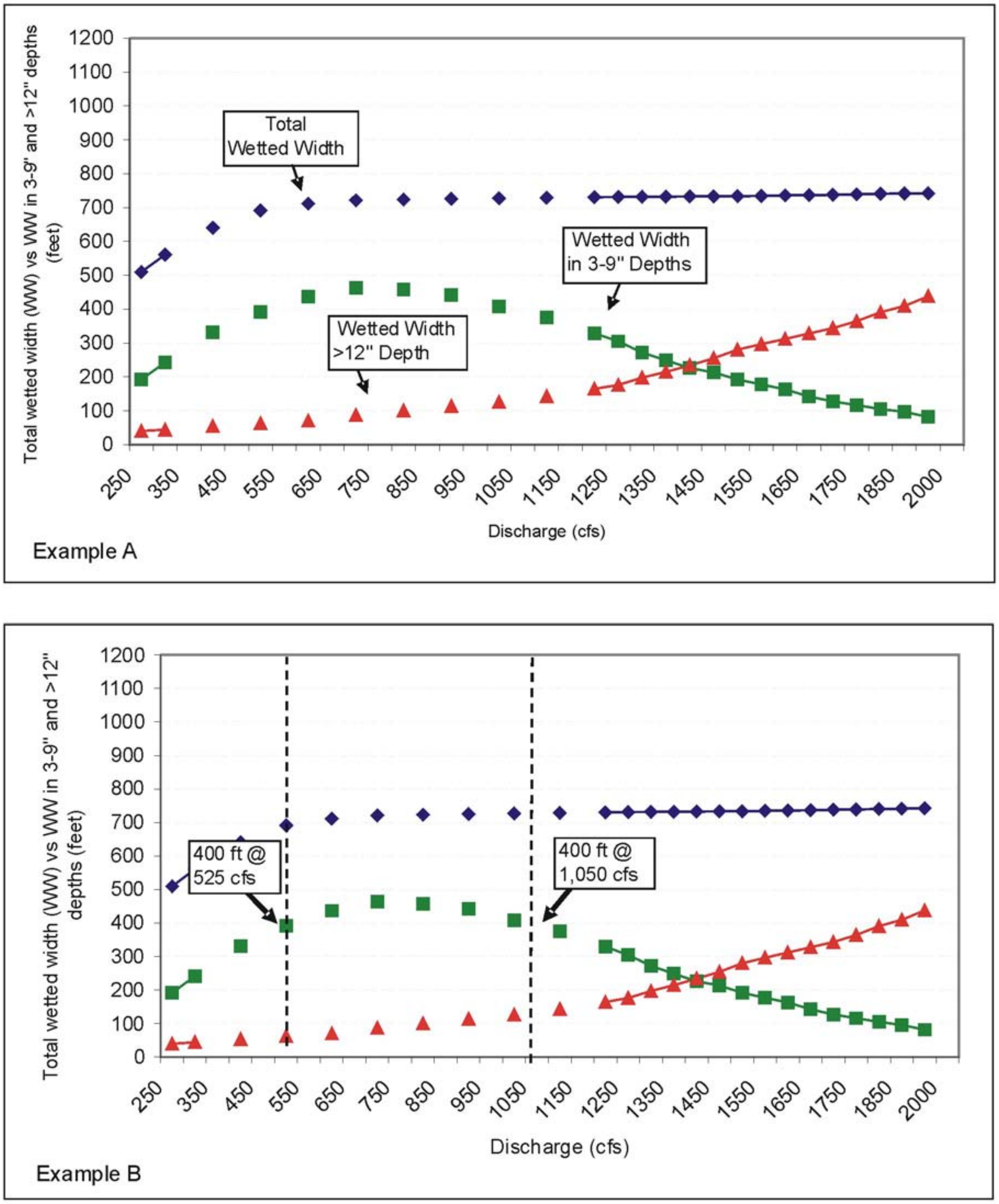
For this analysis of roosting suitability at the site scale, data from 62 SEDVEG Gen3 mocel transects, located between Lexington and Chapman, Nebraska, were evaluated to assess roosting depth abundance during the spring migration period. Two approaches—based on channel width—were taken.

In the first approach, only channels greater than 170 feet (52 meters) wide were evaluated. Transect length within the 3- to 9-inch depth range from estimated daily flows between February 15 and April 15 (60 days) for each year of the 48-year period of hydrology record were collapsed into mean width estimated for each transect for each alternative. Although the exact timing of island leveling activities is unknown, it was assumed that management activities—both flow and mechanical channel restructuring—would occur throughout the 13-year Program's First Increment. Therefore, mean values for indicators during this period would not accurately capture conditions in place at the end of the Program's First Increment. For these reasons, SEDVEG Gen3 model outputs from the 48-year postalternative implementation period were used in all analyses. This period better represents conditions at the end of the First Increment with alternatives in place. SEDVEG Gen3 transect data are grouped to reflect all data, Program-managed areas, and areas of current crane use as shown in table 4-SC-1. (See discussion of braided plan form in "River Geomorphology" in this chapter). Transect groupings included all transects; managed transects; unmanaged transects; transects located upstream of Kearney, Nebraska; transects located downstream of Kearney; and transects located within bridge segments 7 through 2.

This FEIS also evaluated roosting depth abundance in channels greater than 500 feet. The same data set and transect groupings were used as in the above analysis of all channels greater than 170 feet. All transects with usable data, for each day of use, were summed to create a total "transect length" in the 3- to 9-inch-depth range for all transects. Action alternative total transect lengths were then compared to the Present Condition value to obtain a percent change from the Present Condition.

Roosting Depth at the Site Scale

The site-scale analysis focuses on the interaction of discharge with channel morphology to produce various amounts of roosting depth. For example, the channel bottom consists of numerous subchannels of various depths separated by sediment deposits of various heights. Low flows are confined to deeper subchannels within the bottom of the main channel. As discharge increases, water overflows these deeper subchannels into progressively shallower subchannels until it spreads out over the bottom of the channel and covers low elevation sediment deposits. During this initial increase in flow, wetted channel width increases rapidly until the channel bottom is filled. Once the bottom is filled, wetted width increases by water moving up the channel banks. The rate of wetted width increase is reduced after the banks are encountered, but water depth continues to increase (figure 4-SC-1). Roosting depth in the 3- to 9-inch



4-SC-1.—Relationships between total channel wetted width A (blue diamonds), wetted width with depths greater than 12 inches B (red triangles), wetted width within a depth range of 3-9 inches C (green squares), and discharge at habitat site 9BW in 2000.

depth range is generally maximized at flows that just fill the channel bottom (figure 4-SC-1). This relationship between discharge and channel morphology forms the basis for the evaluation of roosting suitability at the site scale.

Transect length within the 3- to 9-inch depth range should be viewed as an index to roosting depth abundance at specific sites, rather than as an absolute quantity. Cranes likely use a subset of depths suitable and available for roosting (Latka and Yahnke, 1986; Folk and Tacha, 1990; and Norling et al., 1990). For example, Finzel et al. (in press) recently estimated roosting area using aerial infrared videography to map crane flocks at roost sites. The estimated area used for roosting by sandhill cranes between Lexington and Grand Island—during spring migration in 2000-2003—ranged from about 182 to 217 acres. To help put this value in perspective, figure 4-SC-1 uses data from a site within bridge segment 3, a segment that contains about 969 acres of channel, of which 355 acres are associated with a channel width greater than 501 feet (estimated from Platte River 1998 GIS database). Measured roosting area within Bridge Segment 3 ranged from 22 to 34 acres (Kinzel et al., in press).

There are no area estimates of roosting depth within the 3- to 9-inch depth range within bridge segment 3, but an example may improve understanding of the potential differences between estimated roosting depth abundance and roosting area. Select 400 feet (figure 4-SC-1) as an example transect length within the 3- to 9-inch depth range. A square 400 feet on each side would contain about 3.7 acres in this example. Within a mile of channel represented by the example site, 13 squares 400 feet on a side could be placed end-to-end, enclosing about 49 acres. This particular sample site, and its companion site 9BE, are believed to represent about 16 miles of channel (Reclamation, 1989 [Prairie Bend]). Clearly, at flows represented in figure 4-SC-1, there is more area in the 3- to 9-inch depth range than is being used by sandhill cranes.

Another argument for viewing transect length within the 3- to 9-inch depth range as an index to roosting depth abundance at specific sites is depicted in figure 4-SC-1. Roosting depth abundance in this analysis assumes that all depths between 3 and 9 inches have equal value. Cranes may treat depths within the range of suitability differently (Latka and Yahnke, 1986; Folk and Tacha, 1990; and Norling et al., 1990). For example, the 400 feet in the 3- to 9- inch depth range at 525 cfs in figure 4-SC-1 may have different depth, velocity, distribution, and other characteristics than the 400 feet that occurs at 1,050 cfs. Most studies of sandhill crane roosting depth have not explored potential preferences within a range of what are currently perceived to be suitable depths.

Finally, transect length within the 3- to 9-inch depth range does not address the issue of disturbance. Sandhill cranes respond to features within the landscape (such as channel banks, wooded islands, bridges, active sandpits, etc.) by avoiding them. Different "disturbance" features illicit differing responses that have been translated into avoidance "buffers" of varying widths (Armbruster and Farmer, 1981; Norling et al., 1990). If a length of transect within the 3- to 9-inch depth range falls within a disturbance buffer, it would be functionally unavailable to sandhill cranes. This situation, like the two situations discussed above, would result in an overestimate of roosting depth abundance.

Given the issues discussed above, we believe roosting depth abundance, as measured by transect length within the 3- to 9-inch depth range, likely encompasses channel depth characteristics that cranes value in a roosting site. For analysis within this FEIS, the index value can be used to make relative comparisons of roosting depth abundance among sites at the same flow and to compare changes in roosting depth abundance at the same site at different flows.

Unobstructed Channel Width

Most sandhill cranes roost in channels greater than 500 feet in width in the Lexington to Chapman reach of the river (Krapu et al.,1984; Davis, 2003). Davis (2003) reported significantly greater channel widths (752 feet versus 271 feet) at occupied roost sites than those measured at unoccupied channel sites.

It is believed that wide channels provide security to roosting cranes, and researchers use the measure of unobstructed channel width to express this relationship.

The second level of analysis—the bridge segment scale—also focuses on roost conditions in the Platte River between Lexington and Chapman. The indicator for roosting suitability at the bridge segment scale is unobstructed channel width, as measured in feet (distance) or acres (area) by two techniques. First, a digital database, supported within a GIS, was used to evaluate unobstructed channel width. Output from the SEDVEG Gen3 model, known as "open width," provided a second estimate of this indicator. Open width is described in detail in "River Geomorphology" in this chapter. Open width is presented here for four reaches:

- Jeffrey Island to Elm Creek
- Elm Creek to Gibbon
- Gibbon to Wood River
- Wood River to Chapman

Two coverages (1982 and 1998), depicting an area along the river from near Lexington to Chapman, and divided into 13 bridge segments (see the *Land Use and GIS Appendix* in volume 3 for details), were compared under the GIS approach. As discussed previously, the SEDVEG Gen3 model outputs from the 48-year postalternative implementation period were used in all analyses, including the determination of unobstructed channel width (open width).

Food Abundance

Studies of sandhill crane spring use of the North and Central Platte Rivers have concentrated—as this analysis does—on the roost site as the focal point of crane home ranges (e.g., Sparling and Krapu, 1994). However, food (or more precisely, nutrient storage) is believed to be the reason sandhill cranes traditionally use the Platte River Valley (Reinecke and Krapu,1986; Tacha et al., 1987; and Krapu, 2003). The importance of the North and Platte Rivers to sandhill cranes for feeding and storing nutrients is exemplified by the fact that some cranes fly up to 1,000 miles out of their flight path to breeding grounds in order to spend 4 to 6 weeks there each spring (Krapu, 2003). Indeed, Krapu believes:

> *"A thorough examination of the role of the CPRV (Central Platte River valley) in the life cycle of the MCP (mid-continent population) of sandhill cranes indicates the MCP exhibits a remarkable level of fidelity to this site, apparently because survival and reproductive success are enhanced as a result of the extended stopover."*
>
> (Krapu, 2003, page 9)

Waste Corn

Waste corn accounted for about 97 percent of sandhill cranes' diets during the late 1970s (Reinecke and Krapu, 1986), and recent studies indicate that waste corn continues to provide significant food resources for cranes using the Platte River valley (Krapu, 2003). Waste corn permits cranes to acquire and store large nutrient reserves as fat for subsequent use during migration and reproduction on the breeding grounds.

There are indications that the relationships between food abundance and cranes' ability to efficiently store nutrients as fat may be changing. For example, in the late 1970s, radio-tagged cranes moved an average of 1.7 miles from their roost sites to feeding areas, and they exhibited a total daily movement of about

6 miles (Service, 1981). More recently, VerCauteren (1998) observed cranes using corn fields 5 miles north and 8 miles south of the Central Platte River, while Krapu and Brandt (U.S. Geological Survey, Jamestown, North Dakota, unpublished data in Davis, 2003) observed cranes foraging up to 12 miles south of the Platte River in 1999 and 2000. In addition to an increase in movement patterns, larger cranes are now storing less fat than in the 1970s (Krapu, 2003 and Krapu et al., in press).

Results from the Platte River Ecology Study (Service, 1981) in the late 1970s indicated that there was abundant waste corn available to meet the needs of wintering livestock, waterfowl, and spring-migrating sandhill cranes using the Central Platte River study area. In the 25-plus years since that study, increased harvesting efficiencies and large increases in numbers of waterfowl using the area, indicate a reduction in waste corn and warrant further study of food availability for migrating sandhill cranes and other wildfowl. It is unclear whether there is currently enough waste corn to meet all needs, but it is likely that further reductions in waste corn abundance will occur. For example, Krapu et al. (2004) reported a loose kernel loss of about 88 pounds per acre (average of 1997-98 data), which is above the average loss (about 78 pounds per acre according to the *Corn Production Handbook*).[20] The handbook indicates that an experienced operator ("expert") using a well adjusted machine in a field with at least 90 percent of the stalks standing and a moisture content below 25 percent should be able to reduce the loose kernel loss to 28 pounds per acre.

The abundance and availability of waste corn are also influenced by postharvest management practices and use by migrating waterfowl (Davis, 2003). Davis (2003) reported high sandhill crane use of ungrazed and grazed stubble (64 to 88 percent), compared to use of tilled and shredded stubble (12 to 36 percent). This investigator believed that fall tillage—which buries waste grain—was increasing along the Platte River during his study (1998-2001). Increases in foraging by expanding populations of Canada and lesser snow geese, that often arrive along the Platte River before migrating cranes, may further affect the abundance and availability of waste corn (Davis, 2003).

Another indicator of changing food abundance is provided by white-fronted geese, which stored abundant fat in the 1970s, but are now unable to store fat while feeding along the Platte River (Krapu, 2003). The issue of reduced waste corn availability for sandhill cranes is addressed briefly in the *Sandhill Crane Appendix* in volume 3, but, in general, it is complex and beyond the scope of this FEIS.

Lowland Grasslands

The remaining 3 percent of diets from sandhill cranes using the Central Platte valley in the 1970s consisted of soil invertebrates gleaned from lowland grasslands (wet meadows), alfalfa fields, and upland grasslands (Reinecke and Krapu, 1986). Cranes appeared to prefer native grasslands and planted hayland over other sites that could potentially provide invertebrates (Sparling and Krapu, 1994; Davis, 2003). The importance of invertebrates in the diet is exemplified by the fact that cranes spend as much time foraging for invertebrates as they do foraging for waste corn (Krapu, 2003).

Invertebrates provide protein—including essential amino acids—and calcium that cannot be acquired from an exclusively waste corn diet (Service, 1981; and Reinecke and Krapu, 1986). Recent studies indicate that cranes store 1 to 1.5 grams of protein per day during their spring stop in Nebraska (Krapu, 2003). Protein storage is likely important in subsequent egg production.

[20]The *Corn Production Handbook* is available from the Agricultural Experiment Station and Cooperative Extension Service at Kansas State University.

Wet meadows are hydrologically linked to river channel flows (Wesche et al., 1994; Sanders et al., 2001; and Henszey et al., in press). The importance of this hydrologic link in the maintenance and biological functioning of wet meadows is discussed in the "Whooping Cranes" in chapters 4 and 5, and will not be repeated here. Wet meadows are important to sandhill cranes as the principal source of invertebrate food. High river surface elevations in spring are believed to facilitate the movement of soil invertebrates into surface layers, where they become accessible to foraging sandhill cranes.

Food Indicator

The food component of spring sandhill crane habitat is also evaluated at the bridge segment scale using the GIS database mentioned above. The approach compares existing acres in various cropland types to projected acreage under future alternative management scenarios. The focus of the food analysis is waste corn, as measured in acres of corn, and invertebrate food, as measured by acres of lowland grassland. The analysis of food abundance is restricted to the Central Platte between Lexington and Chapman, Nebraska.

The abundance of invertebrate food in wet meadows is also evaluated using an analysis of riverflows during the February-March period when sandhill cranes are using the Platte River between Lexington and Chapman. The detailed analysis is discussed in the "Whooping Cranes" in chapters 4 and 5 and is summarized as median flows for sandhill cranes.

Note that an analysis of food abundance is a simplistic approach that does not address the issue of food availability identified above. Food availability is a complex issue that would require the analysis of competition, disturbance, harvesting efficiency for corn, and other factors beyond the scope of this Programmatic FEIS. Food abundance encompasses the issue of availability, and any reduction in food abundance for sandhill cranes should be viewed with concern. Wet meadow invertebrates and waste corn abundance and availability are appropriate topics for further study and monitoring under the adaptive management process.

North Platte Hydrology

The final analysis approach for roosting suitability occurs at the system scale and evaluates existing and simulated flow data (see the *Water Resources Appendix* in volume 3 for details) at selected sites within the North Platte Basin and their assumed effects on water depth. The Present Condition (hydrology period of record, 1947-1994) is used as the standard of comparison. It is assumed that existing conditions reflect the system's responses to the magnitude and frequency of flows and sediment transport in the North Platte River. Existing relationships between discharge and channel depth, and channel width, are the product of these responses.

Because system components are linked, changes in flows and/or sediment supply/transport would likely elicit changes in channel characteristics such as depth and width. Changes in channel depth and/or width may affect roosting suitability. The indicator for this analysis at the system scale is North Platte hydrology (measured in kaf and/or cfs) at selected stream gauges within the North Platte River Basin.

Analysis

Channel transect data were manipulated within the PHABSIM and the SEDVEG Gen3 model, and in supplementary spreadsheet and subroutine analyses, to yield estimates of wetted width supporting a 3- to 9-inch depth range at differing flows at the site scale.

Because proposed action alternatives include mechanical restructuring of the channel at some sites, basic assumptions of channel equilibrium would likely invalidate the use of PHABSIM for comparisons between the Present Condition and action alternative conditions. For this reason, the analysis uses the SEDVEG Gen3 model to determine how proposed island leveling and alternative hydrology would affect the availability of the 3- to 9-inch depth range.

This analysis relied heavily on output from the SEDVEG Gen3 model and the CPR model. The SEDVEG Gen3 model output for analysis of roosting depth abundance was manipulated postprocessing with subroutines developed by Reclamation scientists. No statistical analyses were performed on SEDVEG Gen3 model output.

This analysis evaluated hydrology data from the CPR model and determined that distributions were non-normal. Statistical analyses were therefore performed on CPR model output using the Mann-Whitney U test with an $\alpha = 0.10$.

PRESENT CONDITION

Potential effects to sandhill crane habitat (both positive and negative) from the proposed alternatives were evaluated at three levels or scales. For roosting suitability, the analysis first treats specific sites within the Platte River during specific time periods to determine the relationships between water depth within the channel and flow, and to determine how these parameters affect the abundance of roosting habitat. The relationships identified at the site scale are then extrapolated to the system scale for the North Platte River. Roosting suitability, in terms of channel width, is evaluated at the bridge segment scale along the Platte River. Finally, food suitability is evaluated at the bridge segment scale and only for that area between Lexington and Chapman.

Roosting Suitability—Site Scale

The PHABSIM analysis is presented to familiarize the reader with the relationships between discharge and changes in depth categories. Once these relationships are presented, median monthly flows are used to represent discharge channel relationships. This approach was used to provide a transition between a historic methodology (PHABSIM) and a future methodology (SEDVEG Gen3)—both of which provide output as transect length within the 3- to 9-inch depth ranges.

Physical Habitat Simulation Methodology Analysis

Survey data from the eight habitat sites were selected (measured flow range between 1,068 cfs and 2,062 cfs) and compared to determine the discharge that provided the maximum transect length containing depths between 3 and 9 inches (table 4-SC-2). For these eight sites between Lexington and Chapman, roosting depth abundance is maximized between 800 cfs and 1,600 cfs (mean of 1,175 cfs).

Within these flows, maximum length of transect occupied by depths between 3 and 9 inches ranged from 148 feet to 885 feet (see the *Sandhill Crane Appendix* in volume 3 for details).

Median March flows (1947-1994) were selected to represent discharge in the discharge-roosting depth abundance relationship described above during the spring roosting period under the Present Condition. Median March flows for all eight transect sites were greater than flows that would maximize roosting depth abundance. Median March flows ranged from 1,935.2 cfs (Overton gauge) to 2,141.4 cfs (Grand Island gauge).

Table 4-SC-2.—Mean Wetted Width (3- to 9-Inch Depth Range) at Eight Habitat Transect Sites (2 through 12a) at Various Flows (cfs)*

Flow	Mean Wetted Width (Feet) in the 3- to 9-Inch Depth Range at Eight Habitat Transect Sites							
	2-1 (2,062)	**4A-2 (1,861)**	**6-1 (1,422)**	**8C-2 (1,373)**	**8B-4 (1,802)**	**9BW -2 (1,568)**	**9BE-1 (1,098)**	**12A-4 (1,068)**
400							89	395
550				248				
600			238			115	103	592
700								666
800	142		288	279		145	126	765
900	148	190						803
1,000		192	299		322	182	153	842
1,100			313	228				
1,200	135	191	320		324	196	192	885
1,300			304	200				
1,400	122	183				236	188	831
1,430			291					
1,500			285	172	351			
1,600	121	147	275			256	169	746
1,700					346			
1,800	120					241		657
1,900		130			331			
2,000	112			150	320	208		556
2,100		103	236					
2,200	109				266			427
2,300			213	137				
2,400	99					145		351
2,500			189	139	197		164	
2,600	88	77				104		297
2,700			182	132	144		140	
2,800	79	71				90		254
3,000	72		178		110	74	126	
3,200	62	43		140		69		
3,400	60		182	133		65		
3,430		27	190	130				
3,500					104			
3,600	59			121		53		
3,800		24				49		
4,000					95			

* Multiple transect (three to nine transects per site) measurements were obtained at most sites. The number after the dash identifies a particular site data set. The measured flow for each respective data set is in parentheses. Data are not available at all flows for all sites. Maximum mean wetted widths (3- to 9-inch) for each site are bolded and occur within the range of shaded flows.

SEDVEG Gen3 Model Analysis

The SEDVEG Gen3 model analysis (48 years) under the Present Condition (no island leveling) indicate a mean transect length in the 3- to 9-inch depth range of about 58.9 feet for all transects.

The analysis also examined potential differences between managed and unmanaged transects under the action alternatives and how they compare to the Present Condition. Although no management would occur under the Present Condition, these values are presented here as reference. Present Condition “managed” transects would support a mean transect length of 81.0 feet within the 3- to 9-inch depth range, while unmanaged transects would support 55.0 feet within the roosting depth range.
Fewer sandhill cranes now use the river upstream of Kearney than downstream. Because of this crane-use pattern, the analysis also examined SEDVEG Gen3 model output for transects 2 through 26 (near Lexington to Kearney) and transects 27 through 62 (just downstream of Kearney to Chapman). Transects above Kearney would support a mean transect length of 43.5 feet within the roosting depth range, while transects below Kearney would support 69.5 feet.

Finally, the analysis examined at bridge segments 7 through 2, where over 85 percent of sandhill cranes make their nocturnal roosts (table 4-SC-1). The average transect length in the 3- to 9-inch depth range is 47.0 feet within this reach.

The above analysis focuses on all channels greater than 170 feet and can contain the main river channel and any other smaller channels greater than 170 feet. The second approach to this analysis focused on channels greater than 500 feet and used the same categories as discussed above. As described earlier, the summation of all transect data produced rather large numbers. For example, the estimated total transect length within the 3- to 9-inch depth range for all transects was 7,398, 938 feet. Other transect group lengths (in feet) included:

- Managed transects = 1,692,187
- Unmanaged transects = 5,706,751
- Upstream of Kearney = 3,060,730
- Downstream of Kearney = 4,338,209
- Bridge segments 7 through 2 = 1,976,712

These values will serve as the comparison standards for the Present Condition in chapter 5 analyses.

Roosting Suitability—Bridge Segment Scale

The area occupied at various unobstructed widths was determined from comparisons between 1982 and 1998 GIS data. Data were collapsed into three width categories and compared, employing the assumption that herbaceous islands were part of the 1982 channel (table 4-SC-3). The categories—501 to 750 feet, 751 to 1,000 feet, and greater than 1,000 feet—were arbitrarily selected to focus on widths greater than 500 feet. Area in unobstructed channel width decreased (-0.2 percent) in the 501- to 750-foot category, in the 751- to 1,000-foot category (-9.0 percent), and in the greater than 1,000-foot category (-50.9 percent) between 1982 and 1998. Overall, this analysis indicates that the channel area represented by widths greater than 501 feet is decreasing (-462 acres or -13.3 percent in16 years) under the Present Condition.

Unobstructed view was also estimated using SEDVEG Gen3 model output known as “open view.”
The mean all transect unobstructed view using this approach under the Present Condition is 504 feet.

Table 4-SC-3.—Three Categories (In Acres) of Unobstructed Width Compared (1982 and 1998) by Bridge Segment

*Bridge Segment	Unobstructed Width 501-750 Feet				Unobstructed Width 751-1,000 Feet				Unobstructed Width > 1,000 Feet			
	1982	1998	Change	Percent	1982	1998	Change	Percent	1982	1998	Change	Percent
12a**	83	47	-36	-43.4	0	0	0	—	0	0	0	—
11	100	24	-76	-76.0	12	45	33	275.0	0	0	0	—
10	150	239	89	59.3	45	110	65	144.4	0	0	0	—
9	99	81	-18	-18.2	0	11	11	—	0	0	0	—
8	108	92	-16	-14.8	7	0	-7	-100.0	25	0	-25	-100.0
7	112	203	91	81.3	132	85	-47	-35.6	51	0	-51	-100.0
6	109	119	10	9.2	77	53	-24	-31.2	0	0	0	—
5	194	135	-59	-30.4	52	103	51	98.1	0	0	0	—
4	146	199	53	36.3	99	109	10	10.1	67	0	-67	-100.0
3	253	224	-29	-11.5	236	81	-155	-65.7	25	50	25	100.0
2	221	86	-135	-61.1	177	57	-120	-67.8	0	0	0	—
1	116	239	123	106.0	241	327	86	35.7	543	299	-244	-44.9
Totals	1,691	1,688	-3	-0.2	1,078	981	-97	-9.0	711	349	-362	-50.9

Note: GIS analysis evaluates unobstructed width in all directions for each category. Wooded islands were considered obstructions in 1982, and herbaceous and wooded islands were considered obstructions for analysis of 1998 data.

*Segment 12 - Lexington to Overton
Segment 11 - Overton to Elm Creek (state highway 183)
Segment 10 - Elm Creek (state highway 183) to Odessa
Segment 9 - Odessa to Kearney
Segment 8 - Kearney to state highway 10
Segment 7 - State highway 10 to Gibbon
Segment 6 - Gibbon to Shelton
Segment 5 - Shelton to Wood River
Segment 4 - Wood River to Alda
Segment 3 - Alda to state highway 281
Segment 2 - State highway 281 to Grand Island (state highway 2)
Segment 1 - Grand Island (state highway 2) to Chapman

**12a is a smaller segment than the current (1998) segment.

Roosting Suitability—System Scale

Systems are assemblages of linked components. The Present Condition on the North Platte River reflects the responses of linked components to the external and internal forces and processes that define this system (such as discharge and sediment transport). The system-scale analysis assumes that the previously described relationships at the site scale between discharge and roosting suitability can be used to gain insight into future roosting conditions when only hydrology is available. In other words, changes in flow and/or sediment transport would be reflected as changes in sandhill crane roosting habitat. Although some historic transects exist between Sutherland and North Platte, these sites have not been studied since the 1980s. Thus, this analysis relies on discharge, as represented by current and simulated hydrology conditions, to provide insight into future habitat conditions at sites along the North Platte River.

Data from the North Platte hydrology analyses (*Water Resources Appendix* in volume 3: period of record equals 1947-1994) were used to evaluate the effects of flow on roosting habitat at the system scale.

Discharge data from gauges located at Lewellen, Kingsley Dam, and North Platte, Nebraska, were evaluated. The North Platte River is important to cranes because it provides water to the Central Platte River, and its flows also currently support about 5,000 to 8,000 sandhill cranes that use the channel for roosting at the upper end of Lake McConaughy (Clear Creek Wildlife Management Area and the channel west for about 2 miles). Some 150,000 sandhill cranes also use the river between Sutherland and North Platte, Nebraska. It is assumed that currently existing channel width and depth characteristics provide these cranes with roosting habitat. These characteristics are the result of current discharge. Several discharge parameters were evaluated in the North Platte Basin:

- **Median monthly flow at Lewellen during February, March, and April**: believed important in providing roosting depth abundance: February = 68.7 kaf, March = 72.1 kaf, April = 73.3 kaf.

- **Median monthly flow at Lewellen during May, June, and July**: believed important in maintaining channel width by preventing cottonwood establishment: May = 59.9 kaf, June = 64.4 kaf, July = 51.7 kaf.

- **Kingsley Dam total annual spill**: believed important in maintaining channel configuration in the Sutherland to North Platte reach. The Present Condition average annual spill is 169,100 acre feet.

- **Frequency of spills from Kingsley Dam**: important for the reasons identified above. Frequency of spills is currently 0.60.

- **Annual flow at North Platte, Nebraska**: believed important in maintaining channel configuration. The current median annual discharge of the North Platte River is 391.9 kaf.

- **Median monthly flow at North Platte during February, March, and April**: believed important in providing roosting depth abundance: February = 21.5 kaf, March = 24.9 kaf, April = 23.4 kaf.

- **Median monthly flow at North Platte during May, June, and July**: believed important in maintaining channel width by preventing cottonwood establishment: May = 24.7 kaf, June = 33.5 kaf, July = 91.1 kaf.

Food Suitability—Bridge Segment Scale

The GIS database produced acreage estimates of the applicable cover types (corn fields, wet meadows, alfalfa fields, and grasslands) that provide corn and invertebrate food for sandhill cranes.

GIS analysis of cover types that provide corn and invertebrate food indicates some changes have occurred in the last 16 years. Corn field acreage increased between 1982 and 1998 by 5.1 percent, while other crop acreage declined 3.1 percent (table 4-SC-4). The comparison between 1982 and 1998 indicates an increase in lowland grasses (31.7 percent) and a reduction in acres of alfalfa (-39.9 percent) and upland grasses (-3.9) (table 4-SC-5). These increases in lowland grasses appeared high, and inspection of data within bridge segment 10 indicated increases could be attributed to clearing on Crane Trust lands after 1982. In addition, a large tract of grassland in bridge segment 1 was not included within the flood plain in 1982, but it was included in 1998. Finally, much of the increase in total acres of lowland grassland may reflect conversions of marginally productive farmland to the Conservation Reserve Program.

Sandhill cranes commonly feed in short-stature grasslands, either grazed or hayed wet meadows or alfalfa (Davis, 2003). Conservation Reserve Program plantings generally consist of tall-grass prairie species that provide robust cover unsuitable for crane foraging. Given current hydrologic and economic trends of the area, it is unlikely that lowland grasslands—suitable for crane foraging—would exhibit an increasing trend in acreage without an active management program involving aggressive clearing and seeding of short-stature grasses on well watered sites.

Table 4-SC-4.—Acreages (1998 Compared to 1982) for Corn and Other Crops Within 3.5 Miles of the Platte River, Between 3.5 Miles West of Lexington to Chapman, Nebraska

Bridge Segment*	1982 Corn	1998 Corn	Change	Percent Change	1982 Other Crops	1998 Other Crops	Change	Percent Change
12a**	5,387	5,323	-64	-1.2	566	866	300	53.0
11	15,872	15,907	35	0.2	3,701	4,746	1,045	28.2
10	11,230	11,004	-226	-2.0	1,389	3,160	1,771	127.5
9	12,522	13,492	970	7.7	3,227	2,841	-386	-12.0
8	15,904	16,336	432	2.7	1,443	2,015	572	39.6
7	12,470	14,399	1,929	15.5	2,076	1,010	-1,066	-51.3
6	15,864	16,811	947	6.0	2,547	2,247	-300	-11.8
5	24,276	24,105	-171	-0.7	3,336	3,578	242	7.3
4	10,732	12,489	1,757	16.4	3,626	2,108	-1,518	-41.9
3	14,167	15,263	1,096	7.7	3,307	2,266	-1,041	-31.5
2	15,255	15,426	171	1.1	2,577	2,944	367	14.2
1	23,384	25,567	2,183	9.3	6,532	5,475	-1,057	-16.2
Totals	177,063	186,122	9,059	5.1	34,327	33,256	-1,071	-3.1

*Segment 12a - 3.5 miles west of Overton to Overton
Segment 11 - Overton to Elm Creek (State Highway 183)
Segment 10 - Elm Creek (State Highway 183) to Odessa
Segment 9 - Odessa to Kearney
Segment 8 - Kearney to State Highway 10
Segment 7 - State Highway 10 to Gibbon
Segment 6 - Gibbon to Shelton
Segment 5 - Shelton to Wood River
Segment 4 - Wood River to Alda
Segment 3 - Alda to State Highway 281
Segment 2 - State Highway 281 to Grand Island (State Highway 2)
Segment 1 - Grand Island (State Highway 2) to Chapman

**12a is a smaller bridge section than the 1998 segment 12.

Table 4-SC-5.—Acreages (1998 Compared to 1982) for Lowland Grasses, Alfalfa, and Upland Grasslands Within 3.5 Miles of the Platte River From Overton to Chapman, Nebraska

*Bridge Segment	1982 Lowland Grasses	1998 Lowland Grasses	Change	Percent Change	1982 Alfalfa	1998 Alfalfa	Change	Percent Change	1982 Upland Grasses	1998 Upland Grasses	Change	Percent Change
12a	755	639	-116	-15.4	1,524	1,338	-186	-12.2	1,349	1,678	329	24.4
11	1,569	2,372	803	51.2	5,513	4,118	-1,395	-25.3	3,415	3,260	-155	-4.5
10	481	1,554	1,073	223.1	4,853	2,821	-2,032	-41.9	3,849	3,862	13	0.3
9	580	460	-120	-20.7	3,494	3,289	-205	-5.9	10,791	10,280	-511	-4.7
8	1,382	1,483	101	7.3	2,181	978	-1,203	-55.2	2,458	2,368	-90	-3.7
7	2,103	2,085	-18	-0.9	2,108	1,554	-554	-26.3	3,394	3,232	-162	-4.8
6	594	890	296	49.8	1,723	884	-839	-48.7	2,550	2,840	290	11.4
5	735	712	-23	-3.1	792	514	-278	-35.1	6,316	6,713	397	6.3
4	2,333	2,801	468	20.1	1,054	591	-463	-43.9	3,558	3,250	-308	-8.7
3	4,473	5,940	1,467	32.8	2,108	510	-1,598	-75.8	3,186	2,915	-271	-8.5
2	3,226	4,063	837	25.9	1,726	344	-1,382	-80.1	1,714	1,872	158	9.2
1	3,288	5,351	2,063	62.7	2,772	1,007	-1,765	-63.7	6,476	4,861	-1,615	-24.9
Totals	21,519	28,350	6,831	31.7	29,848	17,948	-11,900	-39.9	49,056	47,131	-1,925	-3.9

*Segment 12a -3.5 miles west of Overton to Overton
Segment 11 - Overton to Elm Creek (state highway 183)
Segment 10 - Elm Creek (state highway 183) to Odessa
Segment 9 - Odessa to Kearney
Segment 8 - Kearney to state highway 10
Segment 7 - State highway 10 to Gibbon
Segment 6 - Gibbon to Shelton
Segment 5 - Shelton to Wood River
Segment 4 - Wood River to Alda
Segment 3 - Alda to state highway 281
Segment 2 - State highway 281 to Grand Island (state highway 2)
Segment 1 - Grand Island (state highway 2) to Chapman

Median February and March flows were evaluated for their effect on wet meadow foraging conditions. It is assumed that higher flows would have a higher potential for making soil invertebrates accessible to foraging sandhill cranes. Under the Present Condition, the median February flows for Overton and Grand Island are 2,177 cfs and 2,089 cfs, respectively. For March, the flows are 1,935 cfs (Overton) and 2,141 cfs (Grand Island). Readers should also look at the "Whooping Cranes" section in chapters 4 and 5 for an expanded evaluation of flow effects to wet meadows. Table 4-SC-6 provides a summary of habitat parameters defined by bridge segments between about Overton and Chapman, and sandhill crane use (nocturnal and diurnal) of bridge segments for the Present Condition (1998).

Table 4-SC-6.—Channel Area, Channel Width Greater than 501 Feet, Channel Area Cleared, Lowland Grasses, Corn (1998 Acres), and Percent Nocturnal and Diurnal Crane Use of Study Segments as an average value for 2000-2003*

Bridge Segment**	Total Channel Area	Channel Width >501 Feet	Channel Cleared 1982-1997	Lowland Grasses	Corn	Percent Cranes Surveyed (Nocturnal)	Percent Cranes Surveyed (Diurnal)
12***	644	47	27	3,038	13,013	0.0	1.6
11	838	69	5	2,372	15,907	0.1	2.9
10	644	350	540	1,554	11,004	0.7	6.7
9	889	92	39	460	13,492	1.6	6.0
8	780	92	441	1,483	16,336	6.0	7.9
7	723	288	467	2,085	14,399	22.5	12.9
6	703	172	13	890	16,811	3.9	17.7
5	946	238	130	712	24,105	19.0	12.3
4	718	308	200	2,801	12,489	15.4	9.6
3	969	355	277	5,940	15,263	18.0	14.8
2	847	143	16	4,063	15,426	11.8	5.9
1	1,865	865	0	5,351	25,567	1.1	2.2
Totals	10,566	3,019	2,154	30,749	193,812	100.00	100.0

Note: Segments are located from about 3.5 miles west of Overton to Chapman, Nebraska, and cover a band 3.5 miles both north and south of the Platte River.

* Source: <http://www.whoopingcrane.org>.

**Segment 12 - Lexington to Overton
Segment 11 - Overton to Elm creek (state highway 183)
Segment 10 - Elm Creek (state highway 183) to Odessa
Segment 9 - Odessa to Kearney
Segment 8 - Kearney to state highway 10
Segment 7 - State highway 10 to Gibbon
Segment 6 - Gibbon to Shelton
Segment 5 - Shelton to Wood River
Segment 4 - Wood River to Alda
Segment 3 - Alda to state highway 281
Segment 2 - State highway 281 to Grand Island (state highway 2)
Segment 1 - Grand Island (state highway 2) to Chapman

***Segment 12 covers more area than segment 12a.

NORTH PLATTE RIVER BASIN FISHERIES

INTRODUCTION

The North Platte River has been significantly altered by the construction and operation of a series of reservoirs in central Wyoming and in Nebraska. Sturgeon, goldeye, sauger, plains minnow, and sturgeon chub have disappeared since the 1900s. Dam construction has resulted in the conversion of a large, turbid river to a series of impoundments. The river below such impoundments is generally clear and is often greatly reduced in volume. Significant recreational fisheries for non-native gamefish, such as rainbow trout, walleye, and channel catfish, have been developed in most of the reservoirs and in many of the tailwaters.

Both the reservoir fisheries and the stream fisheries might be affected by the action alternatives through changes in reservoir elevations, the amount of time water resides in each reservoir, the relative balance between inflows and stored waters, and the rate and timing of flows in the rivers below the reservoirs.

INDICATORS

Indicators for North Platte fisheries include:

- **Reservoir storage content** (volume) and chainges in elevatiopn
- Percent change in the **total standing crop** of fish in each reservoir
- **Temperature and dissolved oxygen** levels in reservoirs and outflows
- **Riverflows** and changes in flows

Reservoirs in the North Platte River drainage were assigned volume "flags," identified by the Wyoming Department of Game and Fish (WG&F), below which they believed that fishery impacts could be significant (i.e., habitat loss, food loss, increased competition, and predation). More details on impacts are discussed in chapter 5, "Environmental Consequences." The following "flags" were incorporated into Reclamation's NPRWUMEIS to highlight reservoir impacts for each alternative:

- Pathfinder Reservoir - 200 kaf
- Seminoe Reservoir - 200 kaf
- Glendo Reservoir - 100 kaf
- Alcova Reservoir - 150 kaf

In addition to these indicators of "significant drawdowns" to help highlight changes in the frequency of various reservoir volumes, the following second set of "flag" volumes were used to represent the occurrence of conditions critical to the survival of the fishery:

- Pathfinder Reservoir - 50 kaf
- Seminoe Reservoir - 50 kaf
- Glendo Reservoir - 63 kaf

For river impacts, the WG&F suggested using streamflow "flags" to identify monthly reservoir outflows and instream flows below which fishery impacts could be significant. The following "flags" were incorporated into the NPRWUMEIS to highlight river impacts for each alternative:

- Fremont Canyon Powerplant bypass - 75 cfs
- Glendo outflows - 25 cfs
- Kortes outflows - 500 cfs
- Gray Reef outflows - 500 cfs

In addition to the above flags, WG&F requested that the analysis check for a stable or increasing storage from April 1-June 30 in Glendo Reservoir. Additional indicators included temperature and dissolved oxygen modeling in Pathfinder Reservoir and the Pathfinder Reservoir ouflow in the North Platte River, temperature and DO impacts in Glendo Reservoir and downstream from Gray Reef Dam, and DO effects below Alcova Reservoir.

METHODS

Reclamation's NPRWUMEIS hydrology model was used as the basic tool in this analysis to provide information about how each of the six alternatives would affect reservoir levels and riverflows throughout the North Platte River. The analysis will compare the number of times in the model study period that the reservoirs fall below the above-referenced flag levels with each of the alternatives in comparison with the Present Condition.

The WG&F requested that the Morphoedaphic Index (MEI) of fish production used by WG&F be used to assess impacts on reservoir fisheries. The MEI is an empirically derived formula for calculating potential fish yields from lakes (Ryder, 1965). Higher MEI levels indicate higher projected fish standing crops. The formula for MEI values is:

$$\text{MEI} = \frac{\text{TDS (ppm)}}{\text{Mean depth (feet)}}$$

The MEI values were calculated for each alternative and compared to the Present Condition. In addition, areal fish standing crops were estimated using the formula above and were multiplied by the reservoir area to give a total standing crop for the reservoir.

Detailed methods for the MEI development, Pathfinder temperature modeling, and empirical DO modeling are available in the *North Platte River Basin Fisheries Appendix*. An overview is presented here. Although there are sections in the FEIS on water quality, this section presents an overview of water quality in the North Platte River and its reservoirs in Wyoming as it relates primarily to coldwater fisheries.

To address questions and concerns over potential temperature effects due to the change in operations of Pathfinder Reservoir, a mathematical temperature model of the reservoir was developed. This model is based on historic data from 1977. The model was constructed from existing flow and water quality data from the USGS gauges on the North Platte and Sweetwater Rivers. Because the gauge record on the North Platte River upstream from Pathfinder Reservoir ended in 1959, the flows for 1977 were taken from the NPRWUMEIS. Weather data from the Natrona County International Airport were purchased from the National Weather Service.

The Pathfinder temperature model was based on 1977 data because of the availability of temperature profiles in the reservoir and the fact that 1977 was the driest year in which there were measured data available for calibration of the model. The model used the generalized code, CE-THERM-R1, a 1-dimensional reservoir temperature simulation computer code that was obtained from the U.S. Army Corps of Engineers Waterways Experiment Station in Vicksburg, Mississippi. Model documentation is included in WES (1995).

The probability of the reservoir hypolimnion in both Seminoe and Pathfinder Reservoirs remaining aerobic during the late summer was estimated using empirical models taken from Reckhow and Chapra (1983). The models are based on regression equations derived from nutrient loading data gathered during the EPA's National Eutrophication Survey and the Organization for Economic Cooperation and Development is Eutrophication Project. The models rely on total phosphorus loadings to a lake or reservoir. Because the total phosphorus in the North Platte River upstream from Pathfinder Reservoir is determined by what passes through Seminoe Reservoir, a model of Seminoe Reservoir was also constructed.

PRESENT CONDITION

Plankton

The productivity of fish in reservoirs is dictated by the available food. The base of the food chain is usually composed of plankton, microscopic plants, and animals. In the Upper North Platte Basin reservoirs, the phytoplankton is dominated by diatoms in the spring. There is an annual bloom of the blue-green alga (technically, cyanobacterium), *Aphanazomenon flos-aquae* later in the summer. The bloom occurs throughout the North Platte Basin from Seminoe Reservoir to Lake McConaughy in Nebraska. The effects of the bloom in the Upper North Platte River Basin reservoirs are characterized in Sartoris et al. (1981). The bloom effectively eliminates other forms of phytoplankton. Because of the tendency to produce a toxin during bloom conditions, there is an associated decrease in zooplankton. All of this tends to decrease fish production late in the summer.

Reservoir Fisheries

Seminoe Reservoir

Stocked rainbow trout are managed under a Basic Yield Concept[21] in Seminoe Reservoir, with WG&F stocking 120,000 catchable rainbow trout annually. Wild populations of walleye and brown trout contribute to the fishery. Native fish species include white and longnose suckers, bigmouth and sand shiners, fathead minnows, and Iowa and johnny darters. Exotic species include walleye; rainbow, brown, cutthroat, and lake trout; carp; and emerald shiners. Gizzard shad have been stocked in Seminoe Reservoir but rarely overwinter successfully. Large annual reservoir elevation fluctuations averaging 37 vertical feet per year during the past 30 years limit productivity (Conder and Deromedi, 1998). Extended periods of below average runoff exacerbate this situation. Turbidity—a result of high runoff and/or low carryover storage— is identified as a key factor influencing the declining trend in the Seminoe Reservoir non-native trout fishery (McMillan, 1984).

Table 4-NPF-1 shows the number of times out of 48 water years that Seminoe Reservoir elevations were less than 6289 feet (200-kaf volume) under the Present Condition.

[21]The Basic Yield Concept describes a fishery where management is primarily directed towards providing anglers with the opportunity to harvest fish. Fisheries may be supported by stocking, but fish grow to catchable size in the wild.

Table 4-NPF-1.—Summary of Elevations Less Than 6289 Feet (~200 kaf) in Seminoe Reservoir Under the Present Condition

Number of Water Years Out of 48											
Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
3	3	3	4	5	6	4	2	0	0	1	3

Under the Present Condition, Seminoe Reservoir does not drop below 50 kaf in volume during the 48-year study period of the operations model. The summary (average) MEI value for the projected fish standing crop results for Seminoe Reservoir under the Present Condition is 6.13, with a total projected fish standing crop of 205 tons.

Pathfinder Reservoir

Pathfinder Reservoir is managed under a Basic Yield Concept for rainbow trout, with wild populations of walleye and brown trout contributing to the fishery. Native fish species include white and longnose suckers, bigmouth and sand shiners, fathead minnows, and Iowa and johnny darters. Exotic species include walleye; rainbow, brown, cutthroat, lake, splake, and Ohrid trout; lake chub; carp; and emerald and spottail shiners. Gizzard shad have been stocked in the reservoir but rarely overwinter successfully.

Large annual reservoir water level fluctuations limit productivity at Pathfinder Reservoir (Conder and Deromedi, 1998). Rainbow trout populations declined during the low runoff period and associated low reservoir water levels beginning in 1988. A combination of increased predation and competition due to concentration of fish in the reduced reservoir pool, as well as turbidity from downcutting through fine sediments in the old river channel with the associated reduced productivity—were responsible for the decline in non-native rainbow trout population. The trout population stabilized during the early 1990s, and the trout fishery improved. The above normal runoff of 1995 and associated increase in the reservoir surface area resulted in an increased trout growth rate with the increased storage (Conder and Deromedi, 1998).

Table 4-NPF-2 shows the number of times out of 48 water years that Pathfinder Reservoir elevations were less than 5787 feet (200-kaf volume) under the Present Condition.

Table 4-NPF-2.—Summary of Elevations Less Than 5787 Feet (~200 kaf) in Pathfinder Reservoir Under the Present Condition

Number of Water Years Out of 48											
Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
5	6	6	4	4	4	5	3	0	3	6	7

Under the Present Condition, Pathfinder Reservoir drops below 50 kaf of volume on two occasions. These are under the conditions represented in the operations model by September 1964 and March 1965. The summary (average) MEI value for the projected fish standing crop results for Pathfinder Reservoir under the Present Condition is 6.78, with a total projected fish standing crop of 226 tons.

Alcova Reservoir

Alcova Reservoir supports an excellent "basic yield" fishery for rainbow trout. The reservoir's trout population is based on the stocking of large numbers of subcatchable trout. The yield to the anglers is a stocked fish which has grown to a catchable size in the wild. Wild walleye and stocked brown trout are also available. Trout populations depend entirely on stocking. With the growth of the walleye population, stocking of trout has shifted from fingerlings to trout averaging 9 inches. Major blue-green algae blooms do not commonly occur in this reservoir; thus, zooplankton production generally remains high during summer months, supporting an excellent growth rate in trout (Conder and Deromedi, 1998). Native nongame species include fathead minnow, white and longnose suckers, bigmouth and sand shiners, and Iowa and johnny darters. Non-native species include lake chub, carp, and emerald and spottail shiners. Largely because of trout fishing, Alcova Reservoir ranks as one of the State's most important reservoir fisheries. It is commonly called "Casper's Playground," alluding to its popularity among Casper, Wyoming residents.

Glendo Reservoir

Glendo Reservoir is managed under a Wild Concept[22] for walleye and yellow perch. Native species include channel catfish, shorthead redhorse, white and longnose sucker, quillback, fathead minnow, Iowa and johnny darter, river carpsucker, and red, bigmouth, and sand shiner. Exotic species include rainbow trout, walleye, yellow perch, black and white crappie, carp, gizzard shad, and emerald, golden, and spottail shiner. Channel catfish were last stocked in 1998 in Glendo Reservoir. Gizzard shad are stocked annually to bolster forage.

Conder and Deromedi (1998) indicate that the annual reservoir drawdown of 87 percent, which severely reduces the available habitat, is the major limiting factor for this reservoir. This late summer drawdown stimulates forage and game fish to emigrate downstream in the outflows.

The summary (average) MEI value for the projected fish standing crop results for Glendo Reservoir under the Present Condition is 12.86, with a total projected fish standing crop of 302 tons. Glendo Reservoir elevations were less than 4580 feet (100 kaf volume) 4 times in August and 4 times in September in the 48 water years under the Present Condition. The model pool levels do not drop below the 63 kaf critical pool level under the Present Condition.

Guernsey Reservoir

Following the irrigation season, the reservoir is emptied and remains so until the following spring. In addition, the reservoir is once again drawn down in June to accommodate an annual silt run. The periodic emptying of the reservoir severely limits the development of any fisheries in Guernsey Reservoir. Conder and Deromedi (1998) indicate that the current reservoir operational regime precludes any fisheries development.

[22]The Wild Concept describes a fishery totally supported by natural reproduction.

Riverine Fish Communities

Kortes Reservoir Outflows

The Miracle Mile, a roughly 5-mile stretch of the North Platte River from Kortes Dam to Pathfinder Reservoir, is a "blue ribbon" trout fishery (class I, trout fishery of national importance) managed under a Trophy Concept[23] for rainbow and brown trout. Rainbows sustain some natural recruitment and are also stocked annually. Brown trout are wild with no stocking. The construction of Seminoe Dam created a productive tailwater fishery, supplying clear, cold water. A minimum flow of 500 cfs was established in 1971 to protect this outstanding fishery. Native fish species include white and longnose suckers, longnose dace, fathead minnow, and bigmouth and sand shiners. Exotic species include rainbow, brown, and cutthroat trout; walleye; carp; and emerald shiners.

Flows are always 500 cfs or greater on a monthly basis for the Kortes Reservoir outflows under the simulated Present Condition.

Fremont Canyon Powerplant Bypass

For approximately 4.1 miles below Pathfinder Dam, the North Platte Riverflows through Fremont Canyon. A cooperative effort among the Service, Reclamation, NRCS, WG&F, Natrona County, Wyoming Flycasters, and local landowners and sportsmen's groups has developed a year-round, 75-cfs flow and public access in this reach. This will provide an excellent fishery resource, called the Cardwell Public Fishing Area, of regional importance. Reclamation implemented this flow in August 2002. In 2002, WG&F completed a habitat improvement project with assistance from Natural Resource Conservation Service (NRCS), Reclamation, and Wyoming Flycasters to design and fund for habitat features in the river channel to maximize fisheries benefits. WG&F estimated a rainbow trout population of 114 trout per mile and 250.9 pounds of trout per mile in this reach in September 2004 (WG&F, 2004, personal communication, Al Conder, Casper Regional Fisheries Supervisor). Growth and condition appeared to be excellent. The fishery should continue to improve as riparian vegetation becomes established and fine materials from channel construction are transported downstream.

Flows are always 75 cfs or greater on a monthly basis for the Fremont Canyon (Pathfinder) Powerplant bypass under the Present Condition.

Gray Reef Outflows

The 32-mile reach of the North Platte River from Gray Reef Dam to Goose Egg (Bessemer Bend) has been designated class I (trout fishery of national importance) or "blue ribbon" fishery by WG&F. This fishery has the highest standing crop of rainbow trout, brown trout, and cutthroat trout in Wyoming. WG&F (2002) estimated the trout population at 1,167 trout per mile in 2001. Walleye are also found in this reach. This fishery is managed under the Trophy Concept, including a one-trout limit, use of artificial flies and lures only, and the release of all trout less than 20 inches. WG&F (2002) reported a catch rate of 0.84 trout per hour in 2001.

[23]The Trophy Concept describes a fishery managed for the opportunity to catch larger than average fish. The fishery will not support as much use as a Basic Yield Concept fishery.

From Bessemer Bend downstream to the Mills Bridge in Casper, the North Platte River becomes a class II trout fishery (trout fishery of state-wide importance), largely from input of fine sediments from Bates Creek. These two reaches received a total of 16,993 angler days per year in 1995 and 1996.

The 100-mile reach of river from Mills Bridge in Casper to Glendo Reservoir is managed under a Basic Yield Concept for rainbow trout, brown trout, and channel catfish. Native fish species include white and longnose sucker; bigmouth, red, common, and sand shiner; creek, flathead, and lake chub; plains killifish; central stoneroller; quillback; shorthead redhorse; green sunfish; stonecat; black bullhead; johnny and Iowa darter; river carpsucker; channel catfish; and fathead and brassy minnow. Exotic species include brown and rainbow trout, walleye, flathead catfish, yellow perch, gizzard shad, and carp.

Reclamation conducted an extensive fish survey of the North Platte River from Casper to the Nebraska State line in March 1999 to supplement WG&F's information on fish communities (Broderick, 2000). Some sites were sampled by backpack electrofishing, while others were sampled by raft-mounted electrofishing. Electrofishing samples were combined into five reaches. The Casper to Douglas reach (upstream of Orin) is characterized by 62 percent native fish and 38 percent exotic species, while the next reach from Douglas to the Glendo Reservoir inlet (which encompasses Orin) is characterized as 40 percent native fish and 60 percent exotic species, principally walleye. The Casper to Douglas reach has 58 percent turbidity tolerant (adapted for turbid rivers) species in the catch, and the Douglas to Glendo inlet reach is characterized as 56 percent of the catch as represented by turbidity tolerant species.

Conder and Deromedi (1998) indicate that sediment accumulation has degraded trout habitat, adversely impacting trout spawning areas, juvenile rearing areas, and aquatic macroinvertebrates. Elevated water temperatures of as much as 30°C limit trout production downstream of the Natrona/Converse County line.

Flows are always 500 cfs or greater on a monthly basis at the Gray Reef Reservoir outflows under the Present Condition.

Glendo Reservoir Outflows

The 22-mile class III river reach from Glendo Dam to Guernsey Reservoir is managed under a Basic Yield Concept for rainbow trout, with wild brown trout also contributing to the fishery. Fingerling rainbow trout are stocked annually to augment natural recruitment. Native species include channel catfish, longnose dace, quillback, fathead minnow, and white and longnose suckers. Exotic species include rainbow, brown, and cutthroat trout; carp; walleye; yellow perch; black crappie; gizzard shad; and emerald and spottail shiner.

Broderick (2000) found that in the sample sites immediately below Glendo Dam, 80 percent of the fish sampled were native species and 20 percent were exotics; 75 percent of the species were turbidity intolerant (adapted for clear water rivers), with 25 percent tolerant.

The North Platte River below Glendo Reservoir provides a popular local fishery for rainbow and brown trout. The sport fishery is limited by fluctuating waterflows. Nonirrigation season flows in this reach are 25 cfs, which suppresses trout populations during the critical wintering period and high flows during the larval and juvenile life stages (Conder and Deromedi, 1998). The nonirrigation season flow of 25 cfs occurs in the river immediately below Glendo Dam via the Glendo Dam low flow outlet works. The Glendo Dam Low Flow Outlet works provide a year-round flow of 25 cfs between Glendo Dam and Glendo Powerplant outlet works.

Flows are always 25 cfs or greater on a monthly basis at the Glendo Reservoir outflows under the Present Condition.

Fish Community Downstream from Guernsey Reservoir to the State Line

The North Platte River below Guernsey Reservoir to the Wyoming-Nebraska border is considered a class V trout fishery (incapable of maintaining a trout fishery). Aquatic macroinvertebrates are greatly reduced during the silt run, and recovery to prerun conditions is slow following reduction in turbidity. During the silt run, the high suspended solids and turbidity drive fish from the river into tributaries. A variance in state water quality standards was granted to allow the silt run to continue without citations (Conder and Deromedi, 1998).

Modifications of an outlet structure, deep pools below the highway 85 bridge, plus augmentation of flow from the Laramie River, provide minimal habitat for gamefish in the river at Torrington. Catchable-size rainbow trout and fingerling channel catfish are stocked in better habitat areas in the fall. Trout provide a put-and-take fishery during fall, winter, and spring. Trout are lost in the summer due to high water temperatures and downstream drift with high irrigation flows. Success of the channel catfish stock has not been determined. During the nonirrigation season, when Inland Lakes water is not being moved from the main stem, no releases are made from Guernsey Reservoir. Any flow occurring below the dam at that time is associated with seepage from the dam.

Broderick (2000) found that the reach immediately below Guernsey Dam to the Laramie River confluence had the highest proportion of native fish (97 percent) of all the sample sites; 86 percent of those fish were turbidity intolerant. Below the confluence of the Laramie River, the species composition shifted, with 77 percent of the catch categorized as native fish species. The proportion of turbidity intolerant species dropped to 25 percent.

Conder and Deromedi (1998) indicate that the existing flow releases from Guernsey Reservoir limit the fishery in the North Platte River, below the dam to the Laramie River confluence, to deep pools where fish can overwinter. Extremely reduced flows also occur below the Laramie River confluence in April, May, and June, further reducing fish habitat availability and impairing overwinter survival. Conder and Deromedi (1998) state that efforts to stock trout and channel catfish in this reach have failed, in part, because of dewatering conditions, high summer irrigation flows causing downstream drift, and entrainment into irrigation canals.

The existing fishery downstream from Guernsey Reservoir to the Wyoming-Nebraska state line is marginal, and there is no official established maintenance flow.

North Platte River Between Wyoming-Nebraska State Line and Lake McConaughy

The North Platte River downstream from the Wyoming-Nebraska State line contains a good channel catfish population upstream from Lake McConaughy. In late spring, there is also a significant white bass sport fishery, likely the result of bass moving upstream from Lake McConaughy to spawn in the river (NGPC, 2005, personal communication, Larry Hutchinson, biologist). Other species in the North Platte River include common carp and white suckers.

Panhandle Streams

Several streams in the Scotts Bluff area that drain out of the Sandhills, such as Nine Mile Creek, Spotted Tail Creek, Dry Sheep Creek, and Sheep Creek, contain brown and rainbow trout populations. These streams are fed primarily from groundwater in the Sandhills. However, most of these streams cross the interstate and the Highline Canal and flow south toward the North Platte River through irrigated lands. Thus, most of them receive some seepage water from the canals and runoff from irrigated lands.

These streams contain brown and rainbow trout (NGPC, 2005). Other species that occur in these streams include common carp, white sucker, and creek chub (Druliner et al., 1999).

These streams are not specifically modeled in the Present Condition. Historic flow conditions are presumed to prevail under the Present Condition.

NEBRASKA SPORT FISHERIES—LAKE MCCONAUGHY AND THE LOWER PLATTE RIVER

INTRODUCTION

Several specific fisheries and recreation resources were examined in relation to Lake McConaughy: walleye, white bass, smallmouth bass, channel catfish, gizzard shad, and Lake Ogallala trout. The Lower Platte River resources examined include the catfish and shovelnose sturgeon fisheries.

INDICATORS

Littoral Habitat—Area of Water Within Specific Depth Constraints: June-August

The amount of Lake McConaughy littoral habitat present indicates the carrying capacity of the reservoir. In reservoirs that are not overexploited, such as McConaughy, carrying capacity of the reservoir is reduced due to an overall reduction in the amount of water in the reservoir. This reduction may not have a direct impact on the availability of sport fish to the angling public. As long as the reduction in carrying capacity is in proportion to the reduction in reservoir contents, the concentration of sport fish—and the resulting angling experience—should not suffer. Of greater risk is when reductions in carrying capacity occur rapidly or progressively over a sustained period of time, as can be the case during prolonged drought. This can lead to an existing fishery population that significantly exceeds the carrying capacity of the reservoir, leading to starvation or disease. The most critical time period for the carrying capacity of the reservoir is during the months of June, July, and August. As a result, the indicator used is the amount of littoral habitat present in the reservoir during those months.

Open Water Habitat—Area of Water Within Specific Depth Constraints: June-August

The amount of open water habitat in Lake McConaughy is similar in function for some specific resources to the amount of littoral habitat, particularly gizzard shad, which make up a large part of the prey base for the reservoir fisheries. The effects of reductions in open water habitat are quite similar to the effects of reductions in littoral habitat, only specifically for gizzard shad and, to some extent, walleye and white bass.

Walleye—Trend in Water Level in April and May, and 3255-Foot Elevation

Walleye are one of the better understood resources in Lake McConaughy in terms of the effects of lake levels on the resource. Walleye spawn in shallow water along the shoreline of the lake between mid-April and mid-May, with timing depending largely on temperature conditions in the lake and, by extension, spring weather patterns. Because walleye spawn in shallow water, the conditions most favorable to successful reproduction are stable or rising water levels during this timeframe. Declining water levels can lead to stranding and subsequent desiccation of eggs above the water line. As a result, the indicator used is the trend in water level in April and May.

White Bass—North Platte Flow Threshold in May

White bass spawn primarily in tributary streams; in this case, the North Platte River. The NGPC has found that North Platte Riverflow levels of 2,000 cfs or above in May are particularly conducive to successful white bass spawning. Therefore, the indicator used is the 2,000-cfs North Platte Riverflow threshold in May.

Smallmouth Bass—3255-Foot Elevation, Rocky Shallow Habitat Availability

Smallmouth bass spawn in shallow, rocky habitat. The best habitat of this type in the reservoir is in Lamoyne Bay, on the north shore of Lake McConaughy. A general elevation of 3255 feet above mean sea level (msl) is thought to represent the elevation necessary to inundate the Lamoyne Bay to the degree that would be conducive to smallmouth bass reproduction. Additional rocky habitat has been recently catalogued in the reservoir, and the NGPC analyzed the availability of this habitat. The results of this analysis are combined with modeled reservoir elevations for the alternatives to provide an indicator of rocky habitat availability, along with the 3255-foot elevation indicator in June.

Channel Catfish—Flow Rate and Flow Changes in the North Platte River

Like white bass, channel catfish spawn primarily in the North Platte River above Lake McConaughy, and the success of reproduction and strength of year class are linked to North Platte Riverflows. Catfish begin staging in April or May, depending on local conditions, then spawn in late May or June, again depending on conditions. Initiation of staging and spawning may be related to a number of factors, including changes in riverflow and water temperature. As a result, changes in flow rate from March-April, and from April-May, are used as indicators for the staging/spawning cue, and riverflow rates are used as indicators for April, May, and June. Unlike white bass, a specific flow threshold has not been identified that is particularly well suited to reproduction; therefore, a comparison across all conditions is made.

Gizzard Shad—3250-Foot Elevation

Gizzard shad make up a large component of the forage base for the game fish in the lake and, as such, are an important resource. Gizzard shad spawn in the protected bays around the shoreline of the lake; and therefore, the indicator used is a general figure for the elevation that provides substantial area of inundated bays. NGPC's best estimate of that elevation is 3250 feet above msl.

Gizzard shad overwinter survival is also strongly influenced by reservoir water surface elevations. Lake McConaughy lies at the extreme northern end of the species range. As such, they are particularly susceptible to freezing conditions, and thermal refugia, such as sheltered stream mouths, offer protection.

When reservoir elevations drop below a certain threshold (generally below about 3240 feet above msl), these stream mouths are not able to provide the sheltered thermal refugia used by a large part of the population for winter survival. It is unclear to what extent these refugia sustain the population, and to what degree the ability of them to provide refugia may remain below this threshold. As a result, the results of this analysis provide a fairly strong indicator of the effects of the Program on winter survival of gizzard shad, but they cannot be considered a prediction.

Lake Ogallala Trout

Lake Ogallala is a shallow afterbay for Lake McConaughy, providing a pool of water from which diversions can be made into the Sutherland Canal. Trout can only survive in cool, well-oxygenated water and, as such, can thrive in Lake Ogallala in the summertime only as long as cool water is released from Lake McConaughy into the lower lake. When water levels in Lake McConaughy fall too low, warm water is drawn down from the surface waters when water is released through the hydropower turbines. As a result, Lake Ogallala temperatures can rise, leading to trout dieoffs in Ogallala. The specific elevations at which this occurs have been calculated based on regression equations derived from historic data. Based on these relationships, water temperatures could be expected to reach 18°C (the approximate temperature at which trout populations in the reservoir begin to be stressed) at approximately 3218 feet above msl in June. The 18°C threshold value is reached at approximately 3226 feet in July, 3233 feet in August, and 3239 feet in September.

Lower Platte River Catfish and Shovelnose Sturgeon

High water in the Lower Platte River in the spring (February-June) provides for habitat creation and maintenance for these fisheries, as well as spawning cues. Specific flow thresholds have not been identified that would best facilitate these processes; therefore, a comparison of all flow conditions is made.

METHODS

All analyses rely on the outputs of the CPR model for the Present Condition and the different alternatives. Different model outputs are used for different resources as applicable. These different outputs are described below.

Resources Bound to Reservoir Elevations

For these resources with known reservoir elevation requirements (Lake McConaughy walleye, smallmouth bass, gizzard shad [spawning and overwintering], and Lake Ogallala trout), end-of-month Lake McConaughy water surface elevations are compared between the Present Condition and each alternative. This comparison is then examined for the particular reservoir elevation or elevation condition that is relevant to the particular resource to determine the percentage of time the requirement is met under the Present Condition and each alternative. If no reference elevation is available for the resource, a general comparison is made over all conditions.

Resources Bound to Area of Habitat Linked to Reservoir Elevations

For those resources with known habitat requirements (Lake McConaughy littoral habitat, smallmouth bass habitat), end-of-month Lake McConaughy water surface elevations are again compared between the Present Condition and each alternative. This comparison is then combined with spatial models of the reservoir, developed by USGS and NGPC, to determine the area of the specific habitat type at those water surface elevations. This area is then compared to the areas of these habitat types that would be available under the Present Condition.

Resources Bound to Reservoir Inflows

For those resources with requirements relating to reservoir inflows (Lake McConaughy white bass and channel catfish), a similar set of comparisons is made using average monthly flows at the Lewellen, Nebraska, gauge, located on the North Platte River just above Lake McConaughy. This is then examined again in reference to the particular flow rate relevant to the particular resource to determine the percentage of time the requirement is met under the Present Condition and each alternative. If no reference flow rate is available for the resource, a general comparison is made over all conditions.

Resources Bound to Reservoir Outflows

For those resources with requirements relating to reservoir outflows (Lake McConaughy walleye), a similar set of comparisons is made using total monthly reservoir outflows. A general comparison is then made over all conditions.

Resources Bound to Lower Platte Riverflows

For Lower Platte River resources (catfish and shovelnose sturgeon), comparisons are made in the same fashion as those examining North Platte Riverflows, above. The only difference is that none of these resources have particular reference flows available; therefore, general comparisons are made across all flow conditions. The gauge data used are from the Louisville, Nebraska, gauge, located approximately midway between the Platte River confluence with the Missouri River and the Elkhorn River confluence with the Platte River.

PRESENT CONDITION

Littoral Habitat

The indicator used for littoral habitat availability, defined in this context as those parts of the reservoir where sunlight reaches the bottom, and the bottom is above the thermocline, is the area of the reservoir with a total depth of less than 65 feet in June, 55 feet in July, and 45 feet in August. A specific threshold for a desirable level of littoral habitat has not been established. Under the Present Condition, the amount of littoral habitat ranges from approximately 14,000 to 15,600 acres in June (figure 4-NSF-1), from approximately 12,000 to 13,500 acres in July (figure 4-NSF-2), and from approximately 10,000 to 11,100 acres in August (figure 4-NSF-3).

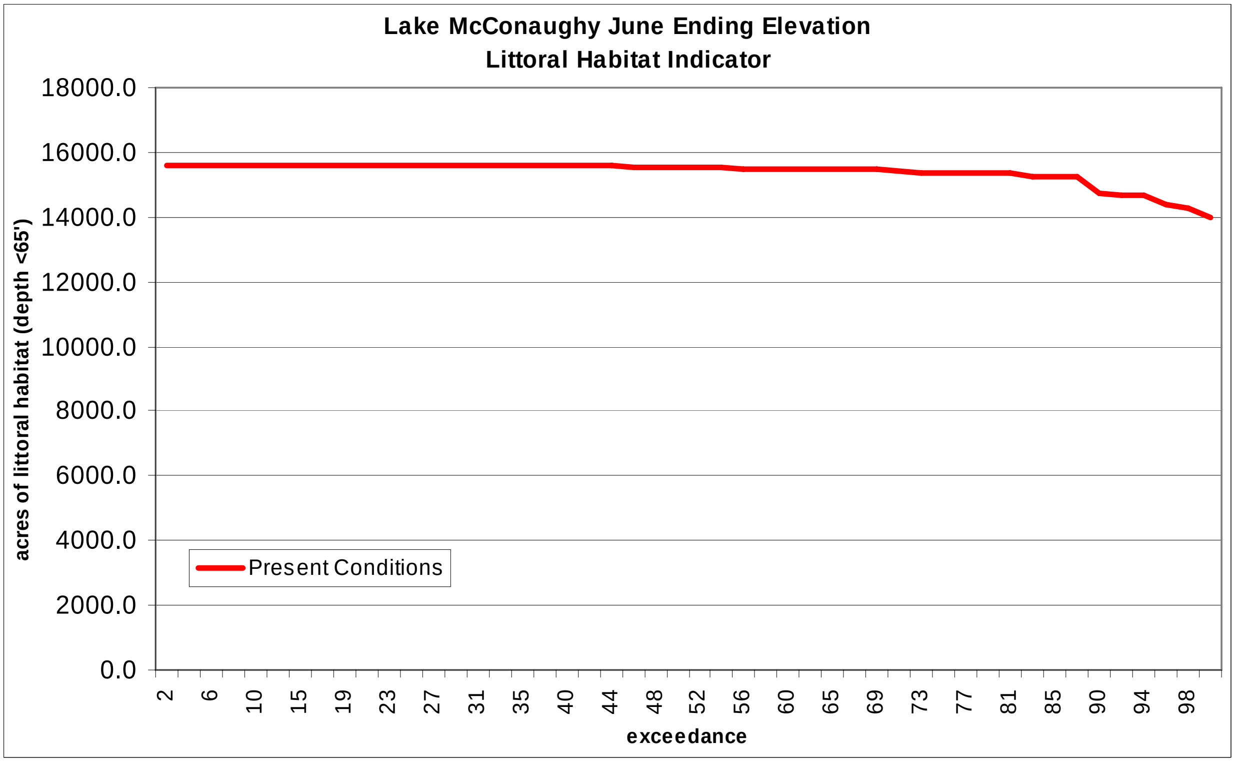


Figure 4-NSF-1.—Lake McConaughy littoral habitat indicator—June ending elevation.

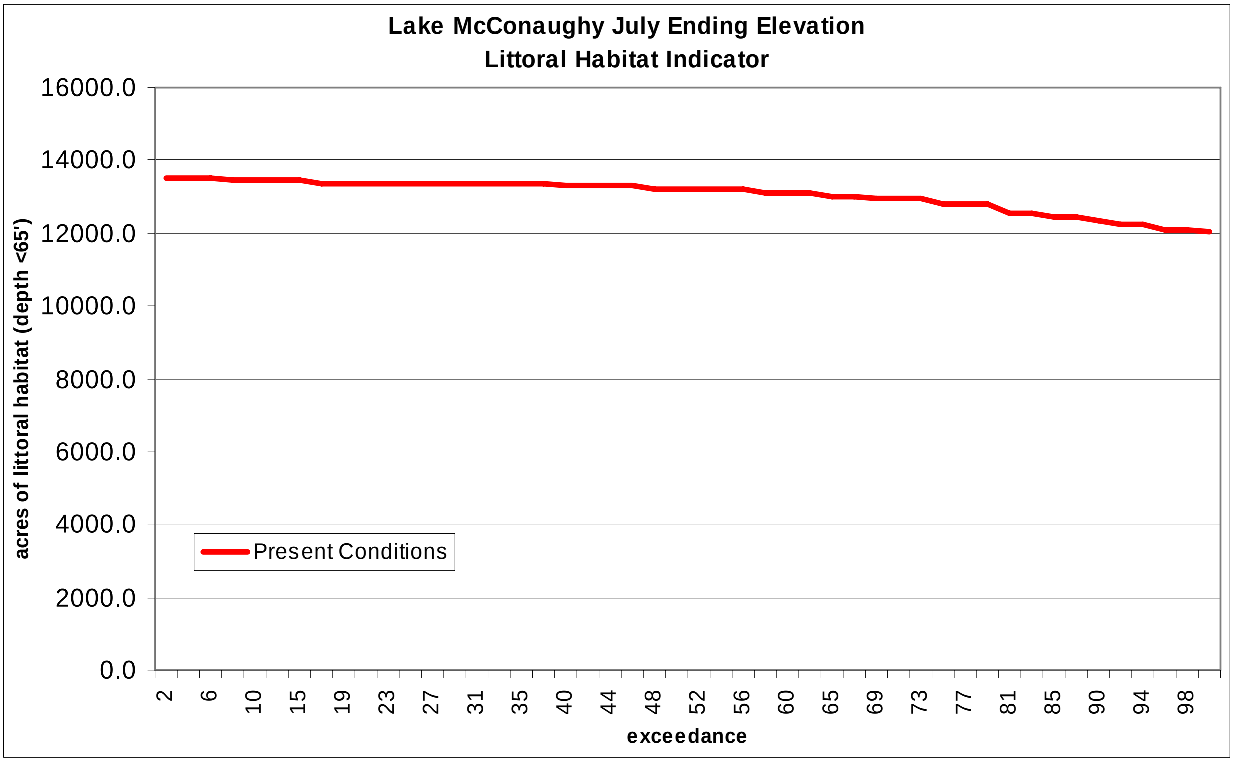


Figure 4-NSF-2.—Lake McConaughy littoral habitat indicator—July ending elevation.

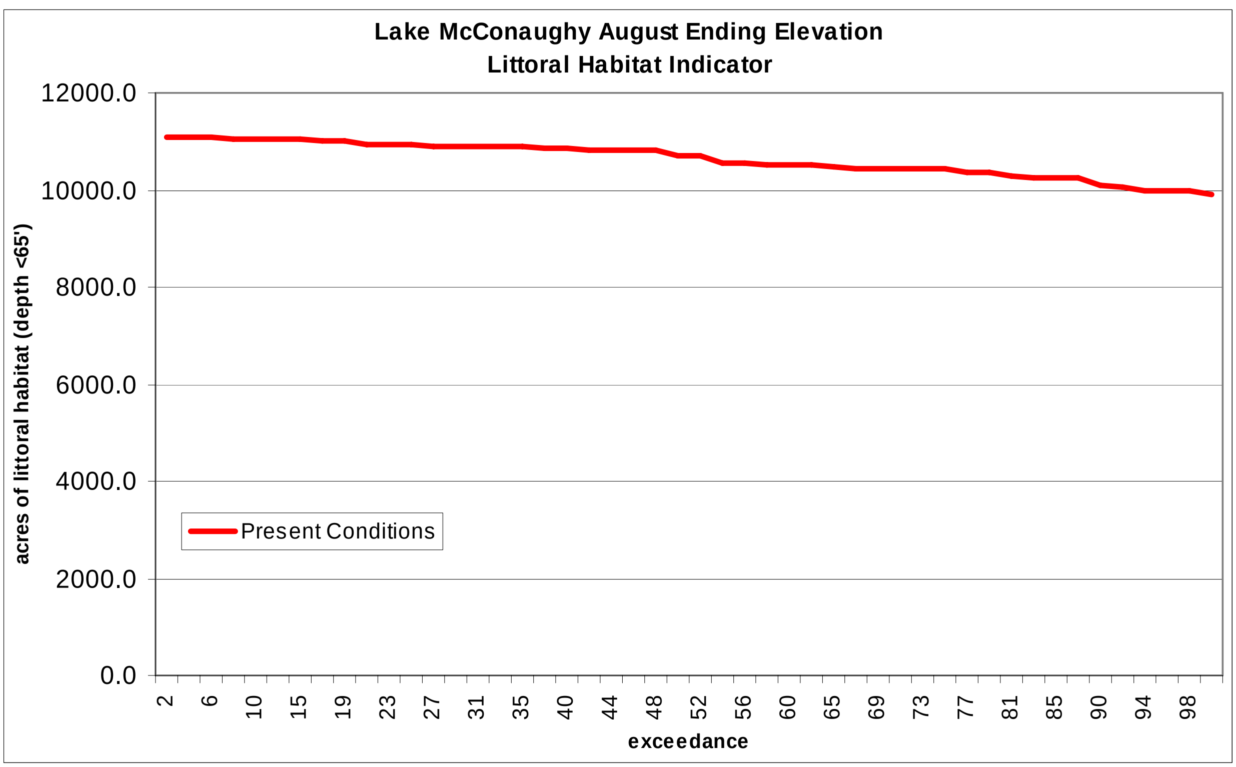


Figure 4-NSF-3.—Lake McConaughy littoral habitat indicator—August ending elevation.

Open Water Habitat

The indicator used for open water habitat availability, defined here as those parts of the reservoir where the bottom is below the thermocline, is the area of the reservoir with a total depth of greater than 65 feet in June, 55 feet in July, and 45 feet in August. A specific threshold for a desirable level of open water habitat has not been established. Under the Present Condition, the amount of open water habitat ranges from approximately 7,900 to 13,100 acres in June (figure 4-NSF-4), from approximately 8,700 to 15,500 acres in July (figure 4-NSF-5), and from approximately 9,400 to 17,300 acres in August (figure 4-NSF-6).

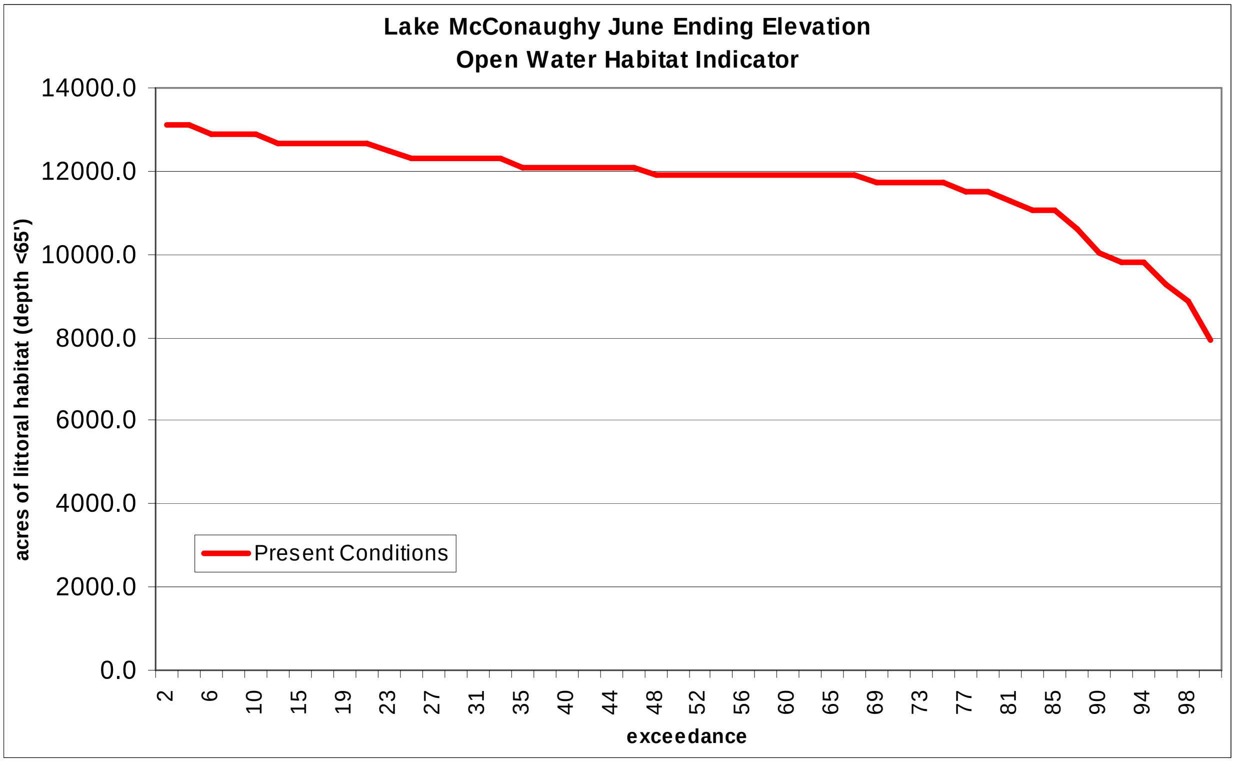


Figure 4-NSF-4.—Lake McConaughy open water indicator—June ending elevation.

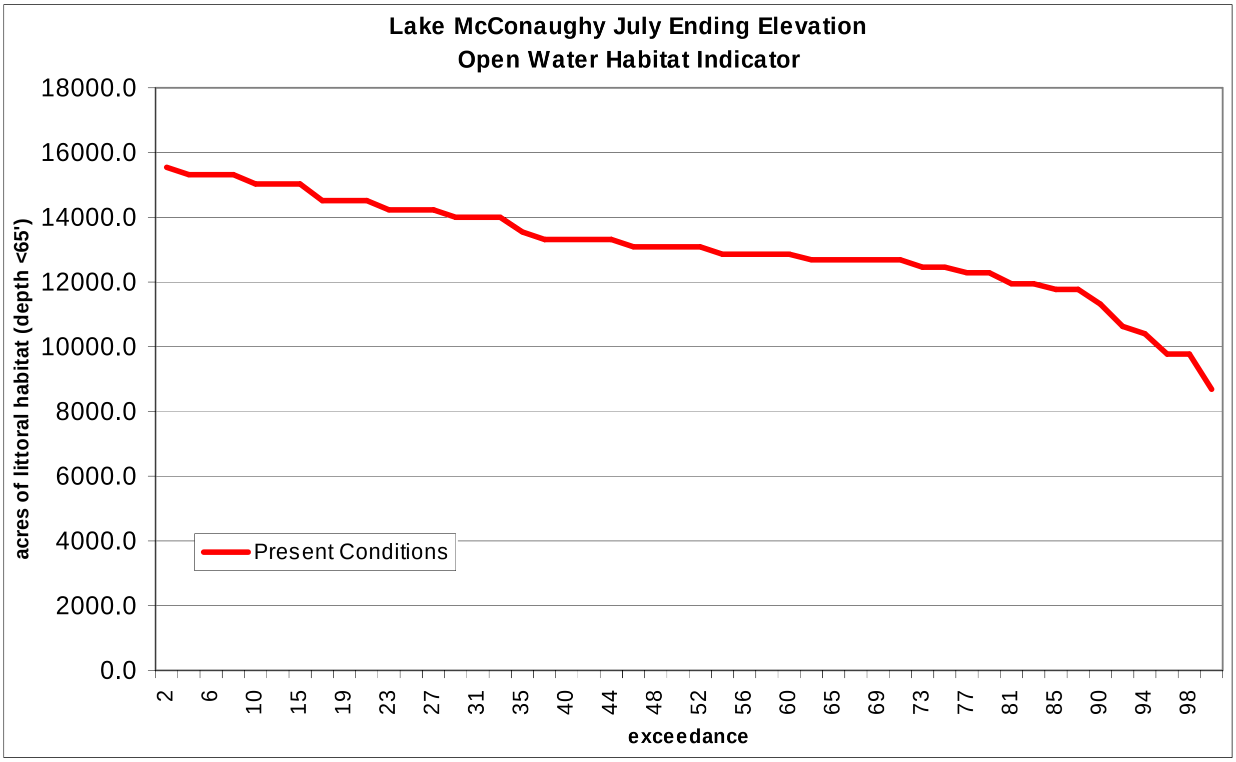


Figure 4-NSF-5.—Lake McConaughy open water indicator—July ending elevation.

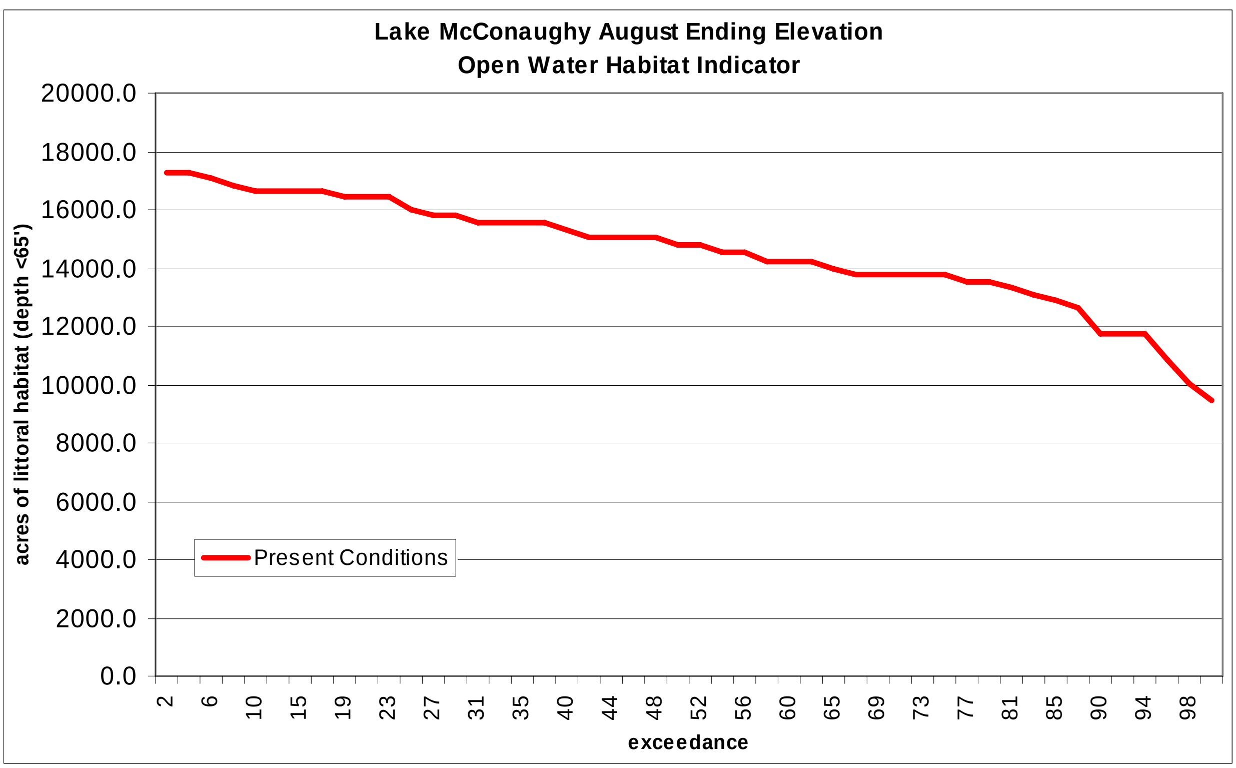


Figure 4-NSF-6.—Lake McConaughy open water indicator—August ending elevation.

Walleye Reproduction

The indicator used for walleye reproduction is water level from mid-April to mid-May. Under the Present Condition, reservoir elevation trends are conducive to successful walleye spawning in approximately 85 percent of years (figure 4-NSF-7). Overall reservoir elevations are conducive to successful walleye spawning in approximately 75 percent of years (figure 4-NSF-8). This should not be taken to mean that this is the sole driving force of the walleye fishery in Lake McConaughy, as approximately 75 percent of the recruitment to the fishery is currently through stocking efforts, and approximately 25 percent is due to natural reproduction. No specific threshold has been identified for larval walleye retention. However, as a general rule, lower outflows are more conducive to successful retention. Under the Present Condition, May outflows range from approximately 20 kaf to 600 kaf, with an inflection point at around 120 kaf, about 10 percent of the time (figure 4-NSF-9). June outflows range from about 20 kaf to over 700 kaf, with an inflection point at around 150 kaf about 15 percent of the time (figure 4-NSF-10).

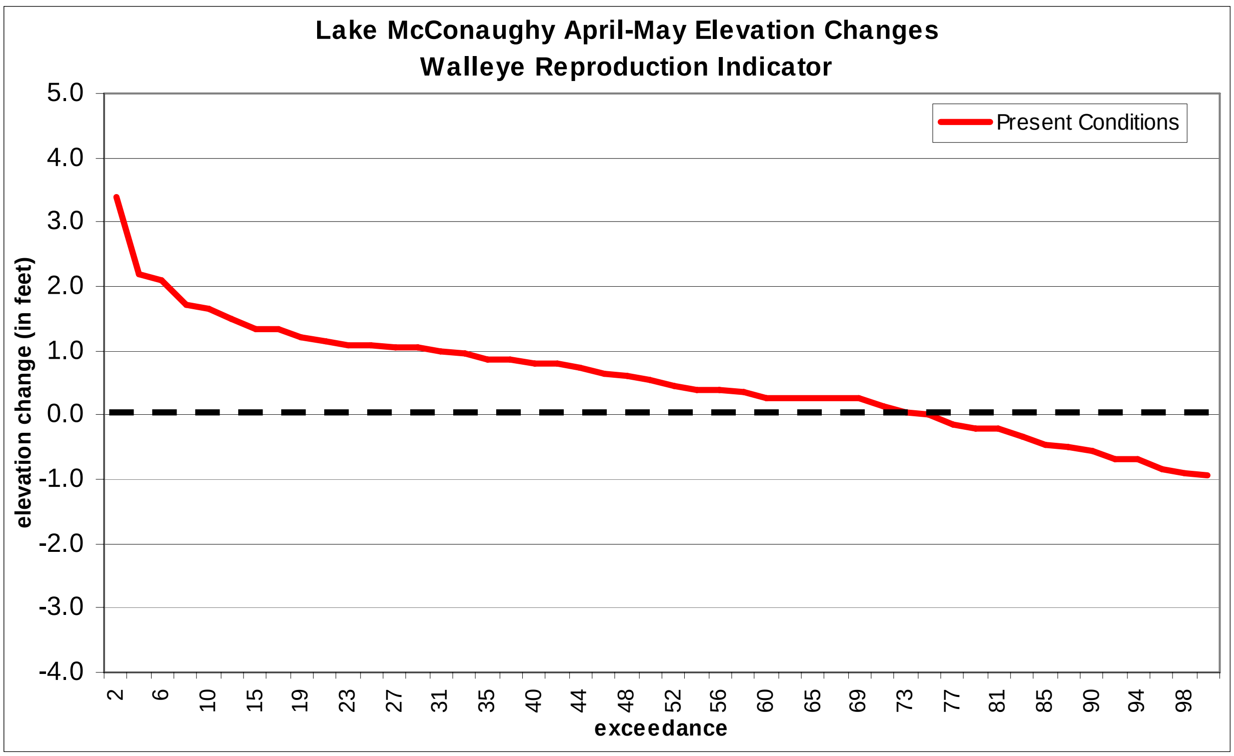


Figure 4-NSF-7.—Walleye reproduction indicator—Lake McConaughy April – May elevation changes.

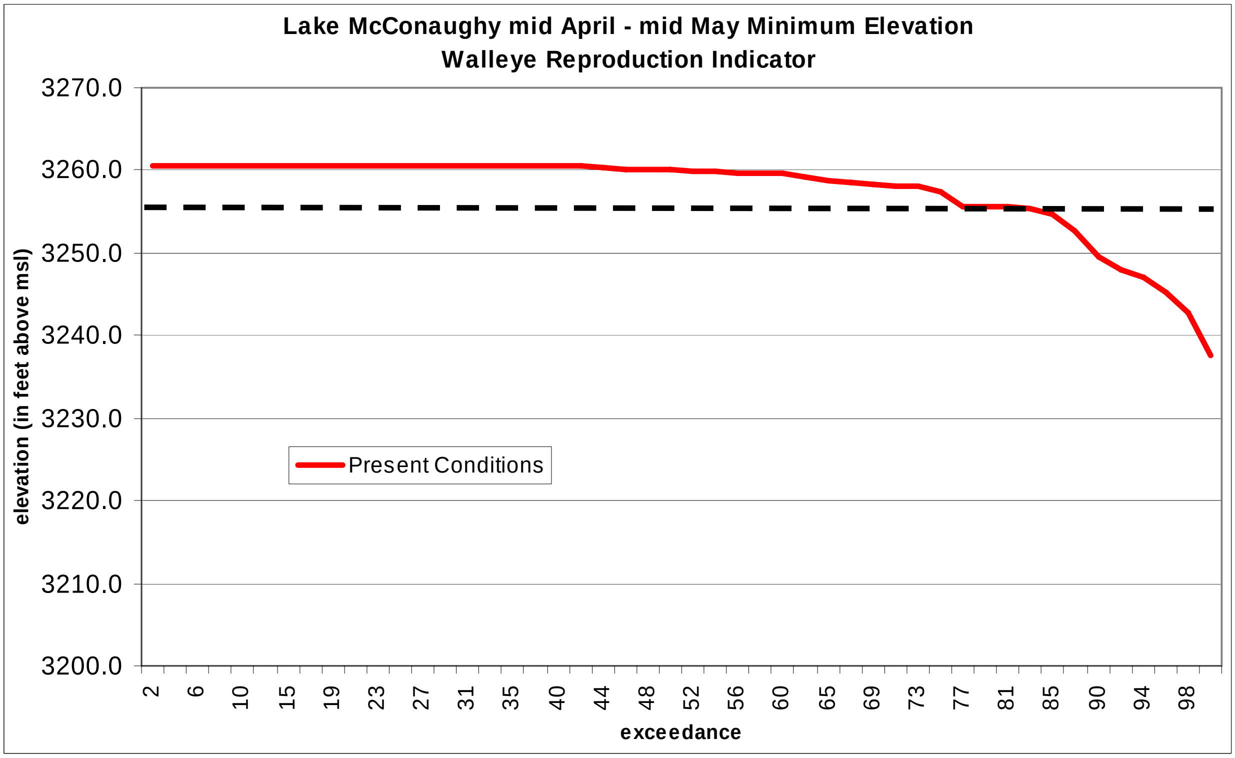


Figure 4-NSF-8.—Walleye reproduction indicator—Lake McConaughy mid-April – mid-May elevation changes.

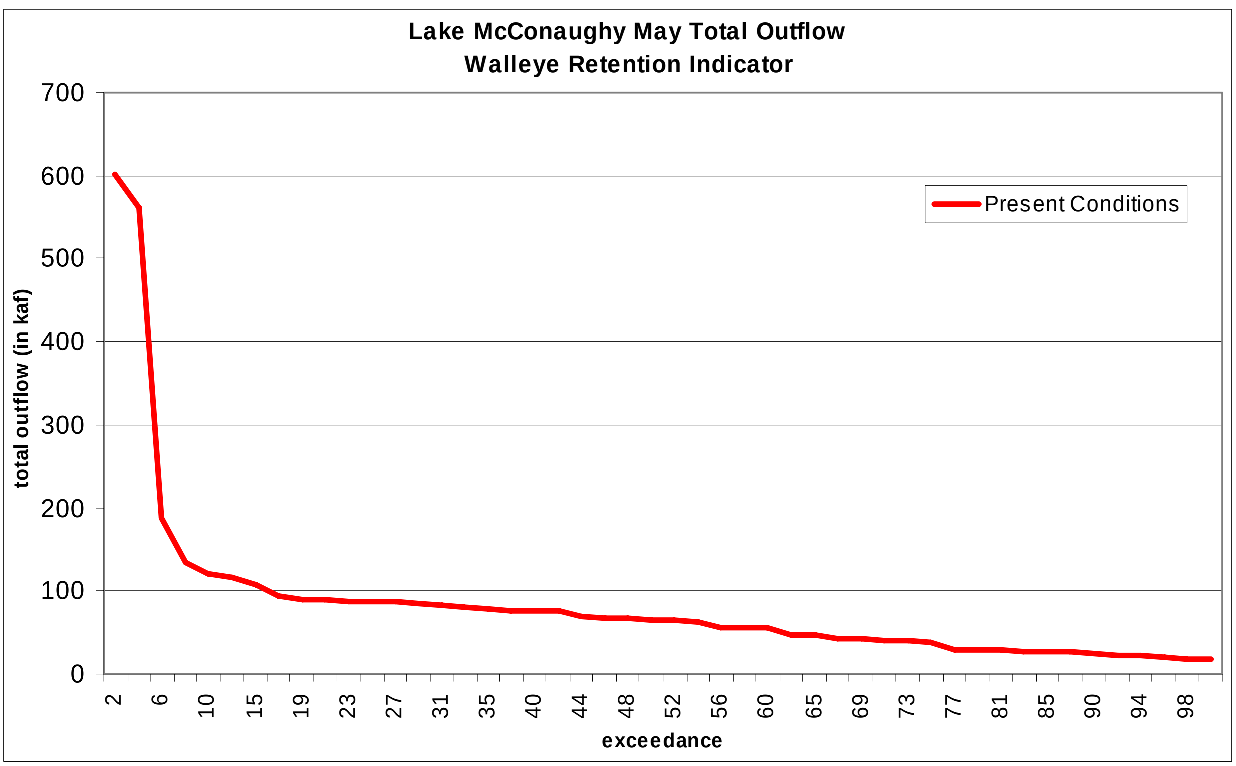


Figure 4-NSF-9.—Walleye retention indicator—Lake McConaughy May total outflows.

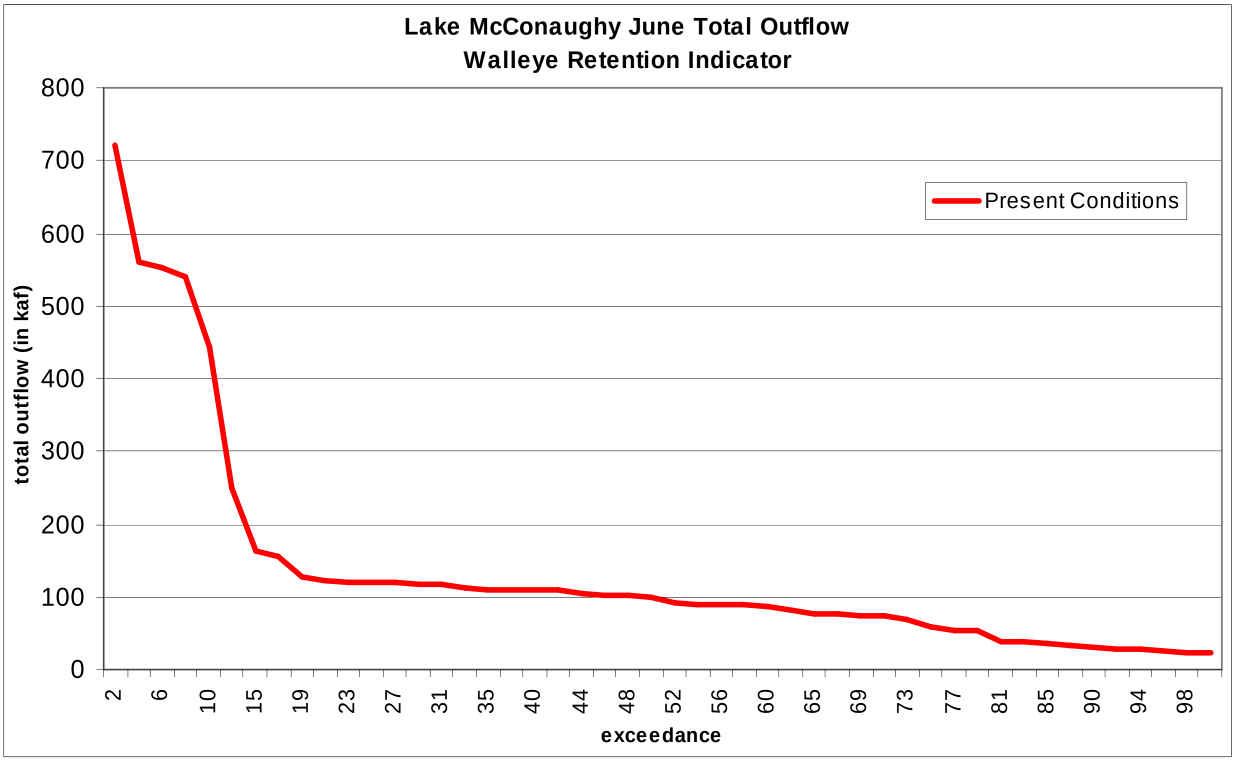


Figure 4-NSF-10.—Walleye retention indicator—Lake McConaughy June total outflows.

White Bass Reproduction

Inflows into Lake McConaughy during the month of May are the strongest influence on white bass spawning success. A flow rate of approximately 2,000 cfs or greater appears to be particularly conducive to successful reproduction. Under the Present Condition, these conditions occur in approximately 12 percent of years (figure 4-NSF-11).

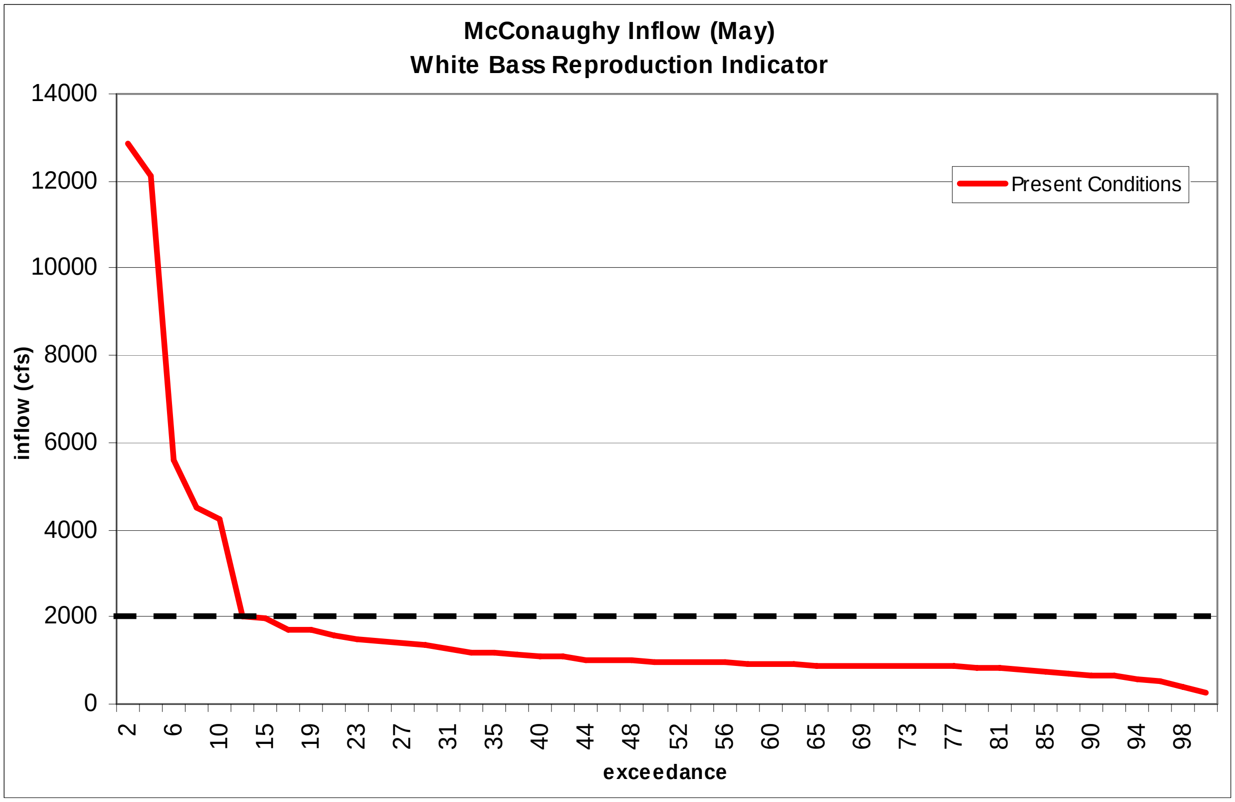


Figure 4-NSF-11.—White bass indicator—Lake McConaughy May inflow.

Smallmouth Bass Reproduction

Smallmouth bass reproduction in Lake McConaughy is represented by the amount of spawning habitat available in June. This is represented in two analyses: the total area of rocky habitat less than 15 feet in depth, and lake levels relative to 3255 feet above msl, the lake level elevation at which the best contiguous habitat in the reservoir (Lemoyne Bay) is sufficiently wetted to facilitate smallmouth bass use for spawning. Under the Present Condition, the area of rocky habitat available in June ranges from approximately 45 acres to 160 acres, with a median of approximately 110 acres (figure 4-NSF-12). The 3255-foot water surface elevation is achieved in June approximately 85 percent of the time (figure 4-NSF-13).

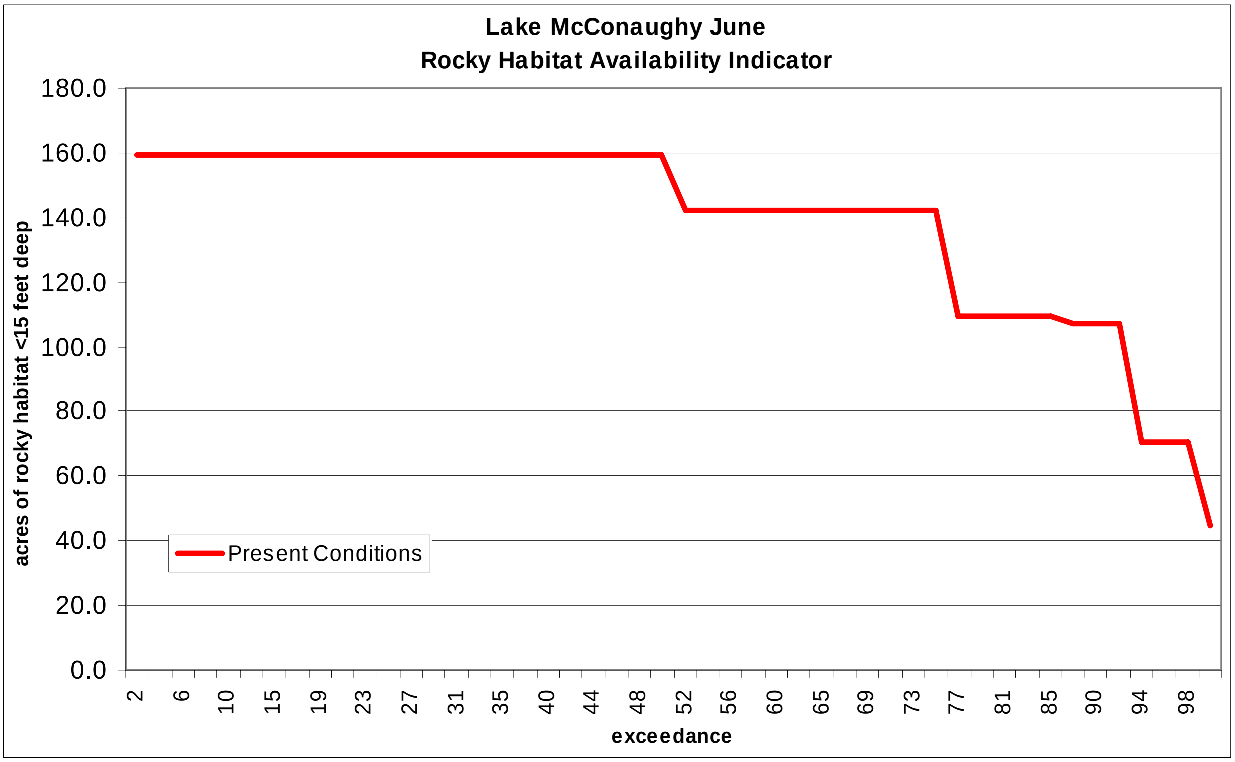


Figure 4-NSF-12.—Smallmouth bass indicator—Rocky habitat availability in June.

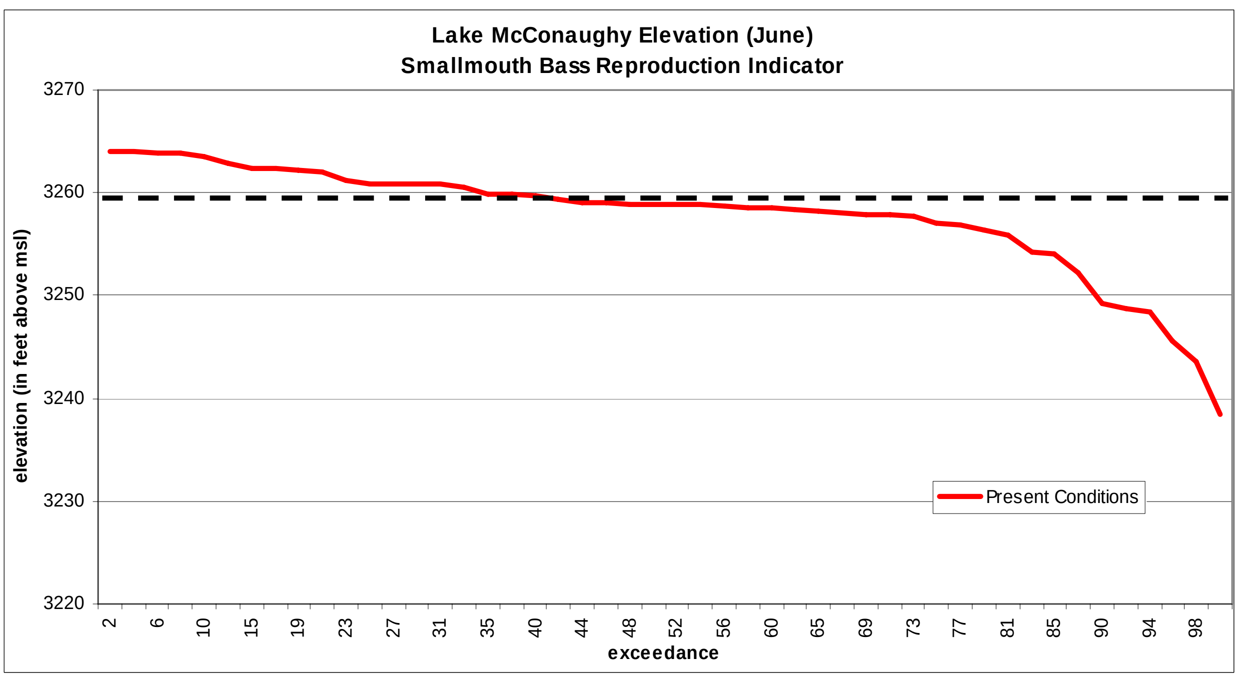


Figure 4-NSF-13.—Smallmouth bass reproduction indicator—Lake McConaughy June elevation.

Channel Catfish Reproduction

Success of channel catfish reproduction is most prominently driven by North Platte River inflow into Lake McConaughy in April, May, and June, and by changes in riverflow in March-April and April-May. No specific thresholds have been identified; however, as a general rule, higher overall flows are more conducive to successful staging and spawning, and greater increases in flow rate provide stronger spawning cues. Under the Present Condition, April inflows range from about 500 cfs to just over 3,000 cfs, with an inflection point at around 1,400 cfs about 20 percent of the time (figure 4-NSF-14). May inflows range from about 300 cfs to almost 13,000 cfs, with an inflection point at around 2,000 cfs about 15 percent of the time (figure 4-NSF-15). June inflows range from about 400 cfs to over 12,000 cfs, with an inflection point at around 2,000 cfs about 20 percent of the time (figure 4-NSF-16). Changes in flow rate from March-April range from a decrease of approximately 700 cfs to an increase of approximately 2,000 cfs, with no change occurring at about the 40th percentile (figure 4-NSF-17). Changes in flow rate from April-May range from a decrease of approximately 900 cfs to an increase of over 11,000 cfs, with no change occurring at about the 35th percentile (figure 4-NSF-18).

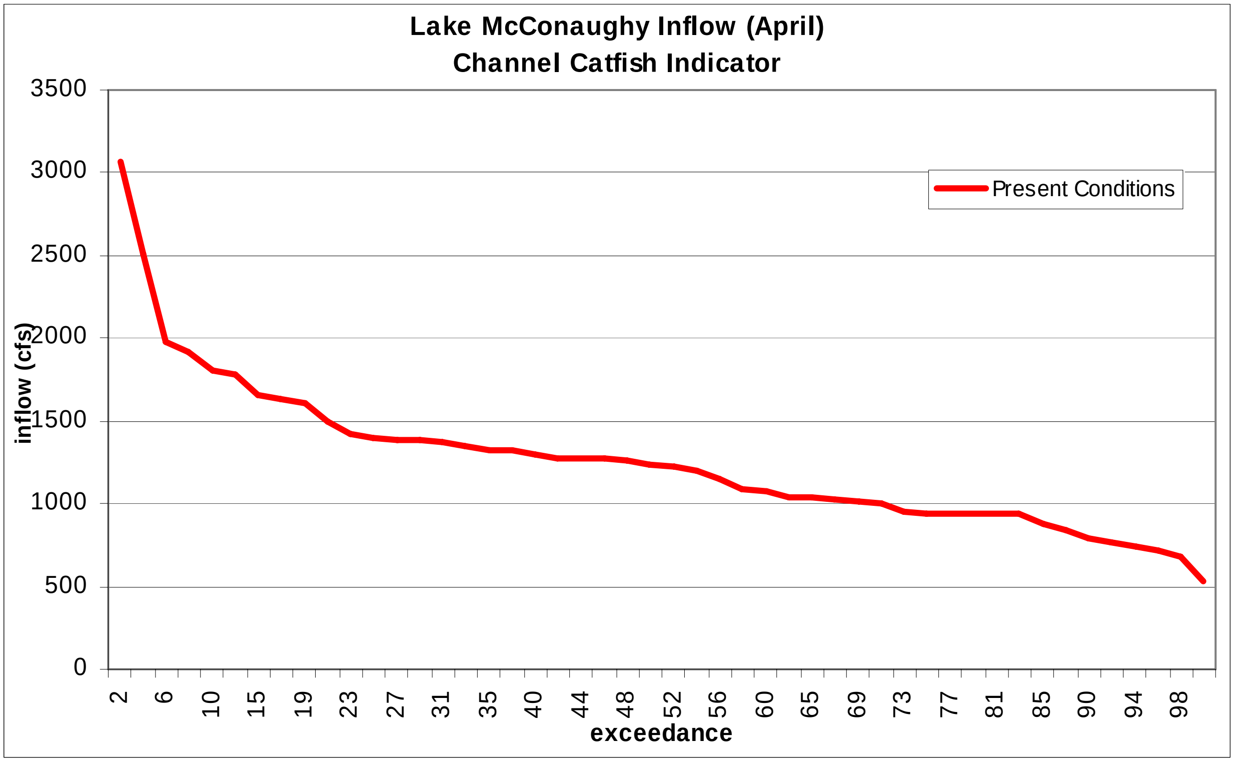


Figure 4-NSF-14.—Channel catfish reproduction indicator—Lake McConaughy April inflows.

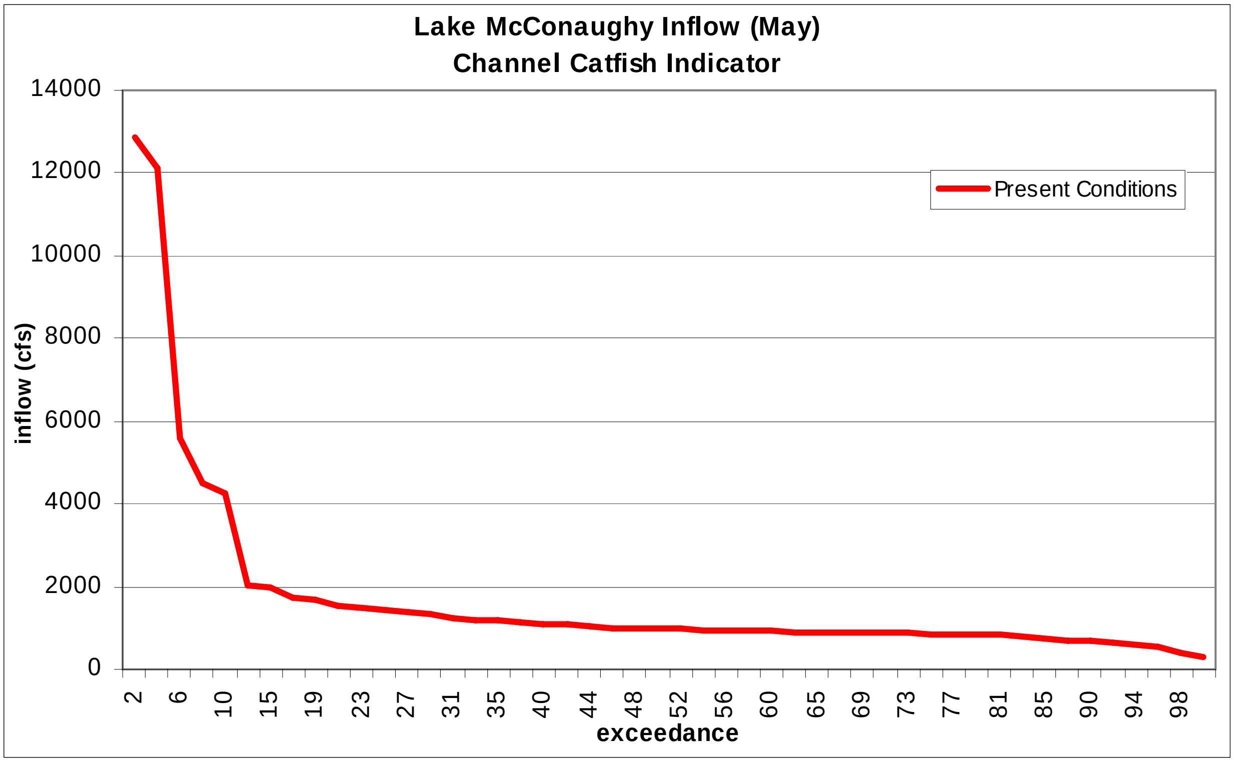


Figure 4-NSF-15.—Channel catfish reproduction indicator—Lake McConaughy May inflows.

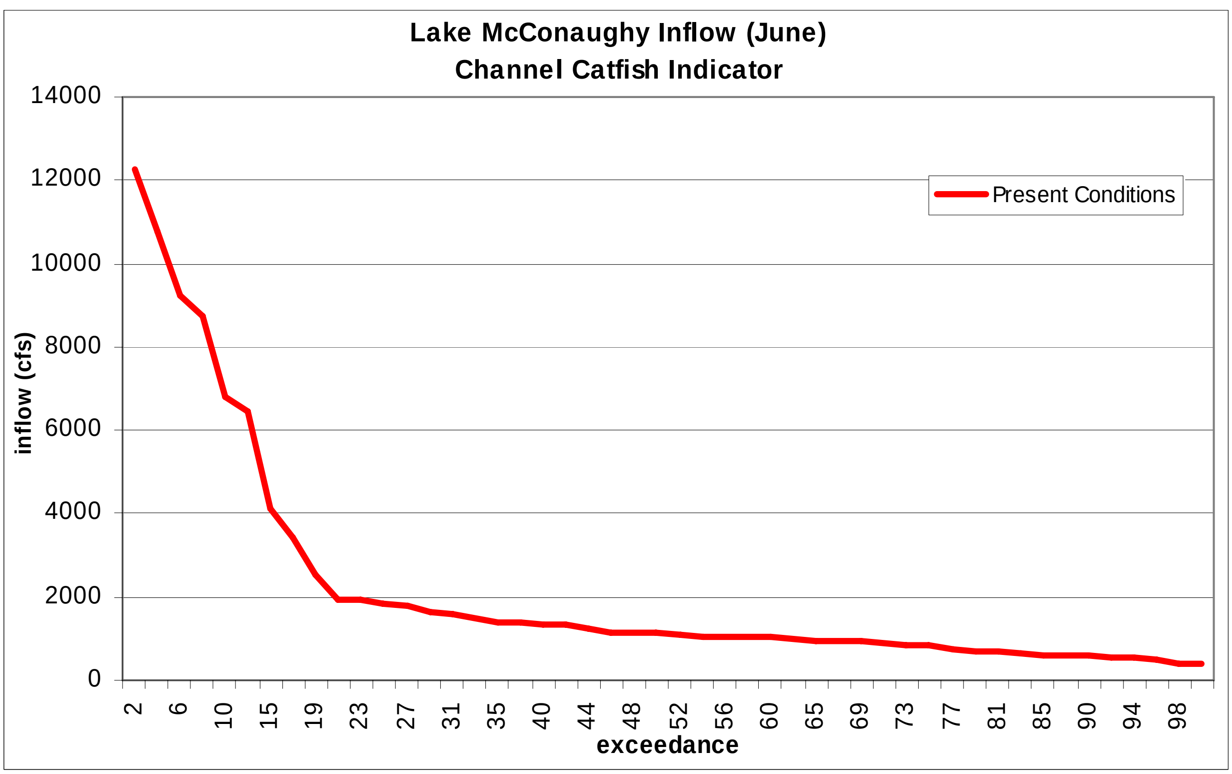


Figure 4-NSF-16.—Channel catfish reproduction indicator—Lake McConaughy June inflows.

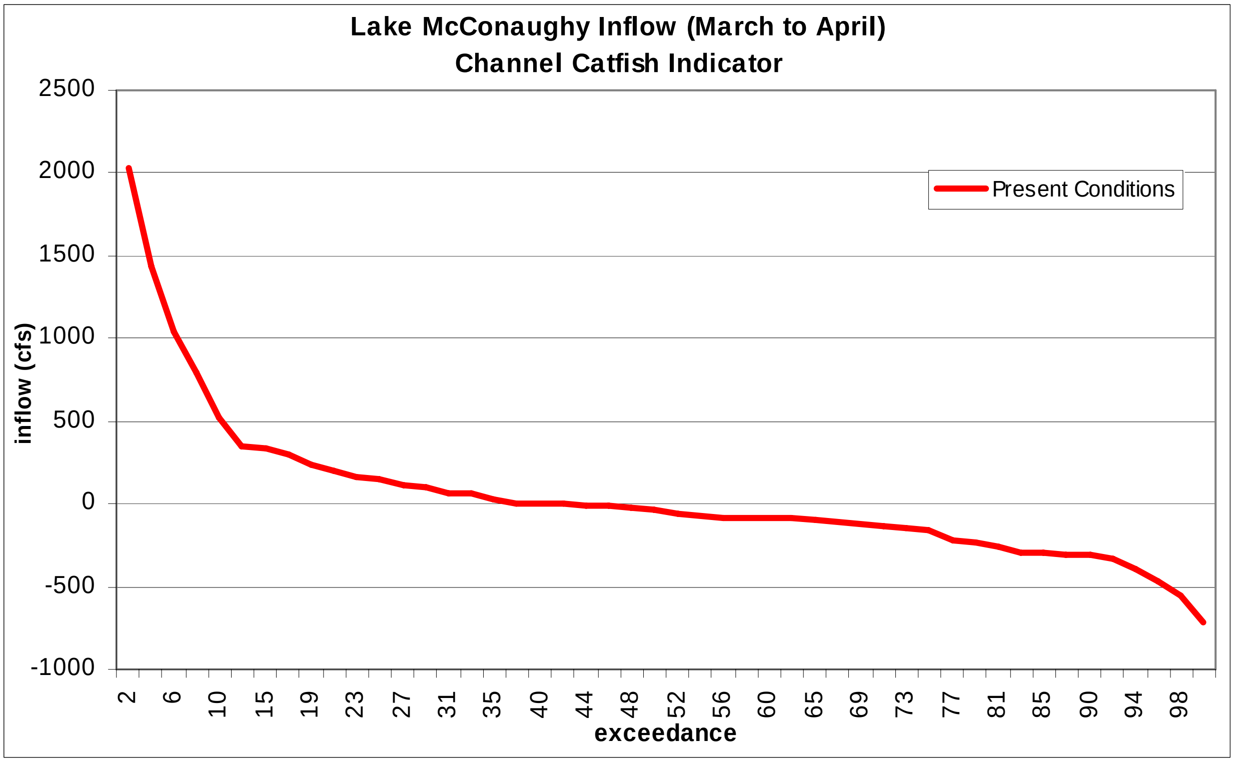


Figure 4-NSF-17.—Channel catfish reproduction indicator—Lake McConaughy March-April inflows.

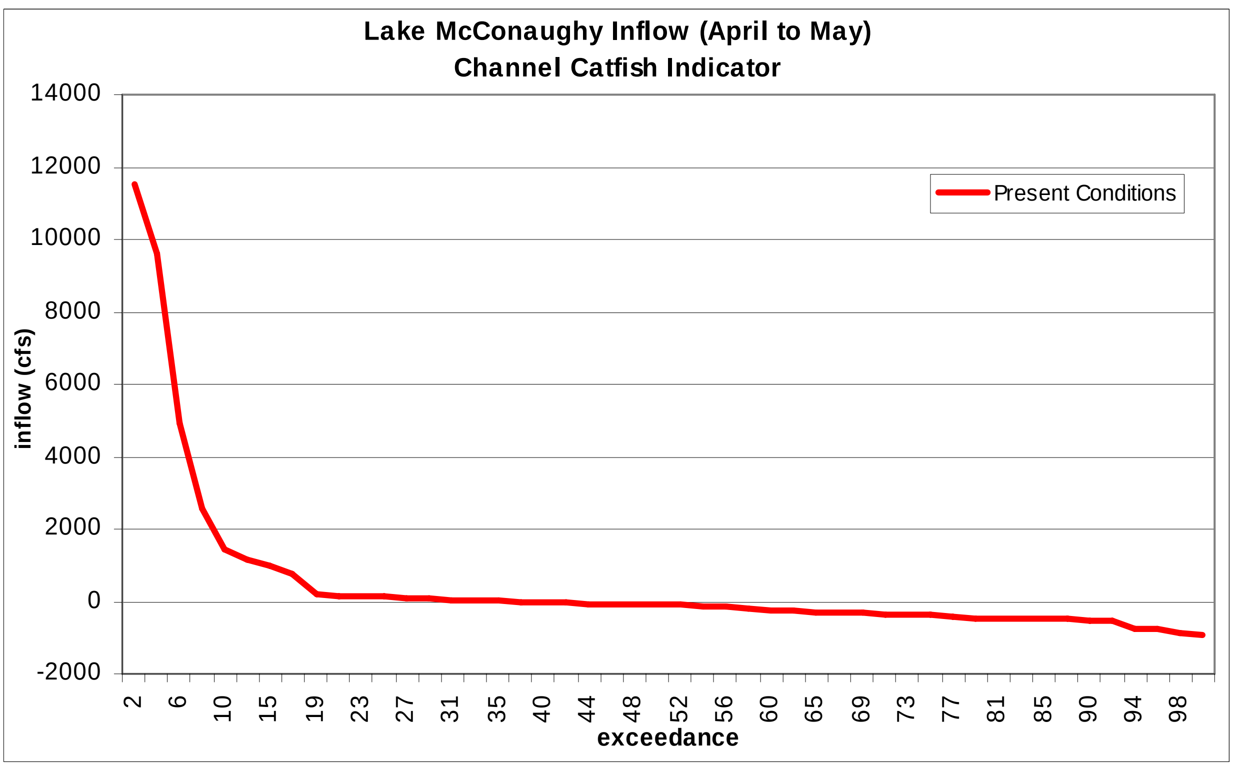


Figure 4-NSF-18.—Channel catfish reproduction indicator—Lake McConaughy April-May inflows.

Gizzard Shad Reproduction

Conditions conducive to gizzard shad reproduction are represented by the elevation at which a large proportion of sheltered bays contain water in June, represented by the elevation 3250 feet above msl. Under the Present Condition, this occurs in approximately 90 percent of years, or 9 years out of 10 (figure 4-NSF-19).

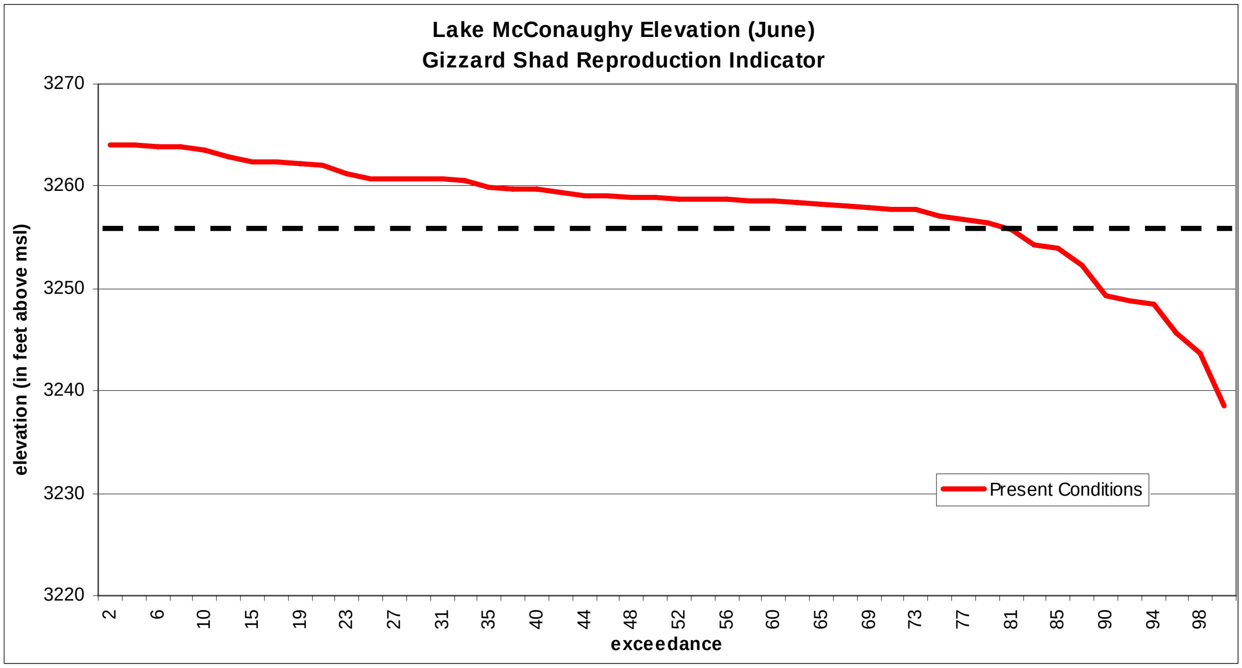


Figure 4-NSF-19.—Gizzard shad reproduction indicator—Lake McConaughy June elevation.

Gizzard Shad Overwintering

Conditions conducive to preservation of a thermal refugia for gizzard shad at the mouth of Otter Creek in winter are represented by the elevation at which the area around the creek mouth is accessible during the winter, represented by the elevation 3240 feet above msl. While this is not the only refugia for gizzard shad in the reservoir, it appears to be the most significant. Under the Present Condition, this occurs in approximately 90 percent of years, or 9 years out of 10 (figure 4-NSF-20).

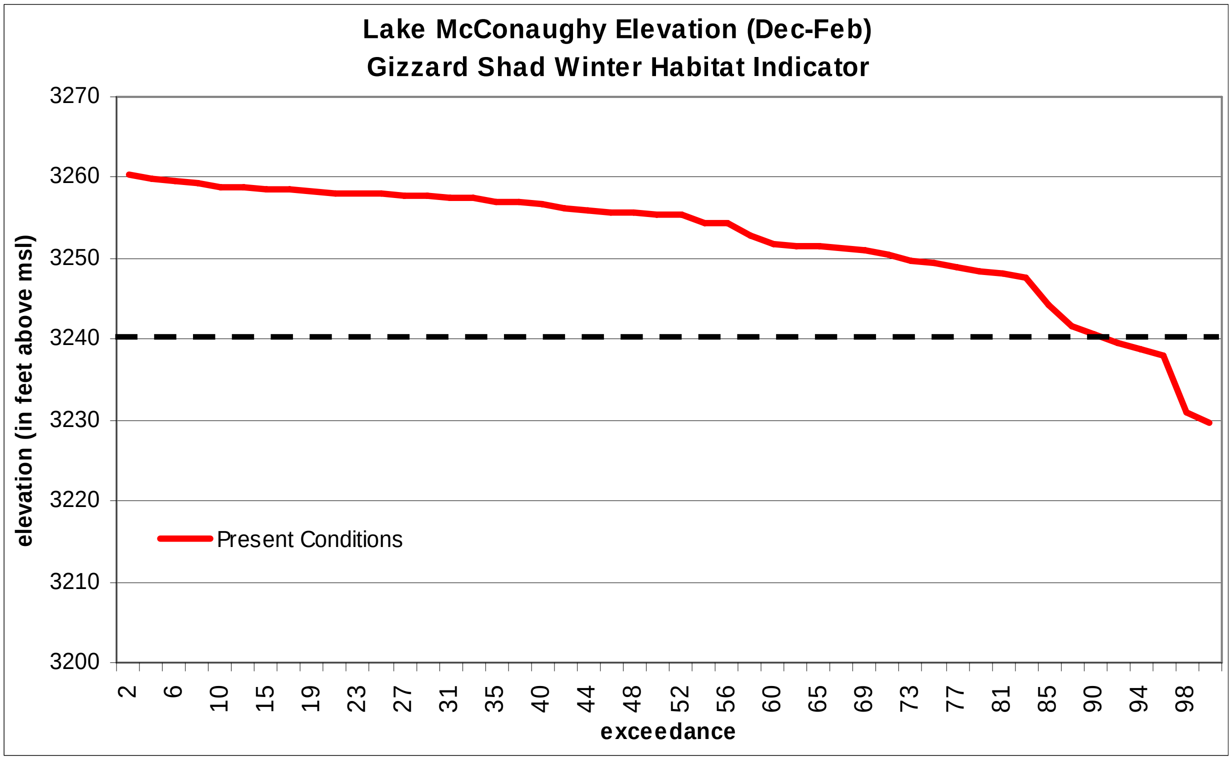


Figure 4-NSF-20.—Gizzard shad indicator—Lake McConaughy December-February elevation.

Lake Ogallala Trout Fisheries Support

The survival of trout in Lake Ogallala is linked to summer water levels in Lake McConaughy and the propensity to draw warmer surface water through the hydropower plant when summer water levels in McConaughy decrease. Using data collected by CNPPD, relationships were established between reservoir surface elevation and temperature of water taken into the plant. In June, water temperatures could be expected to reach 18°C (the approximate temperature at which trout populations in the reservoir begin to be stressed) at approximately 3218 feet above msl. In July, the 18°C threshold value is reached at approximately 3226 feet above msl. In August, it is reached at approximately 3233 feet above msl. In September, it is reached at approximately 3239 feet above msl. Reservoir surface elevations in Lake McConaughy are summarized by month in figures 4-NSF-21, 4-NSF-22, 4-NSF-23, and 4-NSF-24.

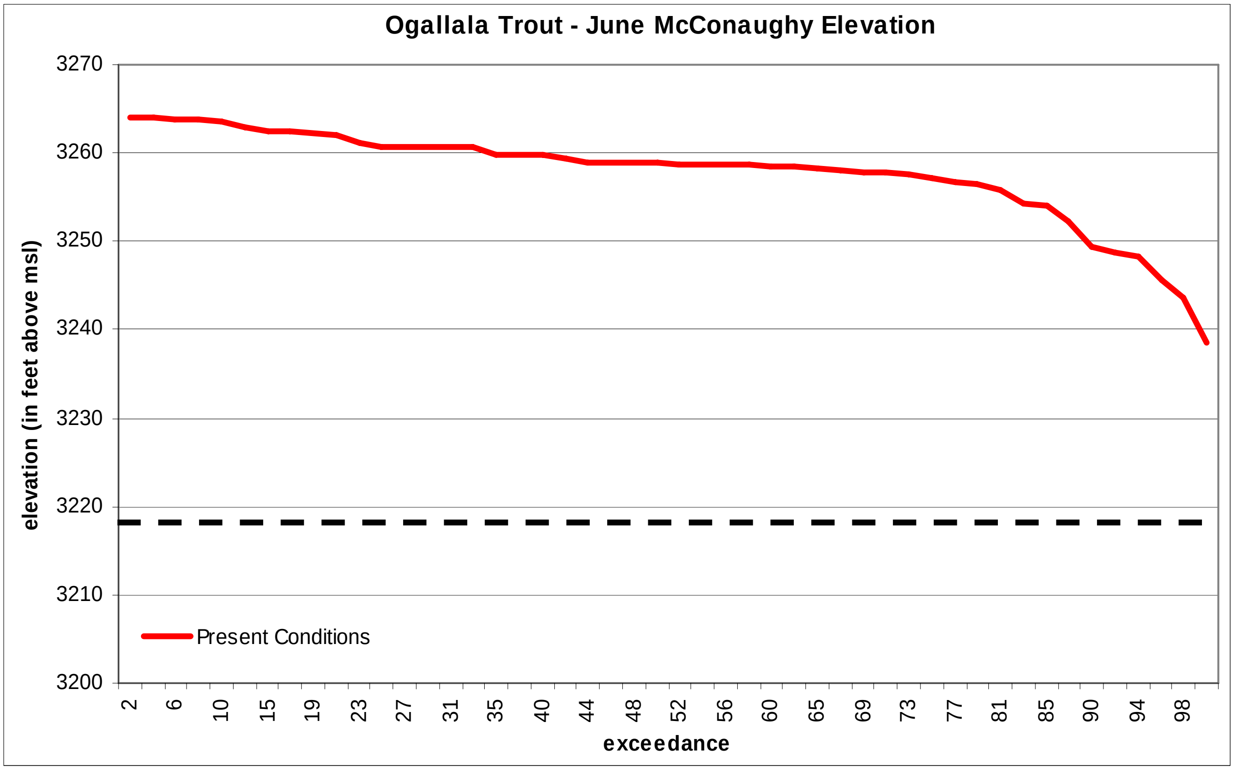


Figure 4-NSF-21.—Lake Ogallala trout indicator—Lake McConaughy June elevation.

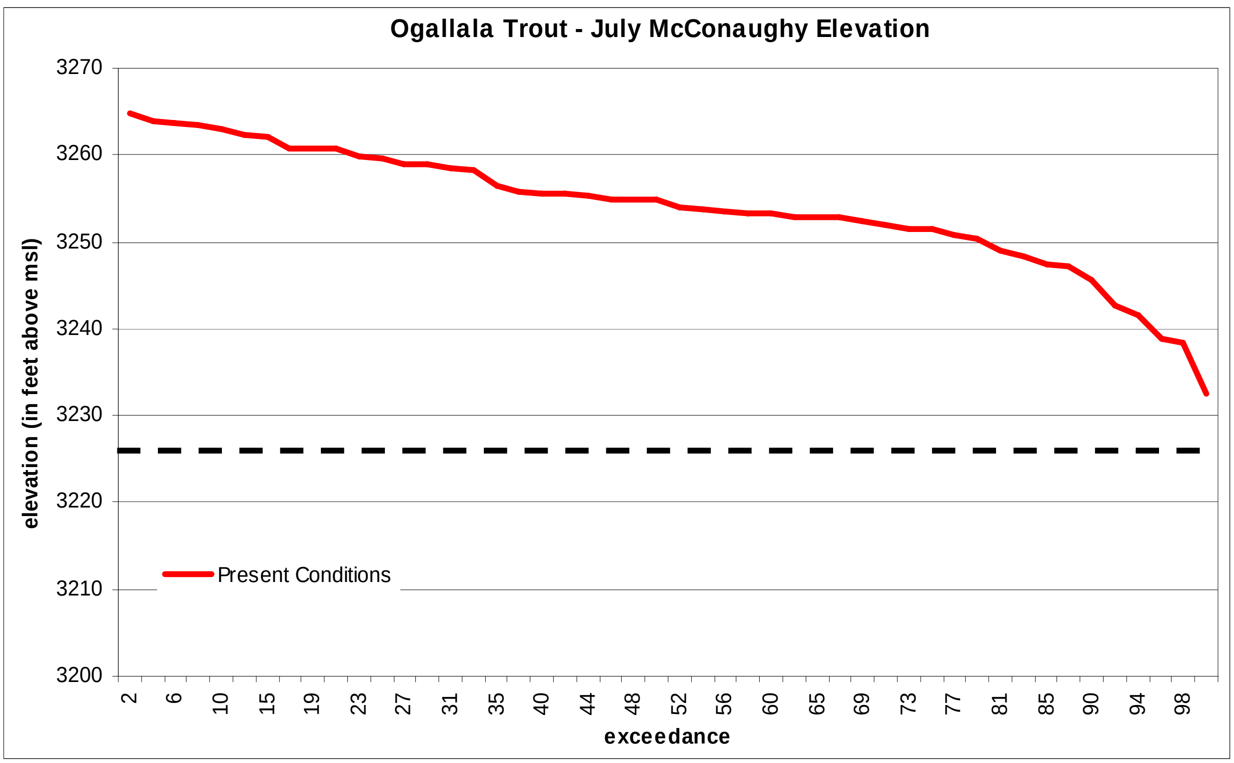


Figure 4-NSF-22.—Lake Ogallala trout indicator—Lake McConaughy July elevation.

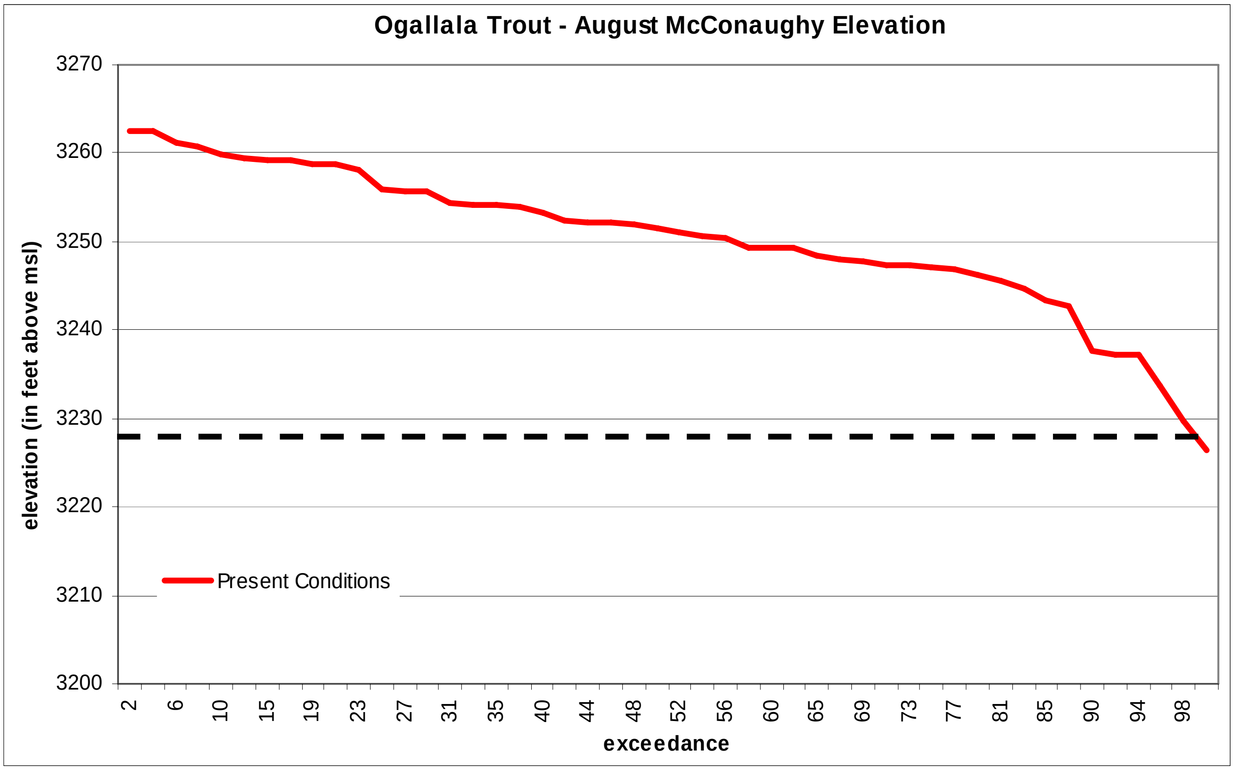


Figure 4-NSF-23.—Lake Ogallala trout indicator—Lake McConaughy August elevation.

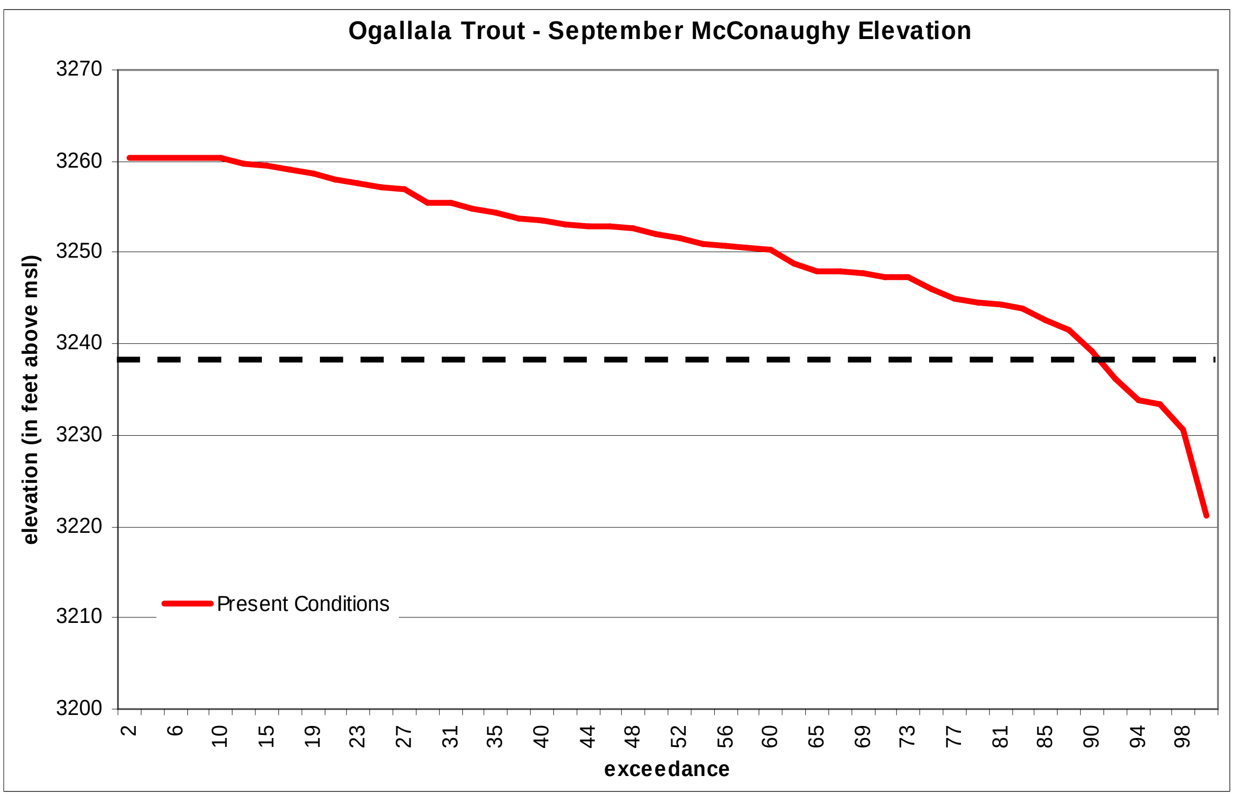


Figure 4-NSF-24.—Lake Ogallala trout indicator—Lake McConaughy September elevation.

Lower Platte River Catfish and Shovelnose Sturgeon

High water in the Lower Platte River in the spring (February-June) provides for habitat creation and maintenance for these fisheries, as well as spawning cues. Under the Present Condition, average February-July flows range from just over 4,000 cfs to just under 29,000 cfs, with an inflection point at around 16,000 cfs, as shown in figure 4-NSF-25.

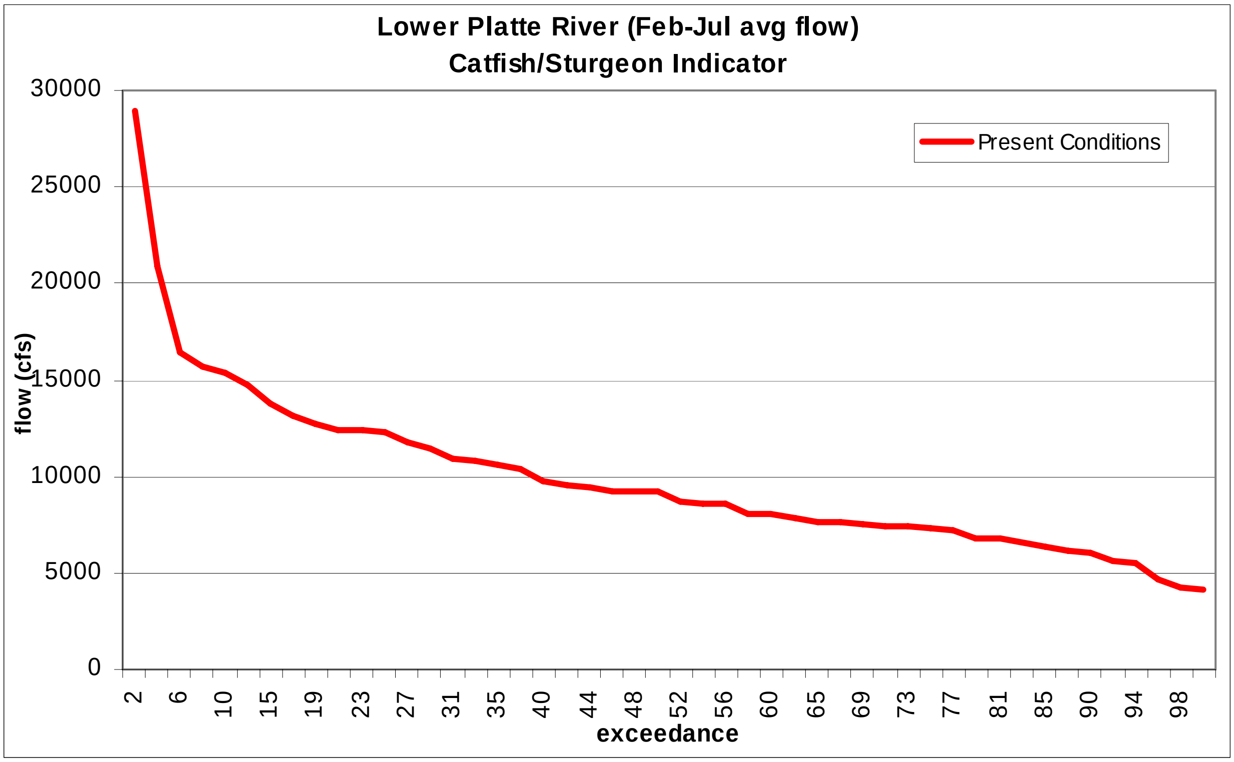


Figure 4-NSF-25.—Catfish and shovelnose sturgeon indicator—Lower Platte River February to July average flow.

CENTRAL PLATTE FISHERIES

INTRODUCTION

One of the most important fish resources affected by the proposed Program is located in the Central Platte River between Lexington and Grand Island, Nebraska (also known as the Big Bend Reach). Of particular importance are small fishes that provide forage for the endangered interior least tern, and larger fish that supply forage for bald eagles.

INDICATORS

- **Physical Habitat**: Monthly habitat duration curves for each alternative were compared to the Present Condition to determine percentage change in fish habitat. Positive and negative percent differences were interpreted as minor (<10 percent) (- or +), moderate (10-20 percent) (-- or ++), or major (>20 percent) (--- or +++), depending on the magnitude of change. Each positive and negative category was tallied to determine which alternative provided the most benefit to the fish community.
- **Stream Channel Changes**: The SEDVEG Gen3 model was used to compare stream channel changes on forage fish habitat between the Present Condition and alternatives.
- **Water Temperature**: Assessment of summer water temperature impacts was a hydrologic analysis that involved calculating the percent of time 1,200 cfs was met or exceeded at Grand Island during June, July, and August for each alternative, using monthly flows provided by the CPR Model. Also, the probabilities of exceeding the 32 ºC (90 ºF) temperature standard were calculated.

METHODS

Physical Habitat

Availability and quality of aquatic habitat have a direct and indirect effect on the abundance and diversity of fish within the Central Platte River. In the Kingsley Project Biological Opinion (Service, 1997), the Service used river channel hydraulic analysis for the Central Platte River that were developed by Hardy and Associates (1992) and habitat suitability indices that were developed by Peters and Holland (1994) to model the relationship between available fish habitat and discharge for various fish “guilds” in the Central Platte River. This habitat model used the PHABSIM component of the Instream Flow Incremental Methodology (IFIM) developed by the Service (Bovee et al., 1998) to combine hydraulic analysis with habitat suitability indices for water depth, velocity, and cover. PHABSIM measures fish habitat suitability in response to changes in depths and velocities associated with varying flows. The output from PHABSIM is a measure of “weighted usable area,” or habitat, versus flow.

A guild is a “group of species which exploit the same class of environmental resources in a similar way” (Root 1967, as cited in Leonard and Orth, 1988). The primary assumption with this analysis is that a diverse assemblage of fish species is needed to maintain the integrity of the fishery and to provide an adequate forage base for both the interior least tern and bald eagle. Twenty-four different native fish species/life stages were grouped into five guilds, based on similarities in the shape of their habitat area curves. In the Kingsley Biological Opinion (Service, 1997), a final discharge/habitat relationship for the five-guild fish community was developed by comparing individual guild curves to determine the minimum percent of optimal habitat for a range of flows. This optimization technique showed that a flow of 1,200 cfs provided the maximum percent of optimal habitat among the minimum habitat values. The PHABSIM analysis assumed that the stream channel was in equilibrium (i.e., no aggradation or degradation) for each alternative.

The effects of alternative flow regimes on physical habitat were determined using the relationships between available fish habitat and discharge (habitat area curves). The CPR model was used to simulate average monthly discharge over a 52-year period of record for each alternative at two locations in the Central Platte River. Using the habitat time series computer programs within PHABSIM, discharge data from Overton and Grand Island, Nebraska were converted to percent of optimal habitat using the final habitat/discharge relationship discussed above for the five fish guilds. Monthly habitat duration curves for each alternative were then compared to the Present Condition to determine percentage change in fish habitat. Positive and negative percent differences were interpreted as minor (<10 percent) (- or +), moderate (10 to 20 percent) (-- or ++), or major (>20 percent) (--- or +++), depending on the magnitude of change. The final step was a tally of each positive and negative category to determine which alternative provided the most benefit to the fish community in the Central Platte River.

SEDVEG Gen3 Model

As discussed above, the PHABSIM analysis was only appropriate where river channels were in equilibrium and not aggrading or degrading. In areas of the Central Platte River where alternatives resulted in aggradation or degradation, another analysis was necessary. The SEDVEG Gen3 model was used to assess effects of stream channel changes on forage fish habitat. Sand shiners were used to represent forage fish for least terns. Sand shiner habitat suitability criteria for depth were used to assess impacts on fish habitat using the SEDVEG Gen3 model. Based on information in Peters et al. (1989) and Conklin et al. (1995), the following optimum depth criteria were used for sand shiners (both juvenile and adult life stages):

- Summer (June 22-Sept 2) - 3 to 20 cm
- Fall, winter, spring (Sept 3-June 21) - 3 to 10 cm

The analysis involved quantifying total channel widths with these optimum depths (i.e., summing wetted widths with these depths across the river channel) for the 48 years of hydrologic record analyzed subsequent to the 13 years of the Program's First Increment. This provided an estimate of channel changes and subsequent effects on forage fish habitat in the Central Platte River.

Water Quality

For the Central Platte River, Dinan (1992), Zander (1995 and 1996), and Sinokrot et al. (1996) demonstrated a relationship between river water temperature and instream flows. Study results indicate that to reduce the frequency and duration of potential lethal maximum water temperatures, flows of sufficient quantity must be provided; and reductions in flow during summer months could increase frequency and duration of high water temperatures that adversely impact fish populations (Dinan, 1992).

As flow increases, the wetted width and water depth increase. Heat supplied to the water surface by the sun or warm air is absorbed by a larger volume of water. In general, higher flows are associated with lower maximum water temperature and less fluctuation around the mean temperature.

Results from Dinan's (1992) effort indicate that a relationship exists between daily maximum water temperature and discharge. Increased flows during summer months can reduce the frequency and duration of daily maximum water temperatures in excess of 35°C throughout the Central Platte River. Flows of 400 cfs at Grand Island provided little or no protection to the Central Platte River fish community from high water temperatures. A flow of 800 cfs reduced the average daily maximum water temperatures and the number of days when temperatures were in excess of 35°C throughout the Central Platte River. A flow of 1,200 cfs further reduced average daily maximum water temperature at all sites and reduced the number of days when maximum water temperatures were in excess of 35°C. Sinokrot et al. (1996) found that a 1,200-cfs minimum flow is required to significantly reduce violations of the Nebraska water temperature standard of 32.0°C (90 ºF) during the summer, and findings of a peer review panel (McCutcheon et al., 1996) found that Sinokrot et al. (1996) had reached credible and scientifically valid conclusions. The critical months identified in the Kingsley Biological Opinion are June, July, and August (Service, 1997).

Water temperature impacts were assessed based on the knowledge that elevated summer water temperatures can have a detrimental effect on the Central Platte River fish community. This analysis used daily summer flow and air temperature data from the Mormon Island thermograph for the period of June 1988-September 1995. There were no data collected in 1989 at this site. This data set differs from the data of 1988-1990 used in the Kingsley Biological Opinion (Service, 1997).

One approach that was used to assess summer water temperature impacts was a hydrologic analysis that calculates the percentage of time 1,200 cfs was met or exceeded at Grand Island during June, July, and August for each alternative, using daily flows provided by the CPR model. Adopting a summer flow recommendation of 1,200 cfs reduces the frequency and duration of high water temperature events. A flow of 1,200 cfs provides the most "cost effective" improvement toward meeting this goal. The alternative with the highest percentage of summer days with flows greater than or equal to 1,200 cfs would provide the most benefit to the fish community. This approach was used in the Kingsley Biological Opinion (Service, 1997).

Another approach that was used to assess temperature impacts was to look at how often, based on probabilities, the state standard would be met with each alternative. A probability distribution based on flow was developed. The analysis was based on historical daily flow data from the Grand Island gauge and the temperature data for the Mormon Island thermograph site. The maximum water temperature data were subset into flow intervals. The intervals were based on 100-cfs increments at lower flows. As flows increased, increments were increased to ensure that each interval included at least 25 temperature measurements. Once the increment size was increased, that became the minimum size for higher flow intervals.

The water temperature data within each flow interval were sorted from low to high and a cumulative frequency distribution was developed. The probabilities of exceeding the 32°C temperature standard maximum were calculated as the complement of the frequency from the cumulative frequency distribution associated with the last occurrence of 32 °C or the last temperature that did not exceed 32 °C. The probability of exceeding this temperature was then aligned with the flow intervals and plotted. Quadratic regression was developed by regressing the probabilities against the interval number and its square root. The maximum flow used in the regression was 6,497 cfs. The probabilities of exceeding 32°C with the highest flow interval was 0.02.

A qualitative assessment was used to determine the potential effects of each alternative on other water quality parameters important to the fish community in the Central Platte River. These parameters included selenium and turbidity. The potential toxicity of Platte River sediments to fish is addressed in "Water Quality" in chapter 4 and the *Water Quality Appendix* in volume 3.

PRESENT CONDITION

Fish surveys conducted on the Central Platte River since the late 1930s have documented a fish community dominated by minnows (Johnson, 1942; Morris, 1960; Bliss and Schainost, 1973; and Chadwick et al., 1997). Fish communities dominated by minnows are common in prairie streams where available aquatic habitat is primarily shallow, open water (Cross and Collins, 1975 and Pflieger, 1975). From 1990 through 1995, the fish community of the Big Bend Reach was monitored twice annually by Chadwick and Associates, Inc. (1992, 1993, 1994) and Chadwick Ecological Consultants (1995, 1996). During the 6-year period, 41 fish species were collected in the Central Platte River, including 15 species of the minnow family (*Cyprinidae*) (excluding carp [*Cyprinus carpio*]). One minnow species, silver chub (*Macrhybopsis storeriana*), was collected on one occasion, and a second species, flathead chub (*Platygobio gracilis*), was collected on only three occasions. The most abundant small fish collected were sand shiner (*Notropis stramineus*), the non-native mosquitofish (*Gambusia affinis*), plains killifish (*Fundulus zebrinus*), red shiner (*Cyprinella lutrensis*), and bigmouth shiner (*Notropis dorsalis*) (Chadwick Ecological Consultants, 1996). Other common fish include fathead minnow (Pimephales promelas), river carpsucker (*Carpiodes carpio*), white sucker (*Catostomus commersoni*), channel catfish (*Ictalurus punctatus*), carp , largemouth bass (*Micropterus salmoides*), and quillback (*Carpiodes cyprinus*) (Chadwick Ecological Consultants, 1996). Species composition of the minnows was quite consistent over the 6-year period, and minnows represented between 33.3 and 57.9 percent of the species collected during a sampling period.

Physical Habitat

Habitat in the Central Platte River is typical of many other Great Plains streams. Low gradient, sandy silt bottoms, highly variable flows, high summer water temperatures, high turbidity, and high chloride and TDS make such streams harsh environments for fish (Matthews, 1987, 1988 and Cross and Moss, 1986). Fish living in plains streams, including those common in the Platte, are generally well adapted to the variable and harsh habitat.

Important fish habitat in the Central Platte River includes deeper pools and shallow areas, side channels, backwaters, and shoreline cover (Morris, 1960 and Peters et al., 1989). Of five main channel habitat types (open channel, bank, snag, backwater, and isolated backwater) characterized by Chadwick Ecological Consultants (1996), open channel accounted for more than 95 percent of all water surface area in the Central Platte River. Pool habitat is most abundant in the Platte River below Grand Island. Tables 4-CPF-1 and 4-CPF-2 summarize available fish habitat under the Present Condition at Overton and Grand Island, Nebraska, in the Central Platte River (see the *Central Platte Fisheries Appendix* in volume 3).

Table 4-CPF-1.—PHABSIM Results for Central Platte River Fish Habitat under the Present Condition at Overton, Nebraska

	Percent of Optimal Habitat			
Percent Exceedance*	**10**	**20**	**80**	**90**
January	65.1	63.4	40.6	37.7
February	66.5	65.2	35.9	35.3
March	65.8	64.8	38.6	36.6
April	64.9	62.7	44.7	37.9
May	66.0	63.3	42.3	37.1
June	63.7	56.6	35.5	34.6
July	65.4	62.4	39.8	38.1
August	59.1	56.0	38.8	36.9
September	60.5	57.9	35.7	23.8
October	67.0	66.4	50.6	40.3
November	66.3	64.1	44.0	38.6
December	67.0	65.9	44.9	39.3

* Percent of optimal habitat that is achieved at least the given percent of the time. (for example, for January, 65.1 percent of the optimal habitat amount is achieved at least 10 percent of the time. Only 37.7 percent of optimal habitat is achieved at least 90 percent of the time.)

Table-4-CPF-2.—PHABSIM Results for Central Platte River Fish Habitat Under the Present Condition at Grand Island, Nebraska

	Percent of Optimal Habitat			
Percent Exceedance	**10**	**20**	**80**	**90**
January	66.4	64.6	43.1	39.2
February	66.7	63.5	35.5	34.7
March	64.4	62.0	36.2	35.3
April	65.2	61.9	40.0	36.2
May	66.7	63.6	38.9	36.0
June	64.8	55.0	34.8	34.5
July	65.5	58.1	36.1	31.2
August	60.3	53.2	35.0	29.8
September	58.7	53.2	22.5	17.1
October	65.1	64.2	44.1	35.2
November	66.2	64.1	40.9	38.4
December	66.8	66.5	47.3	39.2

* Percent of optimal habitat that is achieved at least the given percent of the time. (For example, for January, 66.4 percent of the optimal habitat amount is achieved at least 10 percent of the time. Only 39.2 percent of optimal habitat is achieved at least 90 percent of the time.)

The SEDVEG Gen3 results showed average channel widths (48-year average) for the Present Condition in the Central Platte River that met forage fish depth criteria of 115.8 feet and 749.5 feet for nonsummer and summer, respectively.

Temperature

Droughts are a major feature of the Central Platte River. Low water limits fish habitat and allows water temperatures to reach high summer temperatures. Summer water temperatures of typical plains streams range from 36 ° to 37 °C in the main stems and 32 ° to 35 °C in thermal refugia (Matthews and Zimmerman,1990). These temperatures are typical of the Platte River.

Periodic low summer flows, coupled with high temperatures, are believed to be a critical factor in determining the abundance and diversity of the Central Platte River forage fish community. Between 1974 and 1996, there were 23 reported fishkills occurring between May and September in the Central Platte River NGPC, 1997). Nine of these reports occurred in 1991. Fishkills occurred in 57 percent of the 23 years. Goldowitz (1996) demonstrated that fishkills were highly likely in other years but not documented. Most of the reported fishkills (92 percent) occurred in the Central Platte River between Cozad and Columbus. A dewatered channel was responsible for one fishkill in 1975, and toxic chemicals resulted in fishkills in 1983 and 1989. A wide range of fish species were affected by these kills, including channel catfish, walleye, sunfish, suckers, and minnows. High water temperatures (>32 °C) and low flows were observed for many of the kills. "Water Quality" in chapter 4 summarizes the Present Condition relative to the 1,200-cfs target flow and probability of exceeding the Nebraska temperature standard.

HYDROPOWER

INTRODUCTION

Tables 4-H-1 and 4-H-2 list the hydropower generation facilities in the North and Central Platte Basins that may be affected by the action alternatives. Hydropower generation in the South Platte Basin is located in the South Platte headwaters, above any anticipated effects from the alternatives.

Table 4-H-1.—Hydropower Facilities in Central Platte Region

Feature	Use	Installed Capacity (Megawatts)	Ownership
Kingsley Dam	Peaking	50.0	CNPPD
Jeffrey Canyon	Run of river	18.0	CNPPD
Johnson 1, 2	Run of river	36.0	CNPPD
North Platte	Run of river	24.0	NPPD
Kearney	Run of river	1.5	NPPD
Total		129.5	

Table 4-H-2.—Hydropower Facilities in North Platte Region

Feature	Use	Installed Capacity (Megawatts)	Ownership
Seminoe	Peaking	42	Reclamation
Kortes	Intermediate	36.0	Reclamation
Fremont Canyon	Peaking	66.8	Reclamation
Alcova	Peaking	39.0	Reclamation
Glendo	Intermediate	38.0	Reclamation
Guernsey	Intermediate	6.4	Reclamation
Total		235.2	

INDICATORS AND METHODS

In this analysis, three indicators are employed to capture the effects of the alternatives on the hydropower system:

- **Dependable Capacity**: The dependable generation capacity. The maximum amount of electricity that can be produced by a powerplant is called its capacity. Capacity is often measured in megawatts. The capacity of thermal powerplants is determined by their design and is essentially fixed. In the case of hydroelectric powerplants, capacity varies over time because it is a function of reservoir elevation, the amount of water available for release, and the design of the facility. Because the capacity at hydropower plants is highly variable, the amount of dependable or marketable capacity is of particular significance. The amount of dependable or marketable capacity is determined using various probabilistic methods. For this EIS, dependable capacity is calculated for the summer marketing season (April - September) and the winter marketing season (October - March), using two different probabilistic methods: the 90-percent exceedance method and the minimum median method. The details of these techniques are described in “Hydropower” in the *Economics Appendix* in volume 3 and in Harpman (2003).

- **Generation**: The amount of electrical energy generated. The amount of electrical energy generated in each hydropower system is measured in megawatt hours. A watt is the fundamental unit of electrical energy and is defined as a current of one ampere flowing under one volt of pressure. A megawatt is 1 million (1,000,000) watts. A megawatt hour is the generation of one megawatt continuously for a 1-hour period of time.

- **Economic Value**: The economic value of the hydropower produced. Electricity cannot be efficiently stored on a large scale using currently available technology. It must be produced as needed. Consequently, when a change in demand occurs, such as when an irrigation pump is turned on, somewhere in the interconnected power system the production of electricity must be increased to satisfy this demand. In the language of the electric utility industry, the demand for electricity is known as “load.” Load varies on a monthly, weekly, daily, and hourly basis. During the year, the aggregate demand for electricity is highest when heating and cooling needs, respectively, are greatest. During a given week, the demand for electricity is typically higher on weekdays, with less demand on weekends, particularly holiday weekends. During a given day, the aggregate demand for electricity is relatively low from midnight through the early morning hours, rises sharply during working hours, and falls off during the late evening.

  In general, the economic value of operating a hydropower plant is greatest when the demand or load is the highest. The economic value of operating an existing hydropower plant is measured by the avoided cost of doing so. In this context, avoided cost is the difference between the cost of satisfying the demand for electricity with and without operating the hydropower plant. Conceptually, avoided cost is the savings realized by supplying electricity from a low-cost hydropower source, rather than a higher cost thermal source. These savings arise because the variable cost of operating a hydropower plant is relatively low in comparison to thermal units.

For a description of the method used to estimate generation and the method used to estimate economic value, please see “Hydropower” in the *Economic Appendix* in volume 3.

PRESENT CONDITION

Employing the modeled hydrology for the Present Condition and the methodologies described in “Hydropower” in the *Economics Appendix* in volume 3 and in Harpman (2003) for estimating generation, dependable capacity and economic value yield the “base case” results for the hydropower resource. These results are shown in table 4-H-3 for the North Platte and the Central Platte.

North Platte Hydropower System

As shown in table 4-H-3, the expected annual generation in the North Platte is approximately 703,000 megawatt hours under the Present Condition. The dependable summer capacity, calculated using the 90-percent exceedance method, is approximately 216 megawatts, and the dependable winter capacity is approximately 80 megawatts. For comparison purposes, the installed nameplate capacity of all the plants in the North Platte system is 235.2 megawatts. The dependable or reliably available capacities for the Present Condition represent 92 percent (summer) and 34 percent (winter), respectively, of the installed capacity in the Platte River Basin. The expected annual economic value of electricity production is approximately $45 million (2002 dollars).

Table 4-H-3.—Present Condition for the Hydropower Resource

Scope	Generation (Megawatt Hours)	Economic Value (2002 Dollars)	Dependable Capacity (Megawatts)			
			Minimum Median Method		90 Percent Exceedance Method	
			Summer	Winter	Summer	Winter
North Platte System	702,740	44,732,993	87.12	71.88	215.78	80.37
Central Platte System	465,780	15,835,153	76.36	80.26	89.08	69.48

Central Platte Hydropower System

As shown in table 4-H-3, the expected annual generation in the Central Platte is approximately 466,000 megawatt hours under the Present Condition. Central Platte dependable capacity calculated using the 90-percent exceedance method is approximately 89 megawatts in the summer and 69 megawatts in the winter. For comparison purposes, the installed nameplate capacity of all the plants in the Central Platte System is 129.5 megawatts. The dependable or reliably available capacities for the Present Condition represent 69 percent (summer) and 54 percent (winter), respectively, of the installed capacity in the Platte River Basin. The expected annual economic value of electricity production is approximately $16 million (2002 dollars).

RECREATION

INTRODUCTION

Many state parks, state recreation areas, and state wildlife management areas have been developed around or along the lakes, reservoirs, and rivers of the Platte River system. Originally, water projects within the Basin were developed to harness the irregular flows of water for irrigated agriculture, hydroelectric power generation, and flood control. However, after World War II (especially during the 1950s and 1960s), Americans' interest in and ability to pursue leisure activities greatly increased. More income, leisure, and vacation time, and improved road and highway systems that included the high-speed interstate highways, helped drive recreational interests.

North Platte River

As early as the 1930s, Reclamation, in cooperation with other Federal, state, and local entities, encouraged developing the recreation potential at many of the reservoirs and reaches of the Platte River system. Since then, outdoor recreation has become an important, non-consumptive use of water within this Basin, including boating, camping, fishing, hiking, hunting, picnicking, swimming, water skiing, and wildlife observation.

Central Platte River

The development of the Central Nebraska Public Power and Irrigation District created many benefits. Originally constructed in the late 1930s and early 1940s to bring irrigation to south-central Nebraska (while generating hydroelectric power) the recreational benefits of the project's reservoirs, canals, and canyon lakes became a major resource for lake fishing, boating, and camping. Almost all of the lands surrounding Lake McConaughy are leased to the Nebraska Game and Parks Commission (NGPC) at no cost to be used for recreational or wildlife purposes.

South Platte River

Tamarack Ranch State Wildlife Area is owned and operated by the Colorado Division of Wildlife (CDOW). This area is located along the South Platte River in Logan County in northeastern Colorado. The wildlife area stretches along 14 miles of the South Platte River and provides habitat for upland game, waterfowl, deer and turkey.

Although hundreds of thousands of individuals make use of the recreational resources of the South Platte River system each year, accurate and complete visitor use data are unavailable for many of the recreation areas.

The following section includes tables incorporating available historical visitor use data, and provides a brief description of facilities and types of recreation use for each major recreation site in the three-state basin.

INDICATORS

As for many studies, the analysis of the impacts on recreation assumes that the amount of recreational use is a function of the reservoir surface area available for recreation and for a river the upstream reservoir surface area.

Where data are available, three measurement indices, or indicators, are quantified and displayed for the major recreation reservoirs: surface area, visitor use, and economic value.

- **Surface area**: The average end-of-month reservoir surface area in acres; it is derived from the hydrologic model.
- **Visitor use**: Quantified as the number of visits, defined as one person visiting a recreation site for any part of a day for the purpose of recreation.
- **Economic value**: The amount an individual would be willing to pay for a recreational experience over and above the amount the visitor actually does pay for supplies, travel, entrance fees, and other visit-related expenses in order to have the recreational experience. Economists typically refer to this economic value as "consumer surplus" or "net willingness to pay." It includes only the direct value to the visitor and does not reflect the indirect, or secondary, effects on regional businesses and households derived from visitor expenditures. Any changes in visitor expenditures are taken into account in the regional economic analysis. Regional effects on local economics are quantified separately in "Regional Economics" in chapter 5.

Visitation numbers for Glendo Reservoir and Seminoe Reservoir resource areas are for general recreation users minus anglers. A separate fisheries analysis was performed for these reservoirs in which angler use and economic value is quantified.

Consistent data across resource areas are not available. Therefore, indicators vary among the resource areas depending upon available information (see table 4-R-1).

Table 4-R-1.—Resource Areas and Indicators

Resource Area	Surface Area	Visitor Use	Economic Value
Wyoming Mainstem Reservoirs			
Glendo Reservoir	X	X	X
Guernsey Reservoir	X	X	X
Seminoe Reservoir	X	X	X
Pathfinder Reservoir	X		
Wyoming Six Fisheries			
Cardwell Fishery		X	X
Miracle Mile Fishery		X	X
NPR below Gray Reef Fishery		X	X
Pathfinder Fishery		X	X
Seminoe Fishery		X	X
Glendo Fishery		X	X
Colorado Tamarack Project			
Tamarack State Wildlife Area	Qualitative		
Colorado Six Reservoirs			
Empire Reservoir	X		
Jackson Lake State Park	X		
North Sterling Reservoir	X		
Prewitt Reservoir	X		
Julesburg Reservoir	X		
Riverside Reservoir	X		
Nebraska Lake McConaughy			
Lake McConaughy	X	X	X
Nebraska panhandle inland lakes and streams and Lake Minatare			
Lake Minatare		X	

METHODS

Wyoming

Mainstem Reservoirs

Recreation use occurs at seven of the major water features on the North Platte River: Seminoe Reservoir, Kortes Reservoir, Pathfinder Reservoir, Alcova Reservoir, Gray Reef Reservoir, Glendo Reservoir, and Guernsey Reservoir. All three measurement indices (surface area, visitor use, and economic value) were quantified for Glendo, Guernsey, and Seminoe.

A recreation model using the travel cost method[24] was developed to estimate both the visitation and economic value associated with water-based state recreation areas in Wyoming. Six state parks and recreation areas were included in the study, including Glendo, Guernsey, and Seminoe State Parks. The travel cost model demonstrated statistically that per capita visitor use varies with changes in reservoir

[24]The travel cost method of estimating the value of recreation is based upon observed market behavior of a cross-section of visitors in response to direct out-of-pocket and time costs of travel. It is assumed that individuals will decrease the number of trips to a recreation site as distance increases, other things remaining equal (Walsh, 1986).

surface acres, along with other factors such as age, income, and travel cost (see volume 3, *Recreation Appendix* for a further explanation of this model). Although the model may not yield highly accurate estimates of visitor use in absolute terms, it is believed to be a good predictor of differences among the alternatives due to changes in reservoir volume. Angler visitation was subtracted at Glendo and Seminoe and a separate analysis was performed to estimate those changes. The economic value per visit for recreation activities other than fishing was estimated to be $17.70 in 1993 dollars. This figure was indexed to $24.36 in 2002 dollars using the Consumer Price Index (CPI). The economic value per visit for fishing was taken from the 2001 Addendum to the National Survey of Fishing, Hunting and Wildlife-Associated Recreation (Service, 2001 [Recreation]). The $38 economic value per day for Wyoming anglers (not expenditures) was indexed to 2002 using the CPI yielding $38.60 per angler visit.

Reservoir Fisheries

Pathfinder, Seminoe, and Glendo fisheries are considered to be the "reservoir" fisheries.

Average Scenario

The first scenario is the "average" scenario reflecting the average effects on lake elevations and fisheries over the 48-year period of hydrologic record used as the baseline for the FEIS analyses.

Fisheries Elimination Scenario

The second scenario is the "worst-case" scenario, which will be referred to as the "Fisheries Elimination Scenario." In this scenario, it is assumed that the Program's First Increment occurs during the worst drought period for the 48-year period of hydrologic record. It is also assumed that the reservoir fisheries in Seminoe and Pathfinder Reservoirs are eliminated and would then be restocked during the first increment of the Program.

The Wyoming Game and Fish Department defined the 50 kaf of storage as a critical level for survival of the reservoir fishery. Under severe drought conditions, some of the alternatives could pull Pathfinder and possibly Seminoe reservoirs below 50 kaf in the summer months. In these cases, this analysis assumes that the reservoir fishery would be eliminated and hence angler use would also be greatly reduced until the fishery recovers. The probabilities that the reservoirs would be reduced below the flag level (200 kaf and 50 kaf) at least 1 year during the Program's First Increment vary under the alternatives. These probabilities are presented in table 4-R-2. The expected loss and recovery period is presented in table 4-R-3.

The declines in angler visitation at Pathfinder, Seminoe, and Glendo reservoirs were evaluated on whether the reservoirs fell below 50 kaf in the first increment. Loss and recovery periods for reservoir fisheries were estimated by WG&F. It was assumed that trout anglers at the reservoir fisheries would steadily decline as the fishery approached the flag level of 50 kaf. After 2 years of no trout anglers, visitation would return slowly at first and then in full force surpassing average visitation numbers, then steadily move back to average numbers as the non-game fish returned. Walleye anglers at the reservoir fisheries were assumed to steadily decline as the reservoir approached 50 kaf and return to average numbers only after the reservoir fisheries were fully recovered after 7 years. The value used to estimate the economic value of an angler day is for reservoir fishing is $38.60.

Table 4-R-2.—Probabilities of Pathfinder and Seminoe Reservoir Falling Below Critical Resevoir Levels for Fisheries for at Least One Year in the Program's First Increment

	Seminoe Reservoir		Pathfinder Reservoir		Glendo Reservoir	
	200 kaf	50 kaf	200 kaf	50 kaf	200 kaf	50 kaf
Present Condition	.87	0.0	.98	0.0	.87	0.0
Governance Committee Alternative	.91	.24	.99	.57	.97	0.0
Full Water Leasing Alternative	.68	0.0	.93	0.0	.99	0.0
Wet Meadow Alternative	.97	.57	1.0	.68	1.0	0.0
Water Emphasis Alternative	.95	.24	.99	.68	1.0	0.0

Table 4-R-3.—Annual Angler Visitation Loss and Recovery if Reservoir Fisheries Were Eliminated During the Program's First Increment* Under Severe Drought Conditions

Year	Annual Pathfinder visits (trout)	Annual Pathfinder visits (walleye)	Annual Seminoe visits (trout)	Annual Seminoe visits (walleye)
1	29,587	7,629	22,940	10,306
2	20,000	5,000	14,000	6,300
3	10,000	2,500	7,500	3,200
4	0	0	0	0
5	0	0	0	0
6	20,000	0	14,000	0
7	40,000	0	28,000	0
8	50,000	0	35,000	0
9	50,000	0	35,000	0
10	40,000	0	28,000	0
11	40,000	7,629	28,000	10,306
12	40,000	7,629	28,000	10,306
13	30,000	7,629	22,940	10,306
Total	369,587	38,016	263,380	50,725
*Angler loss and recovery rates defined by WG&F.				

Stream Fisheries

The Cardwell fishery, Pathfinder fishery, Miracle Mile fishery, Seminoe fishery, Glendo fishery, and the North Platte River below Gray Reef Dam fishery were also analyzed. Angler visitation data from WG&F were used. Based upon information from WG&F, it was assumed for this analysis that stream fisheries would be unaffected if (1) streamflows did not drop significantly, and (2) lake levels in the reservoirs above each stream fishery did not decline to such low levels that the temperature of water released from the dam increased significantly.

The value used to estimate the economic value of an angler day for stream fishing is $38.60.

Colorado

Because recreation visitation data are not consistent across the impacted Colorado reservoirs, changes in reservoir surface area are estimated and presented. There can be some inference that decreases in surface area may lead to some decrease in recreation visitation, but this analysis makes no quantification of those impacts.

The following reservoirs in Colorado were used in the EIS analysis to illustrate the types of effects that could accompany a water leasing scenario.[25] Empire Reservoir, Jackson Lake, North Sterling Reservoir, Julesburg Reservoir, Prewitt Reservoir, and Riverside Reservoir.

Nebraska

Lake McConaughy and Lake Ogallala

Lake McConaughy and Lake Ogallala have had a long history of recreational use. Visitation figures date back to 1983 and recreation use occurred even before use data were collected.

As with other affected reservoir sites in the Platte Basin, changes in surface acres were estimated by the hydrology model. The presence of historical data on both visitor use and surface acres allowed estimation of a statistical regression model to predict changes in monthly visitor use at Lake McConaughy for all the alternatives. In addition to surface acres, the model also considered temperature, precipitation, and population as predictors of recreational use. (See the *Recreation Appendix* in volume 3 for further explanation of the model).

To estimate the economic value of recreation at Lake McConaughy, a simple "value transfer" approach was used, in which values determined from economic analyses at similar sites in the U.S. are applied to the site in question. Value transfers are commonly used and are appropriate for sites where there is no current useable information available. In a 1994 report,[26] Reclamation estimated that recreation at Lake McConaughy varied in value between $15.70 to $24.98 per visit in 1994−depending on the specific activity (e.g., boating, camping, fishing). These values had been extracted from a number of studies at other sites (Walsh, 1986). For this EIS, the value range was indexed to 2002 to account for inflation: $19.06 to $30.32. To simplify impact analysis, the average of these two values ($24.69) was used to estimate the economic value of recreation at the lake.

Note again that this is not an estimate of the daily expenditures by recreation users, but the consumer surplus value that is excess to their actual expenditure, which is the standard used for estimating economic value in recreation studies. Effects of changes in local recreation expenditures are captured in the Regional Economic Analysis.

An additional analysis is performed for the effect of the alternatives on the usability of the several boat ramps at Lake McConaughy.

[25] The selection of these locations is purely illustrative. Because any water leasing that may take place would be strictly voluntary, the location of the leased waters cannot be forecast prior to alternative implementation.

[26] Reclamation, Economic and Financial Analysis, FERC Projects No. 1417 and 1835, Nebraska, August 1996.

PRESENT CONDITION

Wyoming

Reservoirs

Under the Present Condition, the total average annual surface area for which recreation use and value could be determined was 8,750 acres at Glendo Reservoir, 1,386 acres at Guernsey Reservoir, 13,180 acres at Seminoe Reservoir, and 13,559 at Pathfinder Reservoir (*Water Resources Appendix* in volume 3). Recent visitor use data for Glendo, Guernsey, and Seminoe reservoirs are displayed in table 4-R-4.

Table 4-R-4.—Recent Annual Visitor Use at Selected Wyoming Sites

	Glendo Reservoir	Guernsey Reservoir	Seminoe Reservoir
2000	209,585	85,061	21,456
2001	190,679	74,708	30,221
2002	178,197	77,504	28,100
2003	206,503	67,201	37,338
2004	200,449	56,717	30,888
5-yr- average	197,083	72,238	29,601
Source: Wyoming State Parks and Historic Sites, 2004.			

The baseline figures are estimated from the recreation model and used to estimate changes in annual recreation visits at the Wyoming reservoirs:

- 182,099 visits at Glendo of which 129,623 are non-angler visits
- 63,076 visits at Guernsey of which 18.9 percent are angler visits and 81.1 percent are general recreation
- 46,643 visits at Seminoe of which 34,423 are non-angler visits

Seminoe Reservoir was different because estimates from Wyoming Division of State Parks and Historic Sites (WSPHS) and WG&F were not in agreement. This could be due to factors such as full year counts by WG&F versus recreation season counts by WSPHS, access of certain arrears not captured by WSPHS vehicle counters, and methodologies. It was determined that WG&F angler estimates (33,246 anglers) would be used and a percent of anglers would be subtracted from the WSPHS estimates to get visitation numbers for other activities. The visitor data from 2002 indicated 26.2 percent of visitors to Seminoe were anglers. There were no estimates of general recreation visitation at Pathfinder (Wyoming Game and Fish Department, personal communication, Al Conder, Casper Regional Fisheries Supervisor, 2004). Present Condition non-angler reservoir visitation as estimated by the recreation model is shown in table 4-R-5. The approximate annual economic value of non-angler reservoir recreation in 2002 dollars totaled approximately $5.7 million:

- Glendo Reservoir $3,200,000
- Guernsey Reservoir $1,700,000
- Seminoe Reservoir $840,000

Table 4-R-5.—Non-Angler Reservoir Visitation*

Glendo Reservoir	129,623
Guernsey Reservoir	63,076
Seminoe Reservoir	34,423
Pathfinder Reservoir	NA
*Angler visitation was subtracted from the visitation estimates for Seminoe and Glendo.	

Glendo Reservoir and Glendo State Park

Glendo State Park has seven campgrounds, six boat ramps, and a marina. This area received almost 210,000 recreation visits in 2000 and averaged approximately 197,083 annual visits during the last 5 years, as shown in table 4-R-4.

Fluctuating water levels are expected as evidenced by the development of upper and lower ramps at two locations. Changes in water levels may affect the usation of some boat ramps or participation in some beach activities.

Guernsey Reservoir and Guernsey State Park

Guernsey State Park has seven campgrounds and three boat ramps. Reclamation completed Guernsey Dam and Reservoir in 1927. The park received 85,061 visits in 2000, and averaged approximately 72,238 during the last 5 years as shown in table 4-R-4. The Civilian Conservation Corps (CCC), in the 1930s, originally developed the park. It has some of the finest examples of CCC work in the Rocky Mountain region. The visitor center/museum is a CCC era building. The State of Wyoming manages the recreational facilities at Guernsey State Park.

Fluctuating water levels may affect the use of these ramps or pursuit of beach activities.

Seminoe Reservoir and Seminoe State Park

Seminoe State Park provides three campgrounds and boat ramps. The park received 21,456 visits in 2000, and averaged approximately 29,601 visits during the last 5 years as shown in table 4-R-4. Although there is another boat ramp at the reservoir that is not considered to be a part of Seminoe State Park, access to this ramp is through the Seminoe State Park.

Fluctuating water levels are expected as evidenced by the development of upper and lower ramps at two locations.

Kortes Reservoir

Reclamation manages the Kortes Reservoir. The reservoir is located in a narrow canyon below Seminoe Dam. Kortes Reservoir was developed primarily as an electric power generation project. There are no developed recreation facilities at Kortes.

None of the alternatives cause the elevation levels at Kortes to fluctuate.

Alcova Reservoir

The Natrona County Roads, Bridges, and Parks Department manage recreation at Alcova Reservoir. The reservoir has six campgrounds, eight boat ramps, and a marina. Dinosaur Interpretive Trail is found near Cottonwood Creek Beach.

None of the alternatives cause the elevation levels at Alcova to fluctuate. No visitation data are collected.

Gray Reef Reservoir

There is essentially no recreation at Gray Reef Reservoir. This reservoir is a re-regulating reservoir; and as such, the water surface elevation can fluctuate from nearly full to nearly empty on a daily basis.

Pathfinder Reservoir

BLM and Natrona County Roads, Bridges, and Parks Department manage recreation at this area. There are three campgrounds, each with a boat ramp. There is an interpretive center and a 1.7-mile interpretive trail located near the dam. Boating, fishing, and hunting are the only recreational activities offered on these parts of the reservoir. Pathfinder National Wildlife Refuge consists of four units: Sweetwater Arm (the largest unit), Goose Bay, Deweese Creek, and the junction of Sage Creek and the North Platte River. Much of the refuge consists of mud flats at low reservoir levels.

Visitation collected by WG&F is 37,216 anglers for the Pathfinder fishery. Approximately 84 percent of anglers fish for trout and other fish while 16 percent fish for walleye. Visitation data on other activities was not available, so only the impacts to the fishery were analyzed.

Reservoir Fisheries

Glendo, Seminoe, and Pathfinder reservoir fisheries are analyzed in this FEIS.

Angler visitation at various stream segments and reservoir fisheries were also evaluated under the Present Condition. At Pathfinder, approximately 80 percent of anglers fish for trout and other fish while 20 percent fish for walleye. At Seminoe, approximately 69 percent of anglers fish for trout and other fish while 31 percent fish for walleye. Total annual angler visitation for reservoir fisheries as estimated by WG&F is illustrated in table 4-R-6:

Table 4-R-6—Wyoming Reservoir Fisheries Annual Angler Visitation and Value under the Present Condition

Fishery	Visitation*	Value
Pathfinder Reservoir Fishery	37,216	$1,436,537
Seminoe Reservoir Fishery	33,246	$1,283,296
Glendo Reservoir Fishery	52,476	$2,025,574
*(Wyoming Game and Fish Department, personal communication, Al Conder, Casper Regional Fisheries Supervisor, 2004)		

Stream Fisheries

Table 4-R-7 summarizes the visitation and visitation value for the Wyoming stream fisheries. Visitation data are from the Wyoming Game and Fish Department.

Table 4--7.—Wyoming Stream Fisheries Annual Angler Visitation and Value under the Present Condition

Fishery	Visitation*	Value
Cardwell Fishery	1,000	$38,600
Miracle Mile	28,953	$1,117,586
NPR below Gray Reef	60,000	$2,316,000
*(Wyoming Game and Fish Department, personal communication, Al Conder, Casper Regional Fisheries Supervisor, 2004)		

Cardwell Fishery

The Cardwell Fishery developed in 2002 and is located below Pathfinder Dam. It is primarily a trout fishery. WG&F estimates annual visitation to be 1,000 anglers (Wyoming Game and Fish Department, personal communication, Al Conder, Casper Regional Fisheries Supervisor, 2004).

Miracle Mile Fishery

The Miracle Mile, known for its excellent fishing, is located on the Platte River 12 miles north of Seminoe Reservoir. The Miracle Mile Area extends downstream for 5 and ½ miles, from below the Kortes Dam to the boundary of the southern unit of Pathfinder National Wildlife Refuge. A minimum flow of 500 cfs is provided from Kortes Dam to maintain the fishery along the Miracle Mile. WG&F estimated annual angler visitation to this section of the river at 28,953 anglers.

North Platte River Below Gray Reef Reservoir Fishery

The North Platte River below Gray Reef Dam to Robertson Road Bridge is 39.8 miles long. The Wyoming Game and Fish Department (WG&F) classifies the tailwater below Gray Reef Dam to Bessemer Bend Bridge as class 1, premium trout water of national importance. The remainder of the reach is class 2, water of statewide importance. WG&F has estimated annual visitation in this reach to be 60,000 anglers.

Colorado

Tamarack Ranch State Wildlife Area

Tamarack Ranch State Wildlife Area is owned and operated by the CDOW. This 10,696-acre area is located in Logan County in the far corner of northeastern Colorado. The wildlife area stretches along 14 miles of the South Platte River; and is intensively managed for waterfowl, upland game, small game, and non-game wildlife. The property provides habitat for waterfowl, upland game, small game, deer, turkey, raptors (including bald eagles), and many migratory neo-tropical birds. In addition to the South Platte River, the property provides sandhill grasslands along the riparian corridor which greatly increases plant and wildlife species diversity.

The area is a very popular quality hunting property with reservation hunting available. Other recreation on the property includes fishing, wildlife viewing, hiking, and camping. Although no formal records of visitor use are kept, it estimated that approximately 8,000 hunter days occurred in 2005 (Budding, 2005). All other forms of recreation (including hiking, fishing, etc.) are estimated at 4,000 user days. Depending on the design, locations, and operations of the project, some unquantifiable changes in recreation may occur.

The main recreational activities are fishing, hunting, hiking, and wildlife observation. Recreational use cannot be quantified due to the uncertainties surrounding how the project will be designed and operated.

Colorado Reservoirs

Some of the action alternatives involve leasing of water from water users in Colorado. Leasing of water in Colorado is most likely to be done from existing reservoir storage. However, under the Full Water Leasing Alternative, one-half of the water is assumed to be leased from ditches and/or canals. This would result in recreational impacts being the same across the alternatives that include leasing water from the South Platte. Leasing would be administered and controlled by the State and dependent upon voluntary participation by water users. Therefore, the location of water leasing cannot be forecast. The following reservoirs were selected for analysis to illustrate the possible effects of water leasing on reservoir storage and surface area. No complete data are available on visitor use.

The lack of useful data prohibits a statistical modeling approach to fully analyze impacts on the Colorado water bodies. Under the Present Condition, surface acres of the six reservoirs analyzed varies from 1,260.9 acres to 2,905.4 acres, as shown in table 4-R-8.

Table 4-R-8.—Average Surface Area Acres of South Platte Reservoirs

Empire Reservoir	2214.4
Jackson Lake State Park	2136.4
North Sterling Reservoir	2108.2
Prewitt Reservoir	1794.5
Julesburg Reservoir	1260.9
Riverside Reservoir	2905.4

Empire Reservoir

Empire Reservoir is operated as a private recreation facility (Jackson Lake State Park, personal communication, Mike Severin, March 8, 2000). Seven private clubs provide access and regulate recreational use. There is no development at this lake. It is primarily a weekend, day-use recreation area.

Jackson Lake State Park

During a normal year, Jackson State Park provides opportunities for boating, camping, fishing, hunting, ice fishing, ice skating, picnicking, swimming, water sports, and wildlife watching. Non-game residents include coyote, fox, raptors (including bald and golden eagles) shore birds, and long eared owls. Transient neo-tropical birds will visit during the spring and fall migrations.

It is estimated that visitor use was 183,106 in 2004 (Gay, 2005). There can be some inference that decreases in surface area may lead to some decrease in recreation visitation, but this analysis makes no quantification of those impacts.

The north side of Jackson Lake is owned by the CDOW and managed as a 400 acre SWA. The property is managed to provide shallow seasonal wetlands and provides habitat for large numbers of waterfowl, shorebirds, raptors (including bald eagles), upland game, deer and transient neo-tropical birds. The property provides hunting, fishing, and wildlife viewing recreation.

Julesberg/Jumbo Reservoir

CDOW manages recreation at this reservoir, which has many access points from county roads. CDOW owns a portion of this 3,185 acre property and manages the entire property for recreation. Uses include hunting, fishing, wildlife observation, boating, and camping. A user fee is required. This property is heavily used by waterfowl, shorebirds, raptors (including bald eagles), and migratory neo-tropical birds.

North Sterling State Park

North Sterling Reservoir was built at the turn of the 19th Century for the purpose of supplying water for irrigated agriculture. Colorado State Parks acquired the area in 1992 and manages recreation on the reservoir through a perpetual easement with the North Sterling Irrigation District.

Prewitt Reservoir

Prewitt SWA is located in the northwest corner of Washington County. Access to the property is limited to 250 vehicles at one time. CDOW manages recreation at this 3,000 acre property. A user fee is required. Uses include fishing, hunting, wildlife viewing, boating, and camping. This property is heavily used by waterfowl, shorebirds, raptors (including bald eagles), and migratory neo-tropical birds. Some small game, upland game, and deer are also present.

Nebraska

Lake McConaughy and Lake Ogallala

Lake McConaughy's recreational resources are regionally recognized for their high quality, water-based recreational attributes, and setting. The project's water and land offer a wide range of year-round recreational opportunities. The area attracts many visitors from states other than Nebraska, creating benefits for the regional economies within the project area. Lake McConaughy is the most heavily visited recreation area within the Basin. NGPC has estimated that Lake McConaughy received an average of 711,644 visits annually over the last 5 years the value of recreation at Lake McConaughy would be approximately $17.6 million in 2002 dollars. Visitation data shows that approximately 74 percent of visitors are non-Nebraskan.

Lake Ogallala is adjacent to Lake McConaughy just below Kingsley Dam. This 320-acre lake was formed when construction material was removed to construct the dam. Lake Ogallala offers developed camping with electrical hookups, showers, restrooms, drinking water, picnic tables, and fire gates. More primitive camping is also offered on the west side of the lake. Fishing is available and public hunting is offered in the fall. A large population of bald eagles winters around this lake and they provide outstanding viewing opportunities. The Central Nebraska Power and Irrigation District built and operates a heated observation facility from mid-December through mid-March. Visitation for Lake Ogallala is included in the Lake McConaughy visitation data described above.

Nebraska Panhandle Inland Lakes and Streams, Including Lake Minatare

Reclamation's North Platte Project includes a series of small lakes in the Nebraska Panhandle which serve to regulate flows of water from the large North Platte reservoirs down to the irrigated project areas near Scotts Bluff, Nebraska.

The North Platte refuge lies in the Panhandle of Western Nebraska. The Refuge Complex encompasses approximately 5,047 acres and is managed by the U.S. Forest Service. Primarily established as a bird sanctuary, 181 species of birds have been observed, including some 200,000 mallards and other waterfowl during for which sanctuary is provided during hunting season. Established in 1916, the refuge is superimposed over Reclamation irrigation project features, and consists of Lake Minatare, Winters Creek Lake, Lake Alice, and Stateline Island units. While portions of Winters Creek Lake and Lake Alice are closed to all public entry, the remainder is open to a variety of public uses most of the year.

Lake Minatare State Recreation Area is one of the most popular and scenic recreation areas in Nebraska's Panhandle, encompassing 2,973 acres, including the 2,158-acre reservoir. The State Recreation Area received approximately 78,000 visitors in 2002. Lake Minatare is 6 miles east and 8 miles north of Scotts Bluff in the historic North Platte River valley. Minatare boasts excellent outdoor recreation opportunities, while irrigating thousands of acres in the lush North Platte Valley. Minatare was built as an irrigation reservoir in 1915, part of a system known as the "inland lakes," which includes three other lakes and water-delivery canals. Essentially a wide spot in the water-delivery system, Minatare is a highly productive fishery despite the heavy irrigation drawdowns from it. Its water turnover rate is one of the fastest in the state. From May, when the lake is full, to the end of the irrigation season in late-September, Minatare loses an average of 52 percent of its water volume. Other Nebraska reservoirs might take three years or more for outflows to exceed their storage capacities.

Lake Minatare has an almost featureless sandy shoreline and bottom but a large number of anglers are attracted to the only sizeable reservoir in the central Panhandle. With 2,158 surface acres when full, Lake Minatare supports a multi-species fishery, including walleye, channel catfish, crappie, yellow perch, wiper, smallmouth bass and white bass.

Lake Minatare's irrigation water is managed differently than most other irrigation reservoirs. Water is delivered to Minatare from the Interstate Canal flowing from a diversion dam on the North Platte River located at Whalen, Wyoming, near the town of Fort Laramie. As irrigation winds down, usually in late-August or early-September, the lake is partially refilled before winter. In spring, it is filled to capacity, just before the irrigation season begins again.

There are a number of cold water streams in Nebraska's panhandle which orginate from groundwater in the Sandhills to the north of the North Platte River in the Scotts Bluff area. There are a number of public fishing areas in Nebraska's panhandle. Anglers frequent the area for rainbow, brown and brook trout. Several of these streams cross Reclamation and other irrigation canals as they flow south to the North Platte River, and hence receive some water from canal seepage and return flows from local irrigated lands. One of the alternatives has the potential to reduce deliveries in these canals and hence may reduce runoff to these streams. The analysis considers likely effects on the stream fisheries.

This analysis considers the extent to which the alternatives could change water operations at these recreation areas.

Other Nebraska Recreation Resources

Central Platte River

The Central Platte, also known as the Big Bend Region, begins at the confluence of the North Platte and South Platte Rivers. The city of North Platte, Nebraska, anchors the western end of the Central Platte Region. The Platte River meanders toward the east for 165 miles in a great southern sweep to Columbus, Nebraska.

Increased participation in birding is beginning to be recognized as an opportunity to increase the nature tourism industry in this section of Nebraska.

Each year the spring and fall migrations of millions of wildfowl-including sandhill cranes, ducks, and geese attract thousands of birdwatchers from all over the country. A study conducted for the EPA estimated that between 14,500 and 22,715 birders visited the Central Platte region annually.

Present Condition Summary Table

The following table 4-R-9 presents the Present Condition summary of visitor use and economic net value. These conditions represent a single year situation. The Present Condition is also described in the "Recreation Appendix" in volume 3.

Table 4-R-9.—Present Condition, Summary of Baseline Conditions*

State	Recreation Area	Average Surface Area (Acres)	Average Annual Visitation	Average Annual Net Value in 2002 Dollars
Wyoming	Glendo Reservoir	8,750	129,623	$3,157,606
	Guernsey Reservoir	1,386	63,076	$1,706,304
	Seminoe Reservoir	13,180	34,423	$838,544
	Pathfinder Reservoir	13,559	Not available	
	Cardwell Fishery	Not applicable	1,000	$38,600
	Miracle Mile Fishery		28,953	$1,117,586
	NPR below Grey Reef Dam Fishery		60,000	$2,316,000
	Pathfinder Reservoir Fishery		37,216	$1,436,537
	Seminoe Reservoir Fishery		33,246	$1,283,296
	Glendo Reservoir Fishery		52,476	$2,025,574
Colorado**	Tamarack Ranch State Wildlife Area	Not Estimated Due to Lack of Data		
	Empire Reservoir	2214.4	Not Estimated	
	Jackson Lake State Park	2136.4		
	North Sterling Reservoir	2108.2		
	Prewitt Reservoir	1794.5		
	Julesburg Reservoir	1260.9		
	Riverside Reservoir	2905.4		
Nebraska	Lake McConaughy	29,501.1	711,644	$17,570,490
	Nebraska panhandle inland lakes and streams, including Lake Minatare	Not applicable	77,535***	Not applicable

*Baseline conditions are shown in full in the *Water Resources*, *River Geomorphology*, and *Target Species* Appendices in volume 3.

**Averages are the low and high single monthly average for May - August for the six Colorado reservoirs.

***Lake Minatare visitation values under the Present Condition only.

AGRICULTURAL ECONOMICS

INTRODUCTION

This section describes the Present Condition for agricultural economies that might be affected by the alternatives. The methods and indicators used to analyze both the Present Condition and the alternative impacts are also described.

Economic Impact Regions

To identify the economic effects of potential activities carried out under the Platte River Cooperative Agreement, eight separate economic impact regions were defined. The purpose of breaking the entire Platte River Basin into smaller regions is to identify and locate, as accurately as possible, where various economic impacts may occur. A number of factors were used to determine each economic impact region, including agricultural production areas and practices, location of recreation sites and activities, origin and final use of water supplies, location and size of cities or industrial markets, highways or other transportation routes, and availability of appropriate economic data.

The eight economic impact regions defined include 18 counties in Colorado, 22 counties in Nebraska, and 8 counties in Wyoming. Figure 4-AE-1 shows the location of economic impact regions geographically, and table 4-AE-1 identifies which specific counties are included in each region. Agricultural economics and land use data have been collected for each of the 48 counties comprising the eight impact regions. Some regions span state boundaries, reflecting the presence of strong interstate trade zones, as well as regional hydrologic boundaries.

Table 4-AE-1.—Platte River Economic Regions and County Groupings

Economic Region	Counties Included
Central Platte Habitat Area (orange)	Adams, Buffalo, Dawson, Gosper, Hall, Hamilton, Kearney, Merrick, and Phelps in Nebraska.
Lake McConaughy area (light blue)	Arthur, Cheyenne, Custer, Deuel, Garden, Keith, Lincoln, and McPherson in Nebraska. Logan and Sedgwick in Colorado.
Scotts Bluff area (yellow)	Banner, Kimball, Morrill, Scotts Bluff, and Sioux in Nebraska. Goshen in Wyoming.
Eastern Wyoming (pink)	Albany, Laramie, and Platte in Wyoming.
North Platte headwaters (medium blue)	Carbon, Converse, Fremont, and Natrona in Wyoming. Jackson in Colorado.
Eastern Colorado (purple)	Larimer, Morgan, Washington, and Weld in Colorado.
South Platte headwaters (green)	Clear Creek, Gilpin, Park, and Teller in Colorado.
Denver metropolitan area (red)	Adams, Arapahoe, Boulder, Denver, Douglas, Elbert, and Jefferson in Colorado.

INDICATORS

The FEIS analysis calculates the current status and impacts on the following agricultural and economic indicators:

- Irrigated water deliveries
- Irrigated acreage
- Cropping patterns and crop production
- Crop yields
- Agricultural revenues

METHODS

The following methods were used to estimate the Present Condition and impacts to each of the indicators:

- **Irrigated acres, cropping patterns**, and **crop yields** were estimated using a 10-year (1988 to 1997) average of data obtained from the annual state agricultural statistical reports published by Wyoming, Colorado, and Nebraska.

- **Crop revenues** were estimated using the above data, along with the 10-year average state-level price for each crop. State prices were also obtained from the annual State Agricultural Statistical Reports published by each State.

PRESENT CONDITION

Irrigated Acreage and Crop Data

Data on crop acreage, yields, prices, and production costs were compiled or calculated for each of the economic regions within the Platte River Basin. Since the above information is available only on either a state or county basis, individual state and county data were used to compute regional values. The principal agricultural economic sectors analyzed in the FEIS, as well as the specific crops grown in the Basin that are used to represent those sectors in the analysis, are listed in table 4-AE-2.

Table 4-AE-2.—Economic Sector Categories and Representative Crops

Economic Sector	Representative Crops Used in Agricultural Model
Grain farming	Barley, corn grain, dry beans, sorghum, wheat
All other crop farming	Alfalfa hay, all other hay, corn silage
Vegetables and melon farming	Potatoes
Oilseed farming	Soybeans
Sugarcane and sugar beet farming	Sugar beets

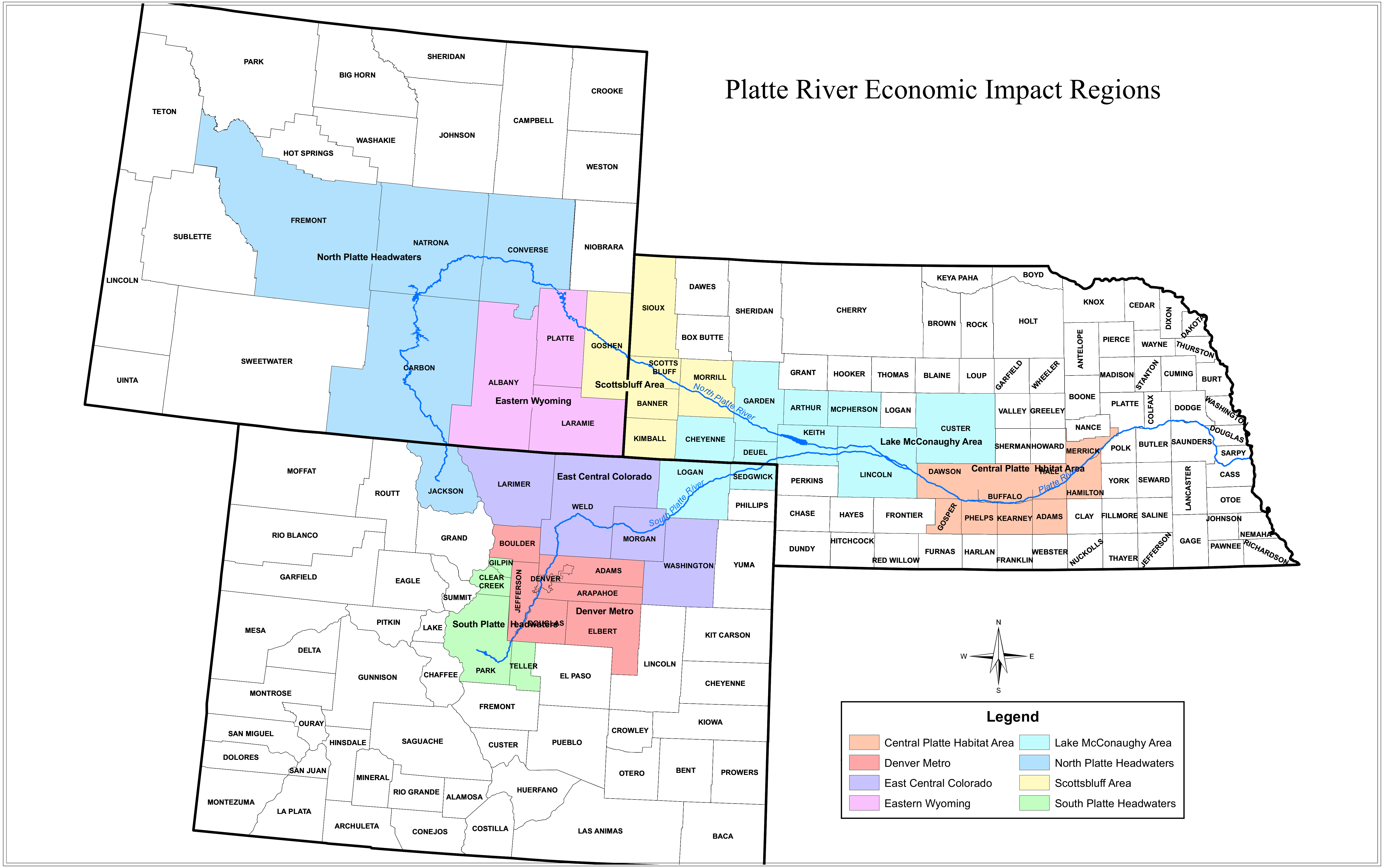


Figure 4-AE-1.— Platte River economic impact regions.

Cropping Patterns and Yields

The cropping pattern indicates the number of acres within a particular region that are planted to individual crops or categories of crops. Table 4-AE-3 summarizes the average acres of irrigated crops harvested between 1988 and 1997 for the three states of the Platte River Basin (Colorado, Nebraska, and Wyoming). Table 4-AE-4 shows the same information for each of the eight economic impact areas within the Basin. It should be noted that values shown for the impact areas were computed using total county data available for all of the counties comprising an impact area, even though, in many cases, portions of each individual county are located outside of the geographical boundary of the Basin.

Table 4-AE-3.—Harvested Acreage of Irrigated Crops, State Totals, 10-Year Average (1988-1997)

Crop	Wyoming	Colorado	Nebraska	Crop Totals
Alfalfa hay	436,350	706,900	391,800	1,535,050
All other hay	482,000	467,600		949,600
Barley	100,500	96,700		197,200
Corn -grain	49,060	811,900	5,210,000	6,070,960
Corn -silage	34,400	104,600	138,000	277,000
Dry beans	37,600	138,550	193,900	370,050
Potatoes		76,722		76,722
Sorghum		49,333	94,889	144,222
Soybeans/beans			799,700	799,700
Sugar beets	61,950	44,050	68,850	174,850
Wheat	14,830	184,620	78,900	278,350
State totals	1,216,690	2,680,975	6,976,039	10,873,704

There is considerable variation in cropping pattern and associated gross value of crop production among the regions. On the basis of irrigated acres harvested, corn for grain is the most important, comprising almost 60 percent of the harvested acres in the Basin. Corn is the leading crop harvested in four of the economic regions and is especially important in the Central Platte Habitat Area, with more than 85 percent of the total harvested area. Alfalfa hay is the second-most important crop in the Basin, in terms of irrigated acres harvested. Alfalfa ranks second in terms of irrigated acres harvested in all of the impact regions, except the Denver metropolitan area, where it ranks first, and the Central Platte Habitat Area, where it is third.

Table 4-AE-4.—Harvested Acreage of Irrigated Crops, by Impact Region, 10-Year Average (1988-1997)

Impact Region	Alfalfa	All Other Hay	Barley	Corn for Grain	Corn for Silage	Dry Beans	Potatoes	Soybeans	Sugar Beets	Wheat	Region Totals
Central Platte Habitat area	50,580	0	0	1,481,020	22,630	0	0	138,990	0	0	1,693,220
Lake McConaughy area	102,560	5,760	0	480,470	23,820	39,770	0	17,110	7,860	23,680	701,030
Scotts Bluff area	92,790	11,300	0	172,490	17,900	91,920	0	0	56,280	11,810	454,490
Eastern Wyoming	51,420	86,250	3,370	8,870	8,430	6,940	0	0	4,540	6,760	176,580
North Platte headwaters	117,770	186,780	11,190	1,890	6,590	2,700	0	0	0	3,490	326,920
Eastern Colorado	121,450	22,100	18,350	254,730	60,640	51,150	5,120	0	35,550	17,940	587,040
South Platte headwaters	0	8,460	0	0	0	0	0	0	0	0	8,460
Denver metropolitan area	34,900	13,010	2,810	16,790	3,980	2,660	0	0	1,930	4,170	80,250
Crop totals	571,470	333,660	35,720	2,416,260	143,990	195,140	5,120	156,100	106,170	64,360	4,027,990

All hay is the leading crop harvested in the North Platte headwaters, eastern Wyoming, and South Platte headwaters impact regions. Dry beans are important in the Scotts Bluff, McConaughy, and eastern Colorado economic regions, where they are ranked third, third, and fourth, respectively, in terms of harvested acreage. Sugar beets are produced in all but three regions, with the majority of the acreage found in the Scotts Bluff and eastern Colorado regions. Even though the 10-year average of harvested acres is relatively small, potatoes are an important crop grown in the eastern Colorado region, while soybeans are the second largest irrigated crop produced in the Central Platte Habitat Area.

"All other hay" is the only crop grown in the South Platte headwaters region. It should be recognized that pasture, hay, and alfalfa are often marketed through livestock production. The complementary relationship between forage production and livestock enhances the actual return.

County crop yields from 1988 to 1997 were obtained from the annual state agricultural statistical reports published by Wyoming, Colorado, and Nebraska. County yields and harvested acres of irrigated crops were used to compute a weighted average yield for each economic impact area. Weighted average yields by crop and region are shown in table 4-AE-5.

Table 4-AE-5.—Weighted Average Crop Yields by Region (1988-1997)

Impact Region	Alfalfa (Tons)	All Other Hay (Tons)	Barley (Bushels)	Corn for Grain (Bushels)	Corn Silage (Tons)	Dry Beans (Hundred weight)	Potatoes (Hundred weight)	Soybeans (Bushels)	Sugarbeets (Tons)	Wheat (Bushels)
Central Platte Habitat Area	4.61			148.68	18.55			47.09		
Lake McConaughy area	4.5	2.16		141.69	18.55	17.37		42.44	19.41	51.33
Scotts Bluff area	4.3	1.65		123.24	18.76	19.20			19.12	52.81
Eastern Wyoming	3.4	1.35	67.34	103.40	15.99	18.85			17.59	58.47
North Platte headwaters	2.88	1.40	79.77	98.16	17.31	19.43				
Eastern Colorado	4.97	2.25	83.30	149.17	23.11	20.50	302.33		22.08	59.14
South Platte headwaters		1.32								
Denver metropolitan area	4.16	2.18	72.18	136.62	19.90	18.76			21.10	56.19

Crop Revenues

Baseline projections of gross crop revenues for each impact region are shown in table 4-AE-6.

Table 4-AE-6.—Estimated Crop Revenues by Crop and Impact Region, 10-Year Average, 1988-1997 ($1,000)*

Crop Name	Denver Metro-politan Area	Eastern Colorado	Eastern Wyoming	Central Platte Habitat Area	Lake McConaughy Area	North Platte Headwaters	Scotts Bluff Area	South Platte Headwaters	Crop Total
Alfalfa hay	$12,630	$52,480	$13,590	$14,190	$28,100	$26,350	$24,270	$0	$171,610
All other hay	2,390	4,200	8,380	0	760	18,730	1,140	940	36,540
Barley	580	4,390	700	0	0	2,750	0	0	8,420
Corn - grain	6,120	101,450	2,520	620,950	191,980	510	59,950	0	983,480
Corn - silage	1,730	30,590	2,940	9,170	9,650	2,490	7,330	0	63,900
Dry beans	980	2,660	2,580	0	14,460	1,030	36,920	0	58,630
Potatoes	0	6,940	0	0	0	0	0	0	6,940
Soybeans	0	0	0	40,380	4,480	0	0	0	44,860
Sugar beets	1,550	29,860	3,260	0	5,580	0	39,340	0	79,590
Wheat	860	3,890	1,430	0	4,400	0	2,260	0	12,840
Region totals	$26,840	$236,460	$35,400	$684,690	$259,410	$51,860	$171,210	$940	$1,466,810

* Agricultural revenues generated from crop production were estimated using data collected from the annual state agricultural statistical reports published by Colorado, Nebraska, and Wyoming for 1988 through 1997. Baseline crop production was projected using the 10-year county averages for harvested acres and yields for each of the crops modeled. Corresponding gross crop revenues were estimated by multiplying the harvested production by the 10-year average state-level price for each crop.

Crop Prices Received

Table 4-AE-7 shows the prices received that were used in the agricultural economic analysis.

Table 4-AE-7.—State-Level, Marketing Year Crop Prices, Average for 1988-1997

		State Average Price Received*		
Crop	**Yield Units**	**Wyoming**	**Colorado**	**Nebraska**
Alfalfa	Ton	78.70	81.50	63.60
Other hay	Ton	72.10	88.80	63.60
Barley	Bushel	3.03	2.92	2.30
Corn - grain	Bushel	2.84	2.75	2.65
Corn - silage	Ton	22.38	22.38	22.38
Dry beans	Hundredweight	19.96	20.76	21.38
Potatoes	Hundredweight	0.00	4.53	0.00
Soybeans	Bushel	0.00	6.33	6.33
Sugar beets	Ton	40.78	37.68	35.53
Wheat	Bushel	3.72	3.78	3.71

Source: Wyoming, Colorado, and Nebraska Agricultural Statistics.

*Prices received for crops were obtained from the Departments of Agriculture in Wyoming, Colorado, and Nebraska. Reported prices are averages of the marketing year average prices over 1988-97. The different state-level prices are weighted proportionally by the number of acres each state contributes to the total irrigated acres within a specific economic impact region.

Irrigation Water Deliveries

Deliveries of irrigation water to each of the economic impact regions are based on the 48-year hydrologic period from 1947 - 1994. Three different hydrology models were used to estimate irrigation deliveries within the Basin. Assumptions and methodologies pertinent to each model are described in “Water Resources” in chapter 4. Annual deliveries of irrigation water from facilities in the Basin were averaged over the 48-year period and used as the Present Condition for deliveries of irrigation water. The estimated amount of irrigation water delivered to crops modeled in each of the impact regions is presented in table 4-AE-8.

Table 4-AE-8.—Annual Irrigation Deliveries Modeled by Impact Region, 48-Year Average, 1947-1994

Impact Region	Irrigation Deliveries (Acre-Feet)
Central Platte Habitat Area	391,500
Lake McConaughy area	140,800
Scotts Bluff area	438,500
Eastern Wyoming	143,400
North Platte headwaters	225,200
Eastern Colorado	1,065,700
South Platte headwaters	8,100
Denver metropolitan area	151,900

REGIONAL ECONOMICS

INTRODUCTION

The alternatives produce economic effects through the management of water and land for habitat restoration. The Program's leasing or acquisition of water will likely reduce somewhat the amount of land irrigated and the crop revenues produced. Changes in management of reservoirs may affect recreation and associated expenditures. Program investments in new facilities or habitat restoration will generate local sales and employment.

INDICATORS

This section describes those aspects of the regional economies that may be affected by Program alternatives, focusing on historic trends and current conditions for:

- Regional employment
- Regional income
- Regional indirect business taxes
- Regional sales

METHODS

For the Platte River EIS, a Basin-wide regional economic impact analysis was developed. The regional impacts from changes in recreational spending, agricultural expenditures, and net farm income, as well as changes associated with the defined alternatives, are analyzed using the Impact Analysis for Planning (IMPLAN) model, an input-output (I-O) modeling framework first developed by the U.S. Forest Service (MIG, Inc., 1999). The IMPLAN model uses the Department of Commerce national I-O matrices to estimate flows of commodities used by industries and commodities produced by industries. The data used in this analysis are 2002 IMPLAN data and structural matrices. Social accounts are included in the IMPLAN database for each region of consideration. Social accounts represent the flow of commodities to industry from producers and consumers, as well as consumption of the factors of production from outside the region. Social accounts are converted into I-O accounts and the multipliers for each industry within the region, which considers the multiple effects of changes in spending described below. These multipliers are the tools that describe the demand generated for goods and services from an industry and, in response, generate demand for other goods and services from those industries, and so on. The percentage of expenditures in each category that would remain within the region and expenditures that would flow outside the region are also accounted for with the IMPLAN model.

The size of the impact area used in a regional economic impact analysis is important because the magnitude of impacts will generally increase as the size of the impact area increases. For example, the economic impacts on the State of Nebraska from retiring a given number of acres of land within, say, Buffalo County will be larger than the economic impacts on Buffalo County from retiring that same number of acres. This is the result of differences in the leakages that occur for different impact regions (leakages are any payments made to imports or value added sectors which do not, in turn, respend the dollars within the region). The State of Nebraska has many different types of businesses and industry that can supply a wide variety of goods and services. Buffalo County does not have the variety of businesses that the state has, so consumers and businesses must go outside the county to purchase some of the inputs that are not available. Spending that occurs outside the study area represents leakages of expenditures which reduce the economic impact of changes in activities within the county compared to all of Nebraska. The same holds true when using individual counties as the economic area. Buffalo County would not have the capacity to absorb all of the impacts, and those impacts to surrounding counties would not be accounted for due to those counties not being in the defined economic region. For this reason, a county-level analysis would not be an accurate method to estimate potential impacts for this Program.

The regional IMPLAN model can be used to translate changes in such things as farm income and expenditures into regional changes in employment, income, sales, and taxes. While the model is suited to calculating these changes, or impacts, due to the alternatives, the model is not suited to project current levels of employment, income, taxes, and sales. To provide a context for interpreting the changes in the regional economic factors, the economic changes were translated into a percent change in the base regional economic activity for each variable.

The percentage of impacts was based on the IMPLAN model with and without the elements of the alternatives. That is, the model's sales, income, indirect business taxes, and employment without any impacts from the alternatives served as the denominator, while the model with impacts served as the numerator. The denominator and the numerator were divided to estimate the percent change in impacts, which were all less than or equal to one-tenth of 1 percent. The baseline economic activity as well as the IMPLAN output files are available on request.

Direct effects are the initial changes in the industry to which there is a change in final demand. The direct effects are equal to the value of the change in final demand used to estimate regional impacts. For example, the direct effects of changes in water deliveries may be changes in the value of agricultural production due to changes in irrigated acreage. Estimates of direct economic impacts are necessary to evaluate the overall effects of the action to that sector of the regional or local economy.

Indirect impacts are the secondary economic effects on regional and local economies that occur as a result of the direct impacts. Using the foregoing example of changes in irrigated acreage, indirect impacts would be changes in final demand for industries needed to support the primary agricultural input requirements. Induced impacts represent the impacts on all local industries as a result of changes in household expenditures generated by the direct and indirect effects.

PRESENT CONDITION

Employment

The top employers in the defined Basin from 1960 through 1996 are services, retail, government, and manufacturing (figure 4-RE-1). Services (business, repair, and personal) accounted for 32 percent of total employment in the Basin in 1996, retail accounted for 17 percent, government accounted for 13 percent, and manufacturing accounted for 9 percent in that same year. As a percentage, farm and agriculture/ forestry/fishing employment combined decreased from 5 percent of total defined Basin employment in 1970, 4 percent in 1980, and 3 percent in 1990 and 1996. In Colorado, services have increased 23 percent from 1960 to 1996, and agriculture decreased 4 percent from 1960 to 1996. In Nebraska, agriculture decreased 16 percent from 1960 to 1996, which was mostly replaced by an increase of 14 percent in the services sector. Wyoming, too, has experienced an increase in the services industry since 1960 of 16 percent, and a 7-percent decrease in the agricultural sector. Basin-wide, the same trends exist; services have increased by 21 percent, and agriculture has decreased by 8 percent in the Basin counties.

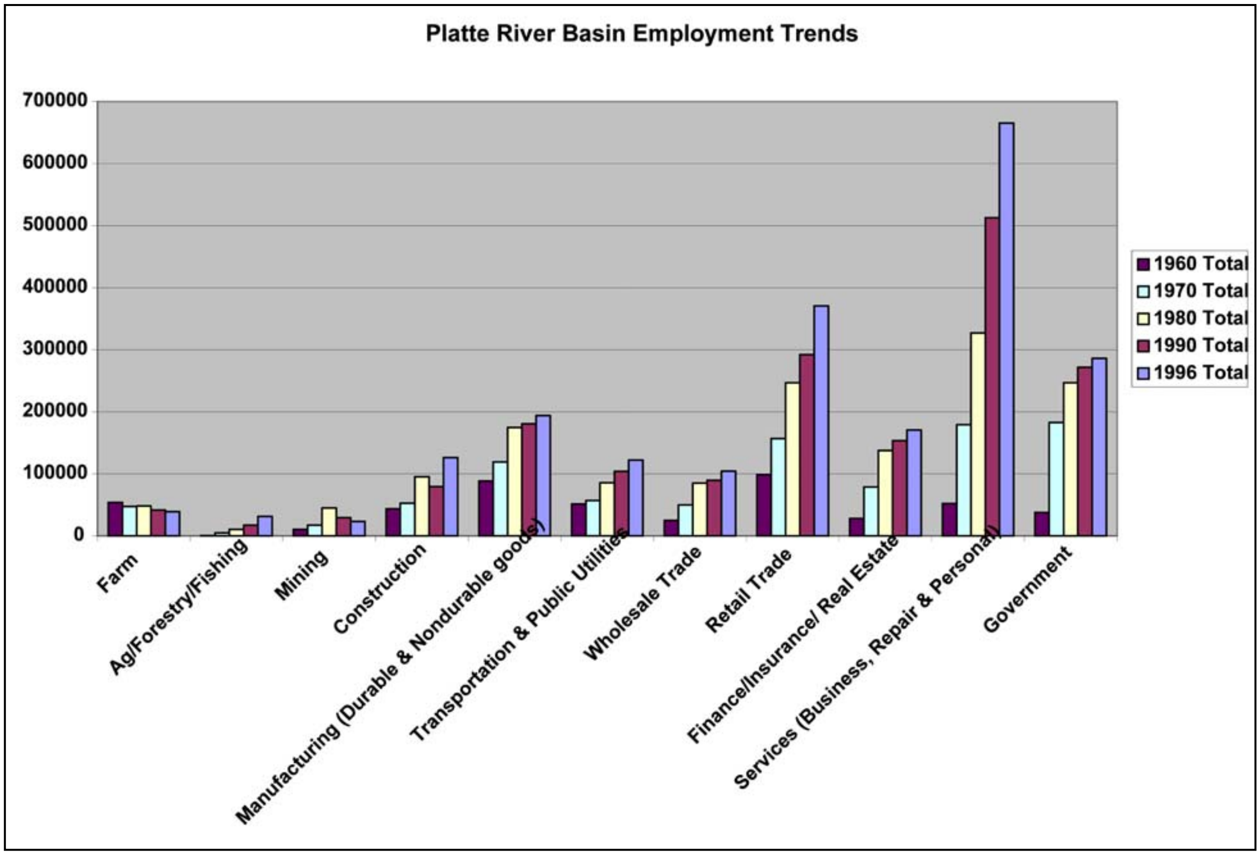


Figure 4-RE-1—Platte River Basin employment trends.

Income

Like employment, income in the Basin is derived mainly from the services sector (figure 4-RE-2). Services accounted for approximately 27 percent of total income in the Basin in 1996, both government and manufacturing accounted for 13 percent, and transportation and public utilities accounted for 10 percent. This is an increase of 8 percent in sales, a decrease of 6 percent in government, a decrease of 4 percent in manufacturing, and an increase of 2 percent in transportation and public utilities-generated income from 1970 to 1996. Farm-generated income decreased approximately 3 percent Basin-wide in these same years. 1960s income data were not available in the same format as the other data and was, therefore, not comparable.

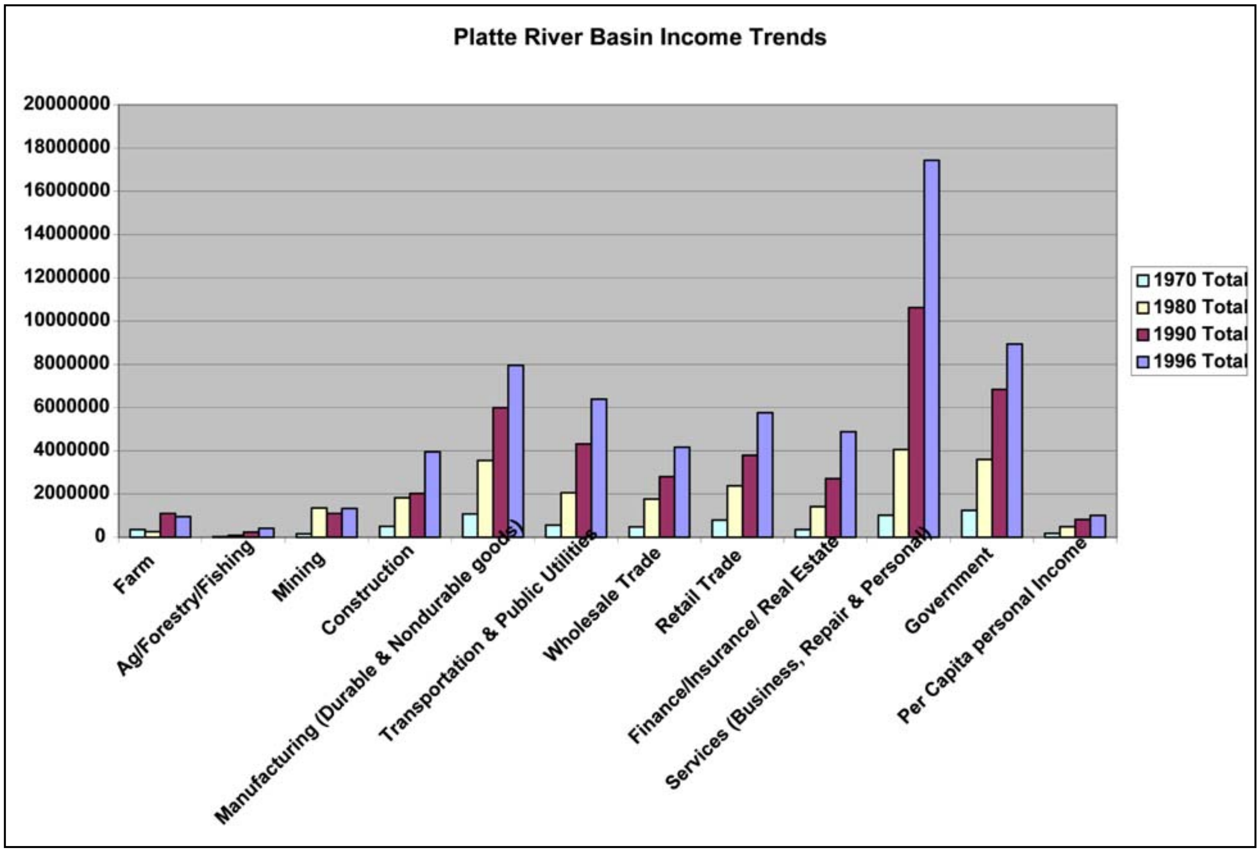


Figure 4-RE-2.—Platte River Basin income trends.

Indirect Business Taxes

Indirect business taxes consist of excise taxes, property taxes, fees, licenses, and sales taxes paid by businesses. These taxes occur during the normal operation of businesses but do not include taxes on profit or income. Indirect business tax numbers are derived from the Bureau of Economic Analysis, Gross State Product data. (MIG, Inc., 1999.)

Sales

According to the 1992 Economic Census, in the Platte River Basin in 1992, wholesalers, manufacturing, retail, and services made up the majority of sales (figure 4-RE-3). This trend holds true for the individual States of Colorado and Nebraska, but, in Wyoming, retail constitutes the majority of sales. Mining contributed a small amount to the overall sales in the Basin; Wyoming was the largest contributor.

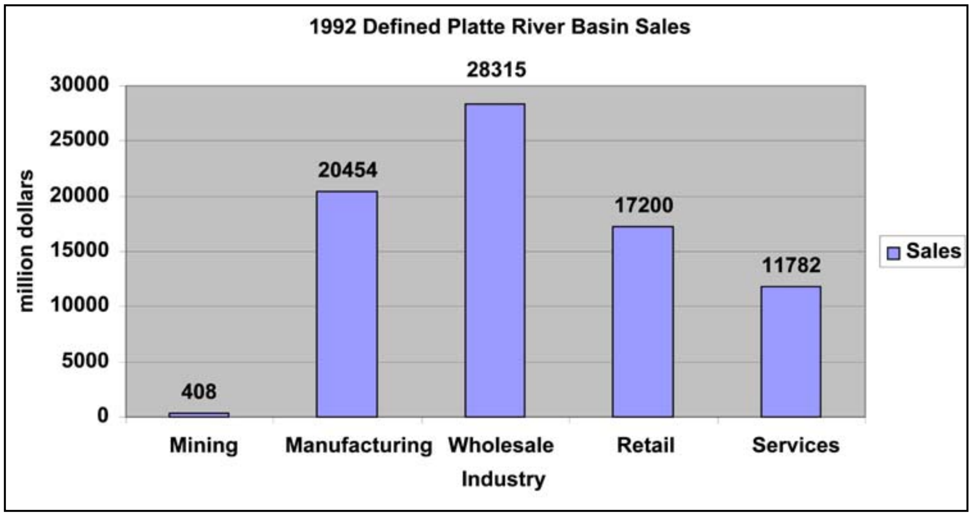


Figure 4-RE-3.—Platte River Basin sales by sector, 1992.

SOCIAL ENVIRONMENT

INTRODUCTION

The Platte River serves the people of Wyoming, Colorado, and Nebraska in many ways that have shaped the Basin socially and economically. The Platte River and project facilities provide M&I water supplies for about 3.5 million people, irrigate millions of acres of farmland, generate millions of dollars of hydroelectric power, support fish and wildlife habitat, and contribute recreation and tourism opportunities. Beginning in the early 1800s, the Platte River has played an instrumental role in the settlement and development of towns, cities, and counties in the Basin.

A key element common among the three states in the Basin has been the strength of agriculture and its prominence as a lifestyle from the time of settlement. The semi-arid Basin required irrigation early in the states' histories to support farming, which, in turn, supported settlement of towns and industrial development. However, as the description of the Present Condition indicates, employment, income, and the overall economic role of agriculture are reduced today compared with other sectors and regional economies.

INDICATORS

Some members of the public expressed concern that the Program would create new habitat areas that would increase public health risks from mosquito-borne diseases, waterfowl-borne diseases, an increase in urban or nuisance resident geese, and the possibility of increased *E. coli* contamination of public waters from waterfowl.

The public has expressed concerns about both out-of-riverbank flooding and shallow or rising groundwater levels. During wet years, parts of the Central Platte River Basin in Nebraska, from the town of North Platte east to Grand Island and beyond, experience problems with high groundwater levels and flooding, primarily waterlogged farm fields and flooded basements. Many reports of existing flooding problems were received at public meetings, and the concern was that enhancement of riverflows may intensify the problem.

The public generally has been concerned about the changes that a Program and land acquisition for habitat would have on land use patterns in the Central Platte River area, as well as economic effects on the region.

Indicators of potential impact are measured by the following parameters:

- ➢ Population and demographics
- ➢ Human health concerns
- ➢ Changes in flooding patterns
- ➢ Land use trends
- ➢ Changes in income and employment

METHODS

Population and Demographics

Historic demographics trends, year 2000 census data, and state projections were assessed, based on several sources, including:

- Jenkins, Alan. The Platte River: An Atlas of the Big Bend Region and The Middle Platte Socioeconomic Baseline which described population, demographic, and economic history and trends

- The Census Bureau factfinder portion of the Web site at <http://www.census.gov>, used most frequently for year 1990 and/or 2000 population and median age data

- Historical census data from the Census Bureau, Denver Regional Office library documents

- State of Wyoming population projections from the Wyoming Department of Administration and Information, Economic Analysis Division at <http://eadiv.state.wy.us>

- State of Colorado population projections from the Colorado Department of Local Affairs, Colorado Demography Section at <http://www.dola.state.co.us/demog>

- State of Nebraska population projections from the Nebraska Department of Economic Development at < http://www.neded.org/>

Human Health Concerns

Research on the risk to human health from avian botulism, avian cholera, and resident goose arbovirus was taken mainly from USGS and U.S. Forest Service technical reports and other Federal and state Web sites. *E. coli* information was collected primarily from the Department of Health and Human Services. Sources from the Centers for Disease Control (CDC) were used for researching and analyzing the West Nile Virus (WNV). The draft analysis was reviewed by several contaminant specialists in the U.S. Forest Service and Reclamation.

In 1999, inquiries were made to the Nebraska State Medical Entomologist and other Central Platte local agencies regarding public complaints, concerns, and studies or requested studies regarding public health and waterfowl, including, but not limited to, disease. The following entities in Nebraska were contacted by the Platte River EIS Office about public complaints or concerns regarding public health and waterfowl diseases:

- City of Lexington, Department of Health (Dawson County)
- City of Kearney, Grand Island-Hall County Health Department
- Public Health Assurance Division, Nebraska Health and Human Services System
- Nebraska State Epidemiologist
- Phelps County Commissioners
- Hamilton County Commissioners
- Merrick County Commissioners
- Hall County Parks
- Buffalo County
- Merrick County

- Hamilton County
- Hall County
- City of Grand Island Parks Manager
- Hall County Airport Manager
- Sandhills District Health Department

None were aware of any complaints, requests for studies, or cases involving public health risks and waterfowl.

Flooding Concerns

During wet years, parts of the Central Platte River Basin in Nebraska, from the town of North Platte east to Grand Island and beyond, experience problems with high groundwater levels and flooding, primarily waterlogged farm fields and flooded basements. The overall interrelationships among riverflows, topography, geology and soils, climate, irrigation, groundwater levels, and riverflows in the Central Platte Valley were examined in the Groundwater and Riverflow Analysis report (Sanders, 2001).

As baseline information for the Present Condition analysis, Reclamation monitored 28 existing wells daily in four lines across the Platte River (at Overton, Elm Creek, Minden, and Alda) and compared daily readings from the wells with three Platte River gauges and precipitation data from March 11 – September 17, 1999. In spring 2000, monitors were installed in 16 of the wells to provide supplementary data. Reclamation analyzed statistical relationships among precipitation, riverflows, and groundwater levels (Sanders, 2001).

Historical and recent flooding trends were analyzed through a comprehensive search of the Nebraska Kearney Hub (dating back to the year 1888) daily newspaper for articles describing previous flood events on the Platte River. The USGS gauging records for Overton and Kearney were used to establish the 12 largest annual flood peaks in the Central Platte area. For each of the 12 largest flood peaks, a search was made, starting a few days before the flood peak and ending a few days after the flood peak. The purpose was to obtain an understanding of the flooding (flood damage) that resulted from the largest flows recorded on the Platte River. The floods were compiled and analyzed by date in descending order of peak flood discharge.

Impacts were analyzed using the CPR model to determine the potential effect from the Program on existing high groundwater levels and seasonal flooding problems. The CPR model analyses included annual peak flows from 1948 to 1994. The maximum 7- and 30-day average increases in groundwater elevation were projected using the CPR model, the SEDVEG Gen3 model, and groundwater response model.

Land Use

Analysis of lands and land use was conducted using:

- Nebraska Public Power District (1999)

- Development and Enhancement Plan for Nebraska Public Power District's Cottonwood Ranch Property, and U.S. Department of the Interior (Interior, 2000).

➢ Central Platte River 1998 Land Cover Use/Mapping Project Nebraska (Friesen et al. 2000), and the Service's "Nebraska Partners Home < http://nebraskapartners.fws.gov/ne1.htm>" (Service, 2003 [Partners]), "Central Platte River," and "Restoring Habitat Along the Central Platte River in Nebraska." Land use trends also were researched using county data.

Income and Employment

Year 2000 Census median household income figures (1999 dollars) were used to analyze income differences among the states in the Basin (Census, 2005) and are discussed in "Environmental Justice" in this chapter. Employment and additional income data are described in the "Regional Economics" section.

PRESENT CONDITION

Population and Demographics

The Denver metropolitan area in Colorado is the largest population in the Platte River Basin, at about 2.5 million in the year 2000 (the entire South Platte River Basin in Colorado has about 2.9 million people), and has grown at an average annual rate of about 2.8 percent each year since 1940. As shown in table 4-SOC-1, the Central Platte Basin in Nebraska is the next largest population group in the Platte Basin, with about 307,000 people, yet has grown slowly at an average annual rate of three-tenths of one percent since 1940. Hall County (includes the city of Grand Island) and Buffalo County (includes the city of Kearney) have the largest populations and have grown faster than the others at about 1 percent annually. The North Platte Basin in Wyoming has a slightly smaller population than the Central Platte at about 265,000 people, and has expanded at a rate of about 1.2 percent each year since 1940. Laramie County (city of Cheyenne) and Natrona County (city of Casper) have the largest populations and grew slightly faster than the other counties since 1940 at about 1.6 percent annually. The Platte Basin has added population at about 2.1 percent annually driven mainly by the Colorado portion.

Table 4-SOC-1.—Historical population in the Platte River Basin

	1960	1970	1980	1990	2000	
Wyoming portion of the North Platte Basin	197,669	199,070	268,512	247,132	264,992	1.2 percent
Colorado portion of the South Platte Basin	1,125,508	1,482,688	1,973,795	2,254,866	2,958,954	2.6 percent
Nebraska portion of the Central Platte Basin	274,779	281,545	300,852	287,631	306,959	0.3 percent
Platte River Basin total	1,597,956	1,963,303	2,543,159	2,789,629	3,530,905	2.1 percent
Source: Census Bureau.						

A closer examination of the Central Platte Habitat Area region of the Central Platte Basin (see "Regional Economics" section) shows that it has grown steadily, driven mainly by the counties north of the Platte River. The counties south of the Platte River have generally grown very little or have declined in population. Part of the reason for this is that the largest cities are in Buffalo and Hall Counties. Over time, more people have moved into the cities and away from rural areas. The Central Platte Habitat Area population expansion and contraction trends are expected to continue (Jenkins et al., 1993).

Human Health Concerns

Some individuals have expressed concerns about how the Program alternatives might impact the incidence of human diseases borne by either mosquitoes or waterfowl. This section assesses the current incidence of those diseases in the study area.

Mosquito-Borne Diseases

Concerns about possible increases in mosquito-borne human disease seem to focus on several related forms of encephalitis, one of which was found in Colorado, and all three have been reported from Nebraska—WNV, Western equine encephalitis, and St. Louis encephalitis. Encephalitis is most frequently carried by the Culex family of mosquito species, which are in the "Artifical Container and Tree-Hole Group" and breed primarily in tin cans, buckets, discarded tires, and other articial containers that hold stagnant water. Culex also breeds in irrigation canals, storm drains, catch basins, and septic seepage and other foul water sources above or below ground level.

West Nile Virus

WNV is believed to have entered the U.S. in the early summer of 1999, perhaps even earlier. Previously, it was found only in Africa, West Asia, and the Middle East. In 2002, WNV spread rapidly from the east coast to western states, including Nebraska. More than 100 species of birds are capable of being infected with WNV, as well as a number of mammals, including humans, horses, cats, dogs, chipmunks, and raccoons (CDC, 2001).

WNV has been reported in at least 25 types of mosquito and other biting insects, but it is believed to be transmitted primarily by the Culex species (*Culex pipiens*, *Culex tarsalis*). This mosquito, often referred to as the "house mosquito," is the most common pest mosquito in urban and suburban settings in the study area. Mosquito breeding takes place when air and water temperatures are warm in the summer. Breeding, egg laying, and larval hatching depend on temperature.

Cases of WNV generally begin to appear in mid- to late-August and continue through October (CDC, 2001). Table 4-SOC-2 shows the number of confirmed WNV cases by year and state, which have declined significantly since peaking in 2003.

Table 4-SOC-2.—Summary of WNV Cases by Year and State

Year	Wyoming	Nebraska	Colorado
2002	2 cases 0 deaths	115 cases 5 deaths	14 cases 0 deaths
2003	362 cases 9 deaths	2,366 0 deaths	2,947 cases 63 deaths
2004	10 cases 0 deaths	54 cases 0 deaths	291 cases 4 deaths
2005 (by mid-August)	none	15 cases 0 deaths	21 cases 0 deaths

Western Equine and St. Louis Encephalitis

Western equine and St. Louis encephalitis appeared in the 1930s, whereas the WNV emerged more recently, beginning in 1999 and perhaps earlier. Western equine encephalitis most often occurs in horses and birds. In Nebraska, from 1964-1997, 14 human cases of the St. Louis variety were reported (CDC, 2001). Data from 1994 and 1995 Nebraska Department of Health and Human Services indicate that most occurrences of Western equine and St. Louis encephalitis were typically associated with mosquitoes breeding in irrigation water on agricultural lands (Dr. W. Kramer, State Medical Entomologist, 1999, personal communication).

Waterfowl-Borne Diseases

Concerns about the potential for increased public health risks from waterfowl-borne disease seem to focus on avian botulism (an infection caused by *clostridium botulinum*), avian cholera, and *E-coli*.

Avian Cholera and Botulism

These diseases rarely occur in humans. Major outbreaks have occurred in the Central Platte area among waterfowl, primarily in the Rainwater Basin in central Nebraska. Botulism in people is usually the result of eating improperly home-canned foods, which contain botulism strains A or B, as opposed to strains C and E, which occur in avian species. There are no documented cases of transmissions of avian botulism from birds to humans (USGS, 2001).

Avian cholera is not considered a high-risk disease for humans because of differences in susceptibility of humans and birds to different strains of *Pasteurella multocida*, the bacterium which causes avian cholera (USGS, 1999 [cholera]). While infections of *Pasteurella multocida* can occur in humans, most infections result from an animal bite or scratch, primarily from dogs and cats. Transmission to dogs and cats may be a result of eating infected birds (Service, 1989).

Escherichia coli

E. coli was first recognized as a cause of illness in 1982. Although most strains of *E. coli* are harmless and live in the intestines of healthy humans and animals, *E. coli* O157:H7 produces a powerful toxin and can cause severe illness. Outbreaks of *E. coli* O157:H7 in humans are most often associated with undercooked, contaminated ground beef and, to a lesser extent, with unpasteurized milk and fruit juice. Waterfowl are not typically vectors for the strain of *E. coli* identified in human disease outbreaks throughout the U.S. (Nebraska Health and Human Services, 2003).

Problems Created by Resident, Nonmigratory Geese

The public expressed concerns about resident geese, generally focusing on fecal contamination of surface waters and a possible result of increased risk of *E. coli* contamination. Other public health risk concerns are the potential for nitrogen, coliform bacteria, streptococcus bacteria, potassium, and similar forms of contamination from fecal material. Where resident goose populations are sizeable (greater than 100 birds), the continuous influx of nutrients contained in Canada goose feces can contribute to the eutrophication of small water bodies, especially those that have restricted circulation and flowthrough, which, in turn, may stimulate algae and weed growth. Bacteria and particulate matter contained in goose feces, when present in sufficient quantity, may lead to the need for special treatment of drinking water drawn from surface ponds or reservoirs where geese congregate (French and Parkhurst, 2001). Studies have shown that fecal input from geese was of little importance to nutrient dynamics of soils; in some instances, fecal matter appears to have no influence; whereas in others, it seemed to stimulate plant growth. Also, research generally has found that droppings from free-ranging migratory birds do not greatly affect nutrient levels in water. Streams and other moving water such as the Platte River are less likely to have increased nutrient loads than isolated wetlands because of constant waterflow. Nutrient levels are more likely to increase as birds become highly concentrated on small water bodies for extended periods of time, such as occurs in small urban ponds with abundant resident geese.

In contrast, most birds using borrow pits along the Platte River are migratory and leave the area by mid-March. The Platte River Basin is used briefly, usually between mid-February and mid-March, by large numbers of migratory geese and other waterfowl on their way to the Northern U.S. and Canada where they breed. The stopover peaks at about 750,000 waterfowl in the Central Platte valley around mid-February on their way to breeding grounds in the northern United States. Previous research indicated that a complete turnover of migrant Canadian geese can occur in one week. Therefore, far fewer than the 750,000 waterfowl in the total stopover inhabit the Central Platte at once.

The Service issues permits for the take of migratory birds and provides states with the means to lengthen hunting seasons whenever there may be a threat to human health and safety, or if property damage is at issue. The Service has recently completed an EIS to address human conflicts with resident Canadian geese, which may allow additional taking.

Flooding

During the first years of the Cooperative Agreement, and especially in 1999, some areas in the Central Platte River valley received very high precipitation and had extensive areas of standing water and associated flooded basements and fields. Concerns were expressed that the Program could increase riverflows and, thereby, increase groundwater levels in the area, exacerbating the existing flooding problems.

Out-of-bank flooding is caused by three primary factors:

- Local snowmelt and ice jams that cause the river to rise between January and March.
- Heavy snowmelt from the upstream Rocky Mountains in spring and early summer that causes the river to rise downstream in the Central Platte River
- Recently, diminished channel or river capacity that increasingly causes out-of-bank riverflows from flows that previously would have been contained in the river

Shallow or rising groundwater levels are primarily a result of large amounts of precipitation in recent decades, local changes in groundwater pumping or importation of surface waters, or, near the river, changes in river stage (Sanders, 2002).

Surface Flooding

Between January and March, local snow melt, rain and ice jams often cause the river to rise (which may result in out-of-bank flooding). In fact, a few of the highest recorded flood stages in the vicinity of Kearney have resulted from localized ice jams, usually occurring from December-March.

In general, the average annual flood peaks have declined with time as reservoirs were constructed, as shown by the USGS stream gauge at Overton, Nebraska. In the 1920s, every annual peak discharge was more than 9,000 cfs. While large spring floods still occasionally occur in the Central Platte, as in the years 1983 and 1984, the frequency of significant floods is now greatly reduced, as can be seen in figure 2-10.

Elevated Groundwater

In the Central Platte River area, groundwater is fairly shallow, often less than 5 feet below the surface. High groundwater tables and standing water in fields and basements farther than one-fourth mile from the river are due primarily to high rainfall and are usually independent of river stage, which can raise the level of the groundwater only fairly close to the river. High groundwater was particularly problematic in the Central Platte between 1980 and 1999, when precipitation was a total of 42 inches above average. In 1999, for example, rainfall totals ran almost 7 inches above normal. Irrigation was delayed well past the normal start of the irrigation season, and irrigation managers reported that they had “a high water table problem all over.” The only pumps running were those draining basements and flooded fields (Kearney Hub,” July 1, 1999). In the years since 1999, when rainfall has been average or below average, elevated groundwater problems have been minimal.

Acreage irrigated from groundwater in the Central Platte Natural Resource District has increased each year since 1950m at an average of 1 percent per year for the last 10 years in most areas in the Central Platte River valley. Above-average rains and conservation measures have countered the groundwater overdraft conditions that lowered the water table during the 1960s and 1970s. In the 1990s, the water table in and around Grand Island rebounded from earlier irrigation pumping depletions, likely as a result of urbanization, reduced groundwater pumping, and several years of above-normal precipitation (Sanders, 2002). However, the drought of 2002 and 2003 drew down groundwater levels again, in some places to critical levels.

Land Use

During the Program's First Increment (10 to 13 years), the Program will protect, maintain, and, where appropriate, restore at least 10,000 acres of habitat in the Central Platte River area between Lexington and Chapman, Nebraska, also known as the Central Platte Habitat Area. Except for two parcels (Cottonwood Ranch and Wyoming Water Development Commission Property) comprising about 30 percent of the 10,000 acres, the exact locations of land to be acquired are not known.

The Central Platte Habitat Area in Nebraska covers approximately 678 square miles and covers nine primarily agrarian counties: Adams, Buffalo, Dawson, Gosper, Hall, Hamilton, Kearney, Merrick, and Phelps. Of the total habitat area, approximately 1,708 acres (0.4 percent) in 1998 were occupied by urban development (commercial, barren surface, power line, and sand/gravel). Rural farmsteads and housing tracts with more than one dwelling were approximately 8,601 acres (2 percent) of the Central Platte Habitat Area. Generally, habitats not in crop production include the river valley riparian areas and major tributary drainages (some native grasses are used for hay production), and sand hills. The total areas covered by agricultural land was approximately 260,000 (59 percent) of the Central Platte Habitat Area (Friesen et al., 2000) (see the land use discussion in the "Central Platte River Terrestrial Vegetation Communities and Land Use Types" section in this chapter).

Public use of, and access to, the Central Platte Habitat Area lands constitute some of the highest uses in the State of Nebraska, totaling approximately 3,500 annual use days of hunting and trapping, 12,800 use days of fishing, and 11,300 use days of nonconsumptive use such as hiking and wildlife viewing. In fact, funds used in the management of these areas depend solely on the sale of hunting and fishing equipment. As a result, management focuses on multiple use with hunting/fishing-based recreation receiving primary consideration, followed by other wildlife-based recreation such as wildlife viewing. Recent resource management efforts have included increasing available habitat for the least tern, piping plover, and whooping crane by increasing open channel habitat through tree removal on river islands and banks. The NGPC provides technical and financial assistance to private landowners willing to restore habitat along the Platte River (NGPC, 2002).

The Partners for Wildlife Program is one example of the many existing and developing habitat improvement land uses and programs in the Central Platte Habitat Area. Through the Partners for Wildlife Program, the U.S. Forest Service provides technical and financial assistance to help farmers and ranchers make their land a better place for fish and wildlife, while sustaining profitable farming and ranching. The priorities for the Nebraska Partners for Wildlife Program are developed in coordination with landowners, the NGPC, the Nature Conservancy, Rainwater Basin Joint Venture, Sandhills Task Force, and others. A total of 22 projects were completed in fiscal year 2002. The projects contributed to the quality and quantity of habitat available to several endangered and threatened species. Approximately 1.5 miles of degraded riverine wetland habitat were restored as a result of the projects. As a specific example, at a river reach near Gibbon, Nebraska, undesirable woody vegetation was removed and silt and invasive vegetation were excavated using bulldozers (Service, 2003 [Partners]).

Cottonwood Ranch

The two land parcels presently known to be included as part of the 10,000-acre Program objective would be Cottonwood Ranch (2,611 acres) and the Wyoming property (438 acres). Cottonwood Ranch is located on both sides of the river between the Johnson-2 Return Channel near Overton and Elm Creek, Nebraska, and is owned and managed by NPPD. Present Cottonwood Ranch land use consists primarily of farming and cattle grazing leases. As of 1999, there were about 240 acres of cultivated row crops and roughly 50 acres of alfalfa. Grazing involves using an 80-acre pasture as a calving area from approximately March-May for 150 cows that can access most of the remaining nonagricultural areas from May until about October when they are removed (NPPD, 1999).

Wyoming Water Development Commission Property

The Wyoming Water Development Commission Property, located about 3.5 miles directly southeast of Kearney, Nebraska, is currently owned by the State of Wyoming, managed by Service, and used primarily for grazing and haying (Service, 2003, personal communication, Dave Carlson, biologist).

Sand and Gravel Mining Operations

The most common industrial use of the Central Platte River channel is for extraction of sand and gravel, primarily to supply material for road construction. The concern has been expressed that Program efforts to restore and protect habitat in this area could compete with this industry by limiting lands available for new operations. In the habitat area, most of the gravel mines are along the main channel, although a significant number are on old channels to the north and south.

Since 1982, the number of sand and gravel establishments and employment in Nebraska has decreased dramatically. Establishments have fallen about 50 percent since that time, and employment has dropped about 65 percent, according to the Census Bureau. The sand and gravel industry produced an annual average of 14.7 million short tons (2,000 pounds) in the 1970s, 11 million short tons in the 1980s, and 12.8 million short tons in the 1990s. This may be attributed to a substantial increase in highway construction in the 1970s, followed by the recession in the 1980s, when highway construction fell. Construction resumed somewhat in the 1990s but not quite at the original pace.

Based on the EIS GIS land use database (Friesen et al., 2000), in 1982, approximately 2,000 acres in the Central Platte Habitat Area were used by sand and gravel operations. In 1998, there were approximately 1,620 acres. This 19-percent decrease in land acres can be correlated with the decrease in demand and production in those same years. In 1998, the Basin accounted for somewhat less than 10 percent of the total establishments in Nebraska. Gravel mines in the eastern portions of the state accounted for roughly 28 percent of total sand and gravel operations in Nebraska.

Income and Employment

Median household income census data are displayed in the “Environmental Justice” section of this chapter for the Wyoming, Colorado, and Nebraska portions of the Basin study area. Wyoming and Nebraska each had a median household income of about $34,000 (1999 dollars), and Colorado’s median household income was at about $47,500. (Additional information about income and employment can be found in “Regional Economics” in this chapter).

CULTURAL RESOURCES

INTRODUCTION

The Program area has experienced many significant historical and cultural events important to different people, often with physical evidence or markers that remain today. The action alternatives may impact culturally significant resources, either directly through land restoration activities, or through modification of reservoir operations and river releases, which might expose previously undisturbed cultural resources.

INDICATORS

- Reservoir and river levels or fluctuations: Can expose cultural resources or make them more readily accessible
-
- Land-disturbing activities: Could affect surface or below-ground cultural resources
-

METHODS

The analysis was to determine the types of impacts that could occur as a result of proposed physical and operational modifications under the proposed Program. The approach used included an assessment of existing laws and mandates and a review of cultural resources surveys that were conducted in the project area.

Applicable Laws and Consultation

National Historic Preservation Act

Federal law requires Federal agencies to consider the effects of their undertakings on cultural resources. The National Historic Preservation Act (NHPA) of 1966 (Public Law 89-665), as amended, is the basic Federal law governing preservation of cultural resources of national, regional, state, and local significance. Specifically, section 106 of the NHPA requires each Federal agency to consider the effect of its actions on "any district, site, building, structure or object that is included in or eligible for inclusion in the National Register." "Eligible cultural resources may also include traditional cultural properties, which are generally defined as locations that are significant due to their association with cultural practices or beliefs of a living community that are: (1) rooted in the community's history, and (2) are important in maintaining the continuing cultural identity of the community" (Parker and King, 1998). Procedures for meeting NHPA, section 106 requirements are defined in Federal regulations, 36 Code of Federal Regulations (CFR) 800.

Section 106 of the NHPA also requires that Federal agencies identify Indian Tribes/Tribal Nations that "might attach religious and cultural significance to historic properties in the area of potential effect" (36 CFR 800.2[4][f][2]). Although this DEIS is programmatic, an effort was made to define general Areas of Potential Effect.

Sacred Sites

Executive Order (EO) 13007 of May 24, 1996, Indian Sacred Sites, directs each Federal agency to accommodate access to, and ceremonial use of, Indian sacred sites on Federal lands (including leased lands and rights-of-way) by Indian religious practitioners, and to avoid adversely affecting the physical integrity of sacred sites. Sacred sites are defined in the EO as ". . .any specific, discrete, narrowly delineated location on Federal land that is identified by an Indian Tribe, or Indian individual determined to be an appropriately authoritative representative. . .." Consultation with Tribes is to occur in compliance with the Executive Memorandum of April 29, 1994, Government-to-Government Relations with Native American Tribal Governments. Reclamation Guidance for Implementing Indian Sacred Sites, EO 13007, states that, at a minimum, Reclamation needs to be informed that a sacred site is located on Reclamation lands, or that a site the Tribe(s) believes to be sacred is in an area that could be affected by proposed Reclamation actions. Additional policies include ECM 97-2 – Departmental for Indian Trust Resources and Indian Sacred Sites on Federal Lands and Reclamation's Protocol Guidelines: Consulting with Indian Tribal Governments, February 3, 1998 (Revised 2001).

Consultation

In compliance with NHPA, EO 13007, and Reclamation's Protocol Guidelines: Consulting with Indian Tribal Governments, a general consultation process was initiated with Tribes for the entire programmatic area. On August 14, 2000, information about the Program and requests for cultural resource responses were sent to 41 American Indian Tribes and Tribal Nations and the three State Historic Preservation Offices (SHPOs).[27] Two responses were received. A letter from the Pawnee Nation, dated August 30, 2000, stated that while it had no objections to the Program, it acknowledged that there might be burial sites in the area. In a letter dated December 4, 2000, the Rosebud Sioux Tribe encouraged EIS preparers to provide any cultural resources survey work that may be completed for their review and comment. On October 10, 2003, a letter was sent to the Pawnee Nation and Rosebud Sioux Tribe, transmitting a working draft version of the DEIS with highlighted cultural resources findings, and comments were requested. No comments were returned.

A January 22, 2004, letter was sent to the 41 American Indian Tribes and Tribal Nations, transmitting the DEIS with a summary of cultural resource findings and a request for any comments. On March 13, 2004, a letter was sent to the Tribes, notifying them of the Federal Register notice and that the comment period on the DEIS was extended. The Southern Ute Indian Tribe responded in several letters with comments that it did not believe there were any known impacts to the areas specifically tied to the Tribe. However, if, during implementation there is an inadvertent discovery of artifacts or remains, the Tribe would like to be notified. The Crow Tribe responded in an August 5, 2004, letter in which it requested consultation on all matters in its 1851 Treaty area.

Concerning cultural resources survey work, due to the programmatic nature of this FEIS, a definite Area of Potential Effect cannot yet be completely delineated, which means that, although some class I survey work was completed, the majority of the survey work will be completed later. The SHPOs were informed about the Program in a year 2000 letter and were consulted during the class I survey process. On January 22, 2004, the DEIS was transmitted to the SHPOs for comment. The Colorado SHPO responded in a February 10, 2004, letter, stating that her office concurs that class III surveys would be required and that Section 106 and National Environmental Policy Act (NEPA) processes should be conducted concurrently. Since this FEIS is programmatic, not all site-specific impacts can be foreseen by the time the programmatic Record of Decision (ROD) is signed. For this reason, programmatic agreements among

[27]For a complete list of Tribes/Tribal Nations contacted, see the *Cultural Resources Appendix* in volume 3.

the government agencies, SHPOs, and interested Tribes will be developed to guide cultural resource consultation and mitigations when Program actions appear likely to cause impacts. The programmatic agreements will cover completion of the Program's future, site-specific NEPA compliance, and implementation.

Other Federal legislation further promotes and requires the protection of historic and archaeological resources by the Federal Government. Among these laws are the Archaeological Resources Protection Act of 1979 and the Native American Graves Protection and Repatriation Act of 1990.

Class I, II, and III Surveys

To adequately assess impacts to cultural resources and, hence, fully comply with the NHPA, class I, II, and/or III survey(s), or cultural resource inventories, are specifically required by the Reclamation Manual, Directives and Standards LND P01 and LND 02-01. A class I survey is primarily a literature and archival search to identify known cultural resources in an area and to assess the need for additional survey information. Class II surveys are based on a sampling of areas to generally indicate the number of sites in an area; for this reason, they are often considered inefficient and are rarely initiated. Class III surveys, usually conducted in lieu of class II surveys, consist of intensive, on-the-ground examinations of all areas to be affected to locate all cultural resources. Due to the programmatic nature of this FEIS, class III surveys were not conducted, but they would be required in conjunction with more detailed planning of site-specific activities.

Some early components of a class I survey were initiated for the North Platte reservoirs using archival searches, and the preliminary results are discussed under each of the reservoirs in the "Present Condition" section below. Consultation by Reclamation with the applicable SHPOs and American Indian Tribes/Tribal Nations will continue throughout the NEPA process and during implementation as needed. Once more, site-specific and detailed information exists for the Program and accompanying, site-specific NEPA compliance, class III surveys would be required for assessing potential impacts to existing cultural resources.

It is expected that a programmatic agreement between the government agencies, the SHPOs, and, possibly, the Tribes will be developed to guide consultation on cultural resources analysis during the Program. This agreement would cover assessment of potential impacts, survey work, and any needed mitigation, once site-specific Program actions are proposed that have the potential to affect cultural resources.

PRESENT CONDITION

Reservoir and River Levels

North Platte Basin

Pathfinder Reservoir

Pathfinder Dam, completed in 1909, is listed on the National Register of Historic Places (NRHP). Approximately 1,602 acres of land at Pathfinder Reservoir have been subjected to class III survey. Seven sites, including the dam itself, have been determined eligible for the NRHP. Fifteen sites have been determined ineligible for the NRHP, and 11 sites have not been evaluated. Note that of the above NRHP eligible sites, five are actually contributing elements of the Pathfinder Historic District (48NA211) but are included here as discrete sites. Likewise, one of the above NRHP ineligible sites is a non contributing element of 48NA211. The historic maximum elevation at this reservoir is 5855 feet, and the historic minimum elevation is 5690 feet. Minimum and maximum reservoir elevations at Pathfinder historically range most frequently between 5755 and 5847 feet.

Alcova Reservoir

There have been approximately 3,372 acres subjected to class III survey at Alcova Reservoir, with 2 NRHP eligible sites and 12 NRHP ineligible sites recorded. The historic maximum elevation at this reservoir is 5500 feet, and the historic minimum elevation is 5409 feet.

Glendo Reservoir

About 7,745 acres have been subjected to class III survey at Glendo Reservoir. A total of 89 cultural resource sites have been recorded; 39 of those sites have been determined eligible for the NRHP or are listed on the NRHP; 38 sites have been determined ineligible for the NRHP; and no determination of eligibility has been made regarding the remaining 12 sites. The historic maximum elevation at this reservoir is 4651 feet, and the historic minimum elevation is 4548 feet, both of which have occurred just once. Minimum and maximum reservoir elevations at Glendo historically range most frequently between 4570 and 4640 feet.

Guernsey Reservoir

About 423 acres have been subjected to class III survey at Guernsey Reservoir. A total of 34 cultural resource sites have been recorded; 16 of those sites have been determined eligible for the NRHP or are listed on the NRHP; 12 sites have been determined ineligible for the NRHP; and no determination of eligibility has been made regarding the remaining 6 sites. The historic maximum elevation at this reservoir is 4420 feet, which has occurred just once, and the historic minimum elevation is 4362 feet. Minimum and maximum reservoir elevations at Guernsey historically range most frequently between 4380 and 4420 feet.

Seminoe Reservoir

About 530 acres have been subjected to class III survey at Seminoe Reservoir. A total of 33 cultural resource sites have been recorded; 13 of those sites have been determined eligible for the NRHP, or are listed on the NRHP; 10 sites have been determined ineligible for the NRHP; and no determination of eligibility has been made regarding the remaining 10 sites. The historic maximum elevation at this reservoir is 6359 feet, and the historic minimum is 6253 feet. Minimum and maximum reservoir elevations at Seminoe historically range most frequently between 6290 and 6350 feet.

Central Platte Basin

At Lake McConaughy, the historic minimum water surface elevation is 3201 feet, which has occurred just once in the period of hydrologic record used for the FEIS analysis, and the historic maximum elevation is 3270 feet. Only a small percentage of the shoreline around the reservoir has been surveyed, and a number of archaeological sites were located. The dam has been determined eligible to the NRHP as a contributing feature to the Kingsley Dam Project.

Land Disturbance Activities

Central Platte Basin

Central Platte Offstream Regulatory Storage Reservoir (CNPPD Re-Regulating Reservoir)

The Water Action Plan identified six possible sites for offstream storage in the Brady to Lexington reach of the Platte. A small reservoir located near the Johnson-2 Return Channel (Johnson-2 Forebay) is assumed to be the one that would be used to store the excess flows from CNPPD's canal and released back at times advantageous to the species. However, other sites have been considered during development of the Water Action Plan and might be substituted for this feature. This analysis therefore examined the potential for disturbance of cultural resources in an area approximately 6 miles wide centered on the Platte River, and extending from approximately Maxwell in Lincoln County to Central City in Merrick County, Nebraska. A partial, preliminary, class I survey was conducted for this area, which is discussed in more detail in "Land Acquisition in the Habitat Area."

Land Acquisition in the Habitat Area

A partial, preliminary, class I survey was conducted using literature and archival searches from the Nebraska SHPO on January 16, 2003, for Central Platte Habitat Area lands in and along the Platte River in central Nebraska. The survey covered an area approximately 6 miles wide, centered on the Platte River, and extending from approximately Maxwell in Lincoln County to Central City in Merrick County, Nebraska (this covers both the area of potential habitat lands and potential offstream regulatory storage sites, above). The file search identified 106 historic properties and 67 archeological surveys within this locale. This search also identified that less than 1 percent of the total area searched has been the subject of other, recent, class III surveys.

Groundwater Management in the Central Platte Groundwater Mound

Additional groundwater management would be implemented in the high groundwater area south of the Central Platte River. Management activities would include:

- Pumping water from the mound into creeks that drain back into the Platte
- Paying willing farmers to dry-land farm every other year and/or to use groundwater instead of their Lake McConaughy storage
- Diverting excess water from CNPPD's canals in the fall and winter and recharging the groundwater mound, then pumping an equivalent amount from the mound

Potential ground-disturbing activities include developing recharge pits or wells.

Riverside Drains

Under this element, a Program would install agricultural drains in the Central Platte region under farm fields of landowners who wish to participate. This element, part only of the Water Emphasis Alternative, would include roughly 100 miles of drains on lands that are currently cultivated and with a typical spring water table less than 5 feet below the surface.

South Platte Basin

Tamarack Project, Phases I and III

The Tamarack Project would likely be located along the south side of the South Platte River in the Tamarack Ranch State Wildlife Area (SWA) and the Pony Express SWA, which is 40 miles upstream of the Colorado-Nebraska state line. Tamarack would involve diverting surface water directly from the South Platte River during times of excess, via canals or wells located adjacent to the river, to small storage or recharge ponds and to recharge groundwater at various distances from the river. When water is needed to meet target flows, it would be pumped from the ponds and ground and conveyed back to the river.

INDIAN TRUST ASSETS

INTRODUCTION

This section identifies Indian trust assets (ITAs) in the Basin and assesses the potential for any impacts.

ITAs are legal interests in property held in trust by the United States for Indian Tribes or individuals. The Secretary of the Interior (Secretary) acts as the trustee for the U.S. with respect to ITAs. All Interior agencies share the Secretary's duty to act responsibly to protect and maintain ITAs reserved by or granted to Indian Tribes or individuals by treaties, statutes, and EOs. These rights are sometimes further interpreted through court decisions and regulations. Examples of trust assets include lands, minerals, hunting and fishing rights, and water rights.

Interior carries out its activities in a manner that protects trust assets and avoids adverse impacts as directed by:

- Executive Order 13175 Consultation and Coordination with Indian Tribal Governments
- Executive Order 13007 on Sacred Sites
- Bureau of Reclamation Guidance for Implementing Indian Sacred Sites Executive Order No. 13007, dated September 16, 1998
- Department of the Interior. Secretarial Order June 7, 1997. American Indian Tribal Rights, Federal -Tribal Trust Responsibility, and the Endangered Species Act.@
- U.S. Department of the Interior 512 Departmental Manual 2
- U.S. Department of the Interior. 2000. Secretarial Order No. 3206. American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act@
- Inadvertent Discovery of Human Remains on Reclamation Lands, Reclamation Manual, Directives and Standards LND-07-01
- Cultural Resources Management, Reclamation Manual, Directives and Standards, LND 02-01

Consultation with Tribes is required by NEPA, Executive Order 13175, and other Reclamation policies and guidance.

INDICATORS

An impact is considered to exist for any action that would result in the following:

- An adverse result in terms of the value, use, or enjoyment of an ITA
- A failure by any Federal agency to protect ITAs from loss, damage, waste, depletion, or other negative effects

METHODS

The existence and location of ITAs were assessed in consultation with the Bureau of Indian Affairs and Tribes/Tribal Nations that had aboriginal claims to the Basin, including the Cheyenne, Arapaho, Sioux, Pawnee, Omaha, and Otoe-Missouria.[28] Research was also conducted using treaties, statutes, EOs, and other mandates.

PRESENT CONDITION

See the "Indian Trust Asset Consultations" section in chapter 6 for consultation actions on ITAs.

Through consultation and research, it was discovered that about 50 years ago, each of the Tribes established with the Indian Claims Commission that they originally occupied a portion of the Basin. In each of these court cases, it was found that the original compensation payments were deficient at the time the Tribes had relinquished their larger segments of aboriginal lands for smaller reservation lands. For this reason, the Indian Claims Commission provided for monetary compensation to settle these off-reservation aboriginal claims. The monetary compensation was accepted by each Tribe, with the exception of the Sioux Nation, which has refused the funds with the primary goal of regaining the 1851 and 1868 treaty lands, particularly the Black Hills in South Dakota. Based on this history, the Sioux Nation believes it may have water rights issues to be addressed in the Platte River Basin. The southern border of the Sioux Nation Treaty area is the North Platte River. However, at present, there have been no further legal actions taken by the Sioux Nation in an attempt to acquire water rights.

For a complete list of Tribes/Tribal Nations identified and contacted, please see the *Indian Trust Assets Appendix* in volume 3. Based upon these consultations, no existing Indian trust assets were identified that could be adversely affected by any of the Program alternatives.

[28]These were Tribes when treaties were written. Since that time, several have divided into multiple Tribes/Tribal Nations and reservations. For a complete list of Tribes/Tribal Nations identified and contacted, please see the *Indian Trust Assets Appendix* in volume 3.

ENVIRONMENTAL JUSTICE

INTRODUCTION

Executive Order e12898 (February 4, 1994), Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, directs each Federal agency to review its programs, policies, and activities to identify and address any **disproportionately** high and adverse human health or environmental effects of their actions on minority and low-income populations. Additional directives include:

- ECM 95-2, NEPA Responsibilities Under the Departmental Environmental Justice Policy
- NEPA Handbook, Bureau of Reclamation
- Environmental Justice, Guidance Under the National Environmental Policy Act, Council of Environmental Quality, December 10, 1997
- Executive Order 12898 of February 11, 1994 "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations"

INDICATORS

The indicators applicable to the environmental justice parameter are whether the proposed action would:

- Create disproportionately high and adverse human health and environmental effects to minority and low-income populations
- Create other negative and inequitable project-related impacts to those populations

METHODS

Census data for race and ethnicity, poverty levels,[29] and median household income (1999 dollars) were analyzed (Census, 2003).

PRESENT CONDITION

The minority percentages of the total population in the Basin are shown in table 4-EJ-1, below. The Hispanic and Latino percentage of the total population is also displayed. The Hispanic population can be of any race and was the largest minority group, at 15.9 percent of the total year 2000 population

[29]The census definition of poverty level uses a set of money income thresholds that varies by family size and composition.

Basinwide; the Colorado portion of the Basin had the highest proportion. The total minority population in the Basin was 16.6 percent. The Basin follows the recent overall national trend of the Hispanic and Latino category becoming the largest minority group.[30]

Table 4-EJ-1.—Basin Minority Populations

Area	Percent of Minorities	Percent of Hispanics and Latinos*
Wyoming portion of the Basin	10.3	7.7
Colorado portion of the Basin	18	17
Nebraska portion of the Basin	7.4	9
Total Platte River Basin	16.6	15.9
*The apparent disparity is due to Census Bureau categories and definitions ("Hispanic" can be of any race).		

The Wyoming portion of the Basin had the highest percentage of individuals in poverty, at 14 percent in the 2000 Census, as shown in table 4-EJ-2. The lowest median household income in the overall Basin occurred in Nebraska, at $33,421. The entire Basin had about 9 percent of residents in poverty and an overall median income of roughly $38,607.

4-EJ-2.—Basin Poverty and Income

Area	Percent of Individuals in Poverty	Median Household Income
North Platte Basin, Wyoming	14	$34,910
South Platte Basin, Colorado	8.4	$47,489
Central Platte Basin, Nebraska	11.3	$33,421
Total Platte Basin	9.1	$38,607
United States	12.4	$41,994

In Colorado, Sedgwick, Washington, Logan, and Jackson Counties had the lowest median household incomes, ranging from $28,280 to $31,820. The three highest median incomes occurred in Jefferson, Elbert, and Douglas Counties, at $57,340 to $82,930.

In Nebraska, McPherson, Garden, and Arthur Counties had the lowest median income, ranging from $25,750 to $27,375. The three highest median incomes in the Nebraska portion of the Basin were in Phelps, Kearney, and Hamilton Counties, ranging from $37,319 to $40,277. Albany County in Wyoming had the lowest median income of $28,790, and Converse and Laramie Counties had the highest at $39,600.

Most localized Program impacts would take place through acquiring specific water leases or land leases or purchases. The location of these actions depend on voluntary participation in the Program and thus cannot be known now. NEPA analysis for these local actions will consider the potential for local environmental justice impacts.

[30]Since the census changed its method of collecting and compiling race and ethnic data for the year 2000 census, the years 1990 and 2000 data are not directly comparable.

At a programmatic level, it seems unlikely that there might be any disproportionate impacts on minority or low-income populations from the Program. Reductions in cropping associated with water or land acquisitions are fairly small and would be distributed throughout the Basin. Further, few of the major crops in the basin are labor-intensive today. In the past, fairly large crews of farm laborers were needed to thin sugar beet crops. However, today’s technology has essentially eliminated the need for so much manual labor. Also, the agricultural economics analysis projects no changes in the amount of land used to produce sugar beets under any of the alternatives. Any changes projected to occur to the current cropping patterns found within the various impact areas of the Platte River Basin are expected to affect only those crops with a much larger land base, such as corn, alfalfa, other hay, and small grains. These crops are not as labor intensive, and any changes to these crops would not disproportionately affect minority or low-income populations.

Chapter 5

Environmental Consequences

INTRODUCTION

This chapter describes the likely environmental consequences for resources affected by the proposed Platte River Recovery Implementation Program (Program). The impacts of the Governance Committee, Full Water Leasing, Wet Meadow, and Water Emphasis Alternatives are compared to the present conditions existing in the Platte River Basin (Present Condition), presented in chapter 4, "Affected Environment and the Present Condition."[1]

The Final Environmental Impact Statement (FEIS) description of impacts is a summary of more extensive analyses carried out by the Environmental Impact Statement (EIS) Team. In most cases, the impacts on resources are described using averages of conditions that would occur over a number of years. More details on the range and variability of impacts can be found in volume 3, which contains technical appendices associated with each resource, available by request from the Platte River EIS Office <http://www.platteriver.org> (see the "Cover Sheet" for contact information).

AFFECTED RESOURCES

The discussion of each resource that may be affected by the alternatives includes the following components:

- **Issue:** The core issue raised in scoping through public involvement and/or interagency consultation

- **Overview:** Briefly summarizes the scope of analysis and the indicators used to measure impacts projected for each alternative, and then summarizes the impacts

- **Impacts Analysis:** A more indepth discussion of potential impacts by alternative compared to the Present Condition

OTHER RESOURCES

Those resources cited in chapter 4, "Affected Environment and the Present Condition," that were analyzed and found to be negligibly affected or not affected are "Indian Trust Assets" and "Environmental Justice."

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[1]The analysis of impacts for each alternative assumes full implementation of that alternative.

WATER RESOURCES

Issue: How would the action alternatives affect streamflows, lake levels, water supplies, groundwater levels, and irrigation deliveries in the Platte River Basin (Basin)?

Overview

SCOPE

North Platte River Basin

The potentially affected environment in the North Platte River Basin consists of the river and reservoirs that might be affected by providing water for environmental deliveries, and irrigated lands by water leasing, or other Program activities.

South Platte River Basin

The potentially affected environment in the South Platte River Basin consists of the river and the riverine and upland areas within a few miles of the river that might be affected by Program groundwater recharge projects, as well as the reservoirs, river, and irrigated lands below Greeley, Colorado, that might be affected by Program water leasing activities.

Central Platte River Basin

The potentially affected environment in the Central Platte River Basin consists of the river and reservoirs that might be affected by providing water for environmental deliveries, and the reservoirs, river, and irrigated lands that might be affected by Program water leasing activities.

INDICATORS

- Impacts to water resources for the North Platte River Basin are indicated by effects on:
  - **Reservoir storage in the North Platte system**: Includes average end-of-month storage, average end-of-month water elevation, years with low storage, largest reservoir drawdowns, and spills from Guernsey Reservoir
  - **Riverflows**: Includes average monthly riverflows and months with low flows
  - **Irrigation deliveries:** Includes deliveries for environmental uses and irrigation

- Impacts to water resources for the South Platte River Basin are indicated by effects on:
  - **Reservoir storage in the South Platte system:** Includes average end-of-month contents
  - **Riverflows:** Includes average monthly riverflows
  - **Irrigation deliveries:** Includes deliveries for environmental uses and irrigation
- Impacts to water resources for the Central Platte River Basin are indicated by effects on:
  - **Lake McConaughy storage**
  - **Riverflows** and diversions at designated reaches
  - **Irrigation deliveries**
  - **Environmental accruals**
  - Overall reduction in **target flow shortages**, as well as the frequency of accomplishment of short-duration near-bankfull flows

SUMMARY OF IMPACTS

North Platte River Basin

Reservoir Storage

Compared to the Present Condition, average total storage in the North Platte River reservoir system would range from no change under the Full Water Leasing Alternative to 9 percent less under the Wet Meadow Alternative. There would be essentially no change in reservoir water elevations at Alcova, Glendo, and Guernsey Reservoirs under any action alternative. All action alternatives would result in fewer years with spills from Guernsey Reservoir than under the Present Condition.

Riverflows

When compared to the Present Condition, flow in the North Platte River below Guernsey Dam would generally be less in the winter (October-March), due to a few years when the volume of spills are reduced, and more in the summer (April-September) under all action alternatives. Under the Present Condition, flows below Kortes and Gray Reef Reservoirs are maintained above 500 cubic feet per second (cfs) to preserve fisheries; however, flows would fall below 500 cfs in 1 year below Kortes and 1 to 2 years below Gray Reef under the action alternatives.

Irrigation Deliveries

Irrigation deliveries are affected in two ways:

- Leasing water to the Program by farmers or districts reduces water deliveries to those water users
- Allocating some of the storage in Pathfinder Reservoir recovered through the Pathfinder Modification Project to environmental purposes, and other Program activities, increases the frequency and magnitude of irrigation shortages.

All alternatives, except for the Full Water Leasing Alternative, increase the number of years where irrigation deliveries fall below either historic deliveries or do not meet a full irrigation demand.

South Platte River Basin

Reservoir Storage

Compared to the Present Condition, storage in South Platte River Basin reservoirs would not change under the Governance Committee and Wet Meadow Alternatives. Under the Full Water Leasing and the Water Emphasis Alternatives, the end-of-month storage contents of Basin reservoirs from which the Program leases water would, on average, be lower in May, June, July, and August than under the Present Condition.

Riverflows

Flow in the South Platte River above the confluence with the Cache La Poudre River (near Greeley, Colorado) would not change under any of these action alternatives.

Flow in the South Platte River below the Cache La Poudre River confluence and above Fort Morgan, Colorado, may be somewhat greater in the months of May and June under the Full Water Leasing and Water Emphasis Alternatives, due to water leasing for Program purposes from off-channel reservoirs and/or direct-flow rights along this reach. Estimated average increases in flow at Fort Morgan are 82 cfs in May and 4 cfs in June under the Water Emphasis Alternative, and 124 cfs in May and 45 cfs in June under the Full Water Leasing Alternative. In other months of the year and under other action alternatives, there would be no difference.

Flow in the Lower South Platte River (beginning someplace downstream of Fort Morgan and above the Nebraska State line) generally would be less in November, December, January, February, and June, due to recharge projects like the Tamarack Project, Phase I, and greater in the remaining months of the year under the Governance Committee, Wet Meadow, and Water Emphasis Alternatives. Estimated average reductions in flow at Julesburg, Colorado, for each of these 4 months range from 340 to 9,242 acre-feet, depending upon the alternative and the month. Estimated average increases in flow for the remaining months of the year range from 156 to 5,373 acre-feet per month. The same is true for the Full Water Leasing Alternative, except that flows in March will on average be less, not more, than under the Present Condition.

Irrigation Deliveries

Relative to the Present Condition, deliveries of irrigation water to users in the South Platte River Basin will not change under the Governance Committee and Wet Meadow Alternatives. Under the Full Water Leasing and Water Emphasis Alternatives, leasing of water for Program purposes would, on average, reduce deliveries of water that is consumptively used by Lower South Platte irrigators in Colorado by about 43,900 and 31,150 acre-feet per year, respectively.

Central Platte River Basin

Reservoir Storage

Reservoir storage in Lake McConaughy would be less than the Present Condition under all action alternatives, except for the Full Water Leasing Alternative, due to increased deliveries for environmental purposes. Average storage ranges from 5 percent less under the Water Emphasis Alternative to 9 percent less under the Governance Committee Alternative.

All alternatives would reduce spills—from 17 percent for the Full Water Leasing Alternative to over 50 percent for the Governance Committee Alternative.

Riverflows

Average flows in the Platte River below Lake McConaughy would decrease in May and June, due to the reduction in spills from Lake McConaughy under all action alternatives, except the Full Water Leasing Alternative, compared to the Present Condition. For all action alternatives, except the Full Water Leasing Alternative, flow in the reach below the Tri-County Diversion Dam to the Johnson-2 Return would be less in June, due to reductions in spills, and flow in May would be higher, due to the release of environmental account (EA) water. For all action alternatives, except the Full Water Leasing Alternative, flows between Overton and Grand Island would decrease in January and December, due to operational changes. For all action alternatives, except the Full Water Leasing Alternative, flows would also decrease in June, due to a reduction in spills, and flow would increase in the remaining months. For the Full Water Leasing Alternative, flows decrease at all points downstream of Lake McConaughy for July and August, due to reduced irrigation deliveries.

Peak flows (flows greater than 10,000 cfs) in the Central Platte Habitat Area are reduced by all action alternatives, except for the Full Water Leasing Alternative. The alternatives increase the achievement of target flows at Grand Island, Nebraska, by a range of 116,000 up to 184,000 acre-feet on an average annual basis.

Irrigation Deliveries

Western Canal, which is located on the South Platte River near the Colorado-Nebraska State line, is the only district in the Central Platte River Basin that experiences shortages to irrigation deliveries under the Present Condition and the action alternatives. Shortages to Western Canal are reduced for the action alternatives, compared to the Present Condition, due to flow accretions in Colorado.

IMPACTS ANALYSIS

The Program alternatives involve several actions to manage water and move it to the Central Platte River for benefit of the target species. These actions impact reservoir operations, reservoir storage, reservoir elevations, reservoir releases, flows through hydropower plants, streamflows, and irrigation deliveries throughout the Basin. These hydrologic changes then affect the species' habitat, as well as other resources such as hydroelectric power generation, reservoir fisheries and recreation, agricultural production and revenues, and local economies, which are described in later sections.

North Platte River Basin

Reservoir Storage

The reservoir storage indicator is divided into five components: average total monthly storage for the system, average end-of-month reservoir water elevations, years with low storage, large reservoir drawdowns, and spills at Guernsey Reservoir.

Average Storage

Total storage for each alternative is shown in figure 5-WR-1; total storage is 3 percent less under the Governance Committee Alternative compared to the Present Condition (see chapter 4, "Affected Environment and the Present Condition"). There is essentially no change in average storage at Alcova and Guernsey Reservoirs. Average storage is reduced in Seminoe and Pathfinder Reservoirs under all action alternatives, except the Full Water Leasing Alternative, when compared to the Present Condition. Average storage is less in Glendo Reservoir for all action alternatives.

Average total reservoir storage would be 4 percent more under the Full Water Leasing Alternative than under the Present Condition. The Full Water Leasing Alternative increases storage in Pathfinder and Seminoe Reservoirs.

Under the Wet Meadow Alternative, average total monthly storage for the North Platte system would be 9 percent less than under the Present Condition, which is the greatest change.

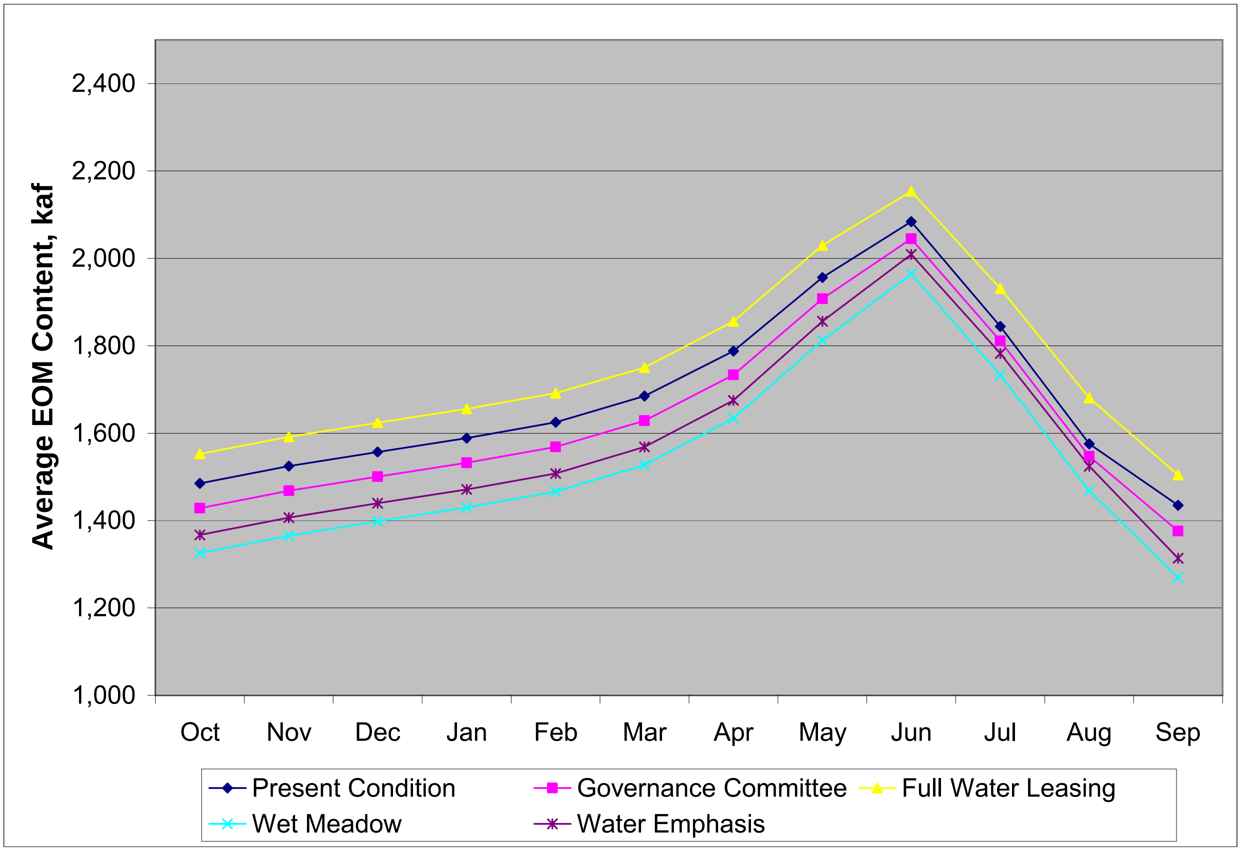


Figure 5-WR-1.—Average end-of-month storage in the North Platte River Basin under all alternatives.

Average End-of-Month Reservoir Water Elevations

Average end-of-month reservoir water elevations are also less under the Governance Committee Alternative than under the Present Condition. The average water elevation at Seminoe Reservoir is 2 to 3 feet less for every month except June through August, when it is 1 foot less. Average water elevation in Pathfinder Reservoir is 1 to 3 feet less than under the Present Condition. Average water elevation in Glendo Reservoir is 1 to 5 feet less than under the Present Condition (table 5-WR-1). There is essentially no change in reservoir water elevations at Alcova and Guernsey Reservoirs under any action alternative.

Table 5-WR-1.—Average End-of-Month Elevation (Feet) for Seminoe, Pathfinder, and Glendo Reservoirs*

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Avg
Seminoe Reservoir													
Present Condition	6,328	6,327	6,326	6,324	6,322	6,321	6,323	6,332	6,340	6,336	6,331	6,329	6,328
Governance Committee	6,326	6,325	6,323	6,321	6,319	6,318	6,321	6,330	6,339	6,334	6,329	6,327	6,326
	(-2)	(-2)	(-2)	(-2)	(-2)	(-3)	(-2)	(-2)	(-1)	(-1)	(-1)	(-2)	(-2)
Full Water Leasing	6,332	6,331	6,329	6,327	6,325	6,324	6,326	6,335	6,343	6,339	6,335	6,333	6,332
	(4)	(4)	(4)	(4)	(4)	(3)	(3)	(3)	(3)	(3)	(4)	(4)	(3)
Wet Meadow	6,321	6,320	6,318	6,316	6,315	6,314	6,317	6,326	6,336	6,331	6,325	6,322	6,321
	(-7)	(-7)	(-7)	(-7)	(-7)	(-7)	(-6)	(-6)	(-5)	(-5)	(-6)	(-8)	(-6)
Water Emphasis	6,324	6,323	6,321	6,319	6,317	6,317	6,320	6,328	6,337	6,333	6,328	6,324	6,324
	(-5)	(-5)	(-5)	(-4)	(-4)	(-4)	(-4)	(-4)	(-3)	(-3)	(-2)	(-5)	(-4)
Pathfinder Reservoir													
Present Condition	5,817	5,817	5,818	5,819	5,820	5,821	5,823	5,826	5,828	5,817	5,815	5,813	5,819
Governance Committee	5,814	5,815	5,816	5,817	5,818	5,818	5,820	5,824	5,826	5,815	5,812	5,811	5,817
	(-2)	(-2)	(-2)	(-2)	(-2)	(-2)	(-3)	(-2)	(-1)	(-2)	(-3)	(-2)	(-2)
Full Water Leasing	5,821	5,822	5,823	5,824	5,825	5,825	5,826	5,829	5,831	5,822	5,820	5,818	5,824
	(4)	(4)	(4)	(5)	(4)	(5)	(4)	(3)	(3)	(4)	(5)	(5)	(4)
Wet Meadow	5,810	5,810	5,811	5,812	5,814	5,814	5,815	5,819	5,823	5,813	5,809	5,806	5,813
	(-7)	(-7)	(-7)	(-7)	(-7)	(-7)	(-8)	(-7)	(-5)	(-5)	(-6)	(-7)	(-7)
Water Emphasis	5,812	5,813	5,814	5,814	5,816	5,816	5,817	5,821	5,825	5,815	5,811	5,808	5,815
	(-5)	(-5)	(-5)	(-5)	(-5)	(-5)	(-6)	(-4)	(-3)	(-3)	(-3)	(-5)	(-4)
Glendo Reservoir													
Present Condition	4,599	4,606	4,611	4,616	4,620	4,626	4,627	4,628	4,628	4,625	4,605	4,592	4,615
Governance Committee	4,595	4,602	4,607	4,613	4,618	4,624	4,625	4,627	4,628	4,624	4,604	4,587	4,613
	(-4)	(-4)	(-3)	(-3)	(-3)	(-2)	(-2)	(-1)	(-1)	(0)	(-1)	(-5)	(-3)
Full Water Leasing	4,596	4,603	4,608	4,614	4,618	4,625	4,626	4,628	4,629	4,625	4,605	4,588	4,614
	(-4)	(-3)	(-3)	(-2)	(-2)	(-1)	(-1)	(-1)	(0)	(1)	(0)	(-4)	(-2)
Wet Meadow	4,592	4,599	4,605	4,611	4,616	4,622	4,624	4,627	4,628	4,622	4,601	4,583	4,611
	(-7)	(-6)	(-6)	(-5)	(-5)	(-4)	(-3)	(-2)	(-1)	(-3)	(-3)	(-9)	(-4)
Water Emphasis	4,593	4,600	4,606	4,611	4,616	4,623	4,624	4,627	4,628	4,624	4,602	4,584	4,611
	(-7)	(-6)	(-5)	(-5)	(-4)	(-3)	(-3)	(-1)	(0)	(-1)	(-2)	(-8)	(-4)

*Numbers in parentheses are the change in feet from the Present Condition.

Looked at by reservoir, average end-of-month water elevation in Seminoe and Pathfinder Reservoirs would be more than under the Present Condition by an average of 3 and 4 feet, respectively, under the Full Water Leasing Alternative. Average water elevation in Glendo Reservoir is 1 to 4 feet less than under the Present Condition.

Under the Wet Meadow Alternative, average end-of-month water elevation would be 5 to 7 feet less at Seminoe Reservoir and 5 to 8 feet less at Pathfinder Reservoir when compared to the Present Condition. Average water elevation in Glendo Reservoir is 1 to 9 feet less than under the Present Condition.

Average end-of-month water elevation under the Water Emphasis Alternative would be 2 to 5 feet less at Seminoe Reservoir and 3 to 6 feet less at Pathfinder Reservoir. Average water elevation in Glendo Reservoir is 1 to 8 feet less than under the Present Condition.

Years With Low Storage

Lower reservoir levels also affect years with low storage. For purposes of analysis, a low storage indicator was defined for each reservoir. Table 5-WR-2 displays the number of years under each alternative when storage for individual North Platte reservoirs would be less than the level used to indicate low storage. Years with low storage will increase by 2 or 3 years under the Governance Committee Alternative compared to the Present Condition.

Table 5-WR-2.—Years With Storage Less Than Low Storage Indicator (kaf)*

	Seminoe	**Pathfinder**	**Glendo**	**Total Storage****
Low Storage Indicator	**200 kaf**	**200 kaf**	**100 kaf**	**650 kaf**
Years With Storage Less Than Low Storage Indicator				
Present Condition	6	12	9	6
Governance Committee Alternative	8	15	11	8
Full Water Leasing Alternative	4	9	15	3
Wet Meadow Alternative	11	18	24	12
Water Emphasis Alternative	10	16	27	10

Note: "kaf" equals thousand acre-feet.

*Out of the 48-year period of record modeled.

**Total storage is a combination of the low storage indicators in Seminoe, Pathfinder, and Glendo, plus 150 kaf in Alcova Reservoir.

Years with low reservoir storage under the Full Water Leasing Alternative would increase by 6 years for Glendo Reservoir; low storage would occur 2 or 3 years less frequently than under the Present Condition for Seminoe and Pathfinder Reservoirs.

Under the Wet Meadow Alternative, years with low storage would increase at Seminoe, Pathfinder, and Glendo Reservoirs.

Under the Water Emphasis Alternative, years of low storage would be slightly fewer than under the Wet Meadow Alternative, but greater than under the other two alternatives, when compared to the Present Condition.

Average May-August Reservoir Drawdowns

The action alternatives have an insignificant effect on the average May through August drawdowns (change in storage) in the reservoirs on the North Platte River (table 5-WR-3) and a moderate effect on the largest May through August drawdown (table 5-WR-4).

Table 5-WR-3.—Average May-August Drawdown (Feet)

	Seminoe	Pathfinder	Glendo
Present Condition	1	11	24
Governance Committee Alternative	1	12	23
Full Water Leasing Alternative	0	9	23
Wet Meadow Alternative	2	10	26
Water Emphasis Alternative	0	10	25

Table 5-WR-4.—Largest May-August Drawdown (Feet)

	Seminoe	Pathfinder	Glendo
Present Condition	21	30	46
Governance Committee Alternative	29	39	52
Full Water Leasing Alternative	25	35	44
Wet Meadow Alternative	34	32	53
Water Emphasis Alternative	26	38	54

Spills at Guernsey Reservoir

Within a river system, spills may provide an important source of high flows that have benefits to the downstream river system. Lower reservoir levels lead to fewer system spills compared to the Present Condition. Table 5-WR-5 compares the number of years with spills from Guernsey Reservoir for all action alternatives versus the Present Condition. For the Governance Committee Alternative, spills would occur in only 8 years as opposed to 12 years. Spills from Guernsey Reservoir would be less frequent under all of the action alternatives.

Table 5-WR-5.—Years With Spills From Guernsey Reservoir

	Years With Spills Out of a 48-Year Period of Record	Percent of Years With Spills
Present Condition	12	25
Governance Committee Alternative	8	17
Full Water Leasing Alternative	11	23
Wet Meadow Alternative	7	15
Water Emphasis Alternative	7	15

Riverflows

Average Monthly Flows

When compared to the Present Condition, flow in the North Platte River will be greater in the winter (October-March) and greater in the summer (April-September) for the Governance Committee Alternative. Flows are greater in the winter, due to slightly higher flow in March, and flows will increase in the summer, due to increased deliveries in September for environmental purposes. Table 5-WR-6 shows the percent of change in the average seasonal flows at four locations on the North Platte River for each alternative.

Table 5-WR-6.—Average Seasonal Flows (cfs) Under the Present Condition and the Percent of Change for Each Alternative

	Winter Average	**Summer Average**
North Platte River Below Kortes Reservoir (Miracle Mile)		
Present Condition	780	1,825
Governance Committee Alternative	2 percent	2 percent
Full Water Leasing Alternative	6 percent	-2 percent
Wet Meadow Alternative	-1 percent	5 percent
Water Emphasis Alternative	-1 percent	7 percent
North Platte River Below Gray Reef Reservoir		
Present Condition	605	2,001
Governance Committee Alternative	2 percent	8 percent
Full Water Leasing Alternative	4 percent	9 percent
Wet Meadow Alternative	1 percent	17 percent
Water Emphasis Alternative	1 percent	20 percent
North Platte River Below Guernsey Reservoir*		
Present Condition	36	3,123
Governance Committee Alternative	-7 percent	1 percent
Full Water Leasing Alternative	12 percent	2 percent
Wet Meadow Alternative	-10 percent	1 percent
Water Emphasis Alternative	-10 percent	1 percent
North Platte River Above Lake McConaughy		
Present Condition	1,363	1,438
Governance Committee Alternative	0 percent	4 percent
Full Water Leasing Alternative	0 percent	7 percent
Wet Meadow Alternative	0 percent	7 percent
Water Emphasis Alternative	0 percent	8 percent

*Changes in flows below Guernsey Reservoir are caused by changes in March of 1974 and of 1987. As simulated, these years require the release of water in March to reduce potential flood damage later in the year. In general, the alternatives do not significantly affect flows below Guernsey Reservoir, except in 1 or 2 years.

When compared to the Present Condition, average monthly flows under the Full Water Leasing Alternative would be mixed between winter and summer. The largest differences would be in flows below Guernsey Reservoir (12 percent more in winter) and below Gray Reef Reservoir (9 percent more in summer, due to environmental deliveries).

Average winter flows below reservoirs would generally increase or decrease slightly in winter and increase in summer under the Wet Meadow Alternative compared to the Present Condition.

Average monthly flows under the Water Emphasis Alternative would generally increase or decrease slightly in winter and be higher in summer when compared to the Present Condition, with the greatest changes occurring in summer below Gray Reef Reservoir.

The large decreases in flows below Guernsey Reservoir in the winter for all alternatives, except the Full Water Leasing Alternative, are due to reductions in spills in March 1974, 1985, and 1987. Generally, there is no flow below Guernsey Reservoir in the winter, except for rare instances when water is spilled due to high reservoir levels and high inflows. The Governance Committee, Wet Meadow, and Water Emphasis Alternatives lower reservoir levels and, thus, reduce the need to spill water in March 1974, 1985, and 1987. The result is an apparent average change in flows below Guernsey during the winter because these 3 months represent a large portion of the winter flows below Guernsey Reservoir, which are usually near zero. However, flows remain unchanged for nearly all conditions.

Months With Flows Less than 500 cfs

Generally, flows below Kortes and Gray Reef Reservoirs are maintained above 500 cfs to preserve high-quality fisheries. Under the Present Condition, these flows are maintained at 500 cfs or above; however, flows would fall below 500 cfs in each of the action alternatives in 1 to 2 years. Table 5-WR-7 displays months with flows less than 500 cfs in the two reaches of the North Platte River. Values in the table represent the number of occurrences out of 48 years (the period of record); thus, a numeral 1 in the December column represents 1 occurrence of flow below 500 cfs in 1 December out of a possible 48 Decembers.

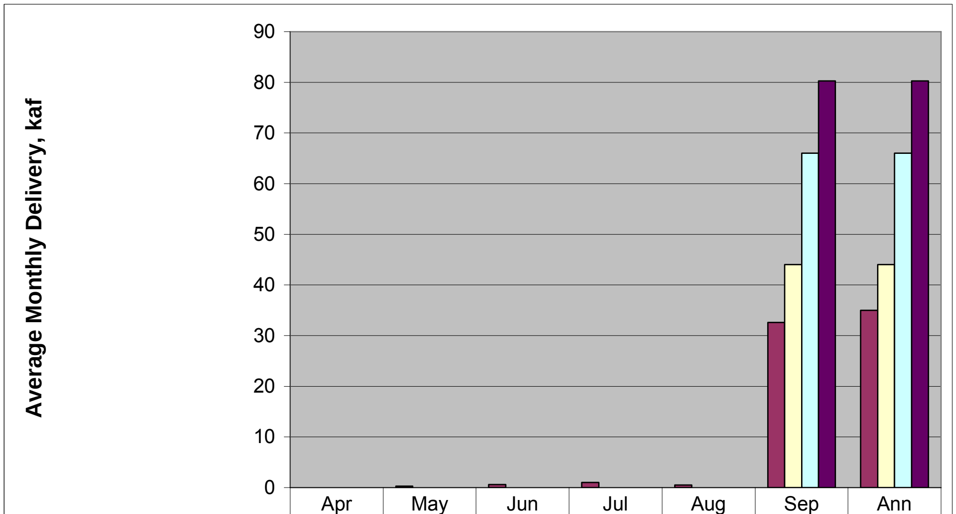
Table 5-WR-7.—Months With Flows Less Than 500 Cubic Feet Per Second, Over 48 Years

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
North Platte River Below Kortes Reservoir (Miracle Mile)													
Present Condition	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Governance Committee Alternative	0	0	1	1	1	1	0	0	0	0	0	0	**4**
Full Water Leasing Alternative	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Wet Meadow Alternative	1	1	1	1	1	1	0	0	0	0	0	0	**6**
Water Emphasis Alternative	0	1	1	1	1	1	0	0	0	0	0	0	**5**
North Platte River Below Gray Reef Reservoir													
Present Condition	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Governance Committee Alternative	0	0	0	0	1	1	0	0	0	0	0	0	**2**
Full Water Leasing Alternative	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Wet Meadow Alternative	0	1	1	1	1	1	0	0	0	0	0	1	**6**
Water Emphasis Alternative	0	0	0	1	1	1	0	0	0	0	0	0	**3**

Irrigation Deliveries

Environmental Deliveries

Under the action alternatives, the North Platte River Basin system would provide deliveries of environmental water to Lake McConaughy. These deliveries would be released under a management plan to benefit target species. With the exception of leased water, environmental deliveries increase the demand on the North Platte River Basin. This leads to lower reservoir levels in the North Platte River Basin and increased irrigation shortages. Figure 5-WR-2 displays the average monthly environmental deliveries under each alternative. The Present Condition is not represented because no environmental deliveries are made under the Present Condition.



	Apr	May	Jun	Jul	Aug	Sep	Ann
Governance Committee	0	0	1	1	1	33	35
Full Water Leasing	0	0	0	0	0	44	44
Wet Meadow	0	0	0	0	0	66	66
Water Emphasis	0	0	0	0	0	80	80

Figure 5-WR-2.—Average monthly environmental deliveries (kaf) from the North Platte River Basin above Lake McConaughy.

On an average annual basis, the Full Water Leasing Alternative would provide greater deliveries to Lake McConaughy than the Governance Committee Alternative, but it would provide less than under the other two action alternatives. The Wet Meadow Alternative would result in the second highest deliveries for environmental purposes compared to the other action alternatives. The Water Emphasis Alternative would deliver the highest annual amount of environmental deliveries of all the action alternatives.

Water Leasing

Table 5-WR-8 displays the average annual lease amount projected under each action alternative and its percentage of annual demand. For the Governance Committee Alternative, water is leased from the Kendrick Project and from the Laramie River Basin. This assumption was made in this FEIS analysis to match the assumptions stated in the Water Action Plan concerning from which reach of the river various amounts of leasing would come, and the Water Action Plan assumption that leasing would be tied to storage rights.

As mentioned in chapter 3, "Description of the Alternatives," it is assumed for this analysis that where water is leased by farmers to the Program, the state will require that other sources of water not be used to replace the leased supply, to avoid any secondary impacts on groundwater and riverflows.

Table 5-WR-8.—Amount of Program Water Leasing (kaf)

	North Platte Project		**Kendrick Project**		**Glendo Unit**		**Laramie River Basin**	
	Average Annual Lease Amount	Percent of Annual Demand	Average Annual Lease Amount	Percent of Annual Demand	Average Annual Lease Amount	Percent of Annual Demand	Average Annual Lease Amount*	Percent of Annual Demand**
Present Condition	0	0	0	0	0	0	0	--
Governance Committee Alternative	0	0	13	18	0	0	3	--
Full Water Leasing Alternative	125	17	19	27	4	6	0	--
Wet Meadow Alternative	0	0	0	0	0	0	0	--
Water Emphasis Alternative	30	4	11	16	0	1	0	--

*Leasing from the Laramie River Basin.
**Percent of annual demand cannot be calculated because total amount of irrigation is not known.

Due to the Full Water Leasing Alternative's emphasis on water leasing, this alternative has the largest reductions to irrigation deliveries from leased water. The Wet Meadow Alternative does not include water leasing, so there would be no effect on irrigation deliveries from leasing.

Irrigation Shortages

Irrigation shortages occur when there is not an adequate water supply to meet irrigation demands. The action alternatives would affect irrigation deliveries in the following way: The Pathfinder Modification Project, which is included in all action alternatives, increases storage capacity over the Present Condition by roughly 54 thousand acre-feet (kaf). This storage space has a very senior water right, being tied to the original Pathfinder storage right. Thus, it puts some additional demand on the river, which, in some years, reduces the amount of water available to holders of more junior water rights.

Irrigation shortages for each alternative are shown in tables 5-WR-9 and 5-WR-10. (Note that water leasing does not create "irrigation shortages." Where water leasing occurs, irrigation demands are reduced by the amount of water leased, and irrigation shortages occur only to the portion of the irrigation demand that remains after leasing.) Impacts of the Governance Committee Alternative would have the greatest effect upon the Kendrick Project, due to its relatively junior water rights.

Table 5-WR-9.—Number of Years Out of 48 Water Years with Irrigation Delivery Shortages

	North Platte Project	Kendrick Project	Glendo Unit	Non-Program Lands*
Present Condition	2	3	21	26
Governance Committee Alternative	3	7	22	27
Full Water Leasing Alternative	2	2	27	26
Wet Meadow Alternative	7	8	26	27
Water Emphasis Alternative	4	7	26	26

* Non-program lands are lands that are irrigated from the North Platte River but do not have a contract for storage with Reclamation.

Table 5-WR-10.—Average Irrigation Delivery Shortages (kaf)

	North Platte Project		Kendrick Project		Glendo Unit		Non-Program Lands	
	Average Annual Shortage*	Percent of Annual Demand	Average Annual Shortage*	Percent of Annual Demand	Average Annual Shortage*	Percent of Annual Demand	Average Annual Shortage*	Percent of Annual Demand
Present Condition	5	1	47	67	9	13	1	0.4
Governance Committee Alternative	8	1	40	57	8	12	1	0.5
Full Water Leasing Alternative	6	1	39	56	7	10	1	0.4
Wet Meadow Alternative	23	3	46	65	10	14	2	0.8
Water Emphasis Alternative	15	2	49	70	9	13	1	0.4

* Average is calculated for years with shortages and does not include years with no shortage.

In contrast, the Full Water Leasing Alternative would result in an almost identical number of years with irrigation delivery shortages as under the Present Condition. The Full Water Leasing Alternative has less impact on this indicator than the other action alternatives.

The Wet Meadow Alternative would result in the highest number of years with shortages to irrigation deliveries. Under this alternative, the average annual shortage in irrigation deliveries would increase. Impacts on irrigation deliveries would be largest under the Wet Meadow Alternative.

The Water Emphasis Alternative would result in the highest, or next to highest, number of years with irrigation shortages for North Platte Project, Kendrick Project, and Glendo Unit lands.

Irrigation Water Deliveries

The total changes in average annual water deliveries to North Platte irrigated lands above Lake McConaughy are shown in table 5-WR-11.

Table 5-WR-11.—Irrigation Deliveries-Total Change in Deliveries (kaf)

	North Platte Project		**Kendrick Project**		**Glendo Unit**		**Non-Program Lands**	
	Average Delivery Change	**Percent of Annual Demand**	**Average Delivery Change**	**Percent of Annual Demand**	**Average Delivery Change**	**Percent of Annual Demand**	**Average Delivery Change**	**Percent of Annual Demand**
Present Condition	0	0.0 percent	-3	-4 percent	-4	-6 percent	-1	-0.2 percent
Governance Committee Alternative	-1	-0.1 percent	-18	-26 percent	-4	-5 percent	-1	-0.2 percent
Full Water Leasing Alternative	-125	-17 percent	-20	-29 percent	-8	-12 percent	-1	-0.2 percent
Wet Meadow Alternative	-3	-0.4 percent	-8	-11 percent	-5	-8 percent	-1	-0.4 percent
Water Emphasis Alternative	-31	-4 percent	-18	-26 percent	-5	-8 percent	-1	-0.2 percent

Kendrick Project

As described in chapter 3, water leasing for the Governance Committee Alternative tends to be concentrated in the Kendrick Project. Water leasing for the Full Water Leasing and Water Emphasis Alternatives is more evenly distributed across the projects. However, water leasing, combined with the shortages to the Kendrick Project, due to the Pathfinder Modification in the Governance Committee and Water Emphasis Alternatives, leads to significant reductions in average annual water deliveries to this project.

North Platte Project, Glendo Unit, and Non-Program Lands

Below Guernsey Dam, total average annual deliveries to water users are reduced (shortage plus water leasing) by less than 1 acre-foot for the Governance Committee Alternative. The Wet Meadow Alternative has the next smallest change in deliveries below Guernsey Reservoir, followed by the Water Emphasis Alternative. The largest change in deliveries occurs under the Full Water Leasing Alternative.

Effects of the Program on Water Use Above Pathfinder Reservoir

Chapter 4 describes the conditions for which the State of Wyoming is likely to place the North Platte River under administration to meet the 1904 water right for Pathfinder Reservoir. Reclamation requests that the state administer water rights on the North Platte River above Pathfinder Reservoir when the forecasted supply available to the North Platte Project is less than 1,100 kaf. The action alternatives can only affect water users above Pathfinder Reservoir in Wyoming through an increase in the frequency and duration of water right administration for Pathfinder's 1904 right. The other impacts of the action alternatives on irrigation shortages or reduced spills from Guernsey Reservoir are borne by water users downstream of Pathfinder Reservoir, as quantified above.

Under the *Cooperative Agreement for Plate River Research and Other Efforts Relating to Endangered Species Habitats Along the Central Platte River, Nebraska* (Cooperative Agreement) and Modified North Platte Decree, it was stipulated that the Program would not make a call on rights upstream of Pathfinder Reservoir in order to fill the 54 kaf of storage in the reservoir that is restored through the Pathfinder Modification. However, the action alternatives, which include the Pathfinder Modification, do place an additional demand on overall reservoir storage compared to Present Condition (figure 5-WR-1) by allocating 5 percent of the storable inflows for Pathfinder Reservoir to the EA and the Wyoming Municipal Account. This decreases Pathfinder Project ownership over time and can, thereby, cause an increase in the number of allocation years and the potential for additional months with water right administration on the North Platte River above Pathfinder Reservoir.

As described in chapter 4, before May 1, Reclamation is deemed to have placed a request for administration of the river to the State Engineer for Pathfinder Reservoir whenever there is a projected allocation of the North Platte Project, without the need to formally request such a call. After May 1, Reclamation has the right to place a priority call for Pathfinder Reservoir whenever there is a projected allocation of the North Platte Project, but Reclamation must formally request such a call.[2]

Water Right Administration Before May 1

When water right administration is underway for Pathfinder's 1904 right, upstream water users with rights senior to Pathfinder's 1904 right are limited to a diversion of 1 cfs per 70 acres, and those with rights junior to Pathfinder may not divert water from the river.

All of the action alternatives, except the Full Water Leasing Alternative, increase the years with water right administration on the North Platte River by 2, from 9 to 11 years. The net increase in the number of months with water right administration is the greatest for the Wet Meadow and Water Emphasis Alternatives, with an increase of 6 months for the study period compared to the Present Condition. The Governance Committee Alternative increases the number of months with water right administration by 3 months for the study period. The Full Water Leasing Alternative reduces the number of months with water right administration by 2 months for the study period.

Table 5-WR-12 displays the number of times for each October, February, March, and April that water right administration was necessary based on the model results for the study period 1947-1994.

[2] This analysis assumes that each time an allocation year is forecast, the river is placed under water right administration by the Wyoming State Engineer. However, this is at the State Engineer's discretion.

Table 5-WR-12.—Number of Times Water Right Administration Was Necessary on the North Platte River Above Pathfinder Reservoir

	October	February	March	April	Total Months*	Years**
Present Condition	0	9	9	9	27	9
Governance Committee Alternative	0	9	10	11	30	11
Full Water Leasing Alternative	0	8	9	8	25	9
Wet Meadow Alternative	0	11	11	11	33	11
Water Emphasis Alternative	0	11	11	11	33	11
*Total number of months of water right administration. **Number of years that have at least 1month of water right administration.						

The potential effects on upstream water use can be separated into two categories: the direct application of water to irrigate fields and the storage of water for use after May 1.

Calls for water right administration are most likely to affect diversions from October 1 to April 30 since October is the first month that an allocation is calculated and April 30 is the assumed cutoff date for implementing a call. Because most of the irrigated land above Pathfinder is over 6000 feet in elevation, it is likely that the ground and rivers will be frozen from November through March. Thus, direct application of water to irrigate fields is likely to be affected the most in October and April. There have never been—and the North Platte River Environmental Impact Statement Model (NPRWUMEIS) does not project any—allocations in October. The ground is usually not frozen for at least part of April, and there is flow available in the North Platte River (>1,000 cfs), which means there is the potential to affect diversions during April. However, the crop water needs are not large in April because of lower temperatures and the fact that crops are just emerging from winter dormancy.

Assuming that half of the irrigated acres above Pathfinder are junior to Pathfinder's 1904 right, a conservative estimate of the effect of a call in October and April is that diversions above Pathfinder will be 25 percent of what would be diverted without a call. The average consumptive use in April is 316 acre-feet for the Present Condition. The average consumptive use in April is 278 acre-feet for the action alternatives. The difference is 38 acre-feet. The change in consumptive use just for those years with a call for water right administration is 138 acre-feet.

The other category of change, storage of water for use after May 1, has more potential to be affected by additional calls. A call could completely eliminate diversions to storage and the irrigation associated with storage during a call. An average of 1,244 acres is irrigated from reservoir storage above Pathfinder Reservoir.[3] However, there is a large amount of variability between wet years and dry years. In dry years (1989-1994), there are less than 500 acres irrigated from reservoir storage above Pathfinder Reservoir. Furthermore, irrigation from reservoir storage above Pathfinder Reservoir was not completely eliminated in years that had historic calls (1989, 1990, and 1992). The difference in acres irrigated from reservoir storage above Pathfinder Reservoir, between dry years with calls and dry years without calls, is 179 acres.

3 Page 220 of the Nebraska vs. Wyoming Settlement Agreement (Appendix G, Exhibit 6, Exhibit A, Supreme Court of the United States, October Term 2000, State of Nebraska v. State of Wyoming, Final Settlement Stipulation, No. 108, Original). *Nebraska v. Wyoming*, 325 U.S. 589 (1945), modified and supplemented, *Nebraska v. Wyoming*, 345 U.S. 981 (1953), further modified, *Nebraska v. Wyoming*, 534 U.S. 40 (2001).

Assuming this difference is all due to the call and not from climatological conditions, 179 acres represents 207 acre-feet of consumptive use, or an average of 13 acre-feet. The total impact of a call would be no more than 345 acre-feet of consumptive use out of 106,152 acre-feet of annual consumptive use.[4]

Water Right Administration After May 1

A request for administration for the 1904 Pathfinder Reservoir water right by Reclamation after May 1 is assumed in the FEIS to be highly unlikely. Reclamation, like all valid water right holders in Wyoming, is not prohibited from requesting a call on the river. There has not been a request for administration of the 1904 Pathfinder Reservoir water right after May 1 since construction of Pathfinder Dam. With this historical perspective of nearly 100 years and the provisions that were implemented in the Modified North Platte Decree, it is viewed that such a request is highly unlikely. Therefore, the alternatives are not expected to affect the frequency of state water right administration after May 1 of the year.

South Platte River Basin

Reservoir Storage

Compared to historic storage levels, storage in South Platte River Basin reservoirs would not change under the Governance Committee Alternative.

For the Full Water Leasing and Water Emphasis Alternatives, 70 kaf of leased water in Colorado is hypothesized to come from storage in six South Platte River Basin reservoirs: Julesburg, Prewitt, Jackson, North Sterling , Empire, and Riverside (in chapter 4, "Affected Environment and the Present Condition," the historic end-of-month storage contents of these reservoirs is summarized). The Full Water Leasing Alternative assumes an additional 29 kaf of water would be leased, primarily through direct flow rights.

Table 5-WR-13 summarizes estimated changes in these end-of-month storage contents associated with the annual water leasing from these reservoirs. These estimates are based on reservoir storage size and historic reservoir contents, which affect the availability of leaseable water. In reality, reservoir-by-reservoir changes in end-of-month storage could be quite different, depending upon the availability and cost of leaseable water at each facility from willing lessors (as noted, water leasing could also involve other reservoirs; these were selected for illustrative purposes).

[4] Appendix G, Exhibit 6, Exhibit A, Table 8a. "Total Annual Consumptive Use Above Pathfinder," page 267, of the Nebraska vs. Wyoming Settlement Agreement.

Table 5-WR-13.—South Platte Reservoir Storage: Average Change in End-of-Month Contents Relative to Historic Conditions, 1950-1994, Under the Water Emphasis and Full Water Leasing Alternatives (acre-feet)

Reservoir	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Julesburg (Jumbo)	0	0	0	0	-2,616	-3,533	-1,986	-512	0	0	0	0
North Sterling (Point of Rocks)	0	0	0	0	-8,576	-11,715	-7,573	-2,783	0	0	0	0
Prewitt	0	0	0	0	-2,255	-3,061	-1,743	-259	0	0	0	0
Jackson	0	0	0	0	-2,504	-3,374	-2,231	-730	0	0	0	0
Empire	0	0	0	0	-1,118	-1,500	-785	-206	0	0	0	0
Riverside	0	0	0	0	-2,287	-3,036	-1,685	-448	0	0	0	0
Totals	**0**	**0**	**0**	**0**	**-19,356**	**-26,219**	**-16,003**	**-4,938**	**0**	**0**	**0**	**0**

Under the Full Water Leasing and Water Emphasis Alternatives, the storage contents of the reservoirs used for water leasing would, on average, be lower during the months of May, June, July, and August than under historic conditions. This reflects the expectation that the leased water generally would be released for Program purposes in May and/or June, and that a substantial portion of this water, were it not leased by the Program, would have remained in storage until later in the irrigation season. By the end of the irrigation season (September), this water would be released from storage whether or not it was leased for Program purposes. Thus, during the remaining 8 months of the year, the reservoir contents do not differ from the Present Condition. No significant effect on end-of-year contents occurs for the reservoirs.

Under the Governance Committee and Wet Meadow Alternatives, there would be no impact on the storage contents of South Platte reservoirs.

Riverflows

Governance Committee Alternative

Under the Governance Committee Alternative, flow in the Lower South Platte River (i.e., beginning at some point below Fort Morgan) generally would be less in November, December, January, and June, and greater in the remaining months of the year, relative to the Present Condition. This reflects the effects of the Tamarack Projects by the State of Colorado for Program purposes.

The magnitude of these changes under this alternative is summarized in table 5-WR-14. Some portion of these effects could be seen as far upstream as Fort Morgan, Colorado, as the State of Colorado identified this as the uppermost likely extent of the Tamarack Project. However, the State of Colorado intends to locate these operations as close to the Nebraska State line as feasible. Thus, the full effects (summarized in table 5-WR-14) would be evident only downstream of all Tamarack Project operations, at the Julesburg gauge.

As indicated by table 5-WR-14, the Tamarack Project would, on average, divert more water from the South Platte River in November, December, January, and June than it would provide as return flows. In all other months, the net effect of the Tamarack Project and additional Program flow re-regulation operations by Colorado would be accretive to flows. The overall annual impact is a reduction in South Platte flows at Julesburg, due to evaporative losses associated with the diversions and due to some accretions not returning to the river until after the end of the modeled period. The scale and effect of

Tamarack Project operations under the Wet Meadow Alternative (implementing Tamarack Project, Phase I, only; not Tamarack Project, Phase III) would be substantially smaller than under the Governance Committee Alternative. Under the Water Emphasis Alternative, with an enlarged Tamarack Project, the effect of the Tamarack operations would be greater.

Table 5-WR-14.—Average Gains or Losses (-) to the South Platte River Per Month (Acre-Feet), Due to Tamarack Project Operations

Alternative	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Governance Committee Alternative	-9,008	-2,064	754	2,865	2,575	-1,834	125	4,441	309	1,893	-858	-8,031	-8,834
Full Water Leasing Alternative: Does not include the Tamarack Projects.													
Wet Meadow Alternative	-4,536	-340	156	1,604	1,645	-751	298	2,605	591	1,154	-2,377	-5,302	-5,254
Water Emphasis Alternative	-9,242	-3,983	578	3,541	2,205	-1,680	1,112	5,373	718	2,336	-3,248	-8,981	-11,271

Wet Meadow Alternative

The Wet Meadow Alternative, like the Governance Committee Alternative, does not include any water leasing components in Colorado. As with the Governance Committee Alternative, flow in the Lower South Platte River (i.e., beginning at some point below Fort Morgan) generally would be less under this alternative in November, December, January, and June and greater in the remaining months of the year relative to the Present Condition. This reflects the effects of the Tamarack Project operations above the Colorado/Nebraska state line. Monthly changes in flow (both negative and positive), due to Tamarack operations under this alternative, would generally be less than for the Governance Committee Alternative because target flows would more frequently be achieved in the Central Platte Habitat Area with water sources other than re-regulated South Platte River flow.

Full Water Leasing Alternative

Estimated average changes in monthly flows resulting from implementation of the water leasing component of the Full Water Leasing Alternative are summarized in table 5-WR-15.

Table 5-WR-15.—Estimated Change in Average Monthly Flows (cfs), 1950-1994, Resulting from Water Leasing Operations Under the Full Water Leasing Alternative

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
South Platte at Kersey	0	0	0	0	0	0	0	0	0	0	0	0	0
South Platte downstream of Weldon Valley	0	0	0	0	124	45	0	0	0	0	0	0	14
South Platte at Balzac	0	0	0	0	184	101	0	0	0	0	0	0	24
South Platte at Cooper	0	0	0	0	184	101	0	0	0	0	0	0	24
South Platte at Julesburg	0	0	0	0	397	307	0	0	0	0	0	0	59

As indicated in table 5-WR-15, the delivery of leased water for Program purposes would be anticipated in the months of May and June only. On average, an increase in flow in the South Platte River at Julesburg, due to water leasing, is estimated at 397 cfs and 307 cfs in May and June, respectively. However, these are averages, and the increase may be more or less in any given year.

The figures below illustrate how increases in flow in May (figure 5-WR-3) and June (figure 5-WR-4) are distributed over the modeled 48-year period. The Full Water Leasing Alternative generates some flow benefits in all modeled years. For this alternative, these maximum benefits were 409 cfs and 338 cfs in May and June, respectively.

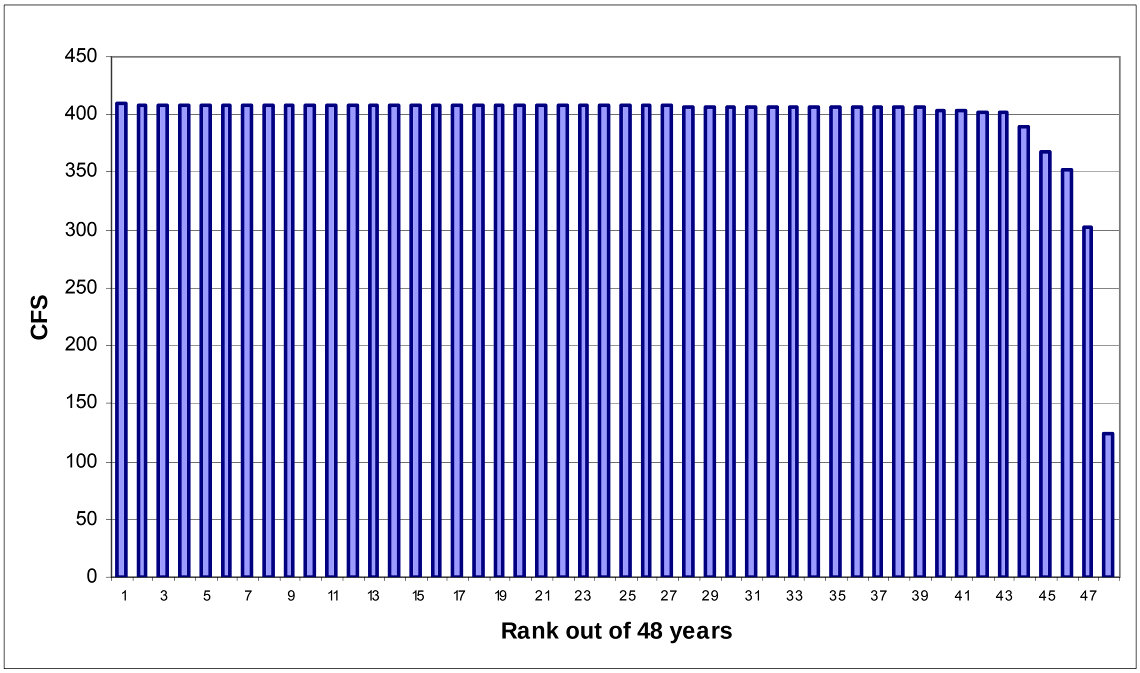


Figure 5-WR-3.—Estimated increase in May streamflow in the South Platte River at Julesburg, resulting from water leasing under the Full Water Leasing Alternative, with the 48 years ranked highest to lowest.

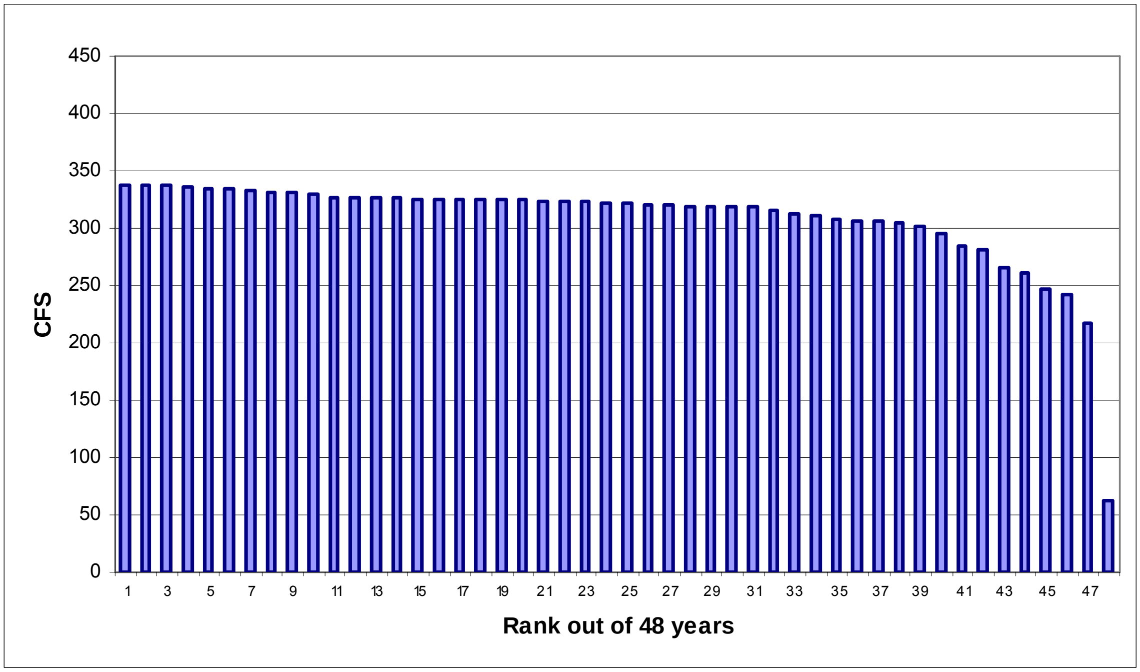


Figure 5-WR-4.—Estimated increase in June streamflow in the South Platte River at Julesburg, resulting from water leasing under the Full Water Leasing Alternative, with the 48 years ranked highest to lowest.

Water Emphasis Alternative

Under the Water Emphasis Alternative, flows in the lower South Platte River would be affected by two Program activities:

- Leasing water from offstream reservoirs and/or direct flow rights, as described above
- Operations of the Tamarack Project between Fort Morgan and the Colorado/Nebraska state line

Estimated average changes in monthly flows resulting from implementation of the water leasing component of the Water Emphasis Alternative are summarized in table 5-WR-16.

Table 5-WR-16.—Estimated Change in Average Monthly Flows (cfs), 1950-1994, Resulting From Water Leasing Operations Under the Water Emphasis Alternative

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
South Platte at Kersey	0	0	0	0	0	0	0	0	0	0	0	0	0
South Platte downstream of Weldon Valley	0	0	0	0	82	4	0	0	0	0	0	0	7
South Platte at Balzac	0	0	0	0	140	7	0	0	0	0	0	0	12
South Platte at Cooper	0	0	0	0	140	7	0	0	0	0	0	0	12
South Platte at Julesburg	0	0	0	0	318	140	0	0	0	0	0	0	38

As indicated in table 5-WR-16, the delivery of leased water for Program purposes would be anticipated in the months of May and June only. On average, an increase in flow in the South Platte River at Julesburg, due to water leasing, is estimated at 318 cfs and 140 cfs in May and June, respectively. However, these are averages, and the increase may be more or less in any given year.

The following figures illustrate how increases in flow in May (figure 5-WR-5) and June (figure 5-WR-6) are distributed over the modeled 48-year period. Note that in 4 of these modeled years, there is no increase in flow in May, and in 5 years, there is no increase in flow in June. The maximum modeled increase in flow at Julesburg was 368 cfs in May and 373 cfs in June.

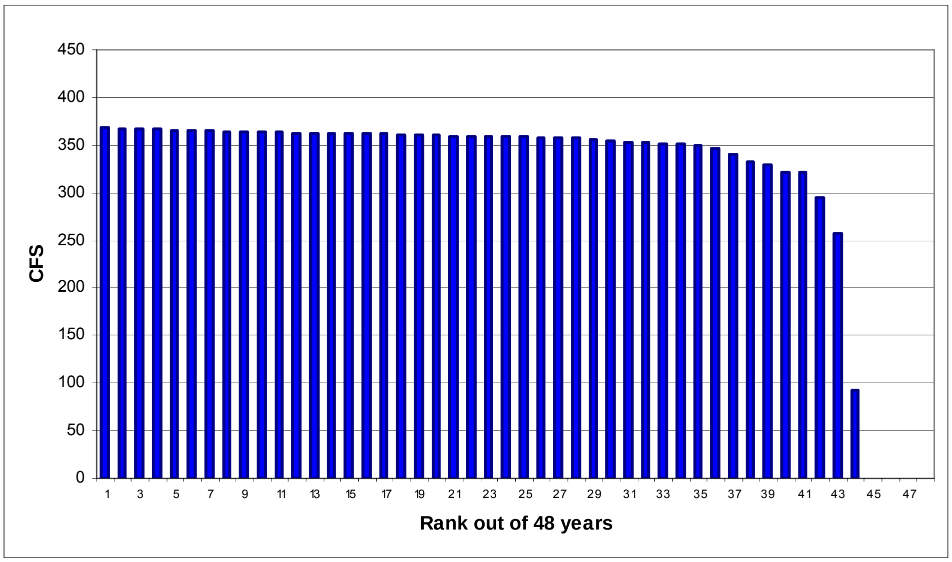


Figure 5-WR-5.—Estimated increase in May streamflow in the South Platte River at Julesburg, resulting from water leasing, with the 48 years ranked highest to lowest.

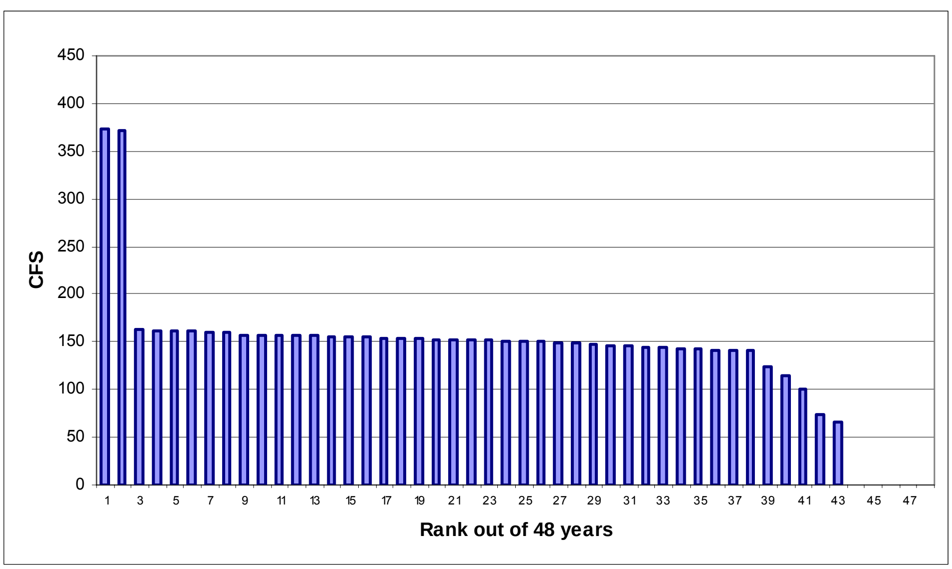


Figure 5-WR-6.—Estimated increase in June streamflow in the South Platte River at Julesburg, resulting from water leasing, with the 48 years ranked highest to lowest

Irrigation Deliveries

Relative to the Present Condition, deliveries of irrigation water to users in the South Platte River Basin would not change under the Governance Committee Alternative or the Wet Meadow Alternative.

Relative to the Present Condition, deliveries of irrigation water to users in the Lower South Platte River Basin would be reduced under the Full Water Leasing and Water Emphasis Alternatives because a portion of the water currently delivered from the six reservoirs and/or from direct-flow water rights for irrigation purposes would be leased and used for target species benefits. Under the Full Water Leasing and Water Emphasis Alternatives, deliveries of consumptively used irrigation water to Lower South Platte irrigators would, on average, be reduced by about 31,150 and 43,900 acre-feet per year, respectively. The maximum modeled reduction over the 48-year period was 33,729 acre-feet for the Water Emphasis Alternative and 47,433 acre-feet for the Full Water Leasing Alternative. The minimum reduction was 5,763 acre-feet and 11,514 acre-feet for these two alternatives, respectively.

Environmental Deliveries

Under the action alternatives, the South Platte River Basin system would be operated to provide deliveries of environmental water to the Central Platte River. Water leased to the Program would be released from storage or bypassed (not diverted from the river to storage or direct flow uses), primarily in May and June, to augment spring flows under the Full Water Leasing and Water Emphasis Alternatives. In addition, Tamarack Project retiming of South Platte River flows under the Governance Committee, Wet Meadow, and Water Emphasis Alternatives would provide additional deliveries of environmental water at times most needed for target species benefits. The aggregate increase in environmental deliveries when the effects of water leasing are combined with the Tamarack Project are illustrated in table 5-WR-17.

Table 5-WR-17.—Program Water for Environmental Purposes (kaf),
Average Annual South Platte River Flow at Julesburg, Colorado

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Present Condition	0	0	0	0	0	0	0	0	0	0	0	0	0
Governance Committee Alternative	0	0	0.8	2.9	2.6	0	0.1	4.4	0.3	1.9	0	0	13
Full Water Leasing Alternative	0	0	0	0	22.3	16.7	0	0	0	0	0	0	39
Wet Meadow Alternative	0	0	0.2	1.6	1.6	0	0.3	2.6	0.6	1.2	0	0	8.1
Water Emphasis Alternative	0	0	0.6	3.5	21.7	8.3	1.1	5.4	0.7	2.3	0	0	43.6

Flows and Diversions

Flow in the South Platte River at Julesburg, Colorado

Flows in the lower South Platte River would change relative to the Present Condition as a result of:

- ➢ Changes in Front Range water use during the first 13 years of implementation of the proposed Platte River Recovery Implementation Program (Program's First Increment) (all alternatives)
- ➢ Colorado's Plan for Future Depletions (all alternatives
- ➢ Tamarack Projects flow re-regulation (Governance Committee, Wet Meadow, and Water Emphasis Alternatives)
- ➢ Water leasing for Program purposes (Full Water Leasing and Water Emphasis Alternatives).

The modeled aggregate effects of these changes on average monthly flows in the South Platte River at Julesburg are summarized in table 5-WR-18.

Table 5-WR-18.—Average Monthly Change in Flow, South Platte River at Julesburg

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Absolute Change from Present Condition (mean cfs)												
Governance Committee	68	77	-34	-52	52	91	81	42	-37	-5	88	32
Full Water Leasing	37	91	94	96	95	80	34	363	281	0	16	27
Wet Meadow	55	52	10	24	84	81	61	28	-15	2	57	37
Water Emphasis	76	39	-50	-55	18	89	92	353	106	11	102	39
Percent Change from Present Condition (percent)												
Governance Committee	20	18	-6	-7	6	16	15	3	-2	-1	38	9
Full Water Leasing	11	21	17	13	11	14	6	29	16	0	7	7
Wet Meadow	16	12	2	3	10	14	11	2	-1	0	25	10
Water Emphasis	22	9	-9	-8	2	15	17	28	6	3	45	11

Note that these values represent changes in South Platte flows after the Tamarack Project (if any) is taken into account. Upstream of such re-regulation, changes in flow would be different.

Central Platte River Basin

Lake McConaughy Reservoir Storage

The Lake McConaughy reservoir storage indicator is divided into five components:

- ➢ Average end-of-month storage
- ➢ Average end-of-month reservoir water elevation
- ➢ Years with storage below 500 kaf
- ➢ Largest May through August drawdown
- ➢ Spills

Lake McConaughy Storage Capacity

Under the Program, Lake McConaughy provides storage capacity for an EA. Water from this account can then be managed and released to benefit the target species. Figure 5-WR-7 displays monthly average water stored in Lake McConaughy (including EA water) for all alternatives as compared to the Present Condition. Reservoir storage would be 9 percent less under the Governance Committee Alternative because increased deliveries would be made for environmental purposes (see the "Flows and Diversions" subsection in this section for more details).

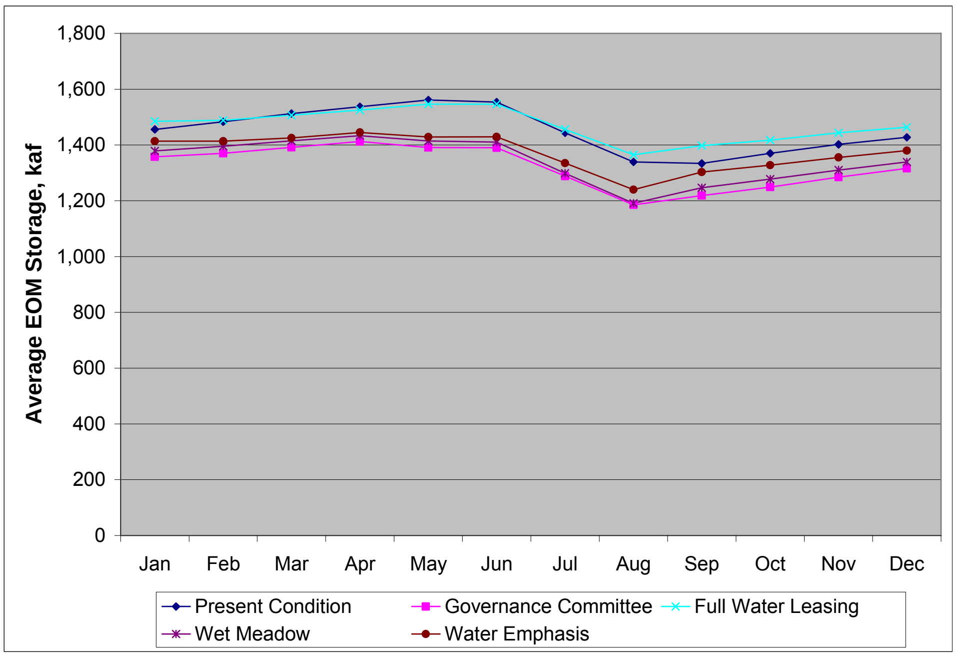


Figure 5-WR-7.—Average end-of-month storage at Lake McConaughy under all alternatives.

End-of-Month Water Elevation

Under the Present Condition, the average monthly elevation of Lake McConaughy would be 3255 feet, with an average monthly storage level of 1,452 kaf. As table 5-WR-19 displays:

- The **Governance Committee Alternative** would lower average water elevation by 6 feet.

- The **Full Water Leasing Alternative** would not change Lake McConaughy average end-of-month water elevations over the 48-year simulation period. The higher lake levels under the Full Water Leasing Alternative (compared to other action alternatives) result because this alternative relies to a greater extent on reductions in consumptive use, rather than on increased demands on storage.

- The **Wet Meadow Alternative** would lower Lake McConaughy average end-of-month water elevations by 5 feet when compared to the Present Condition.

- The **Water Emphasis Alternative** would lower Lake McConaughy average end-of-month water elevations by 4 feet when compared to the Present Condition. The higher lake levels under the Water Emphasis Alternative, compared to other action alternatives, result from increased water provided from the North Platte River above Lake McConaughy and reductions in consumptive use through water leasing.

Table 5-WR-19.—Lake McConaughy: Average End-of-Month Elevation (Feet)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
Present Condition	3,255	3,256	3,257	3,258	3,258	3,258	3,254	3,250	3,250	3,252	3,253	3,254	3,255
Governance Committee Alternative	3,251	3,251	3,252	3,253	3,252	3,251	3,247	3,244	3,245	3,246	3,248	3,249	3,249
	(-4)*	(-5)	(-5)	(-5)	(-6)	(-6)	(-7)	(-7)	(-5)	(-5)	(-5)	(-5)	(-5)
Full Water Leasing Alternative	3,256	3,256	3,257	3,258	3,258	3,257	3,254	3,251	3,253	3,253	3,254	3,255	3,255
	(1)	(0)	(0)	(0)	(-1)	(0)	(0)	(1)	(3)	(2)	(2)	(1)	(1)
Wet Meadow Alternative	3,252	3,252	3,253	3,254	3,253	3,252	3,248	3,244	3,246	3,247	3,249	3,250	3,250
	(-3)	(-4)	(-4)	(-4)	(-5)	(-5)	(-6)	(-6)	(-4)	(-4)	(-4)	(-4)	(-4)
Water Emphasis Alternative	3,253	3,253	3,254	3,254	3,254	3,253	3,250	3,246	3,249	3,250	3,251	3,252	3,251
	(-2)	(-3)	(-3)	(-4)	(-5)	(-5)	(-4)	(-4)	(-1)	(-2)	(-2)	(-2)	(-3)
*Numbers in parentheses are the change in feet from the Present Condition.													

Years With Low Storage

Storage in Lake McConaughy would not be less than 500 kaf at any time of the year under each alternative. Years with low storage under any of the alternatives would not change when compared to the Present Condition.

Average May-August Drawdown

The drawdown of Lake McConaughy typically occurs in summer during the irrigation season. Under the Governance Committee Alternative, the amount of drawdown would not change from the average 19-foot drawdown under the Present Condition (table 5-WR-20).

Table 5-WR-20.—Lake McConaughy May-August Drawdown (Feet)

	Average May-August Drawdown (Feet)	Largest May-August Drawdown (Feet)
Present Condition	8	19
Governance Committee Alternative	8	19
Full Water Leasing Alternative	6	17
Wet Meadow Alternative	9	24
Water Emphasis Alternative	8	20

Average May-August drawdown at Lake McConaughy would increase for the Wet Meadow Alternative, remain unchanged for the Governance Committee and Water Emphasis Alternatives, and decrease for the Full Water Leasing Alternative compared to the Present Condition. The largest May-August drawdown increases for the Wet Meadow and Water Emphasis Alternatives and decreases with the Full Water Leasing Alternative.

Spills

As described in the "Reservoir Storage and Spills" subsection in the "North Platte River Basin:" section in chapter 4, spills can be important as they provide large amounts of water that move sediment within the river channel. Spills include releases from Lake McConaughy to prevent violating the Federal Energy Regulatory Commission (FERC) limits. Table 5-WR-21 shows the spills from Lake McConaughy under the action alternatives as compared to the Present Condition.

Table 5-WR-21.—Lake McConaughy Years With Spills

	Years With Spills Out of a 48-Year Period of Record
Present Condition	29
Governance Committee Alternative	14
Full Water Leasing Alternative	24
Wet Meadow Alternative	15
Water Emphasis Alternative	17

While the Full Water Leasing Alternative slightly reduces spills, the other alternatives reduce spills in about half the number of years.

Flows and Diversions

Average monthly flows are estimated for eight locations on the North Platte, South Platte, and Platte Rivers.

Flows Downstream of Keystone Diversion Dam

The flow in the North Platte River immediately below the Keystone Diversion Dam (figure 5-WR-8) varies greatly by season. Flows tend to be low in the winter, increase in late spring, and achieve their highest levels during the irrigation season. Under the Governance Committee Alternative, annual flows at this location would decrease due to the reductions in spills and the use of water leasing. Flows would be highest during the peak irrigation season (June through August) because the water released to meet irrigation demands exceeds the diversion capacity of the Sutherland Supply Canal and water is conveyed to its diversion point using the North Platte River. Flows at North Platte, Nebraska, would follow a similar pattern under all alternatives (figure 5-WR-8). Peak flows in July are less at North Platte than at Keystone, due to irrigation deliveries between Keystone and North Platte, but flows during September through May are greater, due to accretions to the North Platte River between Keystone and North Platte.

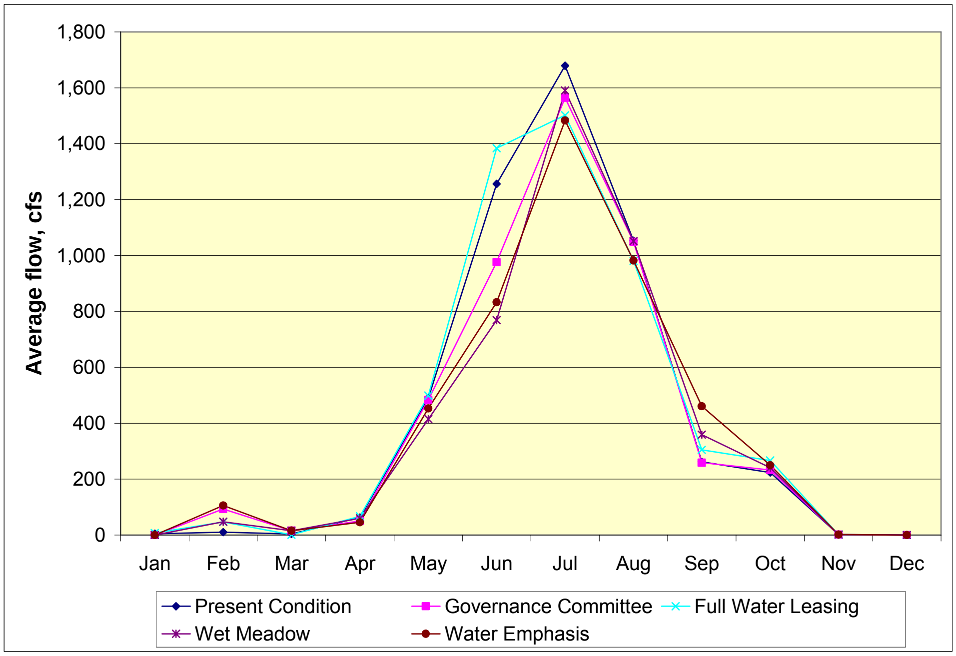


Figure 5-WR-8.—North Platte River flows at Keystone, Nebraska, under all alternatives.

Flow in the South Platte River

Flow in the South Platte River at Julesburg, Colorado (figure 5-WR-9), is lowest during the late irrigation season (July-September) and highest during the spring runoff (May-June). This pattern would be the same for all alternatives.

Flow in the lower section of the South Platte River between the Korty Diversion Dam and the confluence with the North Platte near the town of North Platte, Nebraska, is approximately 200 cfs less than the flow at Julesburg. This is because much of the South Platte flow is diverted into the Sutherland Canal at the Korty Diversion Dam. Only in wet periods does the South Platte flow exceed the capacity of the Sutherland Canal. The flow differences at Julesburg in May and June under the Full Water Leasing and Water Emphasis Alternatives are due to the release of consumptive use leased by the Program in Colorado.

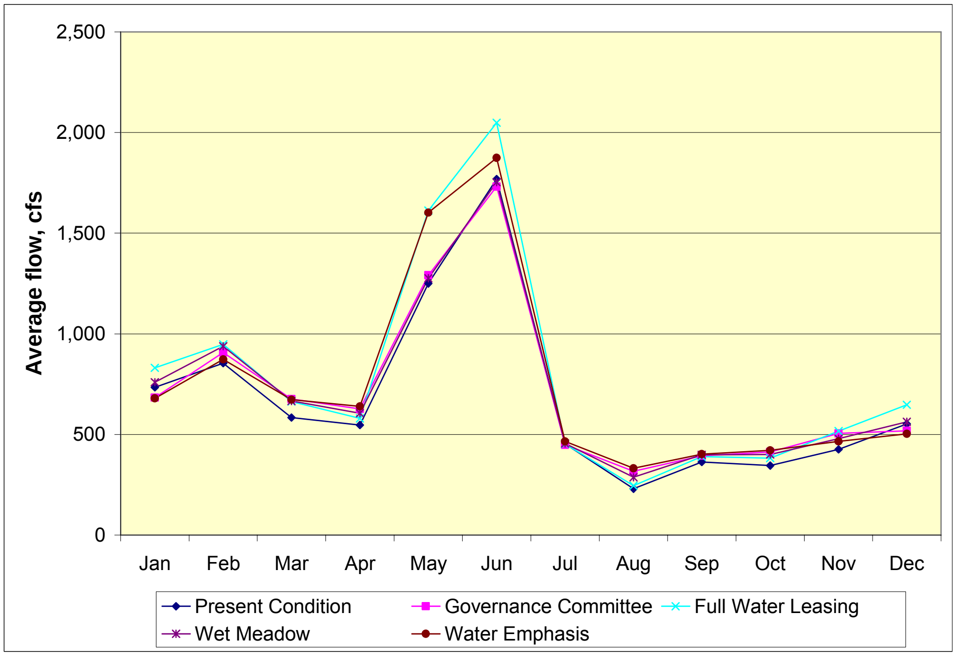


Figure 5-WR-9.—South Platte River flows at Julesburg, Colorado, under all alternatives.

Flow in the Platte River Downstream of the Tri-County Diversion Dam

In the 60-mile-long Tri-County Supply Canal bypass portion of the Platte River, between the Tri-County Diversion Dam and the Johnson-2 Return upstream of Overton, Nebraska, flow patterns would be similar to those of the North Platte River downstream of the Keystone Diversion Dam—low in the upper end of the reach with water increases occurring along the reach. Average monthly flows just downstream of the Tri-County Diversion Dam follow a similar seasonal pattern as those just downstream of the Keystone Diversion Dam. In the reach just downstream of the Tri-County Diversion Dam (figure 5-WR-10) winter flows would be low, averaging less than 200 cfs during some winter months, with occasional periods of zero flow. In most years, however, winter flow accretion in the upper half of this reach is large, typically averaging an increase of about 100 to 200 cfs from the Tri-County Diversion Dam to Brady. In contrast to the low winter flows, irrigation season flows are relatively high because flows required for irrigation between Brady and Cozad are in excess of available Tri-County Supply Canal capacity. The reductions in flows at this location are due to reduced spills and increased leasing of consumptive use downstream of North Platte, Nebraska. The high average flow in June for the Full Water Leasing Alternative is due to higher spills caused by storing leased water in Lake McConaughy during wet years.

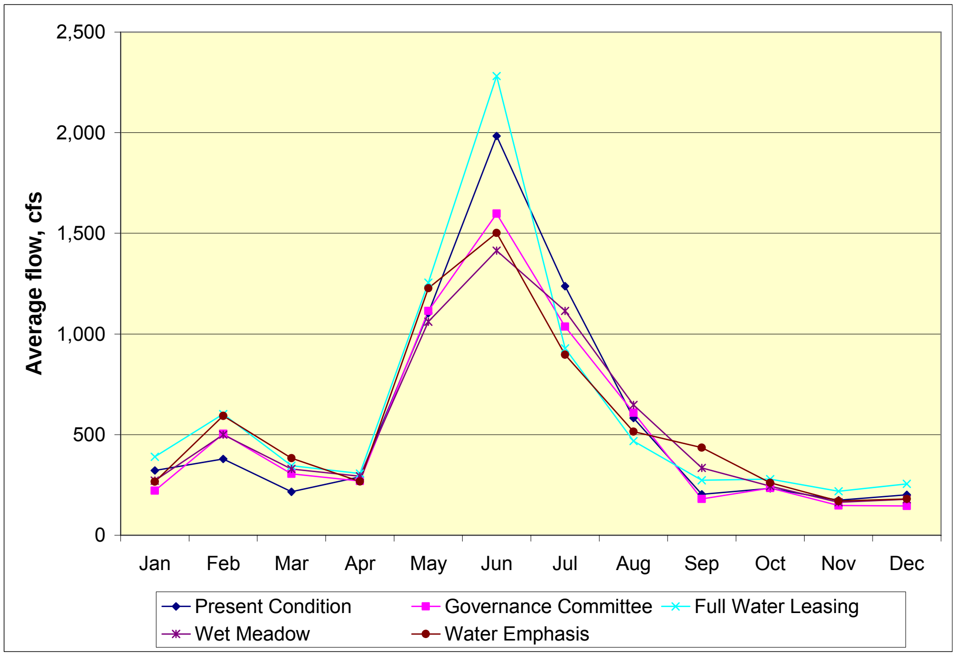


Figure 5-WR-10.—Platte River flows downstream of the Tri-County Diversion Dam under all alternatives.

Flow in the Central Platte Habitat Area

The Platte River flow below the Johnson-2 Return has been simulated for gauges at the towns of Overton, Odessa, and Grand Island, Nebraska. Overton (figure 5-WR-11) is the uppermost gauge in the Central Platte Habitat Area. The Odessa gauge (figure 5-WR-12) is in the middle portion of the reach within the bypass reach of the Kearney Canal diversion. The Grand Island gauge (figure 5-WR-13) is at the lower end of the Central Platte Habitat Area and downstream of the Kearney hydro return. See the "Geographic Markers" section in chapter 4 for a map of these gauges.

All three gauges show the general pattern of high late-winter flows followed by a larger late-spring peak in flow that generally coincides with high South Platte flow and spills from Lake McConaughy. Flows are lowest in the reach during the summer. All alternatives, except the Full Water Leasing Alternative, would tend to reduce December and January flows and increase spring, late summer, and early fall flow levels, and all alternatives would increase average annual flows compared to the Present Condition.

In May, the Governance Committee Alternative, along with the Full Water Leasing and Water Emphasis Alternatives, would provide the highest average flow levels. During summer, all alternatives would result in higher average flows than under the Present Condition. During December and January, all alternatives would reduce flows.

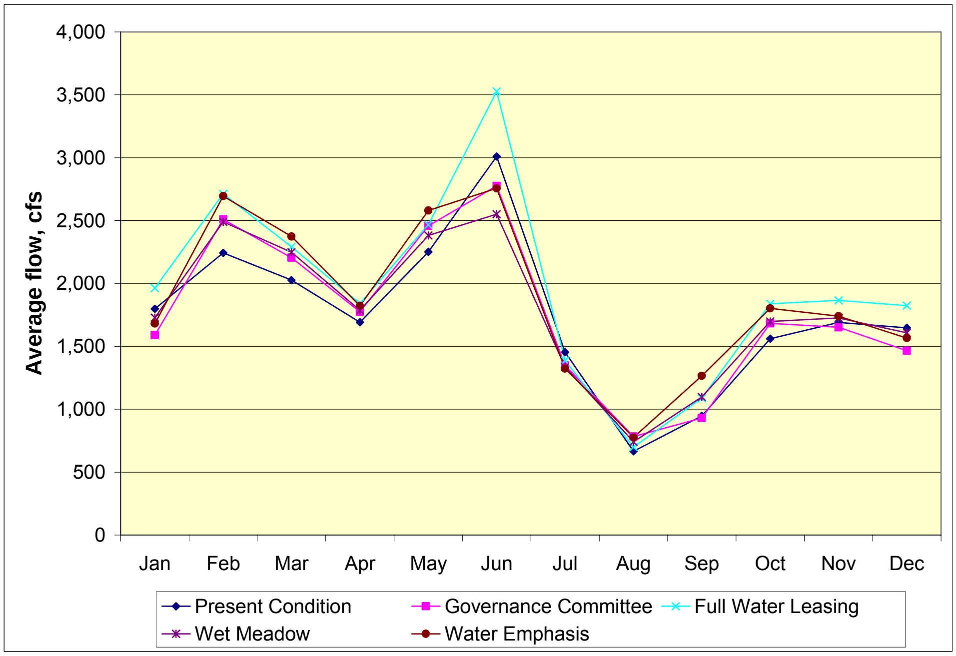


Figure 5-WR-11.—Platte River flows at Overton, Nebraska, under all alternatives.

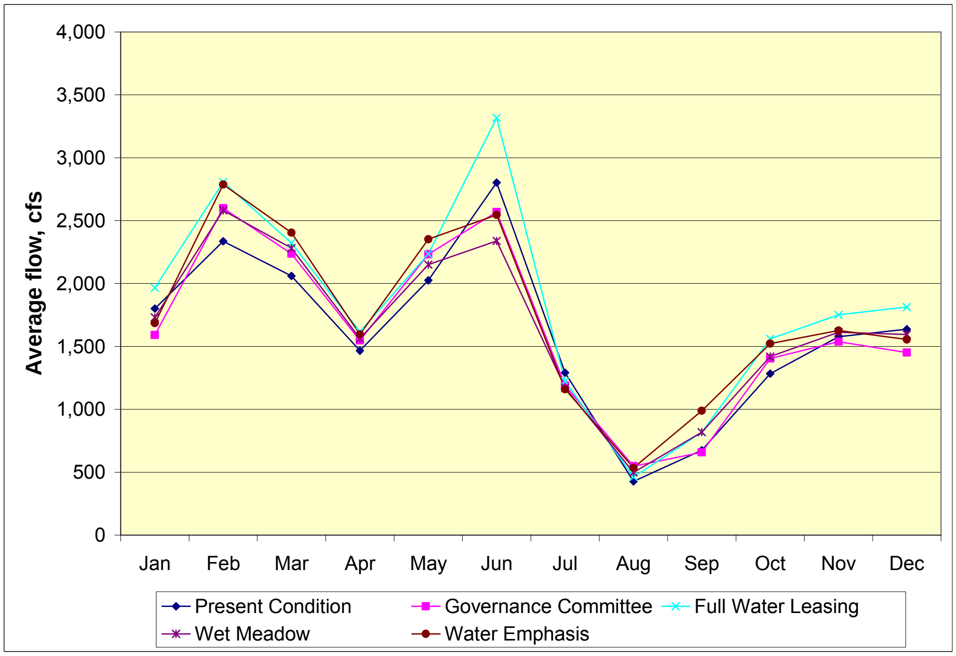


Figure 5-WR-12.—Platte River flows at Odessa, Nebraska, under all alternatives.

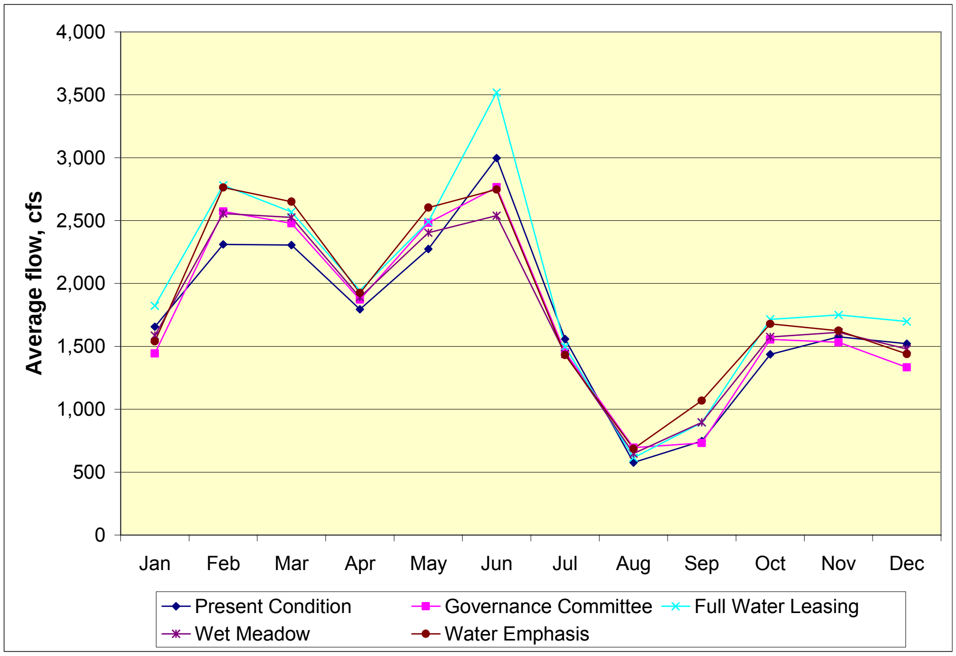


Figure 5-WR-13.—Platte River flows at Grand Island, Nebraska, under all alternatives.

Achievement of Target Flows

All action alternatives improve the achievement of the U.S. Fish and Wildlife Service (Service) species flows and annual pulse flow targets at Grand Island, Nebraska, as shown in table 5-WR-26. The Governance Committee and Full Water Leasing Alternatives increase achievement of target flows by roughly 150 and 137 kaf, respectively, on an average annual basis. The Water Emphasis Alternative shows the most improvement, reflecting the increased focus on meeting target flows, and the Wet Meadow Alternative shows the least improvement, reflecting the reduced focus on meeting target flows.

Peak Flows in the Central Platte Habitat Area

A common effect of each alternative is to decrease the magnitude and frequency of the highest peak flow events in the Central Platte River. This decrease is primarily due to the allocation of a portion of the existing water supply to environmental purposes, which reduces reservoir storage and spills. This is also due to a projected reduction in the magnitude of some South Platte River peak flows from the Program's First Increment changes in South Platte River water use.

Figure 5-WR-14 shows the recurrence frequency of the highest flows (top 20 percent) that occurred in the study period (1947 through 1994). (Note that only the highest 20 percent of the maximum daily flows are shown for clarity). For example, under the Present Condition, the highest peak daily flow of approximately 28,000 cfs is reduced to approximately 24,000 cfs or less in each alternative, except the Full Water Leasing Alternative. For the daily peaks which occurred 10 percent of the time (roughly 5 years out of 48), the Present Condition peak of approximately 16,250 cfs is reduced to 16,000 cfs or less by each alternative. These higher peak flows are important to the formation and maintenance of habitats used by the target species. The effects of the peak flow reductions on habitat are discussed in the "River Geomorphology," "Whooping Crane," and "Least Tern and Piping Plover" in this chapter.

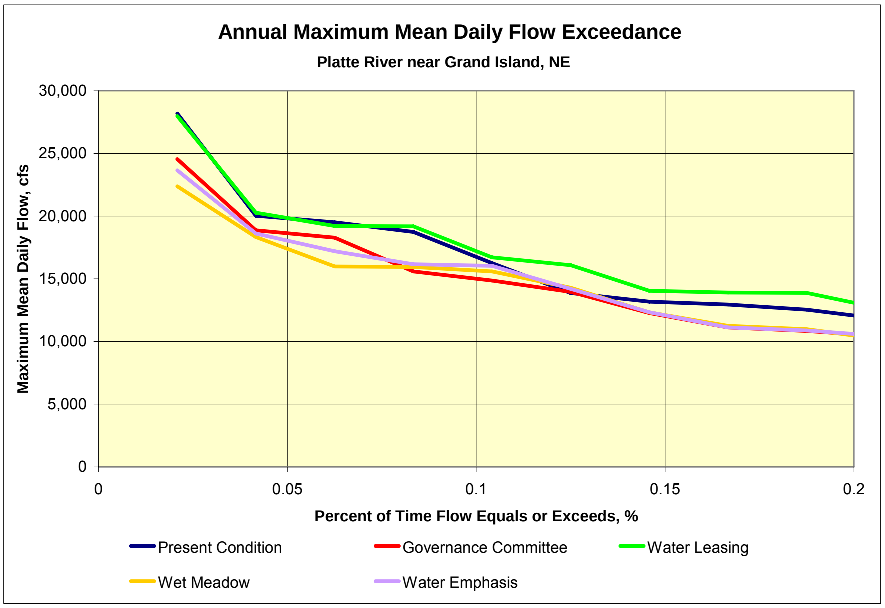


Figure 5-WR-14.—Effect of the alternatives on highest annual flows in the Central Platte Habitat Area.

Figure 5-WR-15 shows the recurrence frequency of all flows that occurred in the study period (1947 through 1994). The decreases in the highest peak flows discussed above are shown (0 to 20 percent portion of the graph), while increases in the frequency of annual peak flows in the 5,000-cfs to 8,000-cfs range (the 20-percent to 100-percent portion of the graph) are also illustrated. Increased occurrences of peak flows in the 5,000-cfs to 8,000-cfs range are primarily due to Program water releases to create short-duration high flows within the channel's flood capacity level. All alternatives significantly increase the occurrence of short-duration near-bankfull flows. These effects are discussed in the "Achievement of Short-Duration Near-Bankfull Flows" subsection below.

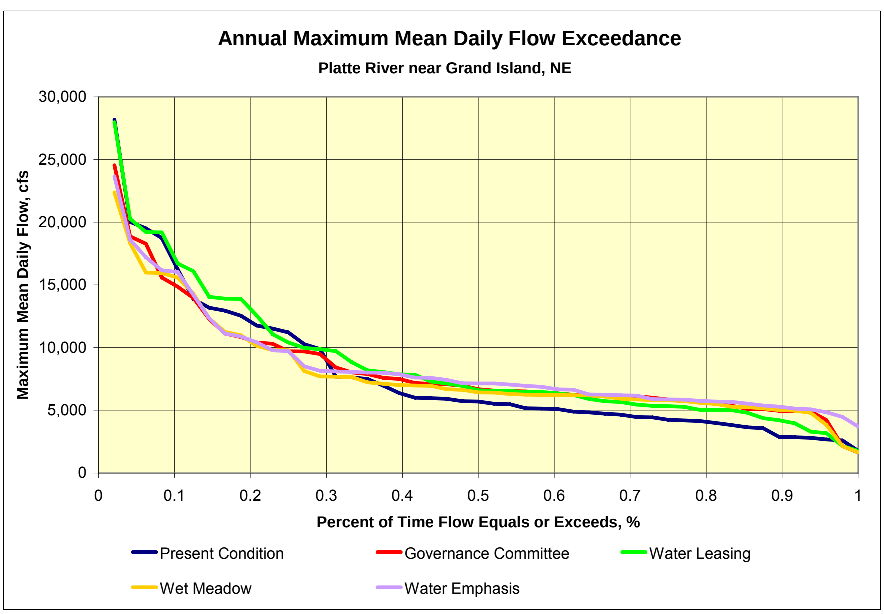


Figure 5-W-15.—Effect of the alternatives on the full range of flows in the Central Platte Habitat Area.

Sutherland and Tri-County Supply Canals

The Sutherland Canal is supplied with water from both Keystone Diversion Dam on the North Platte River and Korty Diversion Dam on the South Platte River. The minimum flows diverted at Keystone would range from a low of 200 cfs under the Present Condition to 250 cfs for all other alternatives. As table 5-WR-22 shows, flows in the Sutherland Canal will tend to be greater in the winter (October through March) and greater in the summer (April through September) for the Governance Committee and Wet Meadow Alternatives. The summer increases are primarily due to increased flows in April and May. The decreases in the summer for the Full Water Leasing and Water Emphasis Alternatives are due to the large amounts of leasing of consumptive use that are included in these alternatives. Reduced flows in the summer also occur at the Korty (Sutherland) Diversion Dam under the Full Water Leasing Alternative because of leasing of consumptive use in Colorado.

The Tri-County Supply Canal diverts water from the Platte River at the confluence of the North and South Platte Rivers and downstream of the Sutherland Canal Return. As table 5-WR-22 shows, average flows in the Tri-County Supply Canal will tend to be greater in the winter and in the summer under all alternatives, with the exception of summer flows under the Full Water Leasing Alternative, which will remain largely unchanged. This tendency for increased diversions under the action alternatives reflects an increased volume of Platte River flows occurring at times and rates that correspond to available capacity in the Tri-County Supply Canal system.

Table 5-WR-22.—Seasonal Average Monthly Flows* Under the Present Condition
and Percent of Change for Each Alternative When Compared to the Present Condition

	Winter Average	**Summer Average**
Keystone (Sutherland) Diversion		
Present Condition	**793 cfs**	**1,071 cfs**
Governance Committee Alternative	4 percent	2 percent
Full Water Leasing Alternative	21 percent	-9 percent
Wet Meadow Alternative	6 percent	6 percent
Water Emphasis Alternative	19 percent	-5 percent
Korty (Sutherland) Diversion		
Present Condition	**314 cfs**	**263 cfs**
Governance Committee Alternative	12 percent	26 percent
Full Water Leasing Alternative	13 percent	-3 percent
Wet Meadow Alternative	11 percent	20 percent
Water Emphasis Alternative	8 percent	20 percent
Tri-County Diversion		
Present Condition	**1,454 cfs**	**1,730 cfs**
Governance Committee Alternative	3 percent	4 percent
Full Water Leasing Alternative	11 percent	0 percent
Wet Meadow Alternative	4 percent	5 percent
Water Emphasis Alternative	8 percent	3 percent
* Values do not include pulse flow volumes.		

Water Leasing

For these alternatives, it is assumed there would be no water leasing above North Platte. Water leasing has been concentrated downstream of North Platte to minimize the conflicts between the delivery of irrigation water and the delivery of environmental water during drought. The analysis assumed water leasing would occur every year.

Table 5-WR-23 displays the amount of water estimated to be available from water leasing in three reaches of the Central Platte River under the Governance Committee Alternative. (Note that all water leasing for any of the action alternatives will only be from willing participants; therefore, it is not possible to forecast where water might be leased. Table 5-WR-23 simply shows the assumptions made for the purpose of analyzing the system-wide effects of water leasing.)

Table 5-WR-23.—Estimated Water Leasing (kaf)

	Brady-Cozad Reach		Tri-County Supply Canal		Kearney Canal	
	Average Annual Lease Amount	Percent of Annual Demand	Average Annual Lease Amount	Percent of Annual Demand	Average Annual Lease Amount	Percent of Annual Demand
Present Condition	0	0.0	0	0.0	0	0.0
Governance Committee Alternative	1.6	0.9	13.9	6.8	0.3	2.2
Full Water Leasing Alternative	23.8	13.8	28.3	13.8	1.8	13.6
Wet Meadow Alternative	0	0.0	0	0.0	0	0.0
Water Emphasis Alternative	11.9	6.9	14.2	6.9	0.9	6.8

Program water leasing would be highest under the Full Water Leasing Alternative compared to the other action alternatives. However, because all water leasing would be voluntary, this projection is only an estimate. Water leasing is not included in the Wet Meadow Alternative.

Irrigation Deliveries for the Western Canal

The effect of each alternative on years with irrigation shortages for the Western Canal is shown in table 5-WR-24. The reduction in years with shortages is due in part to changes in Colorado Front Range water use during the Program's First Increment.

Table 5-WR-24.—Shortages for the Western Canal

	Years With Shortage	Largest Annual Shortage (kaf)	Percent of Annual Demand
Present Condition	8	4.2	17.6
Governance Committee Alternative	1	1	1.7
Full Water Leasing Alternative	1	1	1.7
Wet Meadow Alternative	1	1	1.7
Water Emphasis Alternative	1	1	1.7

Program Water Accruals by Basin

The term "Program water" refers to the amount of water the models estimate will be managed by the Program for use in the critical habitat reach of the Central Platte River. Table 5-WR-25 displays Program water by month for each Basin under the action alternatives.

Table 5-WR-25.—Average Program Water by Basin (kaf)

Alternative	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
North Platte River Basin													
Governance Committee	0	0	0	0	0	0	0	0	35.0	0	0	0	35.0
Full Water Leasing	0	0	0	0	0	0	0	0	44.0	0	0	0	44.0
Wet Meadow	0	0	0	0	0	0	0	0	66.0	0	0	0	66.0
Water Emphasis	0	0	0	0	0	0	0	0	80.3	0	0	0	80.3
South Platte River Basin													
Governance Committee	0	0	0.8	2.9	2.6	0	0.1	4.4	0.3	1.9	0	0	13.0
Full Water Leasing	0	0	0	0	22.3	16.7	0	0	0	0	0	0	39.0
Wet Meadow	0	0	0.2	1.6	1.6	0	0.3	2.6	0.6	1.2	0	0	8.1
Water Emphasis	0	0	0.6	3.5	21.7	8.3	1.1	5.4	0.7	2.3	0	0	43.6
Central Platte River Basin													
Governance Committee	9.7	7.0	7.4	9.4	1.2	1.6	2.4	2.5	1.2	30.4	10.5	9.4	92.8
Full Water Leasing	0	0	0	0	0	0	0	0	0	54.2	0	0	54.2
Wet Meadow	7.2	7	7.4	7.2	0	0	0	0	0	9.9	8.3	7.7	54.7
Water Emphasis	7.8	6.4	7.8	11	2.2	3.8	5.1	5.0	2.1	37.4	8.7	7.8	104.9
Total													
Governance Committee	9.7	7.0	8.2	12.3	3.8	1.6	2.5	6.9	34.1	32.3	10.5	9.4	140.8
Full Water Leasing	0	0	0	0	22.3	16.7	0	0	44.0	54.2	0	0	137.2
Wet Meadow	7.2	7.0	7.6	8.8	1.6	0	0.3	2.6	66.6	11.1	8.3	7.7	128.8
Water Emphasis	7.8	6.4	8.4	14.5	23.9	12.1	6.2	10.4	83.1	39.7	8.7	7.8	228.8

Achievement of Short-Duration Near-Bankfull Flows

A flow management strategy, described in the Adaptive Management Plan, is the creation or augmentation of higher flows within channel capacity in the Central Platte Habitat Area to discourage establishment of vegetation in the channel and to promote creation and mobilization of sandbars. As identified in chapter 3, "Description of the Alternatives," short-duration near-bankfull flows within the existing channel for approximately 3 days are needed to help achieve these aims. Table 5-WR-26 summarizes the achievement of these short-duration near-bankfull flows as simulated for this analysis. The table displays average and maximum volumes of water, in acre-feet, used to create these short-duration near-bankfull flows. It also displays average and maximum flow, in cfs, during these releases at various locations on the river for each alternative.

The volumes shown in table 5-WR-26 are the change in volume of flow during the 3-day event, not the total volume at that point in the river or canal system. Conversely, the flows in table 5-WR-26 are the total flow (maximum or average) for the event, at each point of measurement. Negative changes in volume result from reduced diversions at the Tri-County Diversion Dam, compared to the Present Condition.

Table 5-WR-26.—Short-Duration Near-Bankfull Flows Under Each Alternative

Alternative	Average Pulse Volume (Acre-Feet)	Maximum Pulse Volume (Acre-Feet)	Average Flow During a Pulse Release (cfs)	Maximum Flow During a Pulse Release (cfs)
McConaughy Release				
Governance Committee	34,266	64,563	3,913	5,517
Full Water Leasing	27,380	82,024	3,106	5,187
Wet Meadow	31,481	66,909	3,880	5,700
Water Emphasis	35,534	86,284	3,967	5,700
North Platte River				
Governance Committee	22,708	55,504	2,395	3,500*
Full Water Leasing	14,703	43,996	1,775	3,500
Wet Meadow	20,742	53,360	2,325	3,500
Water Emphasis	21,698	65,620	2,374	3,500
Sutherland Canal				
Governance Committee	9,692	23,951	1,729	2,100
Full Water Leasing	13,850	29,271	1,831	2,100
Wet Meadow	9,014	20,133	1,769	2,100
Water Emphasis	12,346	26,890	1,861	2,100
Tri-County Canal				
Governance Committee	-739	-1,874	1,661	2,024
Full Water Leasing	-1,142	-2,815	1,414	1,499
Wet Meadow	-796	-1,849	1,424	1,823
Water Emphasis	-904	-2,202	1,514	1,770
Platte River Upstream of the Jeffrey Return Channel				
Governance Committee	32,532	58,944	3,466	5,068
Full Water Leasing	25,789	73,272	2,969	5,106
Wet Meadow	29,869	59,255	3,388	6,463
Water Emphasis	34,407	81,958	3,807	7,021
Platte River Downstream of the Jeffrey Return Channel				
Governance Committee	33,944	62,716	3,942	5,675
Full Water Leasing	27,095	76,121	3,361	5,844
Wet Meadow	31,364	62,191	3,912	6,091
Water Emphasis	35,803	84,737	4,167	6,664
Platte River Downstream of the Johnson-2 Return				
Governance Committee	36,479	69,585	4,900	7,837
Full Water Leasing	33,375	80,121	4,716	8,268
Wet Meadow	33,917	66,191	4,793	8,006
Water Emphasis	38,253	89,138	5,006	8,852

* The Governance Committee Alternative commits to restoring at least 3,000 cfs of safe-channel conveyance capacity in the North Platte River by year 5 of the Program as part of a suite of activities to test the Program's ability to deliver 5,000 cfs of Program water to the habitat reach for 3 days during the nonirrigation season. For this analysis, the conveyance capacity of this reach was set at 3,500 cfs to facilitate modeling the quantity of water required to achieve the 5,000 cfs target. However, it is recognized that measures other than establishing this conveyance capacity are likely to be tested as viable alternatives during the Program's First Increment.

Figure 5-WR-16 shows years that have peak flows in various flow ranges at Grand Island, Nebraska. As the figure shows, all action alternatives significantly increase flows in the 5,000- to 7,000-cfs flow range compared to the Present Condition. More modest increases are created for flows in the 7,000- to 8,000 cfs range.

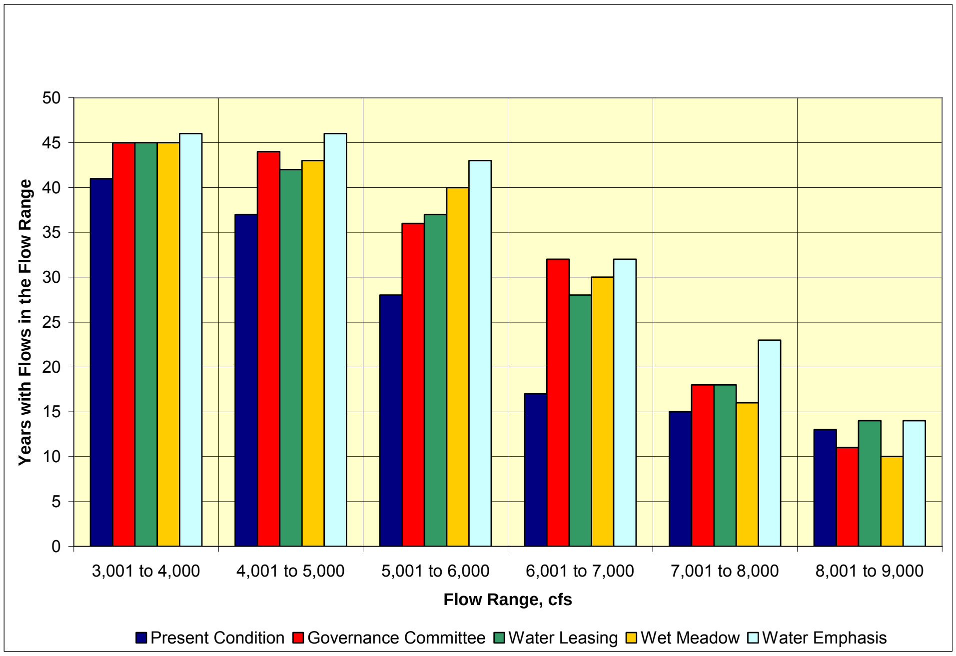


Figure 5-WR-16.—Years out of 48 that have flows at Grand Island, Nebraska, in or above the specified flow range.

Table 5-WR-27 summarizes operation of and releases from the Lake McConaughy EA under each alternative. The reductions in shortages to species and annual pulse flow targets are the measure of hydrologic benefits provided by the Program. All alternatives, except for the Wet Meadow and Water Emphasis Alternatives, are in the 130- to 150-kaf target established by the Cooperative Agreement. Table 5-WR-27 displays the number of years that short-duration near-bankfull flow releases are made, along with whether the short-duration near bankfull flow release was limited by the channel capacity in the North Platte River at North Platte, Nebraska (see chapter 2, "History of Habitat Use and Habitat Trends for Target Species"). The final column shows the number of years that other EA releases are limited by the channel capacity in the North Platte River at North Platte, Nebraska.

Table 5-WR-27.—Program Achievement of Target Flows and Short-Duration Bankfull Flows

	Reductions in Shortages to Species and Annual Pulse Flow Targets (kaf)	Years With Pulse Releases	Years Pulse Release Limited by North Platte Channel Capacity	Years Other EA Releases Limited by North Platte Channel Capacity
Present Condition	0	0	0	0
Governance Committee Alternative	150	30	7	0
Full Water Leasing Alternative	137	24	2	1
Wet Meadow Alternative	116	28	5	0
Water Emphasis Alternative	184	32	11	1

Figure 5-WR-17 shows the average daily flows at Overton, Nebraska, for the Governance Committee Alternative and for the Present Condition. The figure also shows the Service instream flow recommendation for each month of an average year. All other alternatives are similar to Governance Committee Alternative.

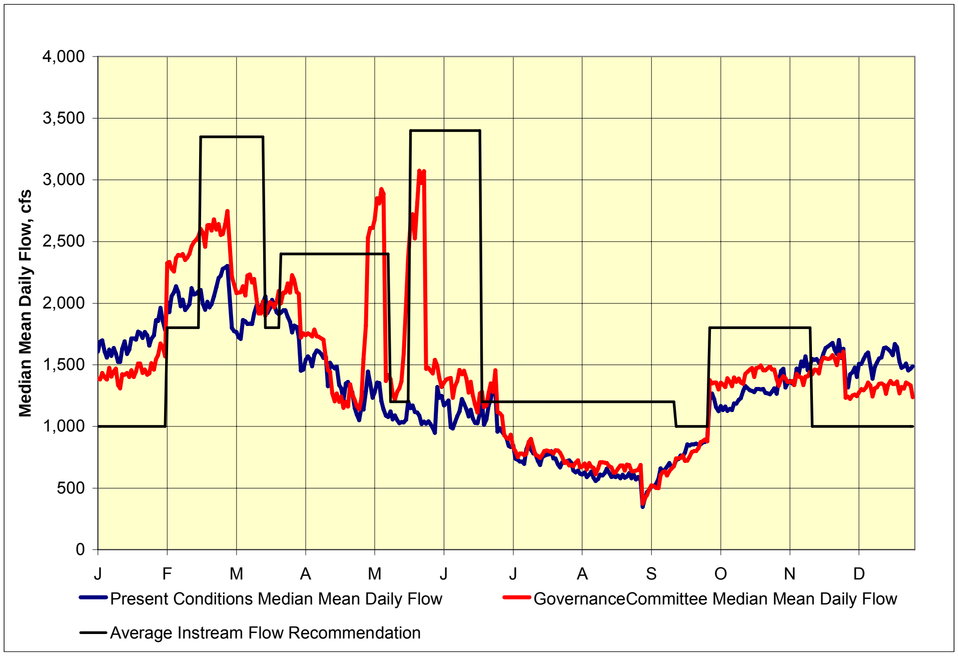


Figure 5-WR-17.—Median Platte River daily flows at Overton, Nebraska, for the Present Condition and Governance Committee Alternative, compared to "normal year" target flows.

Pulse Releases Through the Brady-Cozad Reach of the Central Platte River

The water operations simulated for each alternative include the creation of 2- to 3-day high flows near bankfull in the Central Platte Habitat Area in May to remove new vegetation from sandbars, build higher sandbars to provide more secure nest sites for interior least terns and piping plovers, and achieve other changes in channel morphology that support desirable habitat conditions for the target species. The modeling of these pulse flow releases from Lake McConaughy creates peak flows through the habitat reach (Lexington to Grand Island), ranging from 5,600 to 8,600 cfs, depending upon the alternative. These peaks are well within the channel capacity in the habitat reach.

In the Brady to Cozad reach of the Central Platte River, these pulse releases would create peak flows in the range of 3,800 to 7,100 cfs. Because most riverflows in this reach have been diverted through the Tri-County Supply Canal for the past 60 years, there is no question that this section of the river has lost a substantial amount of its carrying capacity. Therefore, the potential for localized, out-of-bank flooding merits additional attention in this area.

Today, the Platte River at Cozad, Nebraska, has two main channels. The south channel seldom receives any flow from the Platte River, due to sand dams (dikes) that keep all of the flow in the north channel for diversion into the Cozad Canal. The south channel is only used when high flows wash out the sand dams, allowing water to flow into the south channel. The volume of flow needed to wash out the sand dam is not currently known.

The flood stage in the north channel of the Platte River at Cozad, Nebraska, set by the National Weather Service (NWS) is 6.5 feet. The NWS estimates that a stage of 6.5 feet corresponds to a flow of 3,000 cfs. The current stage versus discharge table available from the Nebraska Department of Natural Resources (NDNR) ends at a stage of 4.2 feet; thus, it is not possible to determine the exact flow that corresponds to the stage of 6.5 feet.

The National Weather Service (NWS, 2006) Web site indicates that "minor lowland flooding occurs as both banks overflow at 6 feet, water will enter the KOA campground upstream south of Gothenburg (sic)" (Central Platte Natural Resources District, 2003, personal communication, Duane Woodward). Woodward indicated that the flooding at Gothenburg may be due to the river turning to go under Interstate 80. At high flows, water does not make the turn and flooding occurs. Woodward also stated that flooding occurs with flows over 10,000 cfs, as with the flood that occurred in 1999, but he is not aware of any problems at lower flows. Woodward says there are problems at Brady during the summer when irrigation water is being delivered, but most of that water is diverted above Cozad.

Available information for the Brady to Overton reach strongly suggests that peak flows of the magnitude likely to be created by the Program (below 10,000 cfs) can be safely moved through this area without causing out-of-bank flooding. Flows in this area reached a peak at the Overton gauge of 14,000 cfs from June 10, 1995, to near the end of the month. Aerial surveys of the river, as well as discussions with civil defense authorities in the affected counties, did not reveal significant out-of-bank flooding or damage. In Lincoln County (Brady area), the civil defense coordinator called the damage "negligible," including some water in basements, a few storm sewers backed up in the North Platte area, and small amounts of cropland flooded between Maxwell and Brady. In Dawson County (Cozad area), the coordinator indicated that the river was within its high banks, while the forested area between channels was flooded. A sandpit washed out near Gothenburg (Service, 1995, personal communication, John Sidle).

The Basin, Nebraska, Level B Study, Flood Damage and Control (Missouri River Basin Commission, March 1975) reports that no damage occurs at flows below 10,800 cfs in the Cozad to Overton reach and below 10,700 cfs in the Brady to Cozad reach. The Level B study is currently used by the NDNR to determine damaging flood levels in this reach (NDNR, 2003, personal communication, Brian Dunnigan).

Given that the NWS has established flood stage for only one channel of the Platte River at Cozad; given the lack of significant out-of-bank flooding during historic floods greater than 10,000 cfs; and given the large difference between the Level B study and the current NWS flood stage, it appears that flows in the 7,000-cfs range can be moved through the Cozad to Overton reach of the Platte River without causing significant out-of-bank flows. However, conveyance capacity in this reach must be determined more accurately by the Program prior to pulses greater than 3,000 cfs in this reach.

New Water Uses in Each State

The "New Water Uses in Each State" subsection in the "Water Resources" section in chapter 4 describes how new water uses are developed in each state under the Present Condition. This section describes how the development of new water uses in the Basin might be affected, or not affected, by implementation of a program.

Wyoming

As described in chapter 4, the Platte River and Laramie River in Wyoming have been overappropriated for many years. Therefore, the effects on riverflows of any significant new use of water must be mitigated by retiring an equal existing use, or otherwise offsetting depletions to keep downstream water users whole. Water right transfers, whereby only the historic consumptive use can be transferred, will not be affected by the Program.

Wyoming will issue new water rights for some new uses that do not affect other existing water rights. These new uses are relatively small and typically serve domestic, stock, and miscellaneous purposes. Under the Program, the impacts of these new uses to flows in the Guernsey-to-state-line reach must be mitigated. The effects of the Program on these smaller uses will depend on the ability of the project proponents or the State of Wyoming to meet these mitigation requirements.

Colorado

The State of Colorado has indicated that it will not deny new water rights to water users due to potential shortages to target flows, pulse flows, or peak flows established by the Program. There will be no difference in the way the Colorado water courts decree and approve water use and no difference in the way that the state or division engineers administer existing water rights between present conditions and conditions under the Program.

The South Platte River Basin in Colorado has been overappropriated (meaning more water rights have been decreed than there is water available to fill the decrees) for about 75 years. While there are very limited opportunities for new native appropriations during very high water events, Colorado does not expect extensive development of new native water because undeveloped native flow is very expensive to develop and, due to its junior priority, does not provide reliable yields for municipal water systems.

The available sources for "new" use are those outlined in the Governance Committee Program Document: Attachment 5: Water Plan, Section 9: Colorado's Plan for Future Depletions. The Colorado's Plan for Future Depletions assumes that population growth will result in a net gain in flows to the system because most new sources of water for growth come from changes of irrigation water (by law, changes of water rights are not allowed to adversely affect other existing water rights) or from nontributary or transbasin sources. In the event that the changing water use pattern causes net deficits to monthly flow, Colorado will re-regulate excesses/gains from other months to the deficit month through the various elements of its Plan for Future Depletions.

The proposed Program does not manage or otherwise control Colorado or Front Range water use in any way. The approach that the Program takes, in terms of future water use in the Colorado South Platte River Basin, is to track the changing pattern of water sources and use, to calculate how those changes (compared to the 1997 baseline) will affect the pattern of flows at the Julesberg gauge, and then operate Colorado's new depletion management plan elements in the Lower South Platte to re-time flows leaving the state to offset any adverse effects on Central Platte River flow targets.

Elements of the Colorado's Plan for Future Depletions may "compete" to some extent with other water users required by recent statute to further develop well augmentation plans in the Lower South Platte. On the other hand, there is potential for the Colorado's Plan for Future Depletions to offset adverse effects on Central Platte River flow targets using the same diversion and recharge facilities used by the well augmentation plans. Further, it is hoped that the Program, by providing a single source of retiming in the Lower Platte for all new upstream Colorado water uses, will reduce the total number and size of re-regulation facilities that might be required for Endangered Species Act (ESA) compliance.

Nebraska

Under Legislative Bill 962 (LB962), the NDNR (has designated nearly all of the Platte River above the Kearney Canal diversion as overappropriated and most of the Basin above Columbus as fully appropriated. Thus, new water development activities from surface supplies in this part of the Basin is unlikely. Some additional new water use, based on groundwater supplies, may be allowed if it will not adversely affect current uses of Platte River flows.

As part of the proposed Program, Nebraska's new depletion management plan states that, starting in 2006, a new water user will be responsible for avoiding or offsetting adverse impacts to "state-protected flows." The elements of those flows are: (a) flows needed by surface water appropriators for existing diversion and storage rights; (b) Nebraska instream flow appropriations; (c) flows needed to prevent loss of water supply for wells dependent upon stream flow for recharge; and (d) flows needed to implement the Program's Water Action Plan.

If there is no Program, the Nebraska Department of Natural Resources and Natural Resources Districts' Integrated Management Plan for any fully appropriated or overappropriated Basin and the controls and incentives to implement that Integrated Management Plan will have to provide protection for Nebraska uses (a), (b), and (c), but not for use (d), the flows needed to implement the Program's Water Action Plan. Because the Integrated Management Plans for the presently designated areas have not yet been developed, it is not known to what extent the responsibility for ensuring protection, with or without a Program, will rest on the shoulders of the new water users and the extent to which it might be provided through incentives funded by the state or by some other entity.

The incremental impact of the Program on individual new water users will likely be greatly reduced as a result of the implementation of Legislative Bill 962 (LB962). The Program's incremental impact on the State of Nebraska as an entity may be significantly greater than the impact on those individual water users. For the state, the effect of the Program is clear—to offset for any adverse impacts to Service target flows. Under the state's Depletion Management Plan for new uses,[5] the state will be responsible for offsetting all depletions to target flows caused by uses begun between July 1, 1997, and December 31, 2005, and for any otherwise unmitigated depletions to those flows caused by uses begun after December 31, 2005. Accomplishing those objectives may involve payment to existing water users to curtail or reduce water use, or other projects to reduce demand or to retime flows in the river.

[5] Governance Committee Program Document Attachment 5: Water Plan, Section 8. Nebraska New Depletion Plan.

RIVER GEOMORPHOLOGY

Issue: How would the action alternatives affect channel geomorphology which, in turn, affects the preferred habitat for the target species (i.e., braided river form) in the Central Platte River channel?

Overview

SCOPE

This section describes the effects of the Program alternatives on the geomorphology of the Platte River from near Lexington, Nebraska, downstream to Chapman, Nebraska (see the "Geographic Markers" subsection in the "Introduction" section in chapter 4), compared to the Present Condition.

Chapter 2 discusses the importance and evolution of the desired river habitat, while chapter 4 describes the Present Condition and the factors that influence braided plan form under the Present Condition. The Present Condition is represented by analyzing the river as currently managed over the 48-year hydrologic record (see chapter 4, "Affected Environment and the Present Condition" for a discussion of the Present Condition). The alternatives are represented by evaluating the river's geomorphology over the same 48-year hydrologic record, but with the land and water actions associated with each alternative in place.

INDICATORS

The volume and occurrence of riverflows, availability and rate of sediment transport carried by the river, and stability of the riverbanks strongly affected by topography, influence the plan form, cross section, and profile of a river. Changes in river form can decrease or increase habitat for the target species. Each alternative has three components all focused towards improving habitat for the target species:

- **Water Plan:** Actions that alter flow
- **Mechanical Plan:** Actions that alter topography or plan form and remove permanent vegetation
- **Sediment Augmentation Plan:** Actions that provide sand in the river

Each of these components can be measured by indicators selected to assess the impacts of the alternatives on the desired habitat. The general plan form indicators are overall measures that help assess the result of these three components.

- **Flow Indicators:**
    - Mean annual flow
    - 1.5-year peak flows (representing the short-duration near-bankfull flows)
    - Sandbar height potential

- **Sediment transport indicators:**
  - Maximum and stable sediment transport rates
  - Deposition and erosion
- **Plan form indicators:**
  - Increases in braided river
  - Widest water and open view width of the main channel at mechanical action sites
  - Width-to-depth ratio of the main channel
  - Widest water and open view width of the main channel

SUMMARY OF IMPACTS

Flow

The water plan for every alternative is an improvement over the Present Condition. There is an increase in mean annual flow and in the 1.5-year peak flow, representing the short-duration near-bankfull flow, for all alternatives over the Present Condition. Also, the difference in water surface elevation between the mean annual flow and the 1.5-year peak flows, increases substantially for all alternatives compared to the Present Condition. This difference indicates the sandbar-building potential for each alternative. The Governance Committee Alternative provides the most sandbar-building potential and the Full Water Leasing Alternative provides the least.

Sediment

Under the Present Condition, a significant source of sediment to the Central Platte River is erosion of the bed and banks of the river near Overton. Sediment augmentation under the alternatives is a means to minimize riverbed degradation. In addition, because sediment transport generally increases with flows, increasing the mean annual flow and the 1.5-year peak flows for each alternative increases the need for sediment augmentation to curtail increased bed and bank erosion. The Full Water Leasing Alternative requires the largest volume of sediment augmentation, and the Governance Committee Alternative requires the least volume of sediment. The Governance Committee Alternative is the most successful alternative at reducing the current sediment imbalance.

Plan Form

Mechanically consolidating flow from multiple side channels, and clearing and lowering wooded banks and islands in the river channel, provides substantial immediate improvements. These actions increase the reach length of braided plan form. This improvement through mechanical actions can also be focused at specific locations in the river. Not all sites can be improved through mechanical alterations, and changes in flows and sediment augmentation are required in tandem with mechanical actions to build sandbars to sufficient elevations for nesting and rearing habitat and to prevent degradation in the riverbed. The mechanical enhancements in all alternatives improve habitat over the Present Condition. The Water Emphasis Alternative has fewer channel enhancement sites and, therefore, does not provide as many benefits as the Governance Committee, Full Water Leasing, and Wet Meadow Alternatives, which share the same channel enhancement plan.

The width-to-depth ratio of the main channel of the river improves in the degrading and aggrading reaches of the river, but not in reaches with more consistent sediment transport. The Governance Committee Alternative provides more improvement in the degrading reach (Jeffrey Island to Elm Creek) while the Full Water Leasing Alternative provides more improvement in the aggrading reach (Gibbon to Wood River).

There is significant increase in both width of widest water and open view width for all alternatives, with most consistent increases observed in open view width. The Governance Committee Alternative provides more improvement in the degrading reach (Jeffrey Island to Elm Creek). The Full Water Leasing Alternative provides more improvement in the aggrading reach (Gibbon to Wood River)

Conclusion

- **Governance Committee Alternative:** All the alternatives improve physical habitat to some degree over the Present Condition, but from a geomorphic perspective, the Governance Committee Alternative provides the most overall benefit. Shortcomings of the Governance Committee Alternative include the smallest mean annual flow relative to all alternatives, a higher percent of flow conveyed in the Tri-County Supply Canal rather than in the Platte River, and a medium increase in open view width. However, overall benefits of the Governance Committee Alternative include large 1.5-year peak flows for building sandbars, the most successful sediment budget with the least erosion and least deposition, a successful land plan for increasing habitat through increases in length of braided river, and increased width-to-depth ratios and wetted width of the river, most notably in the degrading reach from Jeffrey Island to Elm Creek.

- **Full Water Leasing Alternative:** This alternative does not have as much sandbar-building potential as the Governance Committee Alternative from the 1.5-year peak flows, requires the largest volume of sand to eliminate a sediment imbalance, and creates more deposition. However, this alternative does produce more improvements than the Governance Committee Alternative in width-to-depth ratio, widest water and open view width in the aggrading reach from Gibbon to Wood River.

- **Wet Meadow Alternative:** This alternative provides consistently good improvements, although it never provides the most benefits.

- **Water Emphasis Alternative:** This alternative provides the smallest benefit of the four alternatives, and is the least desirable alternative from a geomorphic perspective. This alternative is limited by its smaller mechanical action plan and by a larger sediment requirement to prevent erosion.

IMPACTS ANALYSIS

All of the alternatives integrate measures which improve the quality of the Central Platte Habitat Area for the target species. Habitat is improved by altering the riverflow regime (water plan), increasing sediment input to the river (sediment augmentation plan), and by mechanically changing the river plan form (mechanical action plan). Increased mean annual and 1.5-year peak flows produce wider rivers with more fluctuation in the water surface elevation. Greater fluctuation in water surface elevation increases the height of sandbars, improves forage fish and pallid sturgeon habitat, and helps sustain areas of wet meadow.

Adding sand to the river reduces the sediment imbalance and leads to a more consistent rate of sediment transport. Sediment augmentation also offsets erosion that accompanies increases in the mean annual and 1.5-year peak flows proposed in the alternatives. Reaches of braided plan form in the Central Platte River exhibit the most consistent rates of transport and provide wider and shallower river channel as well as more in-channel sandbars. Spatially varying sediment transport rates causes multiple reaches with evolving conditions of both degradation and aggradation. Aggradation can lead to avulsion and the continued formation of multiple anastomosed channels in this overwide river corridor as discussed in "River Geomorphology" in chapter 4. Degrading riverbed conditions may result in narrow, deep channels with an anastomosed or meander plan form that provides minimal habitat for whooping cranes, interior least terns, and piping plovers.

Ultimately, flow and sediment actions can instigate desired changes in channel plan form. However, immediate habitat benefits from a plan form change that shifts anastomosed river conditions to braided river conditions can be obtained through mechanical actions that reduce the effect of an overwide river corridor. Mechanical actions also offer the benefit or ability to focus habitat improvements at specific locations along the river.

The desired outcome of the flow, sand, and mechanical enhancement actions includes more variable flow conditions with more frequent high flow events, a more consistent rate of sediment transport, and a braided plan form. As illustrated in the flowchart in figure 5-RG-1, focusing on one or two of the enhancement actions causes only partial or minor improvements in desired habitat, while the same actions combined result in substantially greater increases. There are more immediate results when mechanical actions are added to sediment and flow actions.

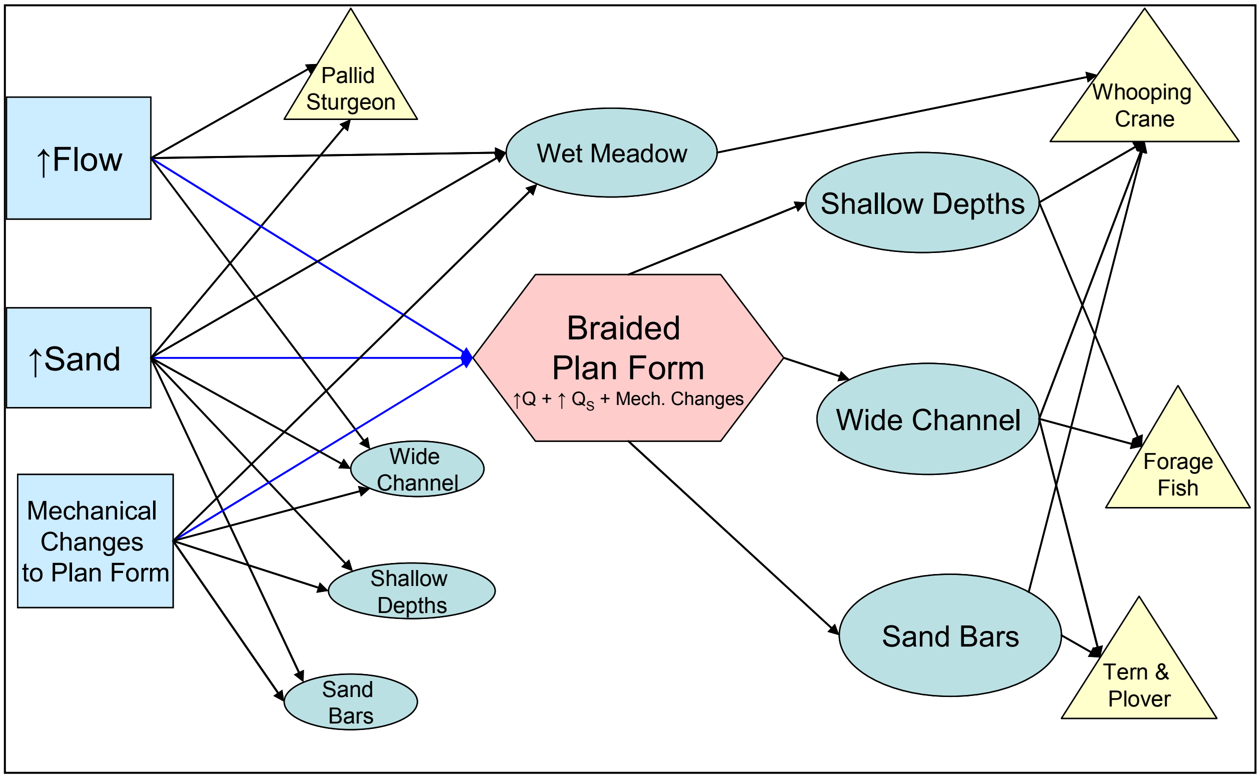


Figure 5-RG-1.—Interactive benefits from water, sediment augmentation, and mechanical actions. Blue boxes denote management activities, green ovals system responses, and yellow triangles the benefitted species.

The enhancement actions proposed under each alternative are listed in table 5-RG-1. There is an individual flow plan for each of the four alternatives, one sediment augmentation plan used by all alternatives, and two plans for mechanical changes to river plan form. The sand augmentation plan and the mechanical plans would be implemented on Program lands acquired from willing sellers.

Table 5-RG-1.—River Components of Alternatives

	Governance Committee Alternative	**Full Water Leasing Alternative**	**Wet Meadow Alternative**	**Water Emphasis Alternative**
Water Plan*	Governance Committee	Full Water Leasing	Wet Meadow	Water Emphasis
Sediment Augmentation	Base Plan	Base Plan	Base Plan	Base Plan
Mechanical Plan	Plan for 5 sites	Plan for 5 sites	Plan for 5 sites	Plan for 3 sites
*Water plans are described in chapter 3.				

The action alternatives are evaluated with respect to the Present Condition using indicators for flow, sediment transport, topography at action sites, and general river plan form. This assessment of alternatives is based on geomorphic and engineering theory and principles. Numerical models support quantitative analysis of the complex flow routing and sediment transport processes. Daily flow values are routed through upstream reservoirs and distribution and hydropower systems by the CPR Model (see the

“Water Resources” section in chapter 4). Reclamation’s Sediment Transport and Vegetation Model (SEDVEG Gen3) (Murphy et. al., 2005) incorporates the daily flow plan, sediment augmentation actions, mechanical actions, and vegetation growth processes into the sediment transport calculations.

Water Plan—Flow Indicators

Water Plan Actions

Each of the four alternative water plans increases the total volume of water (mean annual flow) in comparison to the Present Condition, and also increases the 1.5-year peak flow.[6]

Mean Annual Flow and 1.5-Year Peak Flows

Table 5-RG-2 gives the mean annual flow, the 1.5 year peak flow, and the percent difference relative to the Present Condition. The values are computed from 48 years of flow record and are provided for the Overton and Grand Island areas, as well as the north and south channel of Jeffrey Island. Each alternative may convey flow to Overton in the river via the North Channel of Jeffrey Island, or in the Tri-County Supply Canal via the South Channel of Jeffrey Island. Flows conveyed in the Tri-County Supply Canal exacerbate the sediment deficit in this area, while flows conveyed in the river deliver more sand and decrease the sediment deficit at Overton.

The 1.5-year peak flows are an indicator of the presence of natural and managed short-duration near-bankfull flow events that occur in 2 out of 3 years for each alternative. Regular occurrences of the estimated 1.5-year peak flows event are incorporated into the water plans of the alternatives for improvements to habitat. High flow events can reduce bank stability by scouring seedlings and restricting vegetation growth to higher elevations on the riverbanks. In addition, greater fluctuations in water surface elevations that result from increased short-duration near-bankfull flows set a higher elevation for sandbar formation. Essentially, the short-duration near-bankfull flow maximizes the river width and the sandbar height that can result from a volume of water.

[6]1.5-year peak flows in this analysis are the highest mean daily flows over a 1-5-return interval.

Table 5-RG-2.—Mean Annual Flow and the 1.5-Year Peak Flows for All Alternatives, and Percentage Difference Relative to the Present Condition

Location	Present Condition	Governance Committee Alternative	Full Water Leasing Alternative	Water Emphasis Alternative	Wet Meadow Alternative
North Channel of Jeffrey Island					
Mean annual flow (cfs)	886	834	1,015	949	884
Percent change from Present Condition	—	(-) 6 percent	15 percent	7 percent	0 percent
1.5-year peak flows (cfs)	1,948	3,896	3,509	4,167	4,074
Percent change from Present Condition	—	100 percent	80 percent	114 percent	109 percent
South Channel of Jeffrey Island					
Mean annual flow (cfs)	867	927	960	960	930
Percent change from Present Condition	—	7 percent	11 percent	11 percent	7 percent
1.5-year peak flows (cfs)	1,701	1,921	1,926	1,911	1,857
Percent change from Present Condition	—	13 percent	13 percent	12 percent	9 percent
Platte River at Overton, Nebraska					
Mean annual flow (cfs)	1,751	1,799	1,974	1,908	1,814
Percent change from Present Condition	—	3 percent	13 percent	9 percent	4 percent
1.5-year peak flows (cfs)	3,696	5,800	5,001	5,722	5,636
Percent change from Present Condition	—	57 percent	35 percent	55 percent	52 percent
Platte River at Grand Island, Nebraska					
Mean annual flow (cfs)	1,746	1,796	1,973	1,905	1,809
Percent change from Present Condition	—	3 percent	13 percent	9 percent	4 percent
1.5-year peak flows (cfs)	4,609	6,026	5,639	6,182	5,760
Percent change from Present Condition	—	31 percent	22 percent	34 percent	25 percent
Average of Overton and Grand Island, Nebraska					
Mean annual flow	1,748	1,797	1,973	1,906	1,811
1.5-year peak flows	4,153	5,913	5,320	5,952	5,698
3-year flow	6,803	7,371	7,842	7,539	7,006
5-year flow	10,625	9,612	11,046	9,848	9,401

All of the water plans assume that the volume and peaks of short-duration near-bankfull flows can be conveyed from the Kingsley Dam at Lake McConaughy downstream to Grand Island. However, aggradation at North Platte currently limits the high flows that can be released from the Lake McConaughy (see "Changes to Sediment Transport Near North Platte, Nebraska " sidebar in chapter 2), and methods to reinstate the needed flow capacity are presented in a report by JF Sato and Associates (2005). There is also a high degree of interaction between groundwater flows and Platte River flows (Sanders, 2001). After low flow periods, the initial peaks of a short-duration near-bankfull flow event attenuate, due to bank storage in the more than 160 miles between Lake McConaughy Reservoir (where flows are released) and Grand Island (Reclamation) estimates attenuation using the HECRAS unsteady flow model and an additional procedure to account for bank storage losses to or gains from groundwater (Samad and Randle, 2006).

Although the short-duration near-bankfull flows increase the potential height of sandbars, they also cause an exponential increase in the transport of sediment ($Q_s = f(Q^{2\text{ to }3})$ where "Qs" is sediment load and "Q" is flow) (Julien, 1995) and increase the potential for erosion. This effect, in addition to the existing sediment imbalance, requires the incorporation of sediment augmentation as an important supporting action of the proposed flow plans.

Table 5-RG-2 shows the Full Water Leasing Alternative annually delivers the greatest volume of water, and the Governance Committee Alternative delivers the least volume of water. However, on average across the entire reach from Overton to Grand Island, the Governance Committee and Water Emphasis Alternatives have the largest 1.5-year peak flows, while the Full Water Leasing Alternative has the smallest 1.5-year peak flows.

Based on mean annual flow conditions, the Full Water Leasing Alternative is the only alternative that conveys more than half the flow in the North Channel of Jeffrey Island and less than half the flow in the Tri-County Supply Canal to help reduce the sediment deficit. The Governance Committee Alternative conveys 100 cfs more in the Tri-County Supply Canal than in the North Channel of Jeffrey Island. During 1.5-year peak flow events, the Full Water Leasing Alternative is the only alternative that does not double the flows conveyed in the river via the north channel of Jeffrey Island, but it has a substantial increase of 80 percent over Present Condition flows. In all alternatives, the increase in flow conveyed in the Tri-County Supply Canal via the south channel of Jeffrey Island is between 9 and 13 percent. The increase in flows down the North Channel of Jeffrey Island is regarded as a benefit, since more sand will be delivered to the sediment deficient reach near Overton. The source of this increase in sand delivery would be the bed of the channel in the North Channel of Jeffrey Island. With time, the sand source would migrate upstream to the Lexington area. Limited data indicate that reaches of the river from Cozad to Lexington are depositional, with some degradation in the North Channel of Jeffrey Island. More data are needed to define the changes over time in this river reach.

Table 5-RG-2 also shows an average of the Overton and Grand Island flows at the 3- and 5-year flow events. As described in "Water Resources" in chapter 5, flows from the rare flow events have been shifted to make small increases in the more frequent 1.5-year peak flow events. In the mid-range of high flow events (i.e., 5-year event), the alternatives show less change, and the Present Condition 5-year peak flows are similar or larger than those of the alternatives (table 5-RG-2).

Sandbar Height Potential

Figure 5-RG-2 shows the difference in water surface elevation between the mean annual and the 1.5-year peak flows event for each alternative. This difference in water surface elevation represents the height a sandbar can protrude above the water surface for a majority of the year. The Program focuses on sandbars formed at the 1.5-year peak flow recurrence interval, since these bedforms are actively reworked by flows in the channel at a frequency that prevents the substantial establishment of vegetation. Sandbars with high vegetation interrupt the sight distance across the river for whooping cranes and do not provide preferred nesting habitat for interior least terns and piping plovers. Under the Present Condition, as observed from 1998 infrared aerial photographs (Friesen et al., 2000) and United States Geological Survey (USGS) 1999 to 2001 black and white photographs (NDNR, 2000), there are multiple submerged bedforms in braided reaches, but very few protrude as in-channel sandbars with minimal vegetation.

The flows used to compute the water surface elevations were the averages of Overton and Grand Island values as shown in table 5-RG-2. Values are computed using the evolving riverbed from the SEDVEG Gen3 model. The difference in the water surface elevation at the mean annual flow and the water surface elevation at the 1.5-year peak flow is given as a percent change from the Present Condition and is an average based on 48 years of flow record. Values of water surface elevation are computed from the SEDVEG Gen3 model, which models the evolving changes in the riverbed. The Central Platte River from the South Channel of Jeffrey Island to Chapman has been divided into four reaches, and results are presented for each of the four reaches. These reaches were chosen based on sediment transport characteristics as discussed under the Sediment Augmentation Plan. All the alternatives produce significant differences in water surface elevation for sandbar-building potential. The Governance Committee, Wet Meadow, and Water Emphasis Alternatives have differences in water surface elevations of greater than 50 percent, with the Governance Committee Alternative showing the largest differences. The Full Water Leasing Alternative produces the least difference in water surface elevations, or sandbar-building potential, but still shows a 25 to 30 percent increase.

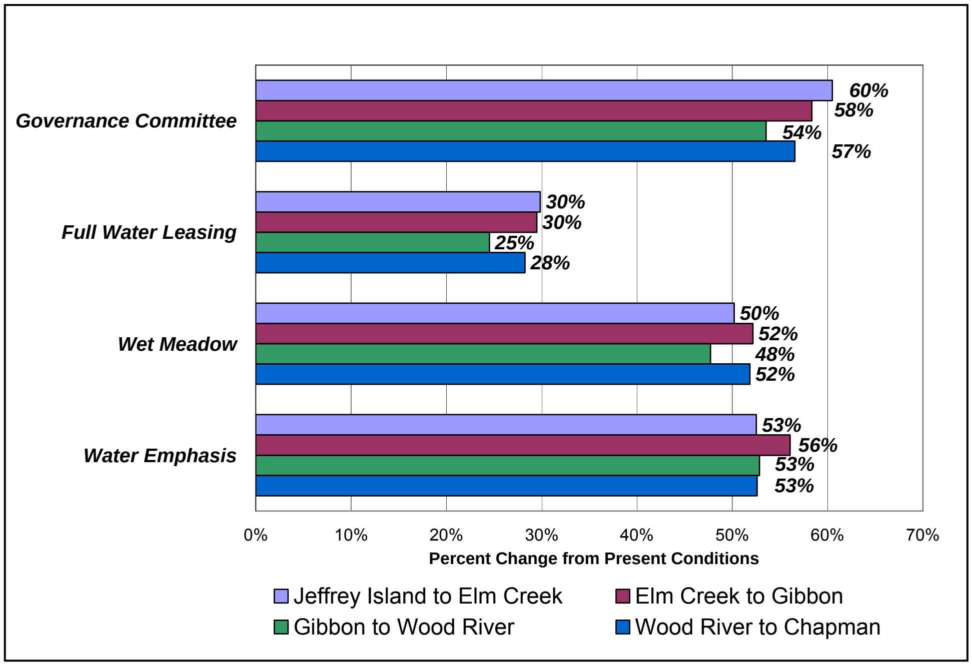


Figure 5-RG-2.—Given in percent change from the Present Condition, the average difference in water surface elevation over 48 years between the mean annual flow and the 1.5-year peak flows for each alternative.

Sediment Augmentation Plan—Sediment Transport Indicators

Background and Purpose

Mean annual and 1.5-year peak flows for the alternatives are larger than mean annual flows and 1.5-year peak flows under the Present Condition, resulting in more sand transport than under the Present Condition. Over 200,000 tons of sand are eroding from the bed and banks near Overton under the Present Condition, and this rate would increase with the larger flows of the alternatives. Sediment augmentation is needed to address the current imbalance in sediment, and also to prevent an increase in erosion from the larger mean annual and 1.5-year peak flows under the alternatives. The Johnson-2 Return flows are the source of imbalance. Therefore, the most benefit occurs by adding sand as close to the Johnson-2 Return as possible. The plan form of downstream reaches can then adjust to a consistent transport rate, eliminating river reaches that predominantly degrade or aggrade.

The sediment transport estimate for the Present Condition was computed two ways in "River Geomorphology" in chapter 4. The first estimate of sediment transport relies on repeat surveys of cross sections (Holburn et al., 2006), combined with sediment rating curves (Randle and Samad, 2003). The second estimate is computed from a one-dimensional numerical model, the SEDVEG Gen3 model (Murphy et al., 2005). The estimates show similar relative changes to sediment transport, but the values from the survey and rating curve estimate are two times as large as transport rates from the numerical model. Due to limited data, the greatest uncertainty in the estimates is associated with the reach between river mile (RM) 222 and RM 211. The numerical model is used to compare the sediment transport rates of the alternatives. Values from the SEDVEG Gen3 model have been increased by a factor of 1.5 to represent an average of the survey and numerical model estimates and are reported in table 5-RG-3. The sediment transport values in table 5-RG-3 are presented for four reaches. The reach from Jeffrey Island to Elm Creek (RM 243.1 to 230) is predominantly degrading; sediment transport from Elm Creek to Gibbon (RM 230 to 201.2) has mixed conditions; Gibbon to Wood River (RM 201.2 to 189.3) is predominantly aggrading, and Wood River to Chapman (RM 189.3 to 160) is relatively stable with the exception of the Present Condition. "Introduction, Geographic Markers" in chapter 4 lists commonly used river mile locations and associated landmarks.

Sediment Augmentation Plan Actions

The sediment augmentation plan for all alternatives is comprised of one site near Overton where 150,000 tons of sand are added to the river. This sediment augmentation plan is independent of sand added through mechanical actions, and sand augmentation is maintained through the 48 years of hydrologic record used in the analysis. For modeling purposes, augmentation was implemented on a 6-month schedule from April through September. At a conversion of 100 pounds per cubic foot, 150,000 tons equates to 18 acres of sand per year when excavation averages 4 feet deep. This plan reduces, but does not eliminate, the sand imbalance, as shown in table 5-RG-3.

Initially, not all sediment from augmentation is conveyed downstream past Chapman. Deposition, like erosion, is a process that modifies the plan form, profile, and cross section of the river to match new rates of flow and sediment transport. Reaches of high and low sediment transport become less extreme over time under constant loads of sand. The volume of sand needed for augmentation may decrease as less sediment is stored in the riverbed, and as sediment transport peaks diminish as a result of the evolving changes in the channel shape.

Augmentation can occur by pushing sand in at steep eroding banks or by spreading sand on the bed of the river at augmentation sites. Rates of augmentation should be controlled by upstream and downstream monitoring, and the transport rate at the site will depend on the riverflow and site geometry. During implementation, sand may be added at multiple locations and in different ways. During high flows, the sand may be promptly transported downstream, allowing larger volumes of sand to be placed in the river prior to managed high flow events. Conversely, the sand may not move noticeably during periods of low flow. An excess amount of sand in the river at a single location should be avoided, since it could decrease transport from the upstream reach.

Table 5-RG-3.—Average Sediment Transport Values (in tons/year)*

	Present Condition	Governance Committee Alternative	Water Emphasis Alternative	Wet Meadow Alternative	Water Leasing Alternative
River Mile 246.5 (South Channel of Jeffrey Island)					
Sediment transport at RM 246.5	0	0	0	0	0
River Mile 243.1 (South Channel of Jeffrey Island)					
Sand augmented	0	0	0	0	0
Tributary inputs	32,000	32,000	32,000	32,000	32,000
Deposition between RM 246.5 and RM 243.1	-51,000	-33,000	-37,000	-35,000	-42,000
Sediment transport at RM 243.1	83,000	65,000	69,000	67,000	74,000
River Mile 230 (near Elm Creek)					
Sediment from North Channel of Jeffrey Island	283,000	298,000	318,000	284,000	309,000
Sand augmented	0	150,000	150,000	150,000	150,000
Tributary inputs	63,000	63,000	63,000	63,000	63,000
Deposition between RM 243.1 and RM 230	-185,000	-74,000	-109,000	-109,000	-170,000
Sediment transport at RM 230	615,000	651,000	710,000	674,000	766,000
River Mile 201.2 (near Gibbon)					
Sand augmented	0	0	0	0	0
Tributary inputs	10,000	10,000	10,000	10,000	10,000
Deposition between RM 230 and 201.2	5,000	3,000	32,000	22,000	32,000
Sediment transport at RM 201.2	621,000	658,000	689,000	663,000	745,000
River Mile 189.3 (near Wood River)					
Sand augmented	0	0	0	0	0
Tributary inputs	0	0	0	0	0
Deposition between RM 201.2 and RM 189.3	58,000	69,000	38,000	53,000	71,000
Sediment transport at RM 189.3	563,000	589,000	651,000	609,000	674,000
River Mile 160 (near Chapman)					
Sand augmented	0	0	0	0	0
Tributary inputs	0	0	0	0	0
Deposition between RM 189.3 and RM 160	-47,000	-7,000	5,000	11,000	-26,000
Sediment transport at RM 160	609,000	596,000	645,000	597,000	700,000
Total					
Deposition for RM 246.5 to RM 160	-220,000	-42,000	-71,000	-58,000	-135,000

*Values are considered over the 48 years succeeding the Program's First Increment from SEDVEG Gen3 model. Values shown are an average of 48 years of hydrologic record. All values were multiplied by a factor of 1.5 to more closely match sediment transport rates from sediment rating curves at Grand Island (Randle and Samad, 2003).

Maximum and Stable Sediment Transport Rates

Sediment transport rates for each alternative, as modeled by the SEDVEG Gen3 model, are shown in table 5-RG-3. Maximum sediment transport rate occurs at RM 230 or RM 201.2. The Full Water Leasing Alternative transports the most sand, at an average maximum of 745,000 tons annually. The Governance Committee Alternative has the lowest maximum transport of the alternatives, at 660,000 tons annually.

The downstream reach from RM 189.3 to RM 160 is relatively stable for all of the alternatives. Sediment transport in this reach is used to estimate the sediment transport of upstream reaches in the future. Estimated future rates of sediment transport (tons per year) for stable river conditions are:

- Present Condition - 585,000
- Governance Committee Alternative - 595,000
- Full Water Leasing Alternative - 690,000
- Wet Meadow Alternative - 605,000
- Water Emphasis Alternative - 650,000

The sand augmentation plan presented here reduces, but does not eliminate, the sand imbalance. Both the maximum and stable rates of sediment transport indicate that the Full Water Leasing Alternative would require the largest volume of sand annually to eliminate the imbalance, and the Governance Committee Alternative would require the least volume of sand of the alternatives.

Deposition and Erosion

The values in table 5-RG-3 indicate the majority of erosion occurs between RM 246.5 and RM 230 in the 48-year period following the Program's First Increment. The reach between RM 201.1 to RM 189.3 predominantly aggrades, and the reach from RM 189.3 to RM 160 is relatively stable for most of the alternatives but degrades under the Present Condition. As shown at the bottom of table 5-RG-3, with 150,000 tons of sand augmentation near Overton, the Governance Committee Alternative erodes the smallest volume from the bed and banks of the channel. This volume is also an estimate of the additional sand needed to eliminate the sediment imbalance under each alternative, so the Governance Committee Alternative would require the smallest sediment augmentation plan of all alternatives.

Under the Present Condition, the most deposition between Overton and Chapman occurs between Gibbon and Wood River (RM 201.2 and RM 189.3). The Wet Meadow and Water Emphasis Alternatives would decrease the volume of deposition in this reach, and the Governance Committee and Full Water Leasing Alternatives would increase the volume of deposition in this reach.

Mechanical Plan—Topography Indicators

Changing the flows and adding sand to the river adjusts the form of the river over time. The channel evolves towards a consistent transport rate that supports more preferred riverine habitat for the target species. However, this shift in river plan form and channel section develops over time. Mechanical alterations can achieve more timely changes in river plan form and can focus these changes at select reaches. There are two mechanical plans that alter the channel plan form:

- The first mechanical plan occurs at five sites and is used for the Governance Committee, Full Water Leasing, and Wet Meadow Alternatives.
- The second mechanical plan occurs at three of the five sites and is used with the Water Emphasis Alternative.

Table 5-RG-4 describes these plans in more detail.

Table 5-RG-4.—Plans for Mechanical Plan Form Change*

Plan	Alternatives	Mechanical Action	Acres Converted to Channel	Locations by Bridge Segment
Five-site plan	Governance Committee, Full Water Leasing, and Wet Meadow	Bank and island lowering, and consolidating flow	387 acres	11, 9, 8, 6, 2
Three-site plan	Water Emphasis	Bank and island lowering, and consolidating flow	292 acres	11, 9, 2
* As noted in chapter 3, "Description of the Alternatives," the locations of land management activities are displayed for illustrative purposes. Actual sites are not known since this depends on willing sellers.				

Mechanical Actions at Managed Sites

Both land plans incorporate the techniques of flow consolidation, bank cutting, and island leveling to initiate changes in river plan form and promote more reaches of wide, braided river. Reduction of an overwide river corridor, as presented in chapter 4, can be accomplished by consolidating flow. The divergence of flows can be prevented by blocking entrances to side channels at high flows, or by redirecting flow in side channels back to the main channel. These actions are an immediate means of converting anastomosed plan form to braided plan form. Bank cutting and island leveling accelerate the process of widening the river if there are sufficient flows to sustain the increase in width. In scenarios analyzed here, the mechanical actions of consolidating flow, bank cutting, and island leveling begin in the fourth year of the program at three sites along the river. The work progresses to all 5 program sites over the course of four, 100-day summer field seasons.

Figure 5-RG-3 illustrates how a river can be modified by consolidating flow through blocking access to side channels and by cutting and lowering a bank and river island. A braided plan form can develop under the Present Condition when flow is consolidated into a single main channel and when there are no more than one or two minor side channels (see the "River Geomorphology" section in chapter 4). Consolidating flow raises stream power, which is necessary to sustain a braided plan form (see the "Stream Power and Plan Form" sidebar in chapter 2). A braided plan form appears to have a more stable transport rate than anastomosed channels in the Central Platte River. Side channels can be converted to low-flow channels by placing culverts through the earth channel block at the entrance to the side channels. During a high flow event, the majority of flow would be retained in the main channel; however, the side channel would continue to receive **low** flows. Flow is returned to the blocked or partially blocked side channels at the downstream end of Program lands.

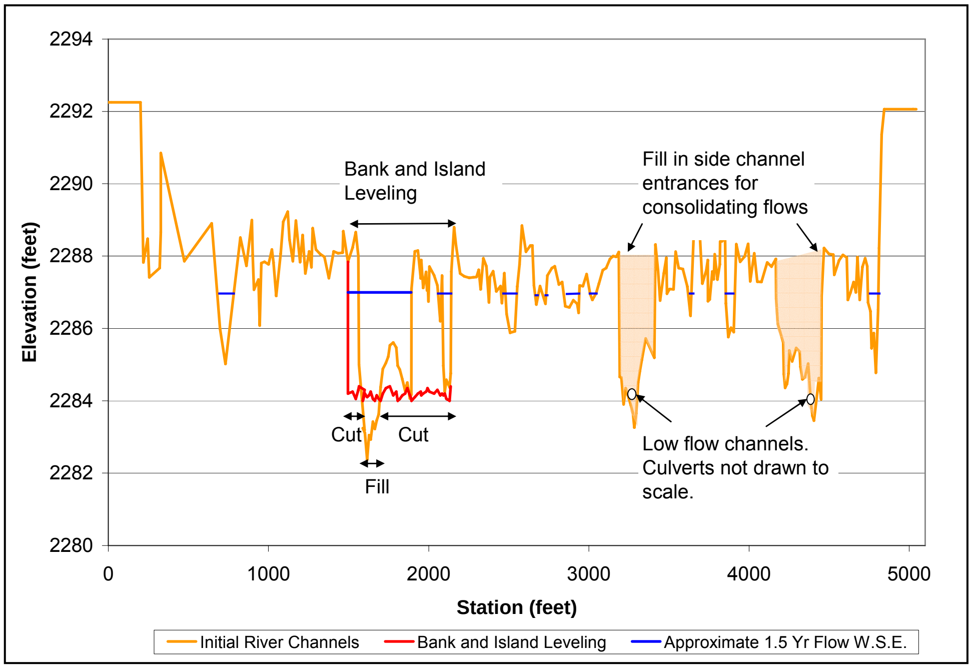


Figure 5-RG-3.—Example of the modification of a river cross section in the mechanical action plan through the consolidation of flow and the lowering of a bank and river island. Figure is exaggerated vertically by approximately 250 times.

For bank and island leveling, vegetation would be cleared from islands and banks within the proposed area of excavation. Sand from the bank cutting or island leveling would then be mechanically pushed, in stages, into the nearby river channel as additional augmentation until the bank or island had been lowered to an elevation that would be submerged by 1,000 cfs. Similar to the sediment augmentation plan, the upstream reach of a bank or island cutting operation would be monitored to prevent the water surface from rising to levels that cause detrimental effects, such as decreased sediment transport or impacts to adjacent landowners. Additionally, downstream locations would be monitored to prevent excessive deposition.

Creating a wide river channel typically reduces the average velocities in the river and reduces the hydraulic capacity of the river to transport sand. When too much width is added to the river channel, sediment begins to deposit in the overwidened reach and vegetation can re-establish on sandbars and divide the width of the river. The extent of river widening is limited by the volume of flow conveyed in the channel. Consolidating flows helps to raise the maximum width of river that can be maintained by available flows.

Increases in Braided Channels at Managed Sites

This indicator of habitat improvement is assessed at sites where mechanical actions occur. The increase in length of braided or wide river channels is a map measurement. Average widths shown in table 5-RG-5 were modeled using SEDVEG Gen3 and were found to be sustainable over 48 years of the hydrologic record. The Governance Committee, Full Water Leasing, and Wet Meadow Alternatives all benefit equally from the mechanical actions, while the Water Emphasis Alternative shows a smaller, but still positive, increase in length of braided or wide river. Mechanical actions at sites 1-4 in table 5-RG-5 include bank and island lowering as well as consolidating flow. At site 5, the existing condition was a braided channel, so it was not necessary to consolidate flow. Instead, the sustainable width of the river was increased by the actions of bank and island lowering.

Table 5-RG-5.—Increase in length of braided and wide channel resulting from the mechanical action plan.

Site	Length of Change		Average Width	Governance Committee, Full Water Leasing, and Wet Meadow Alternatives	Water Emphasis Alternative
	Miles	Feet	Feet	5 Sites (Feet)	3 Sites (Feet)
1	2.95	15,600	600	15,600	15,600
2	2.9	15,300	1,200	15,300	15,300
3	1.15	6,100	1,000	6,100	
4	1.4	7,400	1,000	7,400	
5	1.65	8,700	800	8,700	8,700
Increase in length of braided or wide river				53,100	39,600

Widest Water and Open View Width at Managed Sites

These two additional indicators of habitat improvement are at sites where mechanical actions occur:

- **Widest water** is a measure of the width of the widest wetted surface of a cross section at a flow of 2,000 cfs. This width is limited by riverbanks, sandbars, and islands, but it is not interrupted by the presence of vegetation if the base of the vegetation is below the water surface at 2000 cfs.

- **Open view width** is the widest single channel that has no vertical obstructions in the line of sight, when the line of sight is measured 3 feet above the water surface at a flow of 2000 cfs. Dry riverbanks on either side of the channel can be included in this measure until obstructions on the bank, or the riverbank itself, break the line of sight. Sight obstructions include vegetation or islands in the channel. Open view width is a more direct indicator of suitable habitat for interior least terns, piping plovers, and whooping cranes, since it is a function of vegetation growth.

The widths are measured at year end and averaged over a 48-year period. Open view widths, widest water, and the sustainability of mechanical actions are assessed, using the SEDVEG Gen3 model, at cross sections where mechanical actions occur. The results are based on:

- Site 1: two cross sections
- Site 2: three cross sections
- Site 3: one cross section
- Site 4: two cross sections
- Site 5: one cross section

Widest water and open view widths for each alternative are presented in figure 5-RG-4 as percent change from the Present Condition for each of the alternatives.

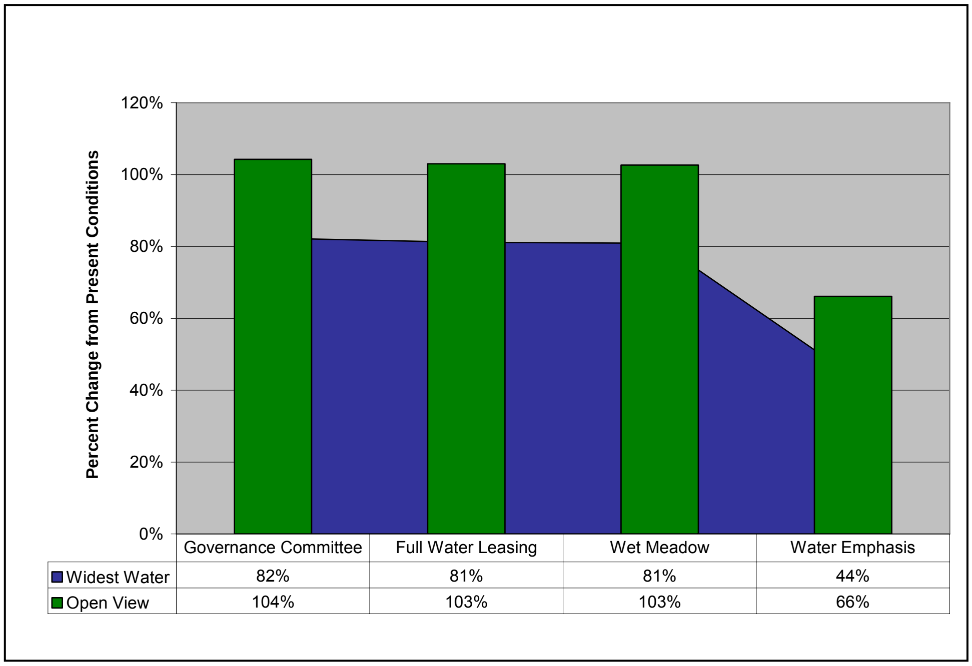


Figure 5-RG-4.—Percent change from the Present Condition in the average river width. The values represent five sites where mechanical plan form change* (consolidating flow, bank cutting, and/or island lowering) has occurred.[7]

In all cases, the mechanical plans make pronounced habitat improvements, over the Present Condition, at the river sites where these actions occur. These improvements in width and extension of the braided condition are immediate and are sustainable over time. The Water Emphasis Alternative, as expected, shows the smallest improvement in width because the mechanical actions occur at fewer sites (three sites), while improvements from Governance Committee, Full Water Leasing, and Wet Meadow Alternatives' mechanical plans are similar (five sites).

Plan Form Indicators

Plan form indicators show the general results of the interactions between the water plan, sediment augmentation plan, and mechanical plan considered over the entire study area.

The width-to-depth ratio is an indicator of both plan form and desired habitat, and the width of the river is a direct measure of desired habitat. Braided rivers have large width-to-depth ratios and provide wide channels with multiple in-channel sandbars, while meander and anastomosed rivers (see the "River Plan Form" sidebar in chapter 2) are characterized by narrow and deep channels with small width-to-depth ratios. The width-to-depth ratio, open view width, and widest water are computed using the

[7] The widest water and open view widths are measured annually at a flow of 2,000 cfs and averaged over the 48 years succeeding the First Increment of the Program. Values are presented as a percent change from the Present Condition. No mechanical actions occur at the five sites for the Present Condition, mechanical actions occur at three of the five sites for the Water Emphasis Alternative; and mechanical actions occur at five of the five sites for the Governance Committee, Wet Meadow, and Full Water Leasing Alternatives.

SEDVEG Gen3 model, which incorporates evolving changes to the riverbed over time. The indicators are measured at a reference flow of 2000 cfs, at the end of each year, and represent an average from 48 years of hydrologic record. All indicators are reported in percent change from the Present Condition.

Width-to-Depth Ratio Indicator

Width-to-depth ratios are measured for four reaches of the river (table 5-RG-6):

- **From Jeffrey Island to Elm Creek** (RM 243.1 to 230): All alternatives show an increase in width-to-depth ratio in the first reach, in response to flows, sand augmentation, and one mechanical action site. Under the Present Condition, this reach is predominantly degrading (eroding).

- **From Elm Creek to Gibbon** (RM 230 to 201.2): This reach includes mixed conditions of aggradation and degradation, and more uncertainty due to the data gap between RM 222 and RM 211. The width-to-depth ratio for all alternatives decreases similarly. The Elm Creek to Gibbon reach contains two mechanical action sites for all alternatives except the Water Emphasis Alternative, which contains one site.

- **From Gibbon to Wood River** (RM 201.2 to 189.3): This reach is an aggrading reach. The width-to-depth ratio of all alternatives, except the Water Emphasis Alternative, increases considerably. The Water Emphasis Alternative has no mechanical action site in this reach, while the other alternatives have one.

- **From Wood River to Chapman** (RM 189.3 to 160.9): In this reach, the river is relatively stable. Governance Committee and Full Water Leasing Alternatives show small improvements in width-to-depth ratio, while the Wet Meadow and Water Emphasis Alternatives show small reductions in width-to-depth ratio. There is one mechanical action site in the fourth reach for all alternatives.

In summary, Governance Committee and Full Water Leasing Alternatives show the greatest benefits in width-to-depth ratio. The Full Water Leasing Alternative provides more benefit in the aggrading reaches and the Governance Committee Alternative provides more benefit in the degrading reach.

Table 5-RG-6 lists the percent change from the Present Condition for these reaches.

Table 5-RG-6.—Percent Change from the Present Condition in Width-to-Average-Depth Ratio for Main Channel*

Width-to-Average-Depth Ratio for Main Channel	Governance Committee Alternative	Full Water Leasing Alternative	Wet Meadow Alternative	Water Emphasis Alternative
Jeffrey Island to Elm Creek (RM 243.1 to 230)	31	18	23	26
Elm Creek to Gibbon (RM 230 to 201.2)	-5	-7	-7	-5
Gibbon to Wood River (RM 201.2 to 189.3)	35	48	39	2
Wood River to Chapman (RM 189.3 to 160.9)	4	6	-2	-4
*Considered over 48 years. Values are from the SEDVEG Gen3 model.				

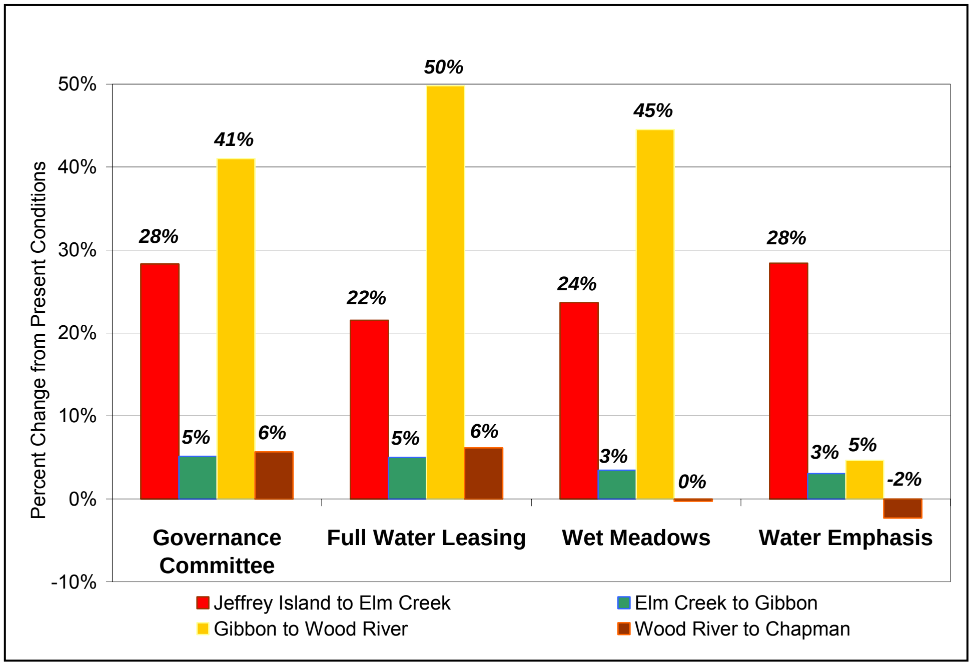


Figure 5-RG-5.—**Widest Water:** Percent change from the Present Condition in the average widest water at a flow of 2000 cfs. Values are averaged over the 48-year period.

Widest Water and Open View Widths

A comparison of widest water and open view widths for all cross sections between Overton and Chapman is shown in figures 5-RG-5 (widest water) and 5-RG-6 (open view). The average values are based on 58 of 62 cross sections (the first two and last two cross sections were not used), with 6 to 9 of the cross sections affected by mechanical actions, depending on the alternative under review. Widest water directly represents geomorphic changes to the channel, while open view width provides more insight on plan form, habitat, and vegetation.

The flow plans of every alternative provide some improvement to the width of the widest water, except the Wet Meadow and Water Emphasis Alternatives in the stable Wood River to Chapman reach. Substantial increases occur in the degrading Jeffrey Island to Elm Creek reach, and occur in the aggrading Gibbon to Wood River reach. The Water Emphasis Alternative is the exception in the Gibbon to Wood River reach, at least partially due to no mechanical action site in this reach. The Full Water Leasing Alternative shows most improvement in the aggrading reach, and the Governance Committee Alternative shows most improvement in the degrading reach, with similar improvement from the Wet Meadow Alternative in both reaches.

All alternatives show significant improvement in open view width, at least partially reflecting the effect of the water plan to restrain vegetation to higher elevations in the river cross section. The largest increase is found in the aggrading Gibbon to Wood River reach. The Full Water Leasing Alternative shows the most improvement in the downstream three reaches, while the Water Emphasis Alternative shows the most improvement in the degrading Jeffrey Island to Elm Creek reach. Of all the alternatives, the Water Emphasis Alternative provides the least improvement, due to smaller changes from the Present Condition in the aggrading Gibbon to Wood River reach.

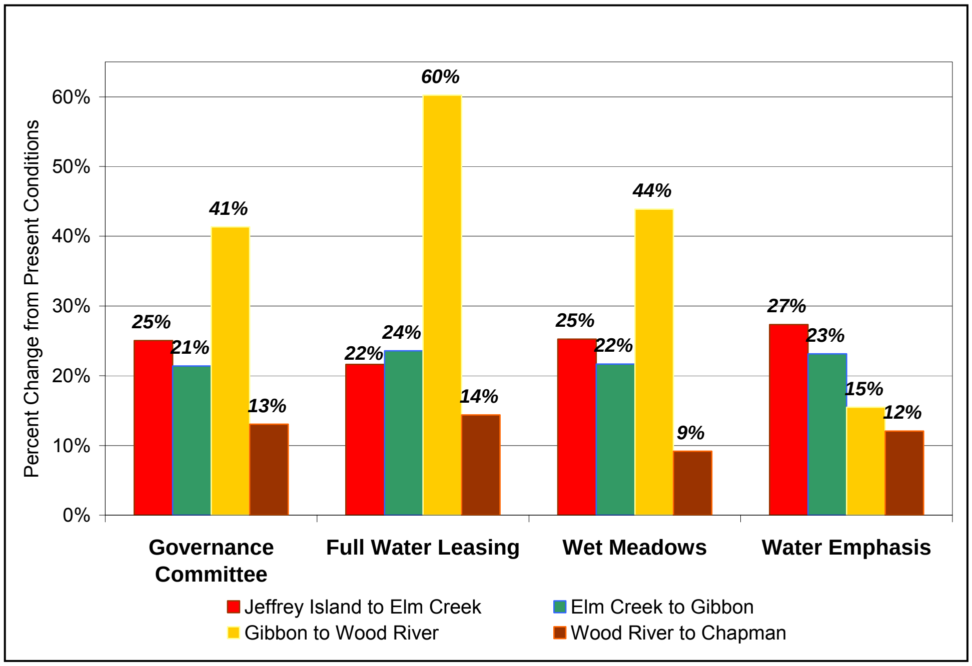


Figure 5-RG-6.—**Open View:** Percent change from the Present Condition in the average open view width, at a flow of 2,000 cfs and averaged over the 48-year period.

WATER QUALITY

Issue: How would the action alternatives affect water quality in the Basin?

Overview

SCOPE

The area of effect includes surface and groundwater in the entire North Platte River Basin in Colorado and Wyoming; the South Platte River Basin below Greeley, Colorado, and in Nebraska; and the Central and Lower Platte River Basin in Nebraska.

INDICATORS

Indicators of impact to water quality include:

- **North Platte River Basin:**
  - Total dissolved solids (TDS)
  - Electrical conductance (EC)
- **South Platte River:** Specific EC
- **Lake McConaughy:** Water temperature in the release to Lake Ogallala
- **Lake Ogallala:** Water temperature
- **Central Platte River:**
  - Water temperature
  - Turbidity: Sediment management and its effect on water quality
  - Contaminants (selenium and metals)
- **Groundwater mound:** Selenium

In addition, river reaches in the study area that have been identified as impaired under the Clean Water Act 303 process were given special attention.

SUMMARY OF IMPACTS

For action alternatives:

- Average annual TDS in the North Platte Reservoirs and stream gauge locations is unnoticeable. Small monthly changes in TDS occur due to reservoir flow and timing.
- A small decrease in specific EC occurs in the South Platte River at Julesburg, Colorado
- Reduced elevations in Lake McConaughy will lead to somewhat warmer releases to Lake Ogallala, which may have an adverse affect on trout habitat in Lake Ogallala
- Reduced chances of exceeding 90 degrees Fahrenheit (°F) in the Central Platte River in the summer months
- Increased or decreased probability of copper toxicity in river sediments in some locations, depending on sites chosen for sand augmentation.

Conjunctive use of the groundwater mound in the Central Platte River Basin area under the Governance Committee and Water Emphasis Alternatives could reduce somewhat high concentrations of selenium that currently exist in some areas of the groundwater mound.

Concentrations of copper in samples of bed, bank, and island sediments in the Central Platte River Basin are currently above the Upper Effects Threshold (UET) for aquatic life (National Oceanic and Atmospheric Administration [NOAA], 1999). However, the potential adverse biological effects from these concentrations have not been studied in resident fish and birds. Movement of sand from islands back into the river channel (included in all alternatives except the Governance Committee Alternative) could somewhat increase the concentration of copper suspended in river sediments and in bed sediments, while augmentation using bank sediments would likely decrease the copper concentration in the bed sediments. The probability of toxicity associated with the metals in the sediments should change little because the Present Condition probabilities of toxicity are near 1 (the maximum possible probability). Compared to the probability of toxicity associated with copper, that of the other metals remains insignificant.

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Table 5-WQ-1 summarizes water quality impacts for the Present Condition and alternatives by site and indicator.

Table 5-WQ-1.—Summary of the Water Quality Aspects of Platte River Endangered Species Recovery Alternatives Evaluation

Site	Indicator	Period or Measure	Present Condition	Governance Committee Alternative	Water Emphasis	Full Water Leasing	Wet Meadow
North Platte River							
Pathfinder Reservoir	TDS (mg/L*)	Median	256	255	257	248	259
		Maximum	331	339	338	329	339
Orin gauge	TDS (mg/L)	Median	529	523	514	521	511
		Maximum	722	698	706	695	722
Glendo Reservoir	TDS (mg/L)	Median	486	481	473	484	478
		Maximum	613	614	615	613	646
Lewellen gauge	TDS (mg/L)	Median	619	618	618	618	618
		Maximum	644	644	646	647	644
Lake McConaughy - Lake Ogallala	April pool elevation (feet) - percent of years above elevation	Percent ≥ 3250 feet	89.6	62.5	60.4	60.4	60.4
		Percent < 3250 feet and ≥ 3240 feet	10.4	22.9	25.0	25.0	27.1
		Percent < 3240 feet	0.0	14.6	14.6	14.6	14.6
South Platte River							
Julesburg gauge	Specific EC (µmho/centimeter)	Median	1,879	1,752	1,752	1,778	1,778
		Maximum	2,500	2,442	2,442	2,409	2,409
Central Platte River							
Grand Island gauge	Temperature: Percent of days flow > 1,200 cfs	June	51.7	55.5	60.8	62.9	56.2
		July	32.7	31.0	31.0	31.9	32.3
		August	7.1	7.7	8.0	7.7	7.7
	Probability of exceeding 90°F	June	0.262	0.242	0.228	0.214	0.245
		July	0.329	0.325	0.329	0.339	0.329
		August	0.425	0.409	0.411	0.431	0.418
* "mg/L" equals milligrams per liter.							

IMPACTS ANALYSIS

The changes in reservoir operations and streamflows, described earlier in this chapter, can affect the water quality in lakes and streams and, hence, can also affect the value of the lake and stream habitat for fish, including fish that interior least terns eat.

North Platte River Basin

The summary table 5-WQ-1 shows a comparison of the median and maximum TDS of four sites at selected points on the river for each alternative and the Present Condition. Increases and decreases in the annual average difference in TDS for sites on the North Platte River above Lake McConaughy were all less than or equal to 10 mg/L. The USGS reports TDS to the nearest 10 mg/L. Thus, these changes would be so small as to be virtually unnoticeable. However, the maximum monthly increase in TDS concentration from the Present Condition is 27 mg/L under all alternatives, except for the Full Water Leasing Alternative, in the Pathfinder Reservoir and 33 mg/L in Alcova Reservoir. The maximum monthly decrease in TDS concentration is 31 mg/L in Pathfinder Reservoir under the Wet Meadow Alternative and 26 mg/L in Alcova Reservoir under the Water Emphasis Alternative. These monthly differences are due to differences in flow timing.

Orin Gauge

The Orin gauge site shows a small average decrease in TDS from the Present Condition under all the alternatives (table 5-WQ-1). The Governance Committee Alternative and the Full Water Leasing Alternative are projected to show a decrease of 3 mg/L, while the decreases are projected at 7 mg/L for the other alternatives. The decrease reflects increased flows in the North Platte River in the reach from Alcova Dam to the gauge. The increased flows in the river reflect the delivery of water from the upper North Platte reservoirs, primarily Pathfinder Reservoir, and result in additional dilution of the saline inflows between Alcova Dam and the city of Casper, Wyoming.

Glendo Reservoir

There is also a decrease in TDS in Glendo Reservoir with all of the alternatives (table 5-WQ-1). In addition, the average difference of the TDS decrease under all of the alternatives is smaller than those decreases shown at Orin. The smaller decrease in TDS in the reservoir reflects the dampening of changes that occur in rivers due to the range of flow like that at the Orin gauge.

Lewellen Gauge

At the Lewellen gauge, there is also a small overall reduction (1 mg/L) in TDS with any of the alternatives (table 5-WQ-1). The decrease is primarily due to dilution because of the increased delivery of water to Lake McConaughy.

Lake McConaughy and Lake Ogallala

Table 5-WQ-2 shows a comparison between each of the alternatives and the Present Condition in the frequency of meeting the benchmark elevations described in chapter 4, "Affected Environment and the Present Condition." The Governance Committee Alternative shows a large reduction in the number of years in which the April water surface elevation is above 3250 feet. There is an increase between the Present Condition and the Governance Committee Alternative from 0 to 8 percent of the years in which April elevations are below 3230 feet, where there is a three in four chance of release temperatures of equal to or greater than (≥)72°F.

Table 5-WQ-2.—Summary of Percent of Years of Meeting Critical April Elevations in Lake McConaughy for Trout Habitat in Lake Ogallala 1947 – 1994 (48 Years)

Elevation	Present Condition	Governance Committee Alternative	Full Water Leasing Alternative	Wet Meadow Alternative	Water Emphasis Alternative
Percent of years ≥ 3250 feet	79.2	43.8	79.2	43.8	47.9
Percent < 3250 feet and ≥ 3240 feet	7.1	10.3	11.6	14.9	15.3
Percent < 3240 feet and > 3230 feet	13.8	45.9	9.2	41.3	36.7
Percent ≤ 3230 feet	0.0	8.3	0.0	8.3	6.3

The percent of the years at which the April elevation is between 3240 and 3250 feet increases from less than 10 percent to greater than 10 percent under all of the alternatives. Under the Present Condition, the April water surface elevation falls below 3240 feet in about 14 percent of the years. However, under the Full Water Leasing Alternative, the April water surface elevation falls below 3240 feet in only about 9 percent of the years and, like the Present Condition, does not fall below 3230 feet in any of the years.[8] Alternatively, the Wet Meadow and Water Emphasis Alternatives show somewhat similar reductions as the Governance Committee Alternative in the frequency of falling below the 3250-foot elevation benchmark. The temperature/dissolved oxygen (DO) model indicates that at an April water surface elevation of 3230 feet, the reservoir would have a release temperature of ≥ 72°F in August in three out of four of the simulated years. At an April elevation between 3230 and 3240, the August release temperature was between 70 and 72°F in three out of four of the simulated years.

South Platte River Basin

Figure 5-WQ-1 shows a comparison of the specific conductance of the South Platte River at Julesburg, Colorado, under the existing conditions and with each of the alternatives. All alternatives decrease the TDS and, thus, the electrical conductance (EC) by a small amount in the South Platte River. The effects of the Governance Committee and Water Emphasis Alternatives are the same and reflect the development of Tamarack Projects. The effects of the Full Water Leasing and Wet Meadow Alternatives are the same and reflect the smaller effects associated with development only of Tamarack Project, Phase I.

[8] It is recognized that under historic operations, Lake McConaughy has fallen below 3230 feet in elevation, in particular in the last several years. These recent years are not in the period included in the FEIS simulated operation. The reservoir also fell below 3230 feet during the drought of the 1950s, which is in the period of the simulated operation. This drought reflects both differences in system capacities, demands, and operations between historic and the Present Condition, and limitations in the capability of the hydrologic model to simulate extreme reservoir operations.

The reason for the EC decrease with Tamarack Projects development has to do with the difference in the EC of the groundwater compared to the South Platte River. In general, the EC of the water in the Sandhill aquifer is much lower than that of the flood plain groundwater, which is influenced greatly by the river. As waters from the South Platte River are diverted into recharge areas, they mix with the groundwater, which has a lower specific conductance.

That EC decrease is shown by the South Platte River when Tamarack Projects groundwater enters the river during the months of February through August (figure 5-WQ-1). The decrease would be significant wherever there is no overlap between the error bars of the monthly means for the specific conductance of the Present Condition and the alternative, as is the case in February through August. The changes in EC projected for the action alternatives represent a minor positive effect on the water quality of the South Platte River near the recharge areas.

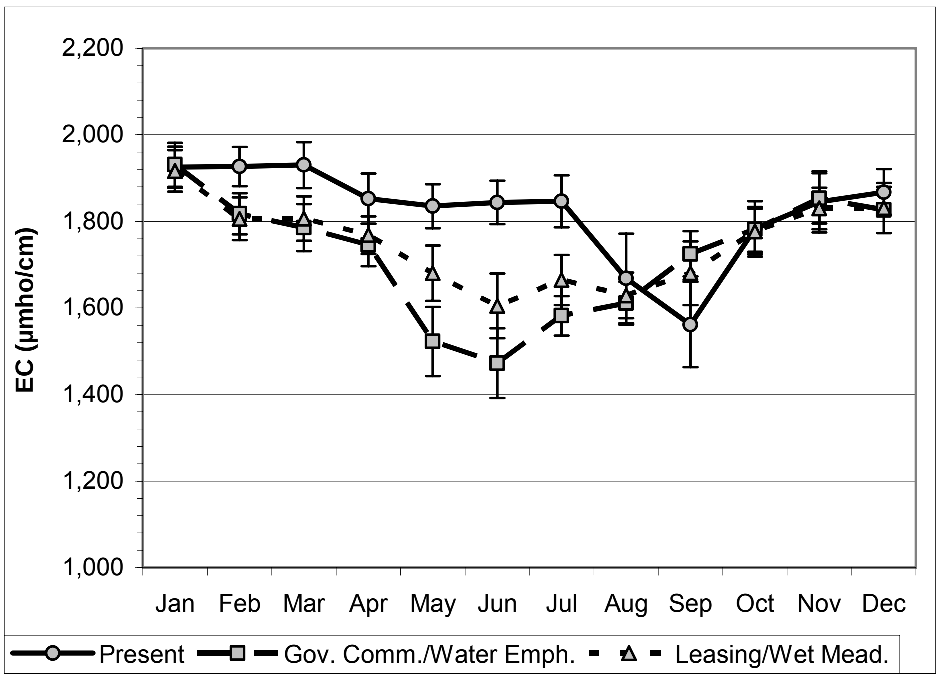

Figure 5-WQ-1.—Mean monthly specific conductance of the South Platte River at the Julesburg, Colorado, gauge compared for the Present Condition and alternatives.

Central Platte River

Table 5-WQ-3 shows the likelihood of flows in the Central Platte River exceeding the 1,200-cfs summer months flow level established as part of the "wet year" and "normal year" flow targets needed to avoid potentially lethal temperatures for forage fish species. The probability of exceeding the 90°F temperature, which is the Nebraska state water quality standard, was compared for the action alternatives against the Present Condition. The daily flow analysis was run over the 48-year hydrologic record. The total number of days in the analysis for June in the 48-year study period amounts to 1,440; there are 1,488 total days in the flow analysis for July and August each.

Table 5-WQ-3.—Number of Days in June, July, and August in the 48-Year Daily* Study that the Flow at Grand Island Exceeded 1,200 cfs and the Probability of Exceeding the Temperature Standard of the Present Condition and Alternatives

Month	Present Condition and Alternatives	Days With Flow Greater Than 1,200 cfs	Mean Daily Probability of Exceeding Temperature Standard
June	Present Condition	744	0.262
	Governance Committee Alternative	799	0.242
	Water Emphasis Alternative	876	0.228
	Full Water Leasing Alternative	906	0.214
	Wet Meadow Alternative	809	0.245
July	Present Condition	486	0.329
	Governance Committee Alternative	461	0.325
	Water Emphasis Alternative	462	0.329
	Full Water Leasing Alternative	474	0.339
	Wet Meadow Alternative	481	0.329
August	Present Condition	106	0.425
	Governance Committee Alternative	115	0.409
	Water Emphasis Alternative	119	0.411
	Full Water Leasing Alternative	115	0.431
	Wet Meadow Alternative	115	0.418
*Total days = 4,418			

Table 5-WQ-3 indicates that about half the days in June (744 of 1,440 days, or about 15 days in June per year) have a flow greater than 1,200 cfs under the Present Condition. The Governance Committee Alternative would increase this to nearly 800 days out of the period of record (or the equivalent of about 17 days in June per year). The July comparison shows a decrease from 486 days to 461 days with the Governance Committee Alternative. The number of days in August with the Governance Committee Alternative at or above 1,200 cfs would increase from 106 to 115.

Of the other three alternatives, the Wet Meadow Alternative shows the next smallest June increase over the Present Condition in the number of days that the flow would exceed 1,200 cfs, while the Full Water Leasing Alternative is projected to cause the greatest increase to over 900 days (or nearly 19 days in June per year).

Similar results are found for the probabilities of exceeding the temperature standard of 90°F during these months. The greatest improvement in June would occur with the adoption of the Full Water Leasing Alternative. In July and August, the Governance Committee Alternative shows improvement over the Present Condition. The Governance Committee Alternative is the only alternative to show any improvement in July, although there is no change under the Wet Meadow and Water Emphasis Alternatives. The benefit to the fishery of flows greater than 1,200 cfs would be reduced frequency and duration of high water temperatures that adversely affect fish populations, including reduced probability of fishkills. Elevated water temperatures affect fish in a variety of ways. Fish physiology can be altered during high water temperature conditions, influencing survival rates, growth rates, embryonic development, and susceptibility to parasites and disease (Heath, 1995).

Table 5-WQ-4 shows a comparison of the projected turbidity of the Platte River near Grand Island with each of the action alternatives and the Present Condition. The minimum turbidities are all shown as one, although they are zero in the analysis. These zeros do not represent clear water but, rather, times when there is no flow in the river. The largest change in turbidity from the Present Condition occurs at the lower frequencies represented by the 25th percentile in table 5-WQ-4, where increases range from 4 to 7 Jackson Turbidity Units (JTU). At the higher frequencies and higher turbidities, there is no more than a 1 JTU difference from the Present Condition. These changes in turbidity may slightly reduce visibility for fish in the river, making them somewhat more susceptible to predation.

Table 5-WQ-4.—Turbidity Summary Statistics for the Present Condition and Each Alternative (JTU)

	Present Condition	Governance Committee Alternative	Full Water Leasing Alternative	Wet Meadow Alternative	Water Emphasis Alternative
Minimum	1	1	1	1	1
25th percentile	17	22	21	22	24
Median	25	28	29	28	29
75th percentile	31	33	29	33	34
Maximum	44	43	43	42	43

The river would look the same—the changes in turbidity would have no discernable effect on aesthetics. Most of the visual characteristics of the water in the Platte River are due to suspended sand. This would not be measured by the turbidity analytical procedure. The increase in total suspended solids (TSS) would result in concentrations that would remain within historic limits and would probably not be noticeable. See the TSS analysis in depth in the *Water Quality Appendix* in volume 3.

Groundwater

The Full Water Leasing and Wet Meadow Alternatives do not have elements affecting the groundwater mound.

Groundwater Mound

Conjunctive Use Element

A conjunctive use element is included in the Water Emphasis Alternative and is one of the options considered for the Governance Committee Alternative. In the alternatives that incorporate the conjunctive use, various amounts of river water are stored in the groundwater mound during the nonirrigation season and later used for irrigation. This storage makes additional amounts of water in Lake McConaughy available for management by the Program.

Several different recharge methods are considered in the conjunctive use management plan. The recharge itself will be with river water, which is low in selenium. However, nitrate fertilizer added to irrigation water causes selenium to be leached to the groundwater.[9] Any recharge method that can carry nitrate into the groundwater has the potential to enhance the leaching of selenium to the groundwater.

Current recharge schemes include both active and passive methods. Active methods, such as well injection of river water, should not increase the leaching of selenium to the groundwater. The methods include:

- Construction of pits at the edges of fields
- Recharge wells that are either similar to production wells or are reversed production wells
- Surface spreading of water on fields during the nonirrigation season

If the mobilization hypothesis concerning fertilizer is correct, the first two recharge methods would not mobilize selenium to any great extent, while the third method may mobilize selenium considerably and cannot be recommended.

Adding low nitrate or nitrate-free recharge to the groundwater mound could help to dilute higher selenium in some areas of the conjunctive use element. As discussed in the "Groundwater Mound, Water Quality" sections in chapter 4, the distribution of elevated selenium is relatively spotty. This may reflect selenium availability in the recharge areas, or it may reflect the nitrate concentration in the recharge. There are significant correlations between nitrate and selenium (r-values between 0.69 and 0.93), indicating that there are possibly other factors involved in mobilizing selenium. Spotty distribution in the soils or vadose zone of the recharge area is a good probability for the cause of the variation (see the W*ater Quality Appendix* in volume 3). As is also noted in the *Water Quality Appendix*, the surficial deposits in the area are loessial. Consequently, a high degree of variation is not only possible, it would be probable. Based on the above, the development of the conjunctive use element, if done in a manner that minimizes the introduction of nitrate into the recharge water, should lead to a reduction in selenium in the groundwater under the conjunctive use area.

Both the Governance Committee and the Water Emphasis Alternatives contain an element which involves managing the groundwater mound south of the Central Platte River. The Governance Committee Alternative's Water Action Plan contains an element that has several options for managing or using this groundwater to increase Platte River flows. All options would be the subject of further feasibility analysis, as well as the National Environmental Policy Act (NEPA) analysis prior to selection and implementation of an approach. Any option that would move water containing high levels of selenium from the groundwater mound to the Platte River should be avoided. Other approaches, such as conjunctive use plans that would store and retrieve Platte River water from the mound to use for irrigation, should not increase selenium inputs to the Platte River, but any plan should be carefully evaluated for selenium issues prior to implementation.

Dry Creek/Fort Kearney Cutoff

The Governance Committee Alternative contains another Water Action Plan element, the Dry Creek/Fort Kearney Cutoff, that also has the potential to increase selenium inputs to the Platte River by moving either water from Funk Lagoon or agricultural drain water to the river. This element should also be carefully evaluated—prior to implementation—for possible transport of selenium to the Platte River.

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[9]Adding nitrates to adsorbed selenium causes selenium to desorb and, thus, be leached into the groundwater.

Riverside Drains

The riverside drains element of the Water Emphasis Alternative has the potential to increase selenium inputs to the Central Platte River if proper precautions are not taken (see the *Water Quality Appendix* in volume 3). Elevated levels of selenium have been found in the groundwater south of this portion of the river (see the "Water Quality" section in chapter 4). Subsurface drains could move this water into the river. Drains should not be installed on the south side of the river where they may intercept the groundwater mound and convey water with elevated selenium levels into the Platte River. Other locations may be found that would achieve the element's objective but avoid areas of higher selenium concentrations. Selenium content of the groundwater should be checked before any drains are constructed in this area. Groundwater on the north side of the river has much lower selenium levels, so drains in this area should not create any water quality problem.

Selenium

The *Water Quality Appendix* in volume 3 contains recommendations for a selenium monitoring effort designed to address both potential food-chain bioaccumulation and potential reproductive toxicity thresholds in plovers and terns. Selenium concentrations within their respective food chains may be a factor limiting the reproductive potential of some plovers and terns nesting in the Central Platte River. However, a change in selenium concentration in Platte River water—if proper precautions are taken—is not among the potential effects of the proposed action addressed in this FEIS. Without a change in water concentrations, no obvious mechanism exists to alter food-chain concentrations, and ultimately selenium concentrations in piping plover and interior least tern eggs. This means that the Present Condition selenium concentrations in the Central Platte River would continue under any alternative implemented—if the above precautions are addressed. Selenium has, therefore, been eliminated from further analysis in this FEIS.

Contaminants

Concentrations of copper in Central Platte river bed and bank samples are currently above the Upper Effects Threshold (UET) for aquatic life (National Oceanic and Atmospheric Administration, 1999). The sediment augmentation occurs in the Overton reach of the river. Metals concentrations in sediments at two of the river cross-sections are shown in table 5-WQ-5. The added sediment at Overton is represented by the bank sediments. The bank sediments have a much lower copper concentration (less than 300 ppm) than the bed sediments at cross-section 19. The bed sediments in the Overton reach of the Platte River have a copper concentration of around 1200 ppm (table 5-WQ-5). The copper concentration in the bed sediments decreases in a downstream direction (increasing cross-section number). The sediment augmentation farther downstream in the Alma reach of the Platte River would be by island leveling. The copper concentration in the island sediments at cross-section 56 is more than 6 times that of the bed sediments. Because of these differences in the copper concentrations in the various sediments, adding sediments at different points in the river could cause a decrease in the upstream reach of the river and an increase in the downstream reach.

Table 5-WQ-5. Metal concentrations in bed, bank, and island sediments at 2 sites in the Platte River

Bed Concentrations (ppm)				
Site	Copper	Nickel	Lead	Zinc
- XS 19	1174	4.1	11.3	206
- XS 56	412	3.1	13.0	73
Bank Concentrations (ppm)				
- XS 19	283	5.5	7.6	67
Island Concentrations (ppm)				
- XS 56	2745	6.8	18.8	88

The projected concentrations of total copper, nickel, lead, and zinc in the sediments with each alternative are shown in table 5-WQ-7 at 2 sites in the Platte River. The projections are based on the respective concentration of copper, nickel, lead, and zinc from river bed samples as changed by augmentation with bank (cross-section 19) or island (cross-section 56) sediments, using the data from table 5-WQ-6 and the SEDVEG-Gen3 model. The effect of the alternatives is determined by the source of the sediments and the location of the activity. In the Elm Creek Bridge segment (segment 10, cross-section 19 in table 5-WQ-6), the added sediment is lower in 3 of the 4 metals (nickel is higher) that currently exceed their UET and would cause a decrease in the concentration over what is currently present. Alternatively, augmentation at the downstream site near Alda (bridge segment 1, cross-section 56 is projected to cause an increase in the concentrations of metals in sediment in the river compared to the Present Condition. Cross-section 56 would receive sediment augmentation from island leveling; the island sediments are higher in their concentration of all 4 of the metals.

Table 5-WQ-6: Bed Sediment Contaminant Concentrations in the Central Platte River, Nebraska (ppm)

Location	Present Condition and Alternatives	Copper	Nickel	Lead	Zinc
Elm Creek Bridge Cross Section 19 (bank sediment)	Present Condition	1,174	4.1	11.3	206
	Governance Committee Alternative	685	4.9	9.3	130
	Full Water Leasing Alternative	735	4.8	9.5	138
	Wet Meadow Emphasis Alternative	748	4.8	9.5	140
	Water Emphasis Alternative	753	4.8	9.5	141
Near Alda Cross Section 56 (island sediment)	Present Condition	412	3.1	13.0	73
	Governance Committee Alternative	2,562	6.5	18.4	87
	Full Water Leasing Alternative	2,596	6.5	18.5	87
	Wet Meadow Emphasis Alternative	2,581	6.5	18.4	87
	Water Emphasis Alternative	2,598	6.5	18.5	87

EPA (2004) has developed a set of logistic regressions to estimate the potential toxicity of various levels of metal (and organic) contaminants in sediments. The application of the regressions to the data in table 5-WQ-7 yields the probabilities of toxicity shown in table 5-WQ-7. The probability of toxicity associated with copper is very high at both locations in the Platte River and remains high after the decrease. Alternatively, the probability of toxicity associated with nickel and lead is relatively low initially (under the Present Condition) and remains so under all alternatives. The zinc probability of toxicity is initially intermediate and decreases at cross-section 19 under all alternatives, but remains above any of the probabilities at cross-section 56.

Table 5-WQ-7: Probabilities of Toxicity of Bed Sediment Contaminants in the Central Platte River (ppm)

Location	Present Condition and Alternatives	Copper	Nickel	Lead	Zinc
Elm Creek Bridge—Cross Section 19	Present Condition	0.961	0.023	0.155	0.438
	Governance Committee Alternative	0.926	0.028	0.126	0.285
	Full Water Leasing Alternative	0.932	0.028	0.129	0.303
	Wet Meadow Emphasis Alternative	0.933	0.027	0.130	0.307
	Water Emphasis Alternative	0.934	0.027	0.130	0.309
near Alda—Cross Section 56	Present Condition	0.868	0.016	0.177	0.148
	Governance Committee Alternative	0.985	0.039	0.247	0.181
	Full Water Leasing Alternative	0.985	0.039	0.248	0.181
	Wet Meadow Emphasis Alternative	0.986	0.040	0.249	0.182
	Water Emphasis Alternative	0.985	0.039	0.247	0.181

A plot of the probability of toxicity and its associated copper concentrations using EPA's logistic growth curve is shown on figure 5-WQ-2. The reason that there is little change in toxicity due to increased copper in the sediments is because the copper concentrations in the Central Platte are on the part of the logistic curve that levels off above a probability of 0.9 and associated with copper concentrations of about 500 ppm. The toxicity projections for the Program alternatives range from about 0.87 to about 0.98 (table 5-WQ-7), although the copper concentrations in the sediments range from a little over 400 ppm to nearly 3,000 ppm (table 5-WQ-6).

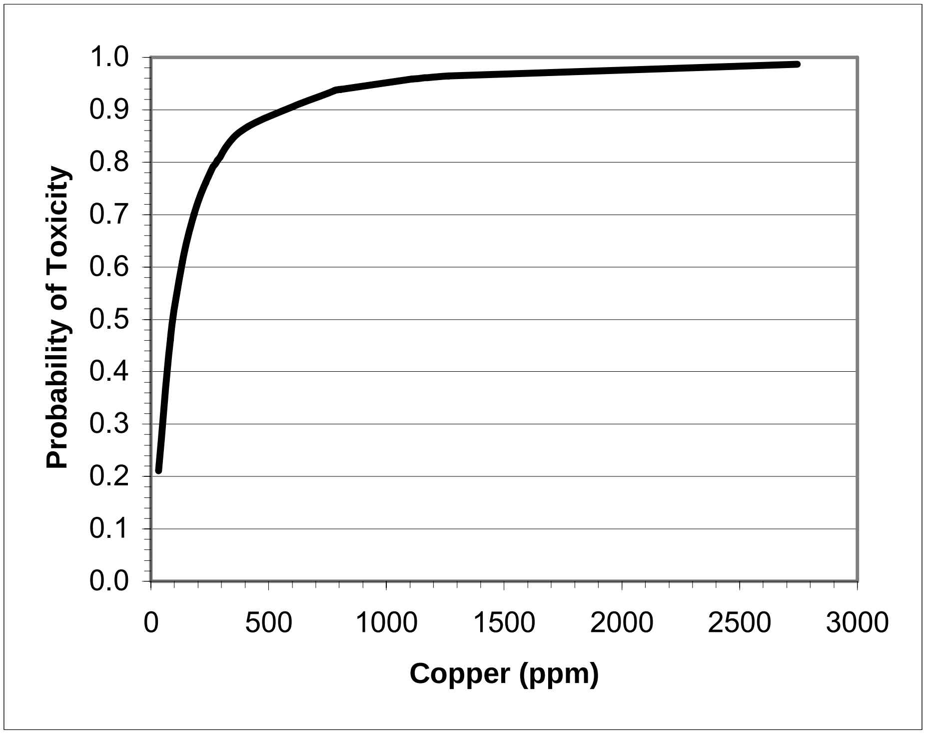

Figure 5-WQ-2. Logistic regression of the probability of toxicity as a function of the copper concentration

The data reported in the *Water Quality Appendix* in volume 3 do not show elevated copper in fish tissue, although the number of samples was relatively small and may not be representative. Similarly, none of the bird egg samples showed elevated tissue concentrations of copper in the Basin. The data may indicate that the copper in the sediments is not bioavailable.

The above results would indicate that copper is not a concern from an acute toxicological perspective at current concentrations in the sediments. However, copper is known to cause numerous sublethal effects on enzymatic activity, energetics, and behavior in fish (Heath, 1995). These effects may only be expressed at the level of the individual when a fish is under stress. Alternatively, the effect may be expressed as an increased susceptibility to predation. Individuals under stress would grow more slowly or may reproduce less. Reduced reproduction and increased predation could result in reduced fish populations in the critical habitat reach of the Central Platte River.

CENTRAL PLATTE RIVER TERRESTRIAL VEGETATION COMMUNITIES AND LAND USE TYPES

Issue: How would the action alternatives affect vegetation communities in the Central Platte River valley and the animal species that depend on them for some part of their life cycle?

Overview

SCOPE

The effect of land habitat management for the alternatives will be focused in the 90-mile Central Platte Habitat Area between Lexington and Chapman, Nebraska.

INDICATOR

The indicator of impacts to vegetation communities in the Central Platte River valley are based on land actions in each alternative:

- Increase or decrease in **acres of habitat types**

Only those land cover/land use types that change with any of the alternatives are discussed in this section.

SUMMARY OF IMPACTS

In general, the Wet Meadow Alternative has the most impact on vegetation communities in the Central Platte Habitat Area. This alternative reduces woodlands by 11 percent (4,015 acres), reduces shrublands by 14 percent (799 acres), reduces herbaceous riparian wetlands by 10 percent (434 acres), and reduces emergent wetlands by less than 1 percent (3 acres). This alternative also increases lowland grasslands by 10 percent (8,210 acres) and decreases bare sand by 1 percent (12 acres).

The Water Emphasis Alternative has the least impact on vegetation communities, reducing upland grasslands by 0.3 percent (93 acres), woodlands by 6 percent (2,010 acres), shrublands by 8 percent (469 acres), and herbaceous riparian by 6 percent (242 acres). The Water Emphasis Alternative also increases lowland grasslands by 7 percent (3,025 acres) and reduces bare sand in the channel by 1 percent (19 acres). All alternatives impact agricultural lands by 1 percent or less (408 to 3,043 acres).

All action alternatives will provide increases in migratory and nesting habitat for the target bird species in the Central Platte Habitat Area and some additional migratory habitat for waterfowl and shore birds. The areal extent of changes in other vegetative communities under all action alternatives is relatively minor, and so the action alternatives are expected to have minor positive and negative effects on resident and migratory populations of animals. Species with minor habitat reductions in the Central Platte Habitat Area are generally quite common, including white-tailed deer, raccoon, opossum, fox squirrel, muskrat, coyote, red fox, beaver, striped skunk, gray catbird, orchard oriole, warbling vireo, black-capped chickadee, American robin, Swainson's thrush, hairy and downy woodpeckers, American goldfinch, brown thrasher, grasshopper sparrow, yellow warbler, willow flycatcher, eastern and western kingbirds, red-headed woodpeckers, belted kingfisher, eastern screech owl, green heron, great blue heron, great and snowy egrets, American woodcock, and turkeys.

IMPACTS ANALYSIS

All of the alternatives include land management plans that seek to restore and maintain land habitat valuable to the target bird species. This is accomplished primarily by converting some Program lands with wooded areas or agricultural lands to wet meadows and by clearing shrubs and trees from river islands. Some alternatives involve moving island sand back into the river channel. All of these actions result in changes in land use and the existing vegetative communities, increasing the availability of open channel habitat and wet meadow habitat used by the target bird species. Table 5-VEG-1 summarizes the changes in land cover types.

Agricultural Lands

In all action alternatives, irrigated and dryland agricultural lands will be reduced by one percent or less in the Central Platte Habitat Area (table 5-VEG-1). Conversion of cropland to wet meadows ranges from 408 acres in the Water Emphasis Alternative to 3,043 acres in the Wet Meadow Alternative. The Governance Committee and Full Water Leasing alternatives convert 2,228 acres of agricultural lands to lowland grasslands. These agricultural lands are adjacent to the Central Platte River and conversions would not occur in one area, but would spread among at least three bridge segments. For the most part, agricultural lands to be converted to wet meadows were wetland communities prior to being converted to croplands. Because acreages of conversion are minimal, no significant effects on native animal communities are expected in the action area.

The locations of Program lands for habitat restoration are not known at this time and it is not possible to determine what the effects might be on prime farmland. However, given that the relative acreages of conversion within the action area are minimal, and given the nature of the proposed land management actions, it is not likely that significant amounts of prime farmland will be irreversibly removed from agricultural production.

The location of an off-channel reservoir in the Central Platte River (Brady to Lexington) area has not been determined and the amount of prime farmland that could be inundated by construction is not currently known. However, the reservoir will not be large and it will be located in an upland area which will contain significant amounts of sloping ground not suitable for prime farmland. Therefore the amount of prime agricultural lands inundated by the reservoir would likely be small.

The Program will lease water from willing leasors as part of each alternative. It is expected that these leases will be of limited duration. Also, while leasing water to the Program, farmers can continue to keep those lands in dryland production. Because of the limited duration of these leases, and because the land remains available for production, the Program's water leasing will not have irreversible impacts on prime farmland.

Lowland Grassland

Lowland grassland habitats increase in all action alternatives. Lowland grassland increases range from 7 percent (3,025 acres) in the Water Emphasis Alternative to 19 percent (8,210 acres) in the Wet Meadow Alternative. These increases are a result of conversion of croplands, upland grasslands, and other wetlands to lowland grassland habitats. The Governance Committee and Wet Meadow Alternatives provide significant increases in lowland grasslands that would benefit target species, as well as other plants and animals inhabiting these wetlands. However, the Water Emphasis Alternative provides minimal increases in lowland grasslands, with minimal benefits.

Woodlands

Riparian woodland habitats decrease in all action alternatives. Decreases in this habitat type range from 6 percent (2,010 acres) in the Water Emphasis Alternative to 11 percent (4,015 acres) in the Wet Meadow Alternative. Decreases in woodlands result primarily from conversion to lowland grasslands. Decreases in woodland habitats will have an impact on plant and animal communities, but these will be localized. Wildlife travel corridors are not expected to be significantly interrupted by these alterations due to the fact that the lowland grassland areas created will also be managed for wildlife and will not become developed areas. Minor reductions in resident and migratory species populations associated specifically with woodlands may occur.

Shrublands

Shrubland habitats also decrease in all action alternatives. In the Wet Meadow Alternative, shrublands decrease by approximately 14 percent (799 acres). In the Governance Committee and Full Water Leasing Alternatives, shrublands decrease by approximately 12 percent (677 acres). The Water Emphasis Alternative decreases shrublands by 8 percent (469 acres). Shrubland decreases are a result of conversion to lowland grasslands or bare sand within the channel. As with woodlands, decreases in shrublands are expected to have only localized effects, leading to some minor reductions in populations of species specifically associated with shrublands for those alternatives with the greatest impact.

Herbaceous Riparian Wetlands

Herbaceous riparian wetlands will decrease in all action alternatives—ranging from 6 percent (242 acres) in the Water Emphasis Alternative to 10 percent (434 acres) in the Wet Meadow Alternative. These decreases are a result of conversion of herbaceous riparian wetlands to lowland grasslands and bare sand within the channel. As with woodlands and shrublands, impacts of decreases in herbaceous riparian wetlands will be localized and are expected to have only a minimal effect on populations of species specifically associated with this habitat type.

Table 5-VEG-1.—Summary Changes in Area of Land Cover Types for Each Alternative Compared to Present Condition

	Present Condition		**Governance Committee, and Full Water Leasing Alternatives**			**Wet Meadow Alternative**			**Water Emphasis Alternative**		
Land Cover Type	**Acres**	**Percent**	**Acres**	**Percent**	**Acres/ Percent Change**	**Acres**	**Percent**	**Acres/ Percent Change**	**Acres**	**Percent**	**Acres/ Percent Change**
Agricultural lands	254,944	59	253,826	58	-1,118/ 0	251,901	58	-3,043/ -1	254,536	59	-408/ -0.2
Other classes*	36,972	9	36,963	9	-8 /0	36,862	8	-109.8 /0	36,963	9	-8/ 0.0
Lowland grassland	43,035	10	47,349	11	4,314/ 10	51,244	12	8,210/ 19	46,059	11	3,025/ 7
Upland grassland	35,636	8	35,543	8	-94/ 0	35,530	8	-107 /0	35,544	8	-93/ -0.3
Wooded	34,963	8	32,537	7	-2,426/ -7	30,948	7	-4,015/ -11	32,953	8	-2,010/ -6
Wetted channel	9,968	2	10,322	2	354/ 4	10,322	2	354/ 4	10,227	2	259/ 3
Shrubs	5,710	1	5,033	1	-677/ -12	4,911	1	-799/ -14	5,241	1	-469/ -8
Open water (ponds, lakes, etc.)	4,282	1	4,282	1	0/ 0	4,282	1	0/0	4,282	1	0/ 0
Herbaceous riparian	4,202	1	3,913	1	-289/ -7	3,768	1	-434/ -10	3,960	1	-242/ -6
Sand and gravel operations	1,672	0.4	1,637	0.4	-35/ -2	1,637	0	-35/ -2	1,637	0.4	-35/ -2
Bare sand (in-channel)	1,408	0.3	1,389	0.3	-19/ -1	1,396	0	-12/ -1	1,389	0.3	-19/ -1
Emergent	1,406	0.3	1,403	0.3	-2.7/ 0	1,403	0	-3/ 0	1,406	0.3	0/ 0
Totals	**434,198**	**100**	**434,198**	**100**		**434,198**	**100**		**434,198**	**100**	

* “Other Classes” equals bridge, development commercial, development single dwelling, powerline, road gravel, road interstate, road paved, other road, and barren surface.

Bare Sand

In-channel bare sand habitats decrease in all alternatives. However, decreases are minimal, and all alternatives decrease bare sand by approximately 1 percent. These decreases in bare sand habitat will not benefit the least tern and piping plover, but the minimal habitat decrease is not expected to significantly affect these target species.

Emergent Wetlands

Emergent wetlands habitats decrease minimally in all alternatives, except the Water Emphasis Alternative, which has no decrease in emergents. Decreases are less than 1 percent (3 acres) in the Governance Committee and Full Water Leasing Alternatives. These minimal decreases will have localized effects on plant and animal species occupying these habitats, and no significant impacts are expected. Emergent wetlands will also increase 24 percent (344 acres) as a result of channel consolidation and creation of 14.2 miles of low flow channel.

Invasive Plant Species

Purple loosestrife and tamarisk are invasive species that colonize disturbed wetland areas. Both are considered noxious weeds in Nebraska. It is possible that clearing and leveling of riverbanks, islands, and sandbars associated with the action alternatives could provide areas that could be invaded by these wetland species. However, the goal of clearing and leveling activities is to create and maintain unvegetated sandbars. A substantial focus of the Program is to prevent or control the revegetation of these sandbar areas. Restoration activities will be closely monitored, and any invasion by purple loosestrife or tamarisk would be controlled through mechanical or chemical means.

South Platte River Riparian Vegetation Communities

The following paragraphs describe the potential for the alternatives to affect riparian habitat along the North and South Platte River.

The "Water Resources" section in chapter 5 describes the changes in flows that will occur in the South Platte River, under various alternatives, due to the Tamarack Projects and water leasing activities. The water leasing elements are designed to increase flows in the Lower South Platte River during the month of May and/or June. Water leasing under the Water Emphasis Alternative increases average May flows in the South Platte River at Julesberg by 318 cfs. The Full Water Leasing Alternative increases average May flows in the South Platte River at Julesberg by 397.

The Tamarack Projects increase May flow volumes at Julesburg by 1,645 to 2,575 acre-feet under the various alternatives. Flows are generally increased in March, April, May, July, August, September, and October (see the "Water Resources" section in this chapter) and reduced in November, December, and January, by up to 9,242 cfs per month. These projects deplete annual flows at Julesburg by roughly 5,254 to 11,271 cfs. This translates to monthly flow increases up to 37 percent in May and monthly flow reductions up to 17 percent in January.

These projects increase spring flows in the Lower South Platte River and reduce winter flows. An increase in flows during May could benefit adjacent riparian, backwaters, and sloughs. However, reductions in flow during January will likely have little or no effect on these vegetation communities.

North Platte River Riparian Vegetation Communities

All of the alternatives have similar effects upon flows in the North Platte River. In general, the alternatives increase average monthly flows in the summer and reduce flows in the winter. Winter flow reductions range from 1 percent below Kortes Reservoir , 0 percent below Gray Reef Reservoir, from 7 to 10 percent below Guernsey Reservoir, and 0 percent above Lake McConaughy. Summer monthly flow increases range from 2 to 7 percent below Kortes Reservoir, from 8 to 20 percent below Gray Reef Reservoir, from 1 to 2 percent below Guernsey Reservoir, and from 4 to 8 percent above Lake McConaughy.

The summer flows could have some beneficial effect on adjacent riparian communities, as well as backwaters and sloughs. Decreased flows during winter months will likely have little or no effect on adjacent vegetation communities.

Effects of Water Leasing Activities on Land Cover and Vegetative Communities

All of the alternatives, except the Wet Meadow Alternative, involve some amount of water leasing to provide improved riverflows. It is expected that water leasing will involve short-term (1 to 3 years) leases from farmers and that the leasing will be distributed widely, so that the effects of water leasing will be dispersed. Table 5-VEG-2 shows an illustrative distribution of leasing for the four alternatives across the economic regions defined in the “Agricultural Economics” section in chapter 4. This table represents the greatest change likely in land cover, as it is assumed that all agricultural lands associated with the leased water revert to a fallow condition, with no substitution of dryland cropping.

Table 5-VEG-2.—Predicted Changes in Irrigated Acres by Alternative*

Alternative	Central Platte Habitat Area	Lake McConaughy Area	Scotts Bluff Area	Eastern Wyoming	North Platte Headwaters**	Eastern Colorado
Governance Committee Alternative	-10,700	0	0	-1,000	-5,200	0
Full Water Leasing Alternative	-38,300	-8,600	23,700	0	-5,900	-1,100
Wet Meadow Alternative	0	0	-300	0	-1,500	0
Water Emphasis Alternative	-18,800	-5,700	-5,300	0	-4,500	0

*No substitution of dryland farming for irrigation assumed.

**The FEIS analysis assumes that leased water will be tied to reservoir storage. Therefore, in this analysis, all lands in the North Platte Headwaters region involved with water leasing are assumed to be below Seminoe Reservoir.

The alternative with the greatest amount of leasing, the Full Water Leasing Alternative, reduces irrigated acreage by roughly 78,000 acres. Temporary fallowing of these lands will increase the diversity of species using this habitat. However, given that these land cover conversions are short term, are distributed widely, and represent roughly one-tenth of 1 percent of the irrigated lands in the Basin, it is unlikely that water leasing will produce any significant regional changes in the availability of habitat.

Migratory Birds

The Migratory Bird Treaty Act requires a permit to take native migratory birds. The recent Executive Order (EO) 13186 requires Federal agencies to avoid impacts to migratory birds. The direct reduction of existing habitats (e.g., island leveling and vegetation removal) could take individual migratory birds and will negatively affect habitat used by some species of migratory birds. In compliance with EO 13186, such activities will be restricted to those periods of the year (generally late summer through early spring) when nesting activities do not occur and the chance of take is minimal. Each site-specific NEPA analysis tiered to this Programmatic FEIS will examine potential methods to reduce impacts to migratory birds and implement those methods found to be reasonable.

In addition to improving habitat for the three target migratory bird species, the action alternatives somewhat increase the migratory habitat for waterfowl and shore birds. Migratory bird species that may experience minor reductions in habitat along the Central Platte River include gray catbird, orchard oriole, warbling vireo, black-capped chickadee, American robin, Swainson's thrush, hairy and downy woodpecker, American goldfinch, brown thrasher, grasshopper sparrow, yellow warbler, willow flycatcher, eastern and western kingbirds, red-headed woodpecker, belted kingfisher, eastern screech owl, green heron, great blue heron, great and snowy egrets, American woodcock, and turkey.

WETLANDS

Issue: How would the action alternatives affect wetlands?

Overview

This section describes effects of habitat management activities on wetlands in the Central Platte Habitat Area. The most significant effect of the alternatives on wetlands will occur during habitat restoration activities as channel habitat and wet meadow habitat are restored. This section focuses on the effects of that restoration.

SCOPE

The analysis includes the impact of land habitat restoration and management on wetland habitats in the study area as described in chapter 3. Only those wetland types that change with any of the alternatives are discussed in this section.

INDICATOR

The indicator of impacts to wetlands is based on land actions in each alternative:

- Increase or decrease in **acres of wetlands**

SUMMARY OF IMPACTS

All action alternatives provide increases in wetlands in the Central Platte Habitat Area.

The Wet Meadow Alternative represents the highest gain in wetland communities, converting 7,802 nonwetlands to lowland grasslands (palustrine, emergent, persistent wetlands). There is also conversion of 417 acres of palustrine, emergent, persistent wetlands (emergent and herbaceous riparian) to palustrine, emergent, persistent wetlands (lowland grasslands). This alternative also converts 40 acres of wetlands to nonwetlands.

The Governance Committee and Full Water Leasing Alternatives have a 4,003-acre gain in wetlands (palustrine, emergent, persistent). There is also conversion of 274 acres of palustrine, emergent, persistent wetlands (emergent and herbaceous riparian) to palustrine, emergent, persistent wetlands (lowland grasslands). These alternatives also convert 40 acres of wetlands to nonwetlands.

The Water Emphasis Alternative has the lowest gain in wetland communities, converting 2,982 acres to lowland grasslands (palustrine, emergent, persistent wetlands). There is also conversion of 265 acres of palustrine, emergent, persistent wetlands (emergent and herbaceous riparian) to palustrine, emergent, persistent wetlands (lowland grasslands). This alternative does not convert any wetlands to nonwetlands.

IMPACTS ANALYSIS

Central Platte Habitat Area

Table 5-WET-1 summarizes wetland impacts by alternative. As shown in table 5-WET-1, lowland grasslands (PEM1) are increased with all action alternatives. Increase in this wetland type within the study area ranges from a 19-percent increase in the Wet Meadow Alternative to a 7-percent increase in the Water Emphasis Alternative. All action alternatives, except the Water Emphasis Alternative, also exchange one wetland type for another; emergent and herbaceous riparian (PEM1) converted to lowland grasslands. In addition, all alternatives include conversion of 344 acres of narrow river subchannels to low flow channels through restriction of higher flows from subchannels.

Table 5-WET-1.—Summary of Wetland Impacts by Alternative (acres)

Existing Community	Converted to	Governance Committee and Full Water Leasing Alternatives	Wet Meadow Alternative	Water Emphasis Alternative
Lowland Grassland Restoration				
Wooded–PFO*	Lowland grassland – PEM	2,235	3,864	1,863
Herbaceous riparian–PEM	Lowland grassland – PEM	271	414	225
Agricultural–NW	Lowland grassland – PEM	1,161	3,188	451
Shrubs–PSS	Lowland grassland – PEM	513	636	354
Upland grasslands–NW	Lowland grassland – PEM	94	107	93
Emergent–PEM	Lowland grassland – PEM	3	3	0
Totals		**4,277**	**8,212**	**2,986**
Island Clearing and Leveling				
Wooded–PFO	River channel – R3UB	152	152	108
Shrubs–PSS	River channel – R3UB	163	163	113
Herbaceous riparian–PEM	River channel – R3UB	19	19	19
Bare sand–PEM	River channel – R3UB	19	19	19
Lowland grassland–PEM	River channel – R3UB	2	2	2
Wooded–PFO	Bare sand – PEM	0	7	0
Totals		**355**	**362**	**261**
Grand Totals		**4,632**	**8,574**	**3,247**
*Cowardin Classification				

Other Wetlands

Some other elements of the alternatives have the potential to affect wetlands in the North and South Platte River.

Pathfinder Modification Project

The Pathfinder Modification Project, which seeks to restore the storage capacity of Pathfinder Reservoir lost to sediment accumulation, is not expected to require a site-specific Section 404 permit under the Clean Water Act. The anticipated modification involves raising the existing spillway crest by constructing a short wall and spillway on top of the existing bedrock spillway. No dredge or fill of materials into existing waters or wetlands is expected. Existing roads lead directly to the construction site.

An analysis of activities under the Clean Water Act will be completed when the final designs are developed.

Central Platte Offstream Reservoir

The Governance Committee Alternative, Water Action Plan, (Governance Committee Program Document: Attachment 5: Water Plan) includes construction of a small offstream reservoir in the Central Platte valley. As with all of the Water Action Plan elements, feasibility investigations of each element must occur before the element is adopted by the Program. Therefore, a specific reservoir site has not been proposed at this time. If the Program chooses to proceed with this element, site-specific NEPA analysis will be undertaken. If wetland impacts are likely, a site-specific analysis of wetland will be undertaken as part of the NEPA analysis of alternatives to support application for a site-specific Section 404 permit.

North Platte River Choke Point

Each of the alternatives involves an effort to restore channel capacity in the North Platte River at North Platte, Nebraska. The Governance Committee has undertaken initial investigations of means to restore flood capacity to this reach of the river (JF Sato and Associates, 2005). Several of the options investigated would likely require Section 404 permits. NEPA and Section 404 analysis will be undertaken if the Governance Committee chooses to proceed with efforts to restore channel capacity in this area.

Site Restoration Management Planning and Implementation

Once specific parcels are acquired, the Program will provide appropriate site development specifications and accompanying management plans. Technical review will be solicited from natural resource agencies and local conservation organizations. Concurrently, site plans will be submitted to Federal, state and local regulatory agencies for a final determination of permit requirements and necessary approvals. Information to be included in this pre-construction review phase will include:

- Statement of site restoration goals and objectives
- Pre-construction site characterization

- Description of restoration treatments and management plans
- Description of the site's anticipated response
- Specification of performance standards, monitoring protocols, and identification of remedial management prescriptions should performance standards and project targets be deficient.
- Documentation of site protection measures and maintenance methods
- Documentation of final assurances (financial obligations, responsible parties, and schedules)

WHOOPING CRANE

Issue: How would the action alternatives affect whooping crane roosting and whooping crane critical habitat?

Overview

SCOPE

Generally, the geographic scope is the Platte River between Lexington and Chapman, Nebraska, and an area of the Platte River valley within several miles of the main river channel.

Habitats lying both within the affected area and the whooping crane migrational range also occur upstream of Lexington, on the Platte, North Platte, and South Platte Rivers. However, as explained in chapters 2 and 4, the present suitability of roosting and stopover habitat upstream of Lexington is marginal as a consequence of long-term channel narrowing. These habitats are not expected to significantly change from the Present Condition under any of the action alternatives. Further analysis of the effects of action alternatives on these river reaches is not warranted.

As in recent decades, migrational stopovers by whooping cranes may continue to occur in the river reaches above Lexington, but such stopovers would be relatively infrequent for all of the action alternatives.

INDICATORS

Whooping crane use and critical habitat were evaluated for:

- **Channel roost habitat:** The amount and spatial distribution of channel roost habitat for attracting migrating whooping cranes
- **Out-of-channel habitat:** Extent and quantity of feeding areas (including riparian meadows)
- **Habitat sustainability:** Effects on ecological processes that sustain riverine and riparian habitats
- **Security and protection from disturbance:** The ability to prevent or avoid disturbances and intrusions on crane habitats.

SUMMARY OF IMPACTS

Roosting Habitat

The Full Water Leasing Alternative most improves both the amount and the distribution of wide channel roosting habitat. Improvements are due to initial mechanical channel widening on Program lands, with continued channel maintenance from sand augmentation and improved channel-forming flow events. The Governance Committee and Wet Meadow Alternatives also provide improvement, albeit more limited. Channel clearing activities and sand augmentation for these alternatives are identical to the Full Water Leasing Alternative, but the Full Water Leasing Alternative provides higher flow events and greater sand transport that maintain wider channels. The higher flows result from reservoirs being maintained at higher pool levels.

For all of the alternatives, the value of channel roost habitat created upstream of Kearney could be negatively affected by hydrocycling discharges from the Johnson-2 Return Canal. The Johnson-2 Return discharges produce repetitive oscillations of river stage in the Johnson-2 Return to Kearney river reach that may disrupt crane roosting behavior and flush cranes from roosts. Cranes flushed at night are subject to risks of injury/mortality from collisions with fixed objects such as powerlines and tree branches. The experience of roost disruption also may inhibit future use by individual whooping cranes.

Feeding Habitat

For all action alternatives, the acreage of grasslands would increase. The Wet Meadow Alternative would provide the largest grassland acreage.

Wet meadow creation in the upstream portion of the Central Platte Habitat Area would be experimental. To the extent the Program attempts to create meadows sand and gravel mineral soils of the former river channel, biological communities, in general, would probably have lower biodiversity and productivity than natural riparian meadows. The abundance and diversity of food resources of meadow created on mineral soils may have limited or very limited value.

Native wet meadows are still prevalent in downstream portions of the Central Platte Habitat Area. The Full Water Leasing Alternative would provide the greatest hydrologic support for these by providing higher spring flows and river water surface elevations, particularly in important high flow years. River water surface elevations from the Governance Committee, Wet Meadow, and Water Emphasis Alternatives appear to be nearly equal. They provide somewhat less support than the Present Condition in high flow years, but greater support than the Present Condition in moderate and low flow years.

The effect of action alternatives on whooping crane waste-grain food supplies would depend, in part, on how other water bird populations that use the Platte River respond (socially and behaviorally) to altered river habitat conditions. An increase in distribution of wide open channel habitat could distribute bird population more evenly and alleviate crowding of large flocks in few river segments, thus easing competition for waste corn.

Habitat Sustainability

Program lands would occupy only a small portion of the Central Platte Habitat Area but the Program alternatives will affect the ability to maintain habitat throughout the 90-mile-long Central Platte Habitat Area. The Full Water Leasing Alternative would result in the greatest improvement to wide channels and river habitat maintenance processes. These improvements result from a combination of mechanical clearing, sand augmentation, and higher channel forming flows. The Governance Committee, Wet Meadow, and Water Emphasis Alternatives also provide channel width improvement, which is comparable to one another but less than those achieved by the Full Water Leasing Alternative.

All alternatives rely on mechanical intervention (i.e., sand augmentation) to offset the continuing impacts of sediment transport imbalances in the Central Platte Habitat Area that exist due to water diversions. Sand augmentation would artificially help to maintain wide channels and reduce channel degradation.

The deficit of sediment supply to the Central Platte Habitat Area will continue with operation of the Tri-County Supply Canal under all alternatives. The water plan for each alternative requires sand augmentation to prevent increasing the imbalance that exists under the Present Condition. The conservation and recovery of whooping crane habitats would be increasingly reliant on artificial/mechanical sediment augmentation measures to offset the sand imbalance.

Security

The Wet Meadow Alternative provides the greatest channel length managed for crane security and, thus, the greatest protection against disturbance and intrusion for roosting cranes. The channel lengths protected by the Governance Committee and the Full Water Leasing Alternatives are about equal to one another and somewhat less than the Wet Meadow Alternative. The Water Emphasis Alternative provides the least protection.

Including out-of-channel lands, the Wet Meadow Alternative provides the largest area of protected habitat—about 16,000 acres. The area-to-perimeter (area:perimeter) ratio is slightly greater than that of other alternatives, an indication that the land parcels would be more contiguous and consolidated. The Governance Committee and Full Water Leasing Alternatives would each protect roughly 9,600 acres and the Water Emphasis Alternative would protect about 7,000 acres.

IMPACTS ANALYSIS

The land and water actions for the alternatives modify riverflows, channel habitat, and wet meadow habitat for the whooping crane, as discussed earlier in this chapter.

Unless otherwise indicated, all impacts are stated in relation to the Present Condition, as noted in chapter 1, “Purpose of and Need for Action.”

Channel Roost Habitat

Open Channel Area

The four action alternatives employ mechanical manipulation to initially widen the channel area. The amounts of widening vary by alternative and are assumed to be fully implemented within the Program's First Increment. The channel manipulation activities of the alternatives are as follows:

- **Governance Committee, Full Water Leasing, and Wet Meadow Alternatives.** Total of about 8.9 miles of bank cutting, island lowering and flow consolidation concentrated primarily between Overton and Kearney, Nebraska, with some channel restoration downstream of Kearney.
- **Water Emphasis Alternative.** A total of about 6.4 miles of bank cutting, island lowering, and flow consolidation at Cottonwood Ranch and at other locations upstream and downstream of Kearney, Nebraska.

GIS Mapping Analysis

Based on GIS analysis, the amount of wide open channels would increase for all action alternatives (table 5-WC-1) compared to the 1998 baseline map. The restored and managed channel area is equal for the Governance Committee, Full Water Leasing, and Wet Meadow Alternatives. Each of these three alternatives would increase wide channels (i.e., open channels greater than 500 feet wide) by about 20 percent. The Water Emphasis Alternative would improve wide channels by about 15 percent.

Table 5-WC-1.—Changes in Open Channel Area Relative to the Present Condition*

	Open Channel Greater Than 500 Feet Wide	
	Acres	**Change From the Present Condition (Percent)**
Present Condition	3,017	—
Governance Committee Alternative	3,654	+21
Full Water Leasing Alternative	3,654	+21
Wet Meadow Alternative	3,654	+21
Water Emphasis Alternative	3,469	+15
*Values are based on GIS analysis.		

Under all alternatives, a significant portion of channel restoration would be located in the upstream portion of the Central Platte Habitat Area, between Kearney and Overton. Distribution of open channel habitats would be most improved, and equally improved, by the Governance Committee, Full Water Leasing, and Wet Meadow Alternatives (figure 5-WC-1). These alternatives most improve habitat distribution in the critical habitat reach where few wide channels now remain. Consequently, whooping crane stopover opportunities would occur over a broader portion of their migrational crossing of the Platte River. The Water Emphasis Alternative also provides benefits but to a lesser extent.

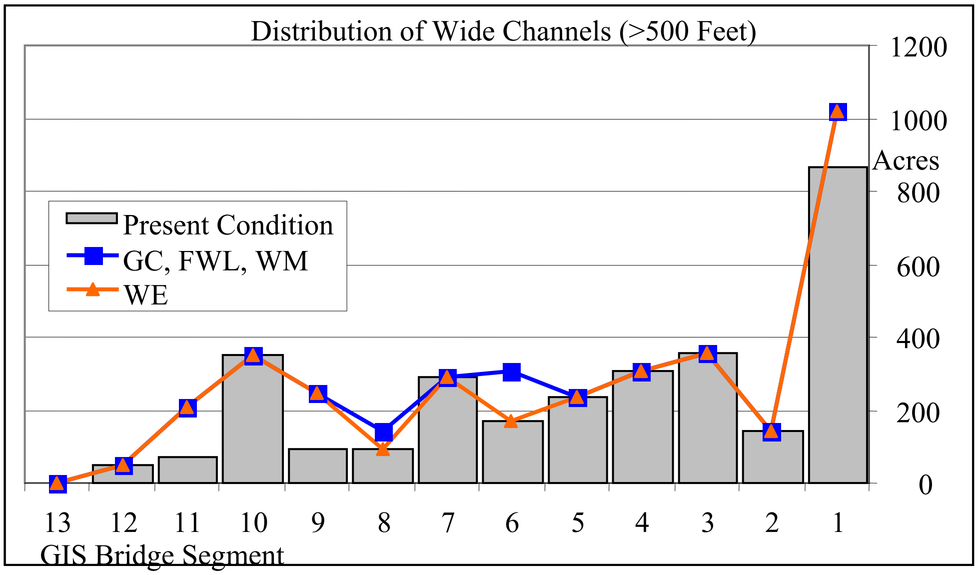

Figure 5-WC-1.—Changes in the amount and distribution of wide channels compared to the 1998 baseline (Present Condition). River bridge segments are numbered east to west, right to left. Grey bars show the Present Condition. Blue line indicates the Governance Committee, Full Water Leasing, and Wet Meadow Alternatives. Orange line indicates the Water Emphasis Alternative.

The changes in the amount and the distribution of open channel area roosting habitat from mechanical widening represent only the "footprint" of land cover changes on Program-acquired lands superimposed on the 1998 mapped conditions. The values do not reflect the sustainability of roosting habitat or the full effect of Program activities throughout the Central Platte Habitat Area because the GIS land cover change computations do not reflect channel changes naturally occurring due to channel processes, either on Program lands or on other river reaches. Program lands account for only a small portion of the Central Platte Habitat Area. The sustainability of open channel habitats—both those restored on Program lands and those off Program lands—would differ for each alternative, as discussed in the "Roost Habitat Sustainability" subsection in this section.

PHABSIM Analysis

The PHABSIM modeling was used to assess relative rank of the effects of each alternative on aquatic characteristics within wide channels (>500 feet). The Governance Committee, Full Water Leasing, and Wet Meadow Alternatives provide comparable improvements to the amount and distribution of channel habitat characteristics considered favorable to whooping crane use. All alternatives improve spring and fall habitat over the Present Condition from the combined effects of water management during crane migration and mechanical channel widening.

During spring, wetted area within wide (>500 feet) channels of the river would be most improved by the Governance Committee, Full Water Leasing, and Wet Meadow Alternatives (table 5-WC-2). Each of these three alternatives would provide comparable increases of roughly 20 to 30 percent in March and April. For the most part, the distribution of improvements would correspond with channel widening represented in figure 5-WC-1. The Water Emphasis Alternative would also improve wetted channel area, but the amount of increase and the distribution (three bridge segments) is generally less than for the other action alternatives (five bridge segments).

Table 5-WC-2.—PHABSIM Model: Wetted Area (acres) in Channels >500 Feet Wide During Whooping Crane Migration (and Percent Change From the Present Condition)

	March	April	May		October	November
Present Condition	3,355	3,375	3,118		3,265	3,464
Governance Committee Alternative	3,771 (+12)	4,014 (+19)	3,908 (+25)		4,070 (+25)	4,181 (+21)
Full Water Leasing Alternative	3,693 (+10)	3,982 (+18)	3,906 (+25)		4,093 (+25)	4,072 (+18)
Wet Meadow Alternative	3,734 (+11)	3,990 (+18)	3,895 (+25)		4,009 (+25)	4,103 (+19)
Water Emphasis Alternative	3,571 (+06)	3,887 (+15)	3,718 (+19)		3,940 (+19)	3,981 (+15)

During fall, the Full Water Leasing Alternative would provide the greatest improvement in wetted area within wide channels (table 5-WC-2). The improvements provided by the Governance Committee and Wet Meadow Alternatives are roughly equivalent to one another and slightly less than the Full Water Leasing Alternative.

Also using PHABSIM, the area of wide channel with a 100-foot minimum shallow width would improve (i.e., increase) for the Governance Committee, Full Water Leasing, and Wet Meadow Alternatives to about the same extent (about 18 to 19 percent) during the spring whooping crane migration period (table 5-WC-2 and figure 5-WC-5). Again, this channel characteristic would improve under the Water Emphasis Alternative but to a somewhat lesser degree.

During the fall migration season, the Full Water Leasing Alternative would provide the greatest improvement for channel area having 100-foot minimum shallow width (table 5-WC-3 and figure 5-WC-6). The improvements provided by the Governance Committee, Wet Meadow, and Water Emphasis Alternatives are roughly equivalent to one another and somewhat less than the Full Water Leasing Alternatives.

Table 5-WC-3.—PHABSIM Model: Average Area (acres) of Wide Channels (>500 Feet) with 100-Foot Minimum Shallow Width During Whooping Crane Migration (and Percent Change From the Present Condition)

	March	April	May		October	November
Present Condition	3,355	3,375	3,118		3,265	3,464
Governance Committee Alternative	3,771 (+12)	4,014 (+19)	3,908 (+25)		4,070 (+25)	4,181 (+21)
Full Water Leasing Alternative	3,693 (+10)	3,982 (+18)	3,906 (+25)		4,093 (+25)	4,072 (+18)
Wet Meadow Alternative	3,734 (+11)	3,990 (+18)	3,895 (+25)		4,009 (+25)	4,103 (+19)
Water Emphasis Alternative	3,571 (+06)	3,887 (+15)	3,718 (+19)		3,940 (+19)	3,981 (+15)

As with GIS computation of open channel, all the PHABSIM based channel habitat computations are based on simple, direct changes from migration season flows for Present Condition and the mechanical reshaping of channels on Program lands (figures 5-WC-2 and 5-WC-3). As explained in chapter 4, the PHABSIM model provides useful information but also has limitations when applied to the Platte River, because it does not reflect the natural evolution or trends in the channel occurring either on Program lands or in the river reaches off of Program lands. This factor is addressed in the "Roost Habitat Sustainability" section below.

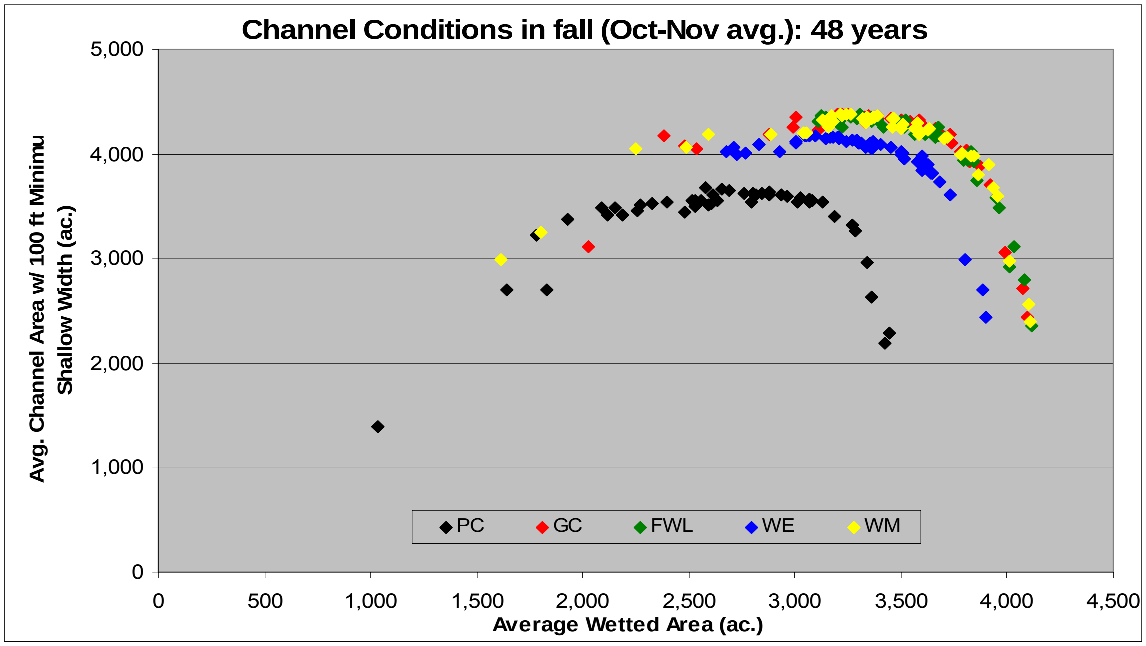

Figure 5-WC-2.—PHABSIM model: average channel habitat conditions during April, the primary months of spring whooping crane migration. Black indicates the Present Condition, red the Governance Committee Alternative, green the Full Water Leasing Alternative, yellow the Wet Meadow Alternative, and blue the Water Emphasis Alternative.

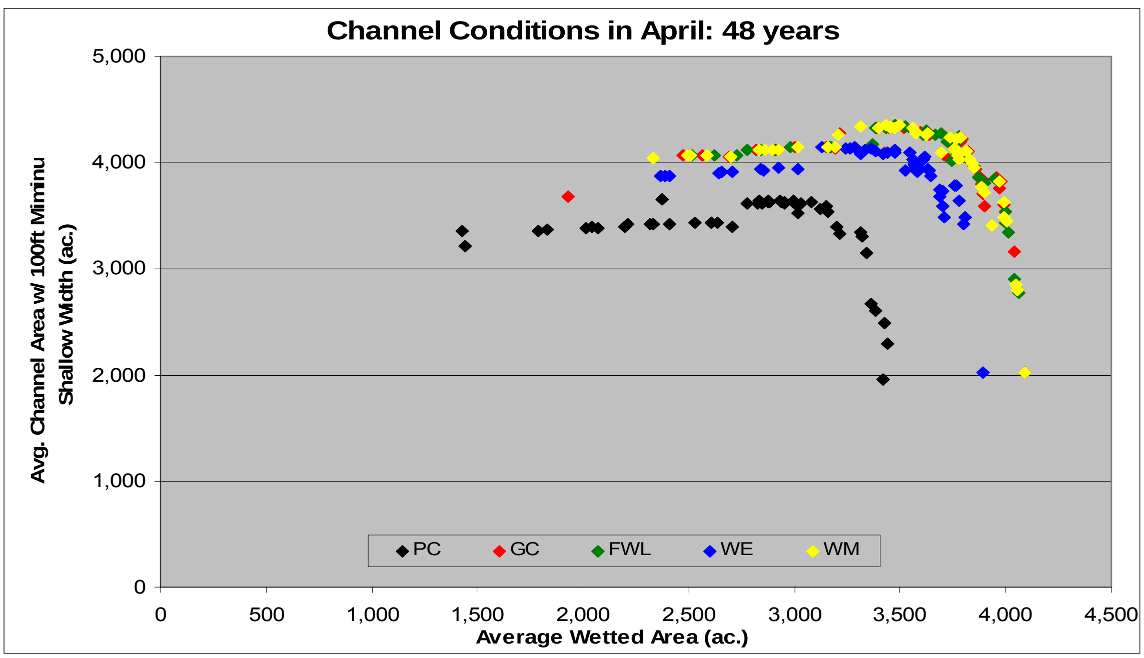

Figure 5-WC-3.—PHABSIM model: average channel habitat conditions during October and November, the primary months of fall whooping crane migration. Black indicates the Present Condition, red the Governance Committee Alternative, green the Full Water Leasing Alternative, yellow the Wet Meadow Alternative, and blue the Water Emphasis Alternative.

Roost Habitat Sustainability

This analysis used the SEDVEG Gen3 model to examine channel width changes during the crane migration seasons for a 48-year period of variable hydrology. Specifically, the analysis focused on the average width of the widest channels at 62 modeled cross sections.

The Full Water Leasing Alternative produced the greatest improvement of widest channels in the Habitat Area (table 5-WC-4). The channel width improvements result from a combination of initial mechanical widening on Program lands, along with sand augmentation and higher channel forming flows. The Governance Committee, Wet Meadow, and Water Emphasis Alternatives would also achieve some channel width improvements, but they would be less than the Full Water Leasing Alternative's improvements. Because channel modifications and sediment augmentation are identical, hydrology is believed to cause the channel width differences between the Governance Committee, Full Water Leasing, and Wet Meadow Alternatives. At the SEDVEG Gen3 model's current stage of development, results should be viewed as a general indicator for ranking the relative response of the alternatives, rather than a predicted quantity of improvement.

Table 5-WC-4.—Projected Change in the Average Width of the Widest Channels of the Central Platte Habitat Area, Compared to the Present Condition*

Alternative	Change in Average Width of Widest Channels	
	Width Change (Feet)	Percent Change
Governance Committee Alternative	+ 112	+23
Full Water Leasing Alternative	+ 124	+28
Water Emphasis Alternative	+ 92	+21
Wet Meadow Alternative	+ 98	+22
*Values are from the SEDVEG Gen3 model.		

Sediment Transport

Sand movement in the Platte River between North Platte and Lexington would continue to be impaired to about the same degree as in the Present Condition, due to operation of the Tri-County Supply Canal and other canal diversions. The amount of sediment naturally supplied by the river to the Central Platte Habitat Area (at Lexington) is estimated to be roughly one-half the average annual load at Chapman for all alternatives.

At the same time, all alternatives increase the sediment transported within the Central Platte Habitat Area (see "River Geomorphology" in this chapter) as the Tri-County Supply Canal and Johnson-2 Return discharges are increased. The difference between the sediment supplied at Lexington and the amount transported within the Central Platte Habitat Area is the net amount that must be supplied by tributary inflows and channel bed erosion. Field surveys of the river channel (Murphy et al., 2004) indicate that bed erosion is a dominant process under the Present Condition.

During the Program's First Increment, all action alternatives would use mechanical intervention (i.e., sand augmentation to the river) to help offset the impacts of sediment transport imbalances in the Central Platte Habitat Area. The volume of sand augmentation is the same under each modeled action alternative.

At restored sites, degradation would resume if sand augmentation activity ceases or moves to other downstream sites, due to continued discharge operations of the Johnson-2 Return.

Based on current field surveys, the Central Platte Habitat Area generally above Shelton bridge appears most susceptible to channel bed degradation from deprivation of sediment supply and the sediment transport deficit. Downstream of RM 195 (near Shelton bridge), field surveys have detected little change or trend in channel volume or channel bed elevations over recent years, and this is generally consistent with the Present Condition estimated by the SEDVEG Gen3 model. The SEDVEG Gen3 model estimates that all of the alternatives would be able to sustain sediment balance in the downstream area during the Program's First Increment—though close monitoring will still be required.

Pulse Flows

Seasonal high flows, or pulse flows, are frequently cited by river scientists as a critical element of a river's flow regime that is necessary to conserve the physical and biological integrity of river systems. The timing, magnitude, frequency, duration, and rate of change are recognized pulse flow parameters (Poff and Ward, 1989 and Poff et al., 1997). Though pulse flows are widely regarded as a major factor affecting channel maintenance processes on the Platte River, the detailed physical and biological mechanisms by which they operate remain uncertain. Therefore, this analysis examined the effect of the alternatives on channel-forming flow events from several technical perspectives, recognizing that all of the alternatives incorporate future scientific investigations and adaptive management.

Murphy et al. (2004) proposed an annual program of short-duration near bankfull flows within the safe channel capacity to increase the annual peak discharges that are equaled or exceeded (on average) two out of three years to 6,000 to 8,000 cfs (measured at Grand Island). This regime would be implemented in coordination with other Program activities (e.g., mechanical widening and sand augmentation). Like the peak flow recommendations of other Platte River investigators in the following subsections (Murphy et al. 2004) proposed that results be closely monitored and adjusted as needed through adaptive management.

To evaluate the achievement of 1.5-year peak flows recommended by Murphy et al., 2004, this analysis compared 1.5-year peak flows of the alternatives to the Present Condition. The Water Emphasis Alternative provides the greatest improvement in the 1.5-year peak flows—an increase of approximately 1,500 cfs (34 percent) (table 5-WC-5). The Water Emphasis Alternative reduces the peak flows in the highest flow years, but improves peak flows at moderate flow years. The 1.5-year peak flows for the Water Emphasis Alternative is closely followed by the Governance Committee Alternative (1,400 cfs; 31 percent), and then by the Wet Meadow (1,150 cfs; 25 percent) and Full Water Leasing Alternatives (1,000 cfs; 22 percent).

Table 5-WC-5.—Achievement of Various Channel Maintenance Flow Recommendations During a 48-Year Simulation Period*

	Present Condition	Governance Committee Alternative	Full Water Leasing Alternative	Wet Meadow Alternative	Water Emphasis Alternative
1.5-year peak flow (CFS) and (percent change from Present Condition)	4,609	6,026 (31)	5,639 (22)	5,760 (25)	6,182 (34)
Frequency that 4-year running average for June achieves 2,600 cfs	19	14	21	14	15
Frequency that 4-year running average for June achieves 3,000 cfs	13	10	16	9	9
Average flow for mid-February to mid-March (cfs)	2,371	2,635	2,725	2,587	2,761
Frequency that 10-year running average of 5-day peak achieves 8,300 to 10,500 cfs range	10	9	13	6	9
*All measurements are at Grand Island, Nebraska.					

Johnson (1994) found high correlations in channel width trends and June flow events, and recommended increases in mean June flows of 2,600 to 3,000 cfs “averaged over several years” to maintain quasi-equilibrium of the existing channels. For this analysis, action alternatives were examined using a 4-year mean June flow—but with the recognition that many existing channels in the upstream portions of the Central Platte Habitat Area have narrowed to an extent that appears to support little whooping crane use. The Full Water Leasing Alternative would improve the frequency of achieving 3,000 cfs from 13 to 16 years (about 23 percent) and is the only alternative that improves this parameter compared to the Present Condition (table 5-WC-5). The Governance Committee, Wet Meadow, and Water Emphasis Alternatives reduce the frequency of meeting this standard by 23 to 31 percent. Using Johnson’s 2,600-cfs standard, the relative ranking among other alternatives is roughly the same (table 5-WC-5).

Johnson (1994) also identified winter flows during cake-ice formation and ice breakup as a mechanism of vegetation removal but gave no specific flow recommendation. Based on information presented to a U.S. Department of the Interior panel, the Service recommended pulse flows during early spring period of ice breakup as part of larger pulse flow strategy (Bowman and Carlson, 1994). All of the action alternatives modestly increase the late winter/early spring flows (mid-February to mid-March) by amounts ranging about 200 to 400 cfs (9 to 16 percent) (table 5-WC-5).

O’Brien (O’Brien and Currier, 1987 and O’Brien, 1994) based peak flows recommendations on an average of the flow ranges for five channel-forming parameters, as well as on flow characteristics during 1969-1986, when the open channel area of the Central Platte River Habitat Area was believed to approach quasi-equilibrium. O’Brien recommended a 10-year running average with 5-day peak flows averaging 8,300 to 10,500 cfs. The Full Water Leasing Alternative improves the frequency of meeting this pulse flow standard. It is the only alternative that improves this parameter compared to the Present Condition (table 5-WC-5).

Finally, the recent review of Platte River Endangered Species Recovery science, conducted by the National Research Council (2005), recommended that flow and habitat recovery activities be focused on a “normative” flow regime. The National Research Council stated, *“To maintain that credibility [in Interior’s recommended management actions], DOI agencies must shift their approach to one based on the normative flow regime because it now [2005] constitutes the best available science”* (National Research Council, 2005, page 147). A normative regime is one that mimics as much as possible of the natural, pre-development structure of the hydrograph (peaks, pulses, base flows, and timing) given system constraints (e.g., storage capacity, conveyance limitations, water rights, and property damage). It is advocated as a means for conserving the integrity of natural characteristics and ecological processes innate to individual river systems (Poff et al., 1997 and Richter et al., 1996).

A current technique commonly used to measure/assess changes in streamflow characteristics consistent with the normative flow regime approach is to evaluate a number of different indicators of hydrologic alteration, or Index of Hydrologic Alteration (IHA) (Richter et al., 1996). In responding to the National Research Council recommendation, the Service initiated an evaluation using the IHA (Service, 2005, personal communication, Don Anderson, hydrologist). Application of the IHA analysis to the Central Platte River is hampered by limitations in the historic flow record, not only for the "pre-development" period, but also, to some extent, for the period prior to the rapid increase in reservoir storage around 1940. Although a substantial level of water development activities was in place by 1923 to 1940, flow records for this period at Overton probably represent a reasonable basis and the best available reference information for an IHA analysis of year-round flow regime changes in the Central Platte River in the 20th century.

The comparison of the 1923 to 1940 flow regime to a comparable period of Basin runoff (1954-1971) reveals that the large flow reductions have occurred with the greatest regularity in February and March (see the *Whooping Crane Appendix* in volume 3). However, the largest flow reductions, both in terms of absolute magnitude and proportional flow reduction, have generally occurred in April through June. On an interannual basis, the largest April and June peak flow reductions occur in years with high flow (i.e., annual frequency of occurrence less than 50 percent). (To date, IHA output is limited to interannual exceedances for 10, 25, 50, 75, and 90 percentile levels.)

To apply the concepts the National Research Council recommended in the FEIS, this analysis focused on the influence of the action alternatives on the ability to retain and improve the annual spring peak flows. Specifically, the analysis focused on the maximum, annual, 5-day peak flow and maximum, annual, 30-day peak flow at levels within the channel capacity (for this purpose, estimated at roughly 10,000 cfs).

Using the IHA (Richter et al., 1996) and flow data of the 1920s and 1930s as the best available information of historic flow characteristics, peak flows were identified as a portion of the flow regime most significantly altered by the Present Condition (Service, 2005, personal communication, Don Anderson, hydrologist). The ability of action alternatives to retain existing spring peak flows and improve the spring peak flows was, therefore, examined.

In the comparison of annual spring peak flows for 5-day duration, all scenarios tend to exceed Present Condition at low and moderate exceedance levels (about 70 percent of years) and underperform the Present Condition for the highest 30 percent of years. For the 30-day peak flow events, the greatest improvement is achieved by the Full Water Leasing Alternative. Under this alternative, peak flows in higher years are conserved, and peak flows in lower flow years are increased. Peak flows for the Governance Committee, Wet Meadow, and Water Emphasis Alternatives are lower and generally comparable to one another, particularly during the highest flow years; i.e., with a frequency of about 1 in 5 years or less (figures 5-WC-4 and 5-WC-5).

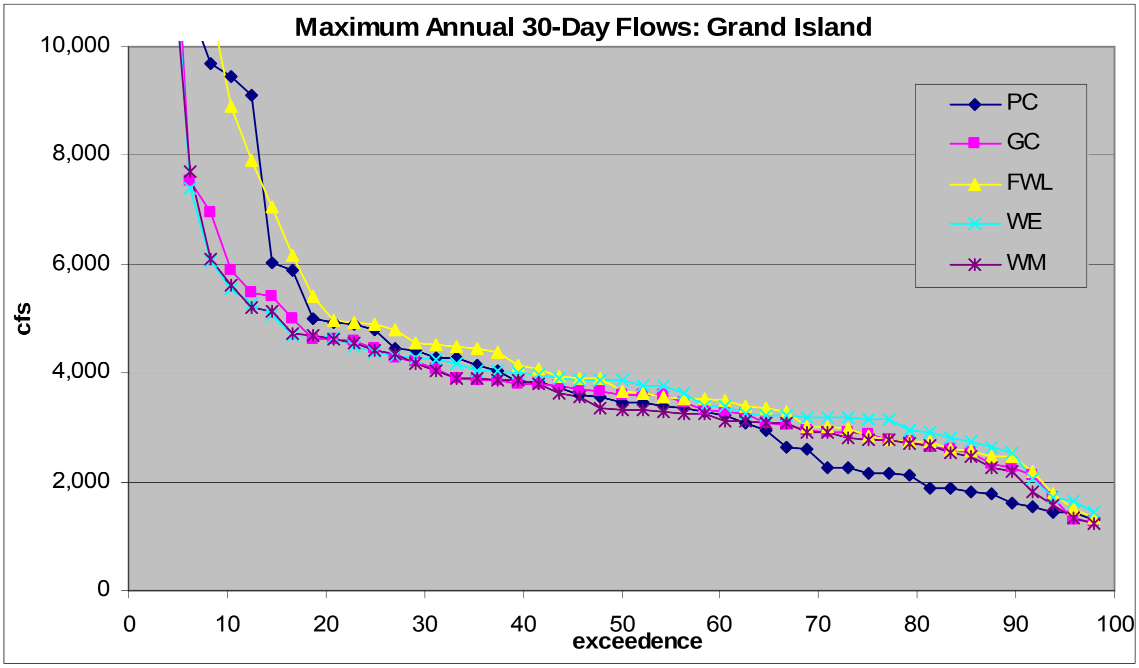

Figure 5-WC-4.—Exceedance curves for annual, 5-consecutive-day peak flow events at Grand Island. Dark blue indicates Present Condition, pink the Governance Committee Alternative, yellow the Full Water Leasing Alternative, maroon the Wet Meadow Alternative, and turquoise the Water Emphasis Alternative.

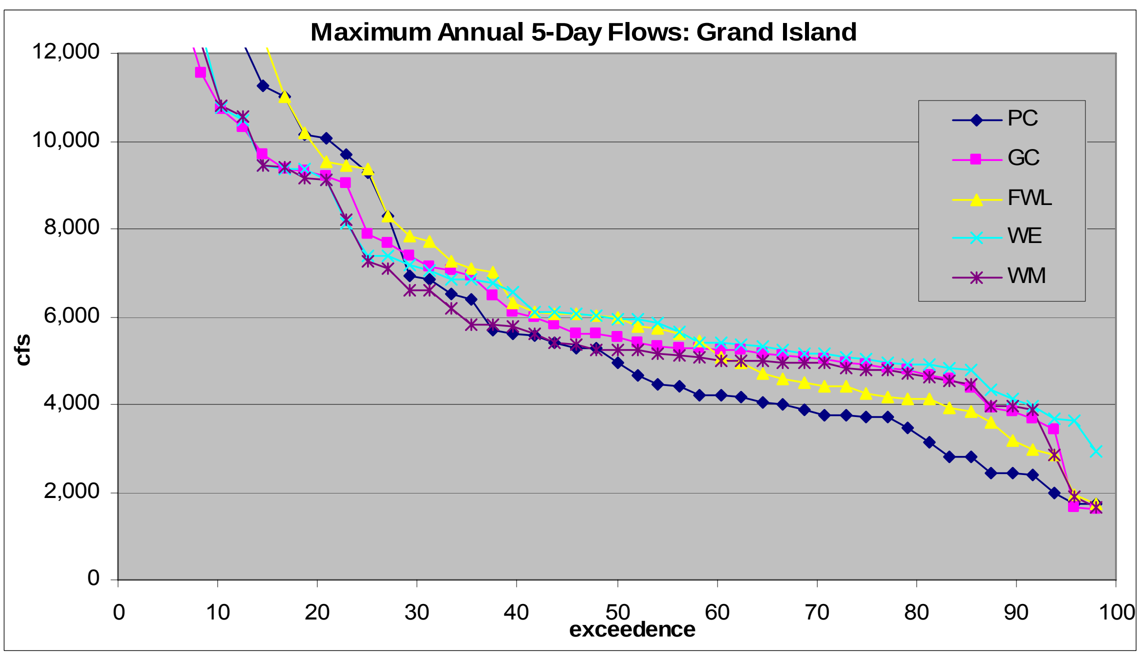

Figure 5-WC-5.—Exceedance curves for annual, 30-consecutive-day peak flow events at Grand Island. Dark blue indicates Present Condition, pink the Governance Committee Alternative, yellow the Full Water Leasing Alternative, maroon the Wet Meadow Alternative, and turquoise the Water Emphasis Alternative.

Out-Of-Channel Habitat—Grassland and Wet Meadows

Amount, Distribution, and Quality

The change in the amount of grassland in the study area ranges from small to modest increases of 2 to 19 percent over the amount that presently exists.

Detailed guidelines for wet meadow restoration have not yet been developed for the Program. Wet meadows created on mineral sandy and alluvial wash soils of the former channel bed may lack developed organic soil horizons. Such areas can have a significantly reduced capacity to support abundant or diverse communities of soil invertebrates and other potential crane food organisms that dwell at or near the soil surface. For example, islands cleared of forest and seeded to grass in the river channel near Kearney (i.e., the Wyoming Water Development Commission property) are not used by sandhill cranes for feeding, probably because the basic physical components needed to produce crane food items are absent[10]. Therefore, grassland acreages on mineral soils may have biological and food resource value significantly less than native wet meadows or grasslands—possibly not useable for crane feeding—and site-specific evaluations would be needed.

The distribution of grassland habitats acquired and restored by the action alternatives are indicated in tables 5-WC-6 and 5-WC-7. One long-term goal of the Program is to achieve a habitat complex in each of 10 bridge segments in the Central Platte Habitat Area (Platte River Cooperative Agreement, 1997). By this standard, the Wet Meadow Alternative (with seven bridge segments) provides the greatest amount of improvement, followed by the Governance Committee and Full Water Leasing Alternatives (with five bridge segments each).

Table 5-WC-6.—Change in Grassland Area in the Study Area Compared to the Present Condition (42,330 Total Grassland Acres)

Alternative	Change in Grassland Area	
	Acres	Percent
Governance Committee Alternative	+4,300	+10
Full Water Leasing Alternative	+4,300	+10
Wet Meadow Alternative	+8,204	+19
Water Emphasis Alternative	+ 872	+ 7

Waste grains gleaned from agricultural croplands are apparently relied on as a high-energy food source by migrating whooping cranes. All program-acquired lands would be in rural settings and would likely have corn and other small grains in close proximity to restored channel habitat. Even so, current information indicates that the availability of waste grain (i.e., corn) along the Platte River has become limited.

The limitation of grain resources is apparently due to increased farm harvest efficiency and to competition among the large populations of water birds that have become concentrated within smaller areas of suitable river habitat along the Platte River (Krapu, 2003). Because of this, the foraging efficiency and physiological condition of the large sandhill crane subspecies staging on the Platte River has declined. As

[10] Sandhill cranes do feed in wetlands and established grasslands outside the channel immediately adjacent to this site.

a surrogate for whooping cranes, it suggests that whooping cranes also may not be able to efficiently forage during Platte River stopovers. Moreover, availability of waste grain for whooping cranes in the spring is further reduced because whooping crane arrival follows the prolonged staging period of sandhill cranes and other water birds along the Platte River.

Table 5-WC-7.—Distribution of Acquired and Restored Grasslands in the Central Platte River, Lexington to Chapman, Nebraska

Bridge Segment	Governance Committee Alternative		Full Water Leasing Alternative		Wet Meadow Alternative		Water Emphasis Alternative	
	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
1	212	4	212	4	212	5	212	4
2	0	0	0	0	463	8	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	14	0	0
6	610	22	610	22	1,343	47	0	0
7	0	0	0	0	0	12	0	0
8	680	64	680	64	1,378	126	0	0
9	980	32	980	32	1,298	30	980	32
10	0	0	0	0	1,683	78	0	0
11	1,695	83	1,695	83	1,695	47	1,700	83
12	135	4	135	4	135	0	135	4
13	0	0	0	0	0	0	0	0
Total	**4,312**	**10**	**4,312**	**10**	**8,204**	**19**	**3,027**	**7**

Increased distribution of open channel area provided by each of the action alternatives would increase riverine habitat for water birds and, thus, may enable distribution of these populations over a broader range within the Platte River valley. This could help alleviate competition for food resources. Bird dispersal would largely depend on the social and behavioral response of the water birds to changed conditions over time; however, the nature and timing of that response is not well known or quantifiable at this time.

Wet Meadow Hydrology—Peak River Water Surface Elevations of Early Spring

Peak flows during late spring, from mid-February to mid-March, occur when plants and animals that inhabit riparian wetlands and backwaters are initiating spring growth and activity. Peak flows, and associated increases in river water surface elevation during early spring, are believed to function, along with precipitation, to help elevate and sustain groundwater levels, thaw soils, and make soil organisms birds use as food become active and available.

As previously mentioned in the discussion of roost habitat sustainability, average flows during the early spring pulse are expected to increase 200 to 400 cfs under all the alternatives. Beyond that, however, channel morphology and bed elevation changes also may contribute to differences in springtime river water surface elevations. River water surface elevations output from the SEDVEG Gen3 model were, therefore, used. The analysis focused on the downstream portion of the Central Platte Habitat Area, where native wet meadows are most prevalent on large islands or peripheral to the river channel, and also on years with the highest river stage (i.e., ≤ 50 percent exceedance). This analysis assumed years with the highest river stages would generally have the greatest influence on the long-term maintenance of wet meadow biological communities.

The computations of early spring river water surface elevations (table 5-WC-8) in the downstream portion of the Central Platte Habitat Area (below RM 195) from the SEDVEG Gen3 model incorporate changes due both to altered hydrology and channel morphology. For all alternatives, the peak river stages during the early spring pulse flow period are slightly improved over the Present Condition. For all alternatives, changes in water surface elevation range between 0 and plus 0.2 foot from the Present Condition.

Table 5-WC-8.—Change in the 30-Consecutive-Day Maximum River Water Surface Elevations (feet) During Early Spring (Mid-February to Mid-March) From the Present Condition Below RM 195

Alternative	<------ Exceedance Level (Percent of Years) ------>					
	0	10	20	30	40	50
Governance Committee Alternative	+.02	-.12	+.02	+.06	+.09	+.09
Full Water Leasing Alternative	+.03	-.01	+.06	+.09	+.09	+.09
Wet Meadow Alternative	-.01	-.09	+.01	+.04	+.05	+.06
Water Emphasis Alternative	+03	-.08	+.03	+.08	+.10	+.12
Note: Values are in feet.						

Field surveys have not detected significant changes or trends in channel bed elevation in the downstream sections of the Central Platte Habitat Area where most wet meadows adjoining the Platte River occur. Currently, no substantial differences in bed elevation are projected for any of the alternatives during the Program's First Increment. Nevertheless, because available data are limited, monitoring would necessarily be a priority early in the program to help refine understanding of this reach of river, the analytical SEDVEG Gen3 model, and effects from the implementation of sand augmentation and mechanical actions.

For all alternatives, the peak river water surface elevations during the early spring are very slightly improved over the Present Condition. For all alternatives, changes in water surface elevation range between 0 and plus 0.2 foot from the Present Condition. Overall, differences in early spring pulse flows among the Action Alternatives appear to be slight.

Wet Meadow Hydrology—Peak Riverflows and Water Surface Elevations of Late Spring

The Full Water Leasing Alternative increases the late spring peak flows over the Present Condition in nearly all years (table 5-WC-9). The highest, uncontrollable peak flow event (i.e., the 1983 event) simulated for the 48-year period of record would continue to occur with this alternative. The higher spring flows result from storage in reservoirs being maintained at higher levels than for the other alternatives. All of the alternatives increase peak flows in years with moderate and low peak flows (i.e., percent exceedance greater than or equal to 40 percent) from 6 to 10.

Table 5-WC-9.—30-Consecutive-Day Peak Flows (cfs) During Late Spring (Mid-April to Mid-July) at Grand Island, Nebraska

	Exceedance Level (Percent of Years)							
	0	10	20	30	40	50	60	70
Present Condition	22,839	9,524	4,679	3,785	2,397	2,132	1,836	1,434
Governance Committee Alternative	20,003	6,223	4,431	3,699	3,487	3,001	2,825	2,415
Full Water Leasing Alternative	22,672	9,260	4,926	4,350	3,318	2,831	2,469	2,115
Wet Meadow Alternative	17,398	5,748	4,060	3,561	3,080	2,834	2,579	2,294
Water Emphasis Alternative	19,326	5,710	4,306	3,861	3,643	3,176	2,975	2,637

River water surface elevations (table 5-WC-10) in late spring were also computed to incorporate the changes due to the altered hydrology and minor changes in channel bed elevation (from the SEDVEG Gen3 model). Qualifications given in the previous subsection (early spring flows) about the limited data and less definitive modeling conclusions for the downstream river reach also apply to these estimates.

Table 5-WC-10.—Change in the 30-Consecutive-Day Maximum River Water Surface Elevations* During Late Spring (Mid-April Through June) From Present Condition Below RM 195.

Alternative	<----Exceedence Level (Percent of Years) ----->							
	0	10	20	30	40	50	60	70
Governance Committee Alternative	-.35	-.80	-.19	-.12	+.16	+.17	+.27	+.23
Full Water Leasing Alternative	-.01	-.14	+.09	+.02	+.18	+.12	+.17	+.22
Wet Meadow Alternative	-.66	-1.10	-.18	-.20	+.08	+.10	+.20	+.18
Water Emphasis Alternative	-.49	-1.00	-.09	-.08	+.23	+.22	+.32	+.36
* Values are in feet.								

For all alternatives, except the Full Water Leasing Alternative, river water surface elevations during late spring are reduced during the highest flow years. Generally speaking, the reductions of the 30-consecutive-day maximum river water surface elevation for all alternatives, other than the Full Water Leasing Alternative, range from about one-tenth of a foot lower than the Present Condition at the 30-percent exceedance level (roughly 1 in 3 years, on average) to about 1 foot lower at the 10-percent exceedance level (roughly 1 in 10 years, on average). The Full Water Leasing Alternative maintains the water surface elevation in the higher years and provides some improvement to years with median peak stage (i.e., water surface elevation) events.

Also, for all alternatives, the peak river stage in years with normal or moderate spring peaks (≥ 40-percent exceedance) are somewhat improved over (higher than) the Present Condition. The improvement is comparable for all alternatives and ranges up to about 0.3 foot higher than the Present Condition.

These data indicate that all alternatives except the Full Water Leasing Alternative would negatively impact wet meadows by negatively impacting river water surface elevations in the wettest years. Relative to the Present Condition, all alternatives could positively impact river water elevation in normal flow years. Transitional meadows, or those areas at higher elevations, may be adversely affected by reduction of hydrologic conditions in wettest years for all alternatives compared to the Present Condition. The lowest and wettest meadows (which are capable of being influenced by river stage in normal years) would be positively impacted. Qualitatively, the general reduction in hydrologic variation among years may result in a slight but—in consideration of changes from historic conditions—nevertheless cumulative reduction in the diversity and dynamics of meadow biological communities.

Wet Meadow Hydrology—Short-Term Peak Flow Events in Spring

Short-term peak flow events are observed to provide physical connections of surface water for riparian meadows, which provide for the spatial (re)distribution of organisms in low-lying wet meadows. Based on past field observations, a continuum of effects to occur throughout a range of high flows would be expected.

The Full Water Leasing Alternative maintains and, in very limited respects (1 year in 48), improves the frequency of these high 7-day flow events (table 5-WC-11). The Governance Committee, Wet Meadow, and Water Emphasis Alternatives are all generally comparable in the frequency of these events, but lower than the Present Condition and, therefore, would result in negative impacts to meadows.

Table 5-WC-11.—Frequency That Annual Short-Term Peak Flow Events at Grand Island Achieve Bankfull Flow Ranges for a 48-Year Period of Simulation

	Present Condition	Governance Committee Alternative	Full Water Leasing Alternative	Wet Meadow Alternative	Water Emphasis Alternative
Frequency that the annual 7-day peak flow achieves 8,000 cfs	13	12	13	11	11
Frequency that the annual 7-day peak flow achieves 12,000 cfs	5	3	7	3	3

Security and Protection from Disturbance

Land uses on Program-acquired habitat parcels would be determined on a site-specific basis, but it is presumed that protection from intrusions and disturbance would be a very high priority for these lands to fulfill their intended habitat functions. Migrating whooping cranes are very wary and typically intolerant of disturbance. The specific lands that are acquired and managed during Program implementation will differ from the conceptual examples delineated in the FEIS. The following analysis, therefore, should be viewed in broad terms as conceptual differences among plans.

The land plan of the Wet Meadow Alternative provides the greatest channel length potentially protected from intrusion and disturbance (table 5-WC-12). The length of protected channel is about double the amount of riverbank protected under the Present Condition. Combined with channel habitats already protected, this amounts to about 77 miles of bank. This is about 43 percent of total bank length of the primary channel in the Lexington to Chapman river reach and about 23 percent of the total bank length of the primary channel in the Hershey to Chapman reach.

Table 5-WC-12.—Approximate Length of Bank of the Platte and North Platte Rivers Primary Channels That Would Be Owned or Managed for Crane Habitat Conservation

	Miles of Protected Riverbank	**Proportion of Bank Protected (Percent)**	
		Lexington-Chapman	**Hershey-Chapman**
Present Condition	33.5	19	10
Governance Committee Alternative	60	33	18
Full Water Leasing Alternative	60	33	18
Wet Meadow Alternative	77	43	23
Water Emphasis Alternative	50	28	15

The lengths of channel bank protected by the Governance Committee and Full Water Leasing Alternatives are nearly equivalent. These alternatives protect approximately 33 percent of the riverbank length in the Lexington to Chapman reach and approximately 18 percent of the riverbank length in the Hershey-to-Chapman reach.

Results of the area and perimeter computations are mixed (table 5-WC-13). Though the Water Emphasis Alternative protects the least amount of land, it has a high area:perimeter ratio. In very general terms, a contiguous configuration may be relatively more effective in protecting against intrusion and disturbance. (In practice, the configuration of lands could differ from those conceptually portrayed in this FEIS.

Table 5-WC-13.—Number of Bridge Segments Containing Program-Managed Land and the Area, Perimeter, and Area:Perimeter Ratio of Program Lands

Alternative	**Number of GIS Segments**	**Total Area (Acres)***	**Total Perimeter (Miles)**	**Area:Perimeter Ratio (Acres Per Miles)**
Governance Committee Alternative	6	9,400	51	182
Full Water Leasing Alternative	6	9,400	51	182
Wet Meadow Alternative	8	16,500	80	205
Water Emphasis Alternative	4	6,700	32	208
The total habitat acres are in addition to the 11,380 acres of habitat that private agencies provide under the Present Condition.				

The Wet Meadow Alternative protects the greatest land area. This alternative has an area:perimeter ratio intermediate to those of the other alternatives. The habitat land plans of the Governance Committee and Full Water Leasing Alternatives are the same, implying that the effective protection may be somewhat reduced from those of the other alternatives.

PIPING PLOVERS AND INTERIOR LEAST TERNS

Issue: How would the action alternatives affect nesting habitat for piping plovers and interior least terns within the Basin?

Overview

SCOPE

Channel nesting habitat in the Central Platte River between Lexington and Chapman, Nebraska is the primary focus of this analysis. However, because actions taken to improve channel habitat conditions in the Lexington to Chapman reach may affect nesting habitat at other sites, several additional locations are included in the analysis. These locations include Lake McConaughy, the Platte River between North Platte and Lexington, Nebraska, and the Platte River between Chapman and Columbus. Resources such as beaches, food, sandpits, and channel sediment deposits (sandbars) are addressed for each of these locations as appropriate.

INDICATORS

Channel nest sites for piping plovers and least terns depend on the capability of flows to build elevated sediment deposits that would not be subsequently inundated from nest initiation to fledging young. Two indicators address the potential for plover and tern channel nesting in the Lexington to Chapman reach of the Platte River:

- **Flow potential to build sandbars**

- **Fledging days:** These are the number of days without flooding—in excess of the required days to complete an entire nesting cycle—available to piping plovers and interior least terns during the defined nesting season. Transect data from the SEDVEG Gen3 model used to evaluate fledging days are aggregated into five groupings for analysis:

  - All transects
  - Managed transects
  - Non-managed transects
  - Transects above Kearney
  - Transects below Kearney

Both indicators are described in chapter 4 and are evaluated here using the CPR model and SEDVEG Gen3 model outputs, various post-processing spread-sheet manipulations of those outputs, and statistical analyses.

Two additional indicators deal with habitat features and/or characteristics outside the channel in the Lexington to Chapman reach—features that may change because of actions targeting this reach:

- **Nonchannel nest sites**: Used to evaluate the nesting substrate that may be available to piping plovers and interior least terns under each proposed action alternative. Nesting substrate includes beaches at Lake McConaughy and managed sandpits along the Lexington to Chapman river reach.

- **River resources:** Addresses several issues and measures previously discussed in chapter 4. These include:

  - Lake McConaughy spills
  - Annual flow at Cozad
  - Water quality parameters and forage fish
  - Median July flow at Grand Island

SUMMARY OF IMPACTS

These alternatives would likely provide benefits to piping plovers and interior least terns using Lake McConaughy, likely degrade channel resources in the North Platte to Lexington reach that currently support piping plovers and interior least terns, maintain to perhaps provide some improvement in channel nesting conditions in the Lexington to Chapman reach (while increasing sandpit nesting opportunities in this reach), and maintain the Present Condition for birds using sandpits and channel sites in the Lower Platte River if higher median flows are not implemented. Impacts to the above indicators are summarized in table 5-PT-1 and discussed individually in the following text.

Table 5-PT-1.—Summary of Indicator Values for Piping Plovers and Interior Least Terns by Alternative.*

Resource Issue/Scale/ Indicator/Measurement Unit	Present Condition	Governance Committee Alternative	Water Leasing Alternative	Wet Meadow Alternative	Water Emphasis Alternative
Potential to build sandbars—percent change from the Present Condition (1.5-year peak flow event):					
Reach 1		60	30	50	53
Reach 2		58	30	52	56
Reach 3		54	25	48	53
Reach 4		57	28	52	53
Fledging days:					
All transects—piping plovers	6.2	8.5	8.3	8.3	8.8
All transects—interior least terns	7.4	9.2	9.4	8.7	9.3
Nonchannel nest sites:					
May end-of month elevations (feet)	3259.5	**3254.2**	3258.6	**3255.6**	**3255.8**
New managed sandpit acres		Increased**	Increased	Increased	Increased
Channel Resources:					
Kingsley spills (mean kaf)	169.1	**93.5**	**165.6**	**82.3**	**102.2**
Annual flows at Cozad (kaf)	287.3	323.0	372.5	337.7	346.1
Turbidity (JTUs)	25	28	29	28	29
July water temperature (P > 90º F)	0.329	0.325	0.339	0.329	0.329
July flows at Grand Island (cfs)	858.6	924.7	812.8	924.3	933.1

*Potential fledging days and Kingsley Dam spills are mean values and all other values represent medians unless identified differently.
**Bolded values indicate statistically significant differences from the Present Condition.

Flow Potential to Build Sandbars

The analysis indicates that flows in the 1.5-year event range would have the potential to build sandbars somewhat higher than the Present Condition under some alternatives at some sites between Overton and Chapman. The "River Geomorphology" section in chapter 5 discusses the differences between water surface elevations for mean annual flows and a 1.5-year peak flow event for each alternative and presents figures to illustrate these differences. The Governance Committee Alternative produces the largest differences, while the Full Water Leasing Alternative produces the smallest differences between water surface elevations for mean annual flows and a 1.5-year peak flow event. As discussed in detail in "River Geomorphology" in chapter 5, adequate sediment would have to be available for such flows to build sandbars.

As explained in chapter 4, this indicator of sandbar potential is an index and is not linked directly to actual sandbars and/or nest sites. Therefore, a monitoring program would be necessary to determine the ability of flows under any implemented alternative to build sandbars suitable for nesting.

Fledging Days

Fledging days for both piping plovers and interior least terns would increase from the Present Condition for all transect categories under all action alternatives (table 5-PT-2). If suitable sandbars are available, then these alternatives would provide an increase in the number of days free from potential inundation. Both situations (suitable sandbars and inundation free days) would be required to improve channel nesting conditions for piping plovers and interior least terns.

Table 5-PT-2.—Fledging Days Under the Present Condition and Alternatives.

	Present Condition		**Governance Committee Alternative**		**Full Water Leasing Alternative**		**Wet Meadow Alternative**		**Water Emphasis Alternative**	
	Plovers	**Terns**	**Plovers**	**Terns**	**Plovers**	**Terns**	**Plovers**	**Terns**	**Plovers**	**Terns**
All transects	6.2	7.4	8.5	9.2	8.3	9.4	8.3	8.7	8.8	9.3
Managed transects	6.4	7.7	8.8	9.5	8.5	9.7	8.4	8.8	9.2	9.8
Unmanaged transects	6.1	7.3	8.5	9.1	8.2	9.3	8.3	8.7	8.8	9.3
Above Kearney	5.5	6.5	7.7	8.2	7.3	8.2	7.2	7.5	8.0	8.3
Below Kearney	6.7	8.0	9.1	9.9	9.0	10.3	9.0	9.6	9.4	10.1

Nonchannel Nest Sites

Median May end-of-month elevations for Lake McConaughy would be lower than the Present Condition for all alternatives. Elevations would be significantly lower than the Present Condition (3259.5 feet) for the Governance Committee Alternative (3254.2 feet), the Wet Meadow Alternative (3255.6 feet), and the

Water Emphasis Alternative (3255.8 feet), but not for the Full Water Leasing Alternative (3258.6 feet). Lower May elevations may provide increased beach nesting opportunity for piping plovers and interior least terns.

An undetermined but additional acreage of sandpits, would be managed for plover and tern nesting under all the action alternatives. As indicated in “Piping Plovers and Interior Least Terns” in chapter 4, sandpits provide nest sites throughout the study area and any additional managed acreage—near the active river channel—may benefit piping plovers and interior least terns in the short term.

River Resources

Factors examined under river resources reflect a mixed future. Reduced spills from Kingsley Dam indicate the river between North Platte and Lexington may experience changes in the future—such as further channel narrowing—that may negatively affect the river’s ability to provide resources to piping plovers and interior least terns currently using this reach. In the Lexington to Chapman reach, mechanical restructuring of the channel and judicious use of pulse flows may offset effects from the significant reduction in frequency and magnitude of spills from Kingsley Dam. Turbidity and water temperature in the Lexington to Chapman reach would not change appreciably from the Present Condition, but see “Water Quality” and “Central Platte Fisheries” in chapters 4 and 5 for a more complete treatment of forage fish issues. Finally, July flows at Grand Island would be similar or somewhat higher than the Present Condition.

Lake McConaughy Spills

Both the frequency and magnitude of spills from Lake McConaughy would be reduced from the Present Condition by all the proposed action alternatives (see “ Water Resources, Central Platte, Spills” in chapter 5 and figure 5-PT-1). The magnitude of spills would be lower than the Present Condition (169.1 kaf) under the Governance Committee Alternative (95.3 kaf), the Wet Meadow Alternative (82.3 kaf), and the Water Emphasis Alternative (102.2 kaf) but nearly the same for the Full Water Leasing Alternative (165.6 kaf)[11].

[11]Spill volumes are presented here as mean values because reduced frequency under the action alternatives results in a “zero” (0) median value for all action alternatives, except the Full Water Leasing Alternative.

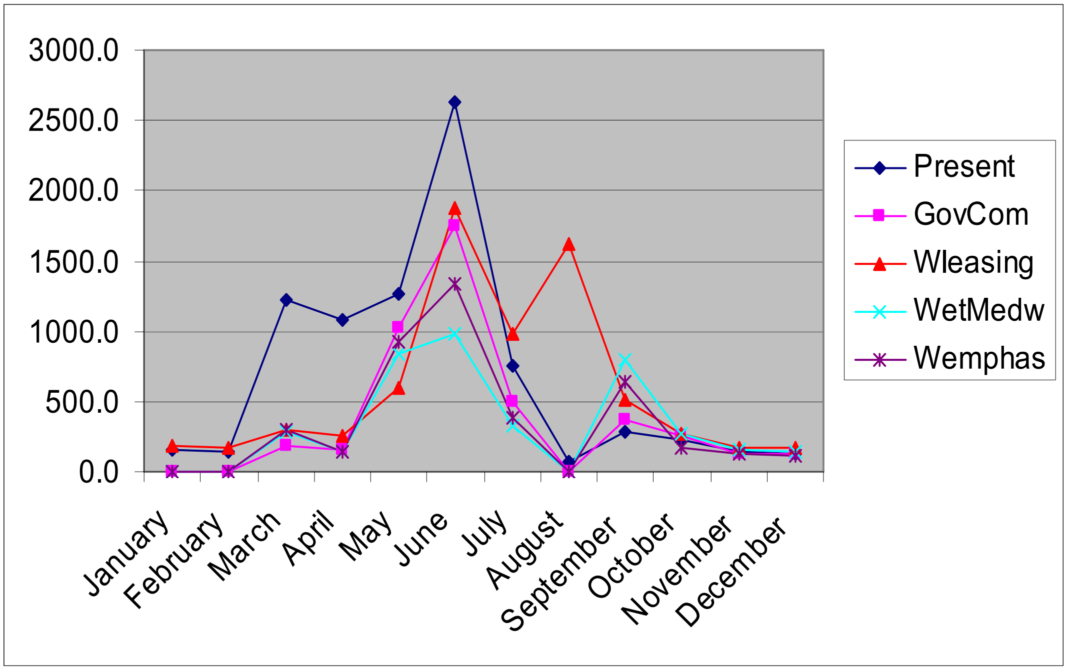

Figure 5-PT-1.—The magnitude of spills from Lake McConaughy under the Present Condition compared to proposed action alternatives. Blue diamonds represent the Present Condition, pink squares the Governance Committee Alternative, red triangles the Full Water Leasing Alternative, and purple stars the Water Emphasis Alternative.

Annual Flow at Cozad

Annual flow at Cozad would be numerically higher, but not significantly greater than the Present Condition (287.3 kaf) for all four of the action alternatives: Governance Committee (323.0 kaf), Water Leasing (372.5 kaf), Wet Meadow (337.7 kaf), and Water Emphasis (346.1 kaf). Although not significantly different from the Present Condition, alternatives providing increased median flows in this river reach should include monitoring provisions if implemented. Monitoring should address any changes in the channel that may adversely affect future resources (e.g., food) used by piping plovers and interior least terns.

Water Quality Parameters and Forage Fish

Water quality parameters are addressed in detail in "Water Quality" and "Central Platte Fisheries" in chapters 4 and 5. In this section, two indicators to tern food are used to assess effects of the proposed action alternatives on tern food resources:

- Probability of exceeding 90ºF water temperature in July at Grand Island
- Turbidity

The probability of exceeding a water temperature of 90ºF in July at Grand Island is similar for all alternatives. When compared to the Present Condition (0.329), the Governance Committee Alternative (0.325) would result in a small reduction in the probability of July water temperatures exceeding 90ºF.

The remaining alternatives would equal the Present Condition (Wet Meadow and Water Emphasis Alternatives) or increase the probability (to 0.339) of July water temperatures exceeding 90ºF (Full Water Leasing Alternative).

Turbidity would remain similar to the Present Condition under the proposed alternatives, with a small increase in median values and a small reduction in maximum values for four action alternatives. Readers are encouraged to pursue the detailed treatments of these parameters in "Water Quality" and "Central Platte Fisheries" in chapters 4 and 5.

Median July Flows at Grand Island

Median July flow at Grand Island would be less than the Present Condition (858.6 cfs) for the Full Water Leasing Alternative (812.8 cfs) and greater than the Present Condition for the Governance Committee (924.7 cfs), Wet Meadow (924.3 cfs), and Water Emphasis (933.1 cfs) Alternatives. Median July flows for the action alternatives are not significantly different from the Present Condition.

Higher median July flows at Grand Island should be evaluated further to determine how they affect streamflow at the Duncan gauge just upstream from the confluence of the Loup River with the Platte River (e.g., using the Duncan stream gauge data with action alternative projections). If projected Program flows differ from the Present Condition at the Duncan gauge, then further study of potential effects to plover and tern nest sites downstream appear warranted.

IMPACTS ANALYSIS

Flow Potential to Build Sandbars

The flow potential to build sandbars evaluates the difference in water surface elevation between the mean annual flow and the 1.5-year peak flows for each alternative. The assumption here is that the greater the difference, the greater the potential to overtop sandbars and, possibly, deposit new sediments and/or scour any annual vegetation that may have developed during the previous growing season. See the "River Geomorphology" sections in chapters 4 and 5 for further details.

Fledging Days

The water surface elevations produced by the SEDVEG Gen3 model were also used to estimate fledging days. As described in chapter 4, fledging days are the number of consecutive days with water surface elevations below the surface elevation recorded at the beginning of the nesting period—in excess of the days required for an average nesting cycle. Values for fledging days under each alternative are compared to the fledging days index value for the Present Condition.

Nonchannel Nest Sites

This indicator addresses potential effects from proposed alternatives on beach nesting at Lake McConaughy and nesting at sandpits within the Lexington to Chapman reach of the Central Platte River.

The May end-of-month elevation for Lake McConaughy is used as an index to beach area available for use by piping plovers and interior least terns. This assessment assumes that median lake surface elevations less than the Present Condition would represent an increase in beach area.
Some alternatives propose to increase the acreage of sandpits managed for plover and tern nesting. This assessment assumes that an increase in area of managed sandpit nesting habitat—located near the active river channel—would benefit piping plovers and interior least terns.

Channel Resources

This indicator spans a rather diverse group of resources and measures that are generally indirectly tied to plover and tern habitat in the Central Platte River. For example, Lake McConaughy spills are important in maintaining the current character of the Central Platte River channel and any nesting habitat value the channel provides. Future frequency and magnitude of spills from Lake McConaughy are evaluated for change from the Present Condition. Piping plovers and interior least terns make some use of the river and adjacent sandpits between North Platte and Lexington. The annual flow volume at Cozad, along with the frequency and magnitude of spills from Lake McConaughy, provide insight into channel maintenance processes at work within this reach. It is assumed that these values reflect conditions that currently support resources (e.g., food) used by nesting piping plovers and interior least terns between North Platte and Lexington. Deviations from current conditions may affect these resources. Water quality parameters discussed in this section include turbidity and temperature as they relate to forage fish. This assessment assumes that large deviations from current water quality parameter values may affect habitat conditions for forage fish.

Finally, median July flows at Grand Island are evaluated for changes from the Present Condition. This analysis assumes that any significant increase in July flows may represent adverse effects to sandbar nest sites in the Lower Platte River.

Governance Committee Alternative

Flow Potential to Build Sandbars

SEDVEG Gen3 model output indicates that the potential to build sandbars via a 1.5-year peak flows event is greatest under the Governance Committee Alternative (see the "River Geomorphology" section in this chapter). Percent change from the Present Condition are predicted to range from 54 to 60 percent, with the largest increase occurring in reach 1. Because the estimated 1.5-year peak flows event may be greater upstream (e.g., reach 1), flow potential to build sandbars may be greater at upstream sites. Actual benefits from these events to piping plovers and interior least terns would be determined via a monitoring program.

Fledging Days

The Governance Committee Alternative would yield more fledging days for both piping plovers and least terns for all the transect categories when compared to the Present Condition (table 5-PT-2).

These comparisons indicate that piping plovers and interior least terns initiating channel sandbar nests within the defined nesting period[12] would have an adequate inundation-free time interval to fledge young if suitable nesting substrate exists. Fledging days would increase over the Present Condition for both plover and terns. However, actual plover and tern nesting response would be the focus of detailed monitoring studies.

Nonchannel Nest Sites

Under the Governance Committee Alternative, Lake McConaughy May elevations would be significantly lower than under the Present Condition (table 5-PT-1). More potential nesting substrate may be available for piping plovers and interior least terns.

This alternative would add an undetermined acreage of sandpits managed for plover and tern nesting. Additional acreage of managed sandpits located near the active river channel would benefit piping plovers and interior least terns.

Both an increase in potential nesting substrate at Lake McConaughy and an increase in sandpit acreage managed for piping plovers and interior least terns would benefit these target species.

Channel Resources

Spills from Lake McConaughy would be significantly reduced under this alternative when compared to the Present Condition, and median annual flows at Cozad would increase from Present Condition levels (table 5-PT-1).

The Governance Committee Alternative would reduce somewhat the probability of July water temperatures exceeding 90ºF at Grand Island (i.e., the Present Condition probability from 0.329 to Governance Committee probability of 0.325) (table 5-PT-1). Median turbidity (JTUs) would increase from 25 (the Present Condition) to 28, while maximum JTUs would decline from 44 (the Present Condition) to 43. It is unlikely that either of these changes would elicit a measurable response in the forage fish communities of the Central Platte River. However, see "Water Quality" and "Central Platte Fisheries" in chapters 4 and 5, for a complete treatment of the fishery resource.

Finally, the July flows at Grand Island would be slightly greater under the Governance Committee Alternative than under the Present Condition (table 5-PT-1).

These comparisons indicate that various locations may be affected by this alternative differently. For example, the significant reduction in volume of Lake McConaughy spills under this alternative and the absence of management actions in the North Platte to Lexington reach may result in further narrowing of the channel in this reach. It is unlikely that the increase in annual flow would mitigate the effects of reduced spills in this reach. Further narrowing of the channel is unlikely to benefit piping plovers and interior least terns using this reach. In other locations, such as the Lexington to Chapman reach, conditions (represented by temperature and turbidity indices)would remain similar to the Present Condition.

[12] Nesting period is defined as May 1 (for plovers) or May 20 (for terns) to August 15.

In the Chapman to Columbus reach, increased July flows at Grand Island—although not significantly different from the Present Condition—may increase the potential for plover and tern nests to be flooded downstream. Conditions should be monitored closely if this flow regime is implemented.

Full Water Leasing Alternative

Flow Potential to Build Sandbars

SEDVEG Gen3 model output indicates that Full Water Leasing Alternative may have the least the potential to build sandbars via a 1.5-year peak flow event (see the "River Geomorphology" section in this chapter). The percent change from the Present Condition is predicted to range from 28 to 30 percent, with the largest increases occurring in reach 1 and 2 under the Full Water Leasing Alternative. Actual benefits from these events to piping plovers and interior least terns would be determined via a monitoring program.

Fledging Days

The Full Water Leasing Alternative is predicted to provide more fledging days for piping plovers and least terns for all the transect categories (table 5-PT-2). These comparisons indicate that piping plovers and interior least terns initiating channel sandbar nests within the defined nesting period would have an adequate inundation-free time interval to fledge young if suitable nesting substrate exists. Fledging days would increase over the Present Condition for both piping plovers and interior least terns. Recall again, however, that detailed monitoring studies would focus on actual plover and tern nesting response.

Nonchannel Nest Sites

Lake McConaughy May end-of-month elevations would be somewhat lower than the Present Condition under the Full Water Leasing Alternative (table 5-PT-1). More potential nesting substrate may be available for piping plovers and interior least terns.

The Full Water Leasing Alternative would add an undetermined acreage of sandpits managed for plover and tern nesting. Additional acreage of managed sandpits located near the active river channel would benefit piping plovers and interior least terns.

Both an increase in potential nesting substrate at Lake McConaughy and an increase in sandpit acreage managed for piping plovers and interior least terns would benefit these target species.

Channel Resources

Spills from Lake McConaughy would be slightly reduced under the Full Water Leasing Alternative when compared to the Present Condition, and median annual flows at Cozad would increase from Present Condition levels (table 5-PT-1).

The Full Water Leasing Alternative would increase somewhat the probability of July water temperatures exceeding 90ºF at Grand Island (i.e., the Present Condition probability from 0.329 to the Full Water Leasing Alternative probability of 0.339) (table 5-PT-1). Median turbidity JTUs would increase from 25 (the Present Condition) to 29, while maximum JTUs would decline from 44 (the Present Condition) to 43. It is unlikely that either of these changes would elicit a measurable response in the forage fish communities of the Central Platte River. However, see "Water Quality" and "Central Platte Fisheries" in chapters 4 and 5 for a complete treatment of the fishery resource.

Finally, the median July flows at Grand Island would be reduced over the Present Condition as shown in table 5-PT-1.

These comparisons indicate that different locations may be affected by this alternative differently. For example, the similar volume of Lake McConaughy spills under this alternative, and the increase in annual flows at Cozad indicate that the channel may retain characteristics that currently support plover and tern nesting in the North Platte to Lexington reach. In other locations, such as the Lexington to Chapman reach, temperature and turbidity indices would remain similar to the Present Condition. In the Chapman to Columbus reach, a small reduction in median July flow may reduce the chance of nest flooding downstream.

Wet Meadow Alternative

Flow Potential to Build Sandbars

SEDVEG Gen3 model output indicates that the potential to build sandbars via a 1.5-year peak flow event under the Wet Meadow Alternative (see the "River Geomorphology" section in this chapter) would lie between the Full Water Leasing and Water Emphasis Alternatives potential to do so (table 5-PT-1). The percent of change from the Present Condition is predicted to range from 48 to 52 percent, with the largest increases occurring in Reach 2 and 4. Actual benefits from these events to piping plovers and interior least terns would be determined via a monitoring program.

Fledging Days

The Wet Meadow Alternative is predicted to provide more fledging days for piping plovers and least terns for all transects categories (table 5-PT-2) when compared to the Present Condition.

These comparisons indicate that piping plovers and interior least terns initiating channel sandbar nests within the defined nesting period would have an adequate inundation-free time interval to fledge young if suitable nesting substrate exists. Fledging days would increase over the Present Condition for both piping plovers and interior least terns. However, actual plover and tern nesting response would be the focus of detailed monitoring studies.

Nonchannel Nest Sites

Lake McConaughy May elevations would be significantly lower than the Present Condition under the Wet Meadow Alternative (table 5-PT-1). More potential nesting substrate may be available for piping plovers and interior least terns.

This alternative would add an undetermined acreage of sandpits managed for plover and tern nesting. Additional acreage of managed sandpits located near the active river channel would benefit piping plovers and interior least terns.

Both an increase in potential nesting habitat at Lake McConaughy and an increase in sandpit acreage managed for piping plovers and interior least terns would benefit these target species.

Channel Resources

Spills from Lake McConaughy would be significantly reduced under the Wet Meadow Alternative when compared to the Present Condition, and median annual flows at Cozad would increase from the Present Condition levels (table 5-PT-1).

The Wet Meadow Alternative would have the same probability of July water temperatures exceeding 90ºF at Grand Island as the Present Condition (i.e., 0.329) (table 5-PT-1). Median turbidity JTUs would increase from 25 (the Present Condition) to 28, while maximum JTUs would decline from 44 (the Present Condition) to 42. It is unlikely that either of these changes would elicit a measurable response in the forage fish communities of the Central Platte River. However, see "Water Quality" and "Central Platte Fisheries" in chapters 4 and 5 for a complete treatment of the fishery resource.

Finally, the July flows at Grand Island would be slightly higher than the Present Condition under the Wet Meadow Alternative (table 5-PT-1).

These comparisons indicate different locations may be affected by the Wet Meadow Alternative differently. For example, the significant reduction in volume of Lake McConaughy spills under this alternative, and the absence of management actions in the North Platte to Lexington reach, may result in further narrowing of the channel in this reach. It is unlikely that the increase in annual flow would mitigate the effects of reduced spills in this reach. Further narrowing of the channel is unlikely to benefit piping plovers and interior least terns using this reach. In other locations, such as the Lexington to Chapman reach and the Chapman to Columbus reach, conditions (represented by temperature and turbidity indices, and July flow at Grand Island) would remain similar to those under the Present Condition.

Water Emphasis Alternative

Flow Potential to Build Sandbars

SEDVEG Gen3 model output indicates that the potential to build sandbars via a 1.5-year peak flows event under the Water Emphasis Alternative (see the "River Geomorphology" section in this chapter) would lie between the Governance Committee (highest) and Wet Meadow Alternatives in its potential to do so (table 5-PT-1). Percent change from the Present Condition are predicted to range from 53 to 56 percent, with the largest increase occurring in reach 2. Actual benefits from these events to piping plovers and interior least terns would be determined via a monitoring program.

Fledging Days

The Water Emphasis Alternative is predicted to provide more fledging days for piping plovers and least terns for all transect categories when compared to the Present Condition (table 5-PT-2).

These comparisons indicate that piping plovers and interior least terns initiating channel sandbar nests within the defined nesting period would have an adequate inundation-free time interval to fledge young if suitable nesting substrate exists. Fledging days would increase over the Present Condition for both piping plovers and interior least terns. Actual plover and tern nesting response would be the focus of detailed monitoring studies.

Nonchannel Nest Sites

Lake McConaughy May elevations would be significantly lower than under the Present Condition under the Water Emphasis Alternative. More potential nesting substrate may be available for piping plovers and interior least terns.

The Water Emphasis Alternative would add an undetermined acreage of sandpits managed for plover and tern nesting. Additional acreage of managed sandpits located near the active river channel would benefit piping plovers and interior least terns.

Both an increase in potential nesting substrate at Lake McConaughy and an increase in sandpit acreage managed for piping plovers and interior least terns would benefit these target species.

Channel Resources

Spills from Lake McConaughy would be significantly reduced under this alternative when compared to the Present Condition, and median annual flows at Cozad would increase from Present Condition levels.

This alternative would have the same probability of July water temperatures exceeding 90ºF at Grand Island as the Present Condition (i.e., 0.329) (table 5-PT-1). Median turbidity JTUs would increase from 25 (the Present Condition) to 29, while maximum JTUs would decline from 44 (the Present Condition) to 43. It is unlikely that either of these changes would elicit a measurable response in the forage fish communities of the Central Platte River. See "Water Quality" and "Central Platte Fisheries" sections of this FEIS for a complete treatment of the fishery resource.

Finally, the median July flows at Grand Island would be higher than the Present Condition (table 5-PT-1).

These comparisons indicate different locations may be affected by this alternative differently. For example, the significant reduction in volume of Lake McConaughy spills under this alternative, and the absence of management actions in the North Platte to Lexington reach, may result in further narrowing of the channel in this reach. It is unlikely that the increase in annual flow would mitigate the effects of reduced spills in this reach. Further narrowing of the channel is unlikely to benefit piping plovers and interior least terns using this reach. In other locations, such as the Lexington to Chapman reach, temperature and turbidity indices would remain similar to the Present Condition. In the Chapman to Columbus reach, increased July flows at Grand Island may increase the potential for plover and tern nests to be flooded downstream. Conditions should be monitored closely if this flow regime is implemented.

PALLID STURGEON

Issue: How would the action alternatives affect pallid sturgeon?

Overview

SCOPE

The immediate area of effect includes the Lower Platte Habitat Area from the Elkhorn River to the confluence of the Platte and Missouri Rivers.

INDICATORS

As discussed in the "Pallid Sturgeon" section in chapter 4, the pallid sturgeon hydrologic analysis is divided into biologically significant intervals:

- **Spawning period:** April-June
- **Habitat formation and maintenance and food base production period:** February-July
- **Summer period:** June-August
- **Fall and winter periods:** September-November and December-January
- **Sediment transport**

The hydrology indicator used to identify the effects of alternatives on pallid sturgeon in the Lower Platte River is riverflow at the Louisville, Nebraska, gauge, located at approximately the midpoint of the pallid sturgeon habitat area in the Lower Platte River. It is important to note that the period of record used for the Louisville gauge is relatively short (beginning 1953). In addition, diurnal fluctuations in riverflows, resulting from hydropower cycling operations on the Loup River and other upstream operations, add considerable subdaily variation to river conditions that is not reflected in the mean daily flow values.

SUMMARY OF IMPACTS

The analyses provided below indicate that the alternatives' water and sediment management activities do not provide significant benefits to the pallid sturgeon. While the alternatives vary slightly from indicator to indicator, they are generally not significantly different from the Present Condition in their effects on pallid sturgeon. The pallid sturgeon research plan does benefit the pallid sturgeon only in that it will provide information that can be subsequently used to secure defined benefits to the species.

IMPACTS ANALYSIS

During the Program's First Increment, the primary benefits for the pallid sturgeon will be provided through a program of research and monitoring. This section describes the effects of the alternatives on pallid sturgeon habitat.

Pallid Sturgeon Spawning Period—April-June

Overall, the spawning period shows very little change from the Present Condition, using either the high or low estimates under any of the alternatives (table 5-PS-1). While the absolute differences in flow may appear substantial, when viewed as a percent change these differences are quite small. They would generally represent a change that, while mathematically calculable, would be difficult to measure in terms of biotic or abiotic effect. While each of the alternatives do produce some calculable effect on pallid sturgeon spawning flows, the realistic effects are likely to be extremely slight. As a result, none of the alternatives exhibit an observable change in the most important and imperiled hydrologic requisite for continued species reproduction in the central part of the species range. The Full Water Leasing Alternative offers a net positive effect on spawning flows, and the remaining alternatives produce a net negative impact on spawning flows.

Table 5-PS-1.—Pallid Sturgeon Spawning Period Average and Absolute Change From the Present Condition by Alternative and Exceedance Interval

April-June		Percent Change from the Present Condition				Absolute (cfs) Change from the Present Condition			
		Average Flow		Highest Flow Month		Average Flow		Highest Flow Month	
		High End	Low End	High End	Low End	High End	Low End	High End	Low End
Governance Committee Alternative	Wettest sixth	-2	-1	-3	-2	-373	-292	-820	-626
	2nd wettest sixth	0	0	-4	-4	43	9	-666	-623
	3rd wettest sixth	2	2	2	2	144	160	212	286
	Average	0	0	-2	-1	-62	-41	-424	-321
Full Water Leasing Alternative	Wettest sixth	0	0	2	1	69	48	385	252
	2nd wettest sixth	4	3	3	2	469	346	448	325
	3rd wettest sixth	4	3	4	3	393	319	469	387
	Average	3	2	3	2	311	238	434	321
Wet Meadow Alternative	Wettest sixth	-3	-2	-4	-3	-620	-474	-1,237	-987
	2nd wettest sixth	-1	-1	-6	-5	-87	-89	-922	-864
	3rd wettest sixth	1	1	0	1	84	116	20	67
	Average	-1	-1	-3	-3	-208	-149	-713	-595
Water Emphasis Alternative	Wettest sixth	-2	-1	-3	-3	-419	-328	-867	-712
	2nd wettest sixth	1	0	-4	-4	80	41	-654	-655
	3rd wettest sixth	3	3	1	1	243	239	86	153
	Average	0	0	-2	-2	-32	-16	-478	-405

Habitat Formation and Maintenance, and Food Base Production Period—February-July

As with the spawning period, changes in the habitat formation and maintenance, and food base production, periods are minimal for any alternative, using either the high or low estimates. The habitat formation and maintenance analysis focuses on the wetter exceedance intervals (wettest three-sixths) and, as such, shows almost no functional change. Examining the calculable differences, most alternatives remain essentially the same (slightly negative), except for the Full Water Leasing Alternative, which entails some small gains in habitat formation and maintenance flows (table 5-PS-2).

Table 5-PS-2.—Habitat Formation and Maintenance Period, Average Percent and Absolute Change From the Present Condition by Alternative and Exceedance Interval

February-July		Percent Change from the Present Condition				Absolute (cfs) Change from the Present Condition			
		Average Flow		Highest Flow Month		Average Flow		Highest Flow Month	
		High End	Low End	High End	Low End	High End	Low End	High End	Low End
Governance Committee Alternative	Wettest sixth	-2	-1	-2	-2	-304	-227	-767	-582
	2nd wettest sixth	1	1	-1	-1	101	87	-159	-157
	3rd wettest sixth	1	1	-1	-1	138	101	-143	-237
	Average	0	0	-1	-1	-22	-13	-356	-325
Full Water Leasing Alternative	Wettest sixth	0	0	0	0	73	53	162	120
	2nd wettest sixth	4	3	3	2	416	315	450	324
	3rd wettest sixth	2	2	3	2	203	157	427	317
	Average	2	2	2	1	231	175	346	254
Wet Meadow Alternative	Wettest sixth	-2	-2	-3	-2	-403	-296	-1,075	-806
	2nd wettest sixth	0	0	-1	-1	0	9	-160	-203
	3rd wettest sixth	2	1	-1	-1	158	125	-156	-237
	Average	0	0	-2	-2	-82	-54	-464	-415
Water Emphasis Alternative	Wettest sixth	-2	-1	-2	-1	-287	-212	-661	-495
	2nd wettest sixth	2	1	-1	-1	173	141	-170	-213
	3rd wettest sixth	3	2	1	0	250	177	70	-61
	Average	1	1	-1	-1	46	36	-254	-256

In contrast to the habitat formation and maintenance analysis, the food base production analysis examines the entire range of flows (all exceedances) and does show some benefits accruing, particularly in drier intervals (table 5-PS-3). While improvements in these intervals are not likely to actually enhance the availability of the pallid sturgeon food base in the Lower Platte River, they could be expected to provide some buffer for production in these drier years, when production would be otherwise impaired. Like the previous analyses, the differences between alternatives are functionally quite small, but it is possible to determine calculable differences. In this respect, the Full Water Leasing and Water Emphasis Alternatives provide slightly greater benefits, primarily in drier years, followed by the Governance Committee and Wet Meadow Alternatives.

Table 5-PS-3.—Food Base Production Period, Average Percent and Absolute Change From the Present Condition by Alternative and Exceedance Interval

February-July		Percent Change from the Present Condition				Absolute (cfs) Change from the Present Condition			
		Average Flow		Highest Flow Month		Average Flow		Highest Flow Month	
		High End	Low End	High End	Low End	High End	Low End	High End	Low End
Governance Committee Alternative	Wettest third	1	1	-1	-1	101	87	-159	-157
	Middle third	3	2	2	1	237	185	213	161
	Driest third	6	5	4	3	286	218	230	163
	Average	3	3	2	1	208	163	94	55
Full Water Leasing Alternative	Wettest third	4	3	3	2	416	315	450	324
	Middle third	5	3	2	2	348	261	284	214
	Driest third	6	5	6	5	303	233	409	296
	Average	5	4	4	3	356	270	381	278
Wet Meadow Alternative	Wettest third	0	0	-1	-1	0	9	-160	-203
	Middle third	3	2	1	1	196	149	193	137
	Driest third	6	5	5	3	289	223	280	200
	Average	3	2	2	1	162	127	105	45
Water Emphasis Alternative	Wettest third	2	1	-1	-1	173	141	-170	-213
	Middle third	4	3	2	1	289	233	255	168
	Driest third	10	8	6	5	480	373	355	281
	Average	5	4	2	2	314	249	147	79

Summer Period—June-August

Unlike the previously discussed periods, the summer period (table 5-PS-4) shows marked improvement across the focus exceedance intervals. System impairment during the summer period is more likely at lower flows, when diurnal temperature fluctuations are most pronounced and prolonged, and flow fluctuations due to operation of tributary hydropower peaking facilities have the greatest impacts. Only very limited evidence exists to suggest that summer temperature fluctuations and diurnal flow fluctuations in the Lower Platte River are a significant factor in food base survival, even under low flow conditions. Nevertheless, the increased ability to buffer these factors under the most vulnerable conditions would be expected to provide some circuitous benefit to the pallid sturgeon. As in the previous analyses, the alternatives are, again, functionally indistinct from each other. In terms of calculable differences, the Governance Committee Alternative provides the greatest level of benefit, followed by the Water Emphasis Alternative, then the Wet Meadow and Full Water Leasing Alternatives.

Table 5-PS-4—Summer Period, Average Percent and Absolute Change
From the Present Condition by Alternative and Exceedance Interval

June-August		Percent Change from the Present Condition				Absolute (cfs) Change from the Present Condition			
		Average Flow		Lowest Flow Month		Average Flow		Lowest Flow Month	
		High End	Low End	High End	Low End	High End	Low End	High End	Low End
Governance Committee Alternative	Driest sixth	0	0	2	1	5	1	51	30
	2nd driest sixth	4	3	5	4	162	115	111	79
	3rd driest sixth	3	2	9	6	80	57	114	73
	Average	2	2	5	4	82	58	92	61
Full Water Leasing Alternative	Driest sixth	2	2	-1	-1	128	97	-20	-19
	2nd driest sixth	4	3	0	1	177	131	1	14
	3rd driest sixth	2	2	1	1	56	45	8	4
	Average	3	2	0	0	120	91	-4	0
Wet Meadow Alternative	Driest sixth	0	0	1	1	8	2	38	20
	2nd driest sixth	3	2	4	3	121	83	81	62
	3rd driest sixth	2	2	6	4	44	34	79	50
	Average	2	1	4	3	57	40	66	44
Water Emphasis Alternative	Driest sixth	1	0	2	1	29	14	51	31
	2nd driest sixth	4	3	4	3	169	125	90	65
	3rd driest sixth	4	3	8	5	96	69	90	57
	Average	3	2	5	3	98	69	77	51

Fall and Winter Periods—September-November and December-January

Insufficient information exists to understand the importance of the fall or winter periods to pallid sturgeon biology in the Lower Platte River. Conceptually, the addition of water in the driest periods could be expected to yield some benefit to pallid sturgeon, as low flow periods could still be disproportionately impacted by fluctuations in stage, due to operation of tributary hydropower peaking operations in the fall, and greater security could be afforded to pallid sturgeon that may overwinter under the ice in the Lower Platte River. These factors should not be weighted too heavily, however, as they are still largely conceptual and are subject to considerable uncertainty.

In consequence, sufficient evidence does not currently exist to support a position on either the impairment or lack of impairment of the system to pallid sturgeon during these periods. The analyses generally found that during these driest exceedance intervals, flow increased in the fall under all alternatives, which may lead to some benefit to the species; however, flow decreased in the winter under all alternatives, which may lead to some disbenefit to the species. Fall benefits were greatest for the Full Water Leasing and Water Emphasis Alternatives, which performed noticeably better than the other two alternatives.

Positive effects in winter were identified for the Full Water Leasing Alternative, while neutral to very slightly negative winter impacts were identified for the Wet Meadow and Water Emphasis Alternatives, and larger negative impacts were identified for the Governance Committee Alternative (tables 5-PS-5 and 5-PS-6).

Table 5-PS-5.—Other Periods, Average Percent Change From the Present Condition by Alternative and Exceedance Interval

September Through November, December Through January		Percent Change from the Present Condition									
		September		October		November		December		January	
		High End	Low End	High End	Low End	High End	Low End	High End	Low End	High End	Low End
Governance Committee Alternative	3rd driest sixth	2	1	6	5	2	2	-6	-4	-6	-3
	2nd driest sixth	2	1	3	2	2	1	-3	-2	-2	-1
	Driest sixth	2	2	14	11	4	3	-2	-1	-1	0
	Average	2	1	8	6	2	2	-4	-2	-3	-2
Full Water Leasing Alternative	3rd driest sixth	3	1	7	5	3	3	4	2	5	3
	2nd driest sixth	4	2	11	8	4	3	5	3	4	2
	Driest sixth	1	1	22	17	6	5	5	4	5	3
	Average	2	1	13	10	5	4	5	3	5	3
Wet Meadow Alternative	3rd driest sixth	6	3	5	4	3	2	0	0	-2	-1
	2nd driest sixth	-1	0	4	2	3	3	-1	-1	-1	-1
	Driest sixth	0	0	10	8	2	2	-1	0	1	1
	Average	2	1	6	5	3	2	-1	0	-1	0
Water Emphasis Alternative	3rd driest sixth	7	5	8	6	4	3	-2	-1	-3	-1
	2nd driest sixth	4	2	9	7	4	3	-1	-1	-1	0
	Driest sixth	4	3	21	16	7	6	1	1	0	0
	Average	5	3	13	10	5	4	-1	0	-1	-1

Table 5-PS-6.—Other Periods, Absolute Change From the Present Condition by Alternative and Exceedance Interval

September Through November, December Through January		**Absolute (cfs) Change from the Present Condition**									
		September		**October**		**November**		**December**		**January**	
		High End	**Low End**	**High End**	**Low End**	**High End**	**Low End**	**High End**	**Low End**	**High End**	**Low End**
Governance Committee Alternative	3rd driest sixth	62	35	221	168	81	72	-239	-159	-225	-132
	2nd driest sixth	34	16	107	69	63	51	-120	-83	-77	-46
	Driest sixth	38	25	337	268	119	96	-45	-31	-23	-12
	Average	44	25	222	168	88	73	-135	-91	-108	-63
Full Water Leasing Alternative	3rd driest sixth	77	40	249	182	163	139	152	103	191	119
	2nd driest sixth	78	45	342	266	171	137	164	116	132	75
	Driest sixth	12	10	518	400	188	152	137	95	134	85
	Average	56	32	369	283	174	143	151	105	152	93
Wet Meadow Alternative	3rd driest sixth	149	87	163	125	135	109	-11	-8	-63	-33
	2nd driest sixth	-15	-8	124	72	146	118	-30	-30	-38	-29
	Driest sixth	-13	-7	244	208	63	51	-27	-9	10	14
	Average	40	24	177	135	115	93	-23	-16	-31	-16
Water Emphasis Alternative	3rd driest sixth	200	122	272	201	184	152	-80	-63	-98	-57
	2nd driest sixth	87	35	267	203	156	118	-30	-18	-25	-15
	Driest sixth	68	54	512	394	216	185	26	23	-7	-3
	Average	118	70	350	266	186	152	-28	-19	-43	-25

Sediment Transport Analysis

As previously discussed, the SEDVEG Gen3 model provides sediment transport rates on a daily basis for a number of cross sections in the Central Platte River reach. The closest of these to the pallid sturgeon habitat area (<RM 40) is at RM 160, near Chapman, Nebraska. The mean and median daily sediment transport rates at this cross section for the full range of years modeled for the alternatives are presented in table 5-PS-7.

Table 5-PS-7.—Daily Sediment Transport Rates of the Alternatives

	Modeled Daily Sediment Transport Rate (in Tons)		**Percent Change From the Present Condition**	
	Mean	**Median**	**Mean**	**Median**
Present Condition	1,121	405	-	-
Governance Committee Alternative	1,179	506	5	25
Full Water Leasing Alternative	1,284	584	15	44
Wet Meadow Alternative	1,176	542	5	34
Water Emphasis Alternative	1,271	610	13	51

The mean daily sediment transport rate is strongly influenced by high flow events, which transport a disproportionately large quantity of sediment. As such, the statistic acts as an indicator for the ability of the upper Basin to contribute large quantities of sediment during these events, which has an effect on the ability of the system to create large macro-bedforms. The median daily sediment transport rate is more indicative of typical conditions on the river and, as such, acts as an indicator of the base contribution of sediment, which has an effect on the ability of the system to retain these bedforms, as well as to create and maintain smaller bedforms, such as submerged "dune" formations. Both of these types of formations are used by pallid sturgeon in the Lower Platte River.

The changes in mean and median transport rates under the alternatives (relative to the Present Condition) vary widely. However, given the uncertainties of the large distance from the modeled point and the Lower Platte Habitat Area, it is unclear to how this variation would be realized at the Lower Platte Habitat Area. The overall effect of these changes is that all alternatives analyzed may have some increase in the ability of the system to create large macro-bedforms and, possibly, a more significant increase in the ability of the system to build and maintain smaller bedforms. This indicates potential for an increase in the availability of these important habitat types for pallid sturgeon in the Lower Platte River under any of the alternatives and an incrementally greater potential for the Full Water Leasing and Water Emphasis Alternatives.

Other Factors

An intensive pallid sturgeon monitoring and research plan was drafted by the Service and, subsequently, refined through cooperation with the pallid sturgeon subgroup of the Technical Committee of the Governance Committee. The primary objective of the plan is to determine specific actions to be taken in order to provide defined benefits to the species. This will be done using information gained through research on species biology and habitat use, and the form, functions, and processes of the Platte River that define, form, and maintain Platte River pallid sturgeon habitat.

The plan was accepted by the Governance Committee on October 31, 2002. Agreement was reached that funds would be allocated to complete the plan in its entirety. Implementation of the five areas of agreement would be initiated as soon as a Program begins, whereas implementation of the three areas of continued disagreement would not occur until after the first evaluation point identified in the plan. The specific details of the plan, including identification of the areas of agreement and disagreement, are in the Integrated Monitoring and Research Plan (IMRP).

OTHER FEDERALLY LISTED SPECIES AND DESIGNATED CRITICAL HABITAT

Issue: How would the action alternatives affect federally listed species (other than target species) and designated critical habitat?

Overview

SCOPE

The action area in Wyoming, Colorado, and Nebraska includes the North Platte River Basin from its headwaters in Colorado to its confluence with the South Platte River; the South Platte River Basin downstream of Greeley, Colorado, to its confluence with the North Platte River; and the main stem Basin from the confluence of the North and South Platte Rivers to the confluence with the Missouri River. A short reach of the Missouri River downstream of the confluence is included in the action area.

INDICATORS

The indicators for potential impacts that may result from the proposed action alternative are:

- The locations of known species under consideration
- Potential impacts to these habitats under the alternatives

Impacts to other federally listed species in the action area are determined based on location of known species and potential impacts to occupied and unoccupied habitat. See the tables in the "Other Federally Listed Species and Designated Critical Habitat" section of chapter 4 for the federally listed species and critical habitat that may be present in the action area.

Because this FEIS serves as the Biological Assessment for ESA Section 7 consultation compliance, different regulatory terminology, analyses, and determinations are required. NEPA compliance requires an analysis of impacts for all alternatives, while ESA Section 7 consultation requires only a determination of effects resulting from the proposed action. This section provides an analysis of impacts of all alternatives for NEPA compliance and, for the Governance Committee, a determination of effect for federally listed species (other than the target species) and designated critical habitat.

IMPACTS ANALYSIS

The action alternatives alter riverflows and land habitat in the Central Platte Habitat Area. The alternatives also affect flows in the North and South Platte River Basins, agricultural activities, and water use (see the "Agricultural Economics" section in this chapter for changes in agricultural production and land use). Program actions incorporated in the alternatives may affect federally listed, nontarget species in the action area.

Because of the wide distribution of some listed species and the uncertainty regarding the specific location of some habitat restoration and water action plan projects (such as water leasing), the potential for site-specific impacts to some listed species, habitats, and designated critical habitats within the action area cannot be predicted until a Program is adopted and specific land and water actions are proposed.

Therefore, following implementation of a Program, potential impacts of site-specific Program activities on listed species other than the target species will be evaluated prior to implementation of proposed Program activities. The Program will take appropriate actions if adverse effects to listed species and/or designated critical habitats are identified. Following consultation with the Service, actions that are likely to jeopardize listed species or adversely modify designated critical habitat will be avoided or offset.

The following impact analysis is divided into two sections:

- Species that are not affected by any of the action alternatives
- Species that may be affected by the action alternatives

The discussion includes anticipated and known impacts of programmatic activities that have the potential to affect listed species other than the target species. The discussion of site-specific impacts also includes the potential effects of water leasing and land management activities that may occur; however, because decisions about these activities must wait until the Program is approved, the location of these future actions and potential impacts cannot readily be identified at this time. Site-specific effects to listed species, resulting from water leasing or habitat management, will be evaluated at the time such actions are proposed, and the appropriate site-specific NEPA compliance and ESA Section 7 consultation will be completed at that time.

No Effect—Species Not Affected by Any of the Alternatives

The following listed species that may be present in the action area would not be affected (in the states indicated) by any of the alternatives under consideration. These species will not be affected because they are not known to occur in the action area, or they may be present in the action area but their habitats will not be affected by either water (e.g., flows or leasing) or land activities (e.g., habitat management). Table 5-FL-1 lists the species not affected by the alternatives. Determinations of effect are identified by state where species may be present in more than one state.

Table 5-FL-1.—Federally Listed Species Not Affected by the Alternatives

Species	States
Black-footed ferret	Wyoming and Colorado
Canada lynx	Wyoming and Colorado
North Park phacelia	Colorado
Eskimo curlew	Nebraska

May Affect—Species Potentially Affected by Program Activities

Listed species and designated critical habitat may be affected by Program activities through:

- River flow and land management activities in the North Platte, South Platte, and Central Platte Rivers
- Effects to aquatic and riparian habitat associated with potential water leasing throughout the Basin.

Species That May be Affected by River Flow and Land Management Activities

This section discusses programmatic effects associated with flow management to the bald eagle in all three states, western prairie fringed orchid in Nebraska, and Ute ladies'-tresses orchid in Wyoming, listed in table 5-FL-2.

Table 5-FL-2.—Federally Listed Species that May be Affected by River Flow and Land Management Activities

Species	States
Bald eagle	Wyoming, Colorado, and Nebraska
Western prairie fringed orchid	Nebraska
Ute ladies'-tresses orchid	Wyoming

Bald Eagle

Effects were measured by the:

- **Impacts/benefits to flow** in the North Platte, South Platte, and Platte Rivers that may affect bald eagle prey
- **Changes in active channel and wet meadow land cover** that may affect bald eagle prey

The Full Water Leasing Alternative is anticipated to provide the greatest benefit for the bald eagle as a result of the flow and channel habitat improvements. The Governance Committee, Full Water Leasing, and Wet Meadow Alternatives provide the greatest increase in channel habitat. The Wet Meadow Alternative provides the greatest increase in lowland grassland habitats. The Full Water Leasing Alternative is the only alternative that improved bald eagle wintering flow conditions in the Platte River below the Tri-County Diversion Dam and along the Lower Platte River at Louisville. The Governance Committee and the Water Emphasis Alternatives (and, to a lesser extent, the Wet Meadow Alternative) impact bald eagle wintering flows along the South Platte River and Platte River above Overton. In the Central Platte River, the Full Water Leasing and Water Emphasis Alternatives provide the greatest reductions in instream flow shortages for the months of December through February, while the Governance Committee and Wet Meadow Alternatives exacerbate shortages in the month of December.

Flow in the South Platte River

All alternatives affect the flows in the South Platte River during the bald eagle wintering period. The Governance Committee and the Water Emphasis Alternatives reduce December and January flows by 6 to 9 percent. The Wet Meadow Alternative has a smaller impact. The Full Water Leasing Alternative increases these winter flows by 13 to 17 percent (see “Water Resources” section, “Impacts Analysis,” “South Platte River Basin” subsection in this chapter).

Flows in North Platte Above Lake McConaughy

The average seasonal flows above Lake McConaughy during October through March do not change from the Present Condition for all alternatives (see the “Water Resources” section, “Impacts Analysis,” “North Platte River Basin” subsection in this chapter.

Flows in North Platte Below Keystone Diversion Dam

The flow in the North Platte River immediately below the Keystone Diversion Dam (see the “Water Resources” section, “Impacts Analysis,” “North Platte River Basin,” “Water Leasing” subsection in this chapter) does not change significantly from the Present Condition for all alternatives during the bald eagle wintering period from December to February. A marginal increase in February flows occurs for all alternatives. Flows at North Platte, Nebraska, would follow a similar pattern under all alternatives.

Flows in the Platte River Below the Tri-County Diversion Dam

In the reach just below the Tri-County Diversion Dam (see the “Water Resources” section, “Impacts Analysis,” “North Platte River” subsection), winter flows would be low, averaging less than 200 cfs during some winter months, with occasional periods of zero flow. The Full Water Leasing Alternative is the only alternative anticipated to increase flow during the December and January wintering time periods. All of the alternatives are expected to provide improved flow in February.

Reduction to Instream Flow Shortages at Grand Island

The greatest reduction to instream flow shortages occurs in February (table 5-FL-3), with the Full Water Leasing and Water Emphasis Alternatives providing the largest reduction to shortages. Reductions to instream flow shortages in January are mixed with the Full Water Leasing and Water Emphasis Alternatives, providing improvements in shortages, while the Governance Committee and Wet Meadow Alternatives marginally increase instream flow shortages.

Table 5-FL-3. Raw Monthly Reduction to Species Target
Flows For the Bald Eagle Wintering Period (Thousand Acre-Feet)

Alternative	December	January	February
Governance Committee Alternative	0.00	-0.05	16.08
Full Water Leasing Alternative	0.00	0.17	20.49
Wet Meadow Alternative	0.00	-0.25	13.24
Water Emphasis Alternative	0.00	0.33	19.44

Flows in the Lower Platte River at Louisville

In the food base production analysis, the Full Water Leasing and Water Emphasis Alternatives provide slightly greater benefits, primarily in drier years, followed by the Governance Committee and Wet Meadow Alternatives (see the "Pallid Sturgeon" section in this chapter). It is anticipated that the slightly greater benefits would provide some buffer for food base production for nesting bald eagles in drier years, when production might otherwise be impaired.

For bald eagle wintering flows along the Lower Platte River, positive effects were identified for the Full Water Leasing Alternative, while neutral to very slightly negative winter impacts were identified for the Wet Meadow and Water Emphasis Alternatives.

Habitat for Waterfowl

All alternatives are anticipated to provide some degree of benefit over the Present Condition by providing increased channel and wet meadow habitats for wintering waterfowl. The Governance Committee, Full Water Leasing, and Wet Meadow Alternatives are expected to increase wetted channel habitat in the Central Platte River by 4 percent, while the Water Emphasis Alternative increases wetted channel habitat by 3 percent. The Wet Meadow and Water Emphasis Alternatives increase lowland grasslands by 19 and 7 percent, respectively, from the Present Condition, while the Governance Committee and Full Water Leasing Alternatives increase lowland grassland habitats by 10 percent from the Present Condition.

Determination of Effect

Wyoming: In Wyoming, there are a large number of bald eagles that winter along the North Platte River from November through March. They concentrate in historically used roosts at night and forage opportunistically over central Wyoming during the day. They make extensive use of the North Platte River and its reservoirs to hunt fish and waterfowl, but they also range widely over the sagebrush grasslands in search of winter-killed big game and livestock to scavenge. Altering the North Platte River hydrology under the action alternatives may alter forage fish populations, but the impacts are anticipated to be small.

Foraging on the river and reservoirs in winter is restricted by availability of open water. Alterations of hydrology, due to the action alternatives, are unlikely to have any impact on icing, as this is largely dependent on ambient air temperature.

Flow management activities associated with the action alternatives are not anticipated to adversely impact wintering bald eagles. The Governance Committee Alternative may affect, but is not likely to adversely affect, bald eagles in Wyoming.

Colorado: In Colorado, flow management activities associated with the action alternatives are not anticipated to adversely impact nesting and wintering bald eagles. The Governance Committee Alternative may affect, but is not likely to adversely affect, bald eagles in Colorado.

In Colorado, under the preferred alternative, the Tamarack Project, located near Crook, would re-regulate flows in the South Platte River. This Tamarack Project is expected to increase April through September flows at the Julesburg gauge by an average of approximately 10 kaf over flows that would otherwise occur during that period. Flows in the South Platte River below Fort Morgan generally would be less in November, December, January, and June.

There is one known active bald eagle nest in the action area along the South Platte River. There also are bald eagles that winter along the South Platte River from November through March, including a small number that winter along the South Platte River downstream from Crook. Bald eagles typically concentrate in historically used roosts at night and forage opportunistically along the Front Range during the day. Efforts are underway to document important night roosts, although none are known in the action area at this time.

Foraging on the river and reservoirs in winter is restricted by availability of open water. Reduced flows during winter and in June would not significantly impact eagles. During the dry 2002-03 winter, bald eagle distribution shifted from the South Platte River onto area reservoirs, while bald eagle numbers remained high CDOW, personal communication, 2003). Altering the hydrology also is unlikely to have any effect on icing, as this is largely dependent on ambient air temperature.

Nebraska: In Nebraska under all alternatives, the increase in wet meadow and channel habitats and the ability to re-regulate water to help meet target and pulse flows in the Central Platte River will benefit the bald eagle by providing feeding and loafing habitat for migrant and wintering waterfowl, a food source for bald eagles. Adverse impacts to the bald eagle could result from removal of riparian woodland habitat that provides winter roosting, feeding perches, loafing habitat, and potential nesting habitat. The Program's Land Action Plan (*Governance Committee Program Document:* Attachment 4, Land Plan) refers to the bald eagle as a "species of concern" and denotes that the Program would, where practical, select restoration, maintenance, and other management measures for the target species that do not harm or may benefit "species of concern." The Governance Committee Alternative impacts bald eagle wintering flows along the South Platte and Platte River above Overton. The Governance Committee Alternative also marginally increases shortages to target flows in the Central Platte River for January. Because of these flow-related impacts, the Governance Committee Alternative may affect, and is likely to adversely affect, the bald eagle in Nebraska.

Enhancement of flows to meet pulse and target flows would help to maintain a live river and support fish populations on which the bald eagles feed. All action alternatives provide additional improvements to river habitat by increasing areas of wide river channel, and by offsetting erosion and channel degradation.

Western Prairie Fringed Orchid

Effects to the orchid were measured by:

- ➢ Changes in short-term peak flows that affect surface water communication with wet meadows in the Central Platte River
- ➢ Changes in long-term peak flows that affect the groundwater subirrigation along the Central and Lower Platte Rivers

The Full Water Leasing Alternative is anticipated to provide the greatest benefit for the western prairie fringed orchid. All action alternatives, with the exception of the Full Water Leasing Alternative, include storage resulting in reduction of spring flows (i.e., 30-day peak flows in mid-April and June) and, therefore, likely reduction of subirrigation of wet meadows orchid habitat.

Short-Term Peak Flow Events in Spring

The Full Water Leasing Alternative maintains and may improve the frequency of these short-duration near bankfull events compared to Present Condition (see the "Whooping Crane" section in this chapter). The Governance Committee, Wet Meadow, and Water Emphasis Alternatives are all generally comparable in the frequency of these events, but they are lower than under the Present Condition.

Peak River Water Surface Elevations of Early Spring

The computations of river water surface elevations (see the "Whooping Crane" section, "Impacts Analysis," "Out-of-Channel Habitat—Grassland and Wet Meadows" subsections in this chapter) in early spring focus on changes due to the altered hydrology. The analytical SEDVEG Gen3 model is somewhat uncertain but does not seem to indicate substantial channel bed elevation differences among the action alternatives. For all alternatives, the peak river stage during the early spring pulse flow period is modestly improved over the Present Condition.

Wet Meadow Hydrology—Peak River Water Surface Elevations of Late Spring

As with the computations for early spring, computations of river water surface elevations (see the "Whooping Crane" section, "Impacts Analysis," "Out-of-Channel Habitat—Grassland and Wet Meadows" subsections in this chapter) in late spring incorporate changes due to the altered hydrology and minor changes in channel bed elevation (from the SEDVEG Gen3 model). For all alternatives except the Full Water Leasing Alternative, river water surface elevations during late spring are significantly reduced in 10 to 20 percent of years—mainly as a result of reduced flow. These are the years that correspond with the highest peaks (1-in-10 to 1-in-5 average reoccurrence). Also, for all alternatives, the peak river stage in years with normal or moderate spring peaks is somewhat higher than under the Present Condition.

The 7-day peak flow events follow a similar pattern (see the "Whooping Crane" section, "Impacts Analysis," "Security and Protection From Disturbance" subsection in this chapter). Water surface elevations in years with the highest peak flows (1 in 10 to 1 in 5 years) are diminished for all alternatives.

Peak water surface elevations in normal years are increased for all alternatives. The amount of increase is comparable for the Governance Committee, Wet Meadow, and Water Emphasis Alternatives, but it is somewhat greater for the Full Water Leasing Alternative.

Wet Meadow Hydrology—Lower Platte River Peak Flows

Changes in Lower Platte River peak flows are minimal for all alternatives, using either the high or low estimates. Examining the calculable differences, most alternatives remain essentially the same (slightly negative), except for the Full Water Leasing Alternative, which entails some small gains in peak flows (see "Pallid Sturgeon" section in this chapter).

Determination of Effect

In Nebraska, flow management activities that result in decreased early and late spring peaks for the Governance Committee Alternative has the potential to adversely impact the western prairie fringed orchid.

Flow management activities associated with the Governance Committee Alternative may affect, and is likely to adversely affect, the western prairie fringed orchid in Nebraska. The Program's Land Plan (Habitat Protection Plan) refers to the western prairie fringed orchid as a "species of concern" and denotes that the Program would, where practical, select restoration, maintenance, and other management measures for the target species that do not harm or may benefit "species of concern." Given the reduction to peak river flows in the Central and Lower Platte Rivers, the Governance Committee Alternative is judged to adversely affect the western prairie fringed orchid in Nebraska.

Ute Ladies'-Tresses Orchid

In Wyoming, the Ute ladies'-tresses orchid is known to occur along tributaries to the North Platte River and may occur along the main stem North Platte River. However, all of the action alternatives have relatively minor effects on the volume and range of flows in the North Platte River, and it is not anticipated that any of the action alternatives would adversely impact the Ute ladies'-tresses orchid in Wyoming.

Flow management activities may affect, but are not likely to adversely affect, the Ute ladies'-tresses orchid in Wyoming.

Species That May Be Affected by Water Leasing

This section discusses programmatic impacts to listed species, other than the target species, that may potentially be affected by water leasing in the Basin (listed in table 5-FL-4). All alternatives, through these water leasing actions, have the potential to affect streamflows in areas occupied by one or more listed species. Given the undetermined, site-specific nature of future water leasing, the effects of these activities on listed species cannot be determined at this time. However, in all cases, the Program has the choice about where to implement such actions. Further, water leases are likely to be of limited duration.

In evaluating all offers of water to the Program, the Program will consider and assess the potential for adverse effects to these species and ensure, through consultation with the Service, that Program actions do not jeopardize the continued existence of listed species nor adversely modify designated critical habitat.

This analysis assumes that specific parcels proposed for water leasing during Program implementation will undergo site-specific NEPA compliance and ESA Section 7 consultation with the Service (consistent with applicable regulations and guidelines) to evaluate offers of leased water to ensure that Program actions do not jeopardize the continued existence of listed species nor adversely modify designated critical habitat. Species and/or designated critical habitat potentially affected by water leasing activities include those listed on table 5-FL-4.

Table 5-FL-4.—Federally Listed Species
that May Be Affected by Water Leasing

Species	States
American burying beetle	Nebraska
Colorado butterfly plant	Wyoming and Colorado
Colorado butterfly plant critical habitat	Wyoming
Preble’s meadow jumping mouse	Wyoming and Colorado
Preble’s meadow jumping mouse critical habitat	Wyoming
Ute ladies’-tresses orchid	Wyoming and Colorado
Wyoming toad	Wyoming

American Burying Beetle

Effects were measured by the presence of a water leasing component that occurs in the Basin south of the Central Platte River in Dawson, Frontier, Gosper, and Lincoln Counties, which represents the potential conversion of irrigated cropland to grassland.

The Governance Committee, Full Water Leasing, and Water Emphasis Alternatives each have water leasing components that have the potential to provide benefits to the American burying beetle. The Full Water Leasing Alternative provides the greatest amount of leased water, and the Governance Committee Alternative provides the least. Alternatives were not ranked based on quantities of leased water because the amount of converted grasslands within the Central Platte Habitat Area could not be quantified. The Wet Meadow Alternative does not have a water leasing component and would be considered the least beneficial to the American burying beetle.

The Governance Committee, Full Water Leasing, and Water Emphasis Alternatives have water leasing components that provide approximately 7, 120, and 60 kaf, respectively, toward species and annual pulse target flows. Water leasing is anticipated to occur within irrigation districts below the North Platte and South Platte River confluence, which has the potential to affect American burying beetle habitats. The Wet Meadow Alternative does not have a water leasing component; therefore, the Wet Meadow Alternative would not adversely impact the American burying beetle in Nebraska. Given the undetermined, site-specific nature of future parcel-specific water leasing actions, actual impacts to the American burying beetle are not known. At this time, all Program activities are assumed to be beneficial to the species as a result of grassland restoration in the Central Platte Valley.

The Program's Land Plan (Habitat Protection Plan) refers to the American burying beetle as a "species of concern" and denotes that the Program would, where practical, select restoration, maintenance, and other management measures for the target species that do not harm or may benefit "species of concern." This language does not provide assurances that impacts to species will be avoided. Given the undetermined, site-specific nature of the future of parcel-specific water leasing actions, impacts to the American burying beetle are not known but are assumed to be beneficial. This analysis assumes that specific parcels proposed for water leasing during Program implementation will undergo site-specific NEPA compliance and ESA Section 7 consultation with the Service to ensure Program actions do not jeopardize the continued existence of listed species nor adversely modify designated critical habitat.

Determination of Effect

The Governance Committee Alternative may affect, but is not likely to adversely affect, the American burying beetle in Nebraska.

Colorado Butterfly Plant, Preble's Meadow Jumping Mouse, Ute Ladies-Tresses Orchid, and Wyoming Toad

Because of the wide distribution of some listed species and the uncertainty regarding the specific location of some habitat restoration and Water Action Plan projects (such as water leasing), the potential for site-specific impacts to some listed species and designated critical habitats within the action area will not be known until a Program is adopted and specific land and water actions are proposed.

Determination of Effect

Under the Governance Committee Alternative, the only proposed water leasing that occurs in the same state as these species is in Wyoming. Water leasing under the preferred alternative could have beneficial impacts in some Wyoming tributaries. Converting irrigation diversion to instream flow through water leasing could lead to hydrologic conditions more favorable to some species and habitats. Stream channels could be more active locally, providing disturbance favorable to colonization by early successional plant species such as willows. Overbank flooding would be more frequent, improving soil moisture on the flood plain. Significant increases in riparian zone scour/erosion due to water leasing are unlikely. Increases in flow along tributary creeks and canals should remain well within the range of historic variations in flow. If anything, the tendency to increase flows in May or June of most years along certain main stem tributaries, at the expense of flows later in the irrigation season, should generally enhance the health of riparian zones relative to the Present Condition.

Water leasing could adversely affect riparian habitats and species occupying habitats that are dependent on irrigation return flows to maintain water levels. Localized impacts to riparian and wetland conditions associated with smaller canals and creeks are possible in cases where:

- ➢ Return flows from farm irrigation were a significant contribution to the local water table and surface hydrology
- ➢ No other water users rely on the local return flows or canal deliveries to this site

In these cases, water tables could decline locally, and this could negatively impact local vegetation and associated wetlands used by listed species. The Program could also reduce the availability of potential reintroduction sites for the Wyoming toad through reductions in irrigation return flow. Site-specific effects on listed species and designated critical habitats will be determined at the time water is offered for lease with appropriate site-specific NEPA compliance and ESA consultation with the Service conducted.

Because the impacted species occupy a limited area in the Basin and, in fact, are outside the areas in Wyoming that are likely to provide leased water (i.e., the Kendrick Project near Casper—see the "Governance Committee" section in chapter 3), it seems unlikely that the Program will have any adverse effect on these species. In this regard, it should also be noted that in their July 6, 2004, letter, "Letter to Initiate Formal Consultation on the Program," the Service and Reclamation expressed the position that they, as members of the Governance Committee, would not approve any proposed water leases to the Program that would result in a reduction of water to habitat occupied by the Wyoming Toad (found primarily near Mortenson Lake in the Laramie River drainage).

In their February 15, 2006 amendment to the "Letter to Initiate Formal Consultation on the Program," Reclamation and the Service also made the following commitment:

> *Individual section 7 consultation will occur on a site-specific, case-by-case basis prior to approving any water leases in Wyoming. We believe that in the unlikely event that* Spiranthes *or other listed species do occur in proposed water leasing areas, any potential impacts to these species can be avoided by: (a) taking land out of cultivation for only one or two years at a time and closely monitoring habitat conditions to ensure mesic conditions of occupied habitat; (b) providing maintenance flows within drainages containing occupied habitat during the irrigation season while out of cultivation; and /or (c) avoiding water leasing activities in areas experiencing drought for several consecutive years until habitat conditions recover. Reclamation and the Service are committed to taking these and other conservation measures as appropriate to avoid impacts to* Spiranthes *and other federally listed species.*

Therefore, the preferred alternative may affect, but is not likely to adversely affect, these species.

SUMMARY OF EFFECTS DETERMINATIONS FOR ALL LISTED SPECIES

Overview

This section summarizes the effects determinations required by ESA Section 7 for the target species, other listed species, and designated critical habitat within the action area for the preferred alternative. The determination of effects is made for the preferred alternative, the Governance Committee Alternative.

TARGET SPECIES

The effects determinations for the target species are shown in table 5-ALS-1. The determinations are discussed for each species below.

Table 5-ALS-1.—Summary of Effects Determinations for the Target Species for the Preferred Alternative (Governance Committee)*

Species	Effects Determinations
Whooping crane	May affect, likely to adversely affect
Interior least tern	May affect, likely to adversely affect
Piping plover	May affect, likely to adversely affect
Pallid sturgeon	May affect, likely to adversely affect
Whooping crane critical habitat	Likely to adversely affect

*By policy, if a Federal action will (or is likely to) result in both adverse and beneficial effects to listed species, the appropriate determination is "may affect, likely to adversely affect." This is true even where net effects may be positive (U.S. Fish and Wildlife Service and National Marine Fisheries Service, 1998).

Whooping Crane and Whooping Crane Critical Habitat

Upstream of Lexington, Nebraska

The Governance Committee Alter native is not likely to affect whooping cranes or whooping crane habitats upstream of Lexington, Nebraska. The main stem of the Platte River (and North Platte and South Platte Rivers) comprises roughly 60 miles (40 percent) of a 150-mile-wide primary corridor of crane migration but lacks suitable habitat.

Central Platte Habitat Area

Within the Central Platte Habitat Area, including the 54-mile river reach (Lexington to Shelton) designated as critical habitat, the Governance Committee Alternative produces several benefits and adverse effects.

The Governance Committee Alternative would initially restore wide channels, thus increasing both the amount and distribution of channel habitat available for whooping crane use. This is expected to increase whooping crane stopover opportunity in river reaches where attractive habitat no longer exits. Mechanical channel reconfiguration at the scale described by the Governance Committee Alternative has not previously been attempted, but small-scale mechanical channel widening of the same nature has been successfully implemented on the Platte River.

Under the terms of the ESA, the effects of the Governance Committee Alternative must be weighed along with cumulative effects (i.e., activities that are federally authorized, funded, or permitted and are reasonably certain to occur, but that are not part of the Program). In this regard, the value of channel habitats restored upstream of Kearney by the Governance Committee Alternative may be reduced by hydrocycling from the Johnson-2 Return (see "Hydrocycling" in the "Cumulative Effects" section in this chapter.

Channel habitat loss is believed symptomatic of sediment deprivation and transport imbalance under the existing water management operations. An additional, small decrease in natural sediment supply to the Central Platte Habitat Area would occur under the Governance Committee Alternative, due to small reductions in flows down the main Platte River channel above the Central Platte Habitat Area. This alternative will rebalance sediment transport using mechanical augmentation/earth moving. The feasibility and efficacy of mechanical augmentation will be tested by the Program during this process. The benefits of the Governance Committee Alternative described in FEIS analysis rely on assumed rates , locations, and timing not currently detailed within the Governance Program Document.

The Governance Committee Alternative is likely to have both beneficial and potentially adverse effects on wet meadows. For existing native meadows, springtime peak riverflows to help sustain the groundwater hydrology would be negatively affected in high flow years (1 in 3 years) and have slight positive affects in moderate and low peak flow years. The frequency of overbank flows into wet meadows, presently occurring (at different magnitudes) in 14 to 28 percent of years, would be reduced to 8 to 24 percent of years.

The Governance Committee Alternative will also attempt to restore meadows that have been converted to other land uses, or create meadows. Meadow conversion and creation will be experimental and uncertain in several respects: while restoration methods and evaluation criteria have not been fully developed, some past restoration efforts appear to have attained some qualified success; however, other pilot restoration experiments have failed or achieved very limited success. Restoration on accretion sand and gravels, for example, may require significant effort, monitoring, and oversight. Methods for wet meadow creation and restoration, and methods of evaluation, would require further development and refinement through adaptive management.

The Governance Committee Alternative is likely to benefit whooping crane protection from disturbance and intrusion. The length of riverbank in the Central Platte Habitat Area that is protected would increase from 19 to 33 percent. The land area managed for whooping crane protection would increase roughly double, from about 9 percent under Present Condition to about 17 percent with the Governance

Committee Alternative. Due to the rural setting, some of this area would likely remain undisturbed without Program acquisition.

Table 5-ALS-2 lists the indicators for whooping crane critical habitat, their importance, and benefits and/or detrimental effects of the Governance Committee Alternative.

Table 5-ALS-2.—Whooping Crane Critical Habitat Indicators in the Central Platte Habitat Area

Indicator	Relative Importance	Benefit/Detrimental Effects
Widen channels on Program lands	High	High benefits
Sustainability of wide channels	High	Potentially high benefit
Wet meadows creation/restoration	Moderate	Undetermined
Hydrology of existing meadows	Moderate	Low benefits - moderate detrimental effects
Security/protection	Moderate	Moderate benefits

Piping Plover and Interior Least Tern

The Governance Committee Alternative would result in both some adverse and some beneficial effects to resources used by piping plovers and interior least terns within the identified study area. Effects are discussed as they relate to four geographic locations used by the species within the Basin.

Effects at Lake McConaughy

Lake McConaughy has been an important production site for piping plovers—both under baseline conditions (1997) and in recent years under drought facilitated reductions in reservoir storage. The reservoir currently produces more plovers than all other nesting sites within the defined study area combined. These conditions are anticipated to continue under the Governance Committee Alternative and may even improve somewhat under predicted lower May end-of-month water surface elevations for this alternative when compared to the Present Condition.

Lake McConaughy does not produce the same benefits for interior least terns as for piping plovers. (Central Platte River sandpits and Lower Platte River sandbars and sandpits all support more tern nests and fledge more young terns than are supported or fledged at the reservoir.) The Governance Committee Alternative is predicted to produce the largest reduction in surface elevation. While such reduction may benefit plovers and perhaps terns to some degree, regional weather patterns and nesting habitat management will continue to have the biggest impact on plover and tern use at Lake McConaughy.

Effects Within the North Platte to Lexington Reach

Plovers and terns use this river reach. Nesting is now restricted to sandpits, but both species use the river for foraging and likely also for young brood cover.

Lake McConaughy Spills

The Governance Committee Alternative would reduce both the frequency and magnitude of spills from Kingsley Dam (see the "Piping Plovers and Interior Least Terns" section, "Impacts Analysis," "Fledging Days" subsection in this chapter). The reduction in magnitude (44.7 percent) is significant. Spills (unscheduled water releases) play a major role in structuring and maintaining downstream channel characteristics such as depth and width. These characteristics, and the flows and sediments that also define them, provide conditions that support channel sandbars and food for plovers and terns. A reduction in spills would likely lead to further narrowing and deepening of the remaining channel, reducing invertebrate and small fish (food resources) availability in this reach and adversely affecting the species' habitat.

Annual Flow at Cozad

A sandpit near Cozad is an important nesting site for plovers and terns. It is assumed that annual flows in the river channel, along with sandpit resources, provide habitat currently used by plovers and terns. Annual flow at Cozad would be numerically higher (12 percent) but not statistically greater than the Present Condition for the Governance Committee Alternative. Increased flows may affect current channel resources.

The combination of reduced spills—with no mitigation from mechanical restructuring of the channel—and little change or a small increase in annual flows at Cozad support a prediction for further reductions in channel width that will likely occur in this reach under the preferred alternative. If further reduction in channel width occurs within this reach, channel resources used by plovers and terns would likely be adversely affected.

Effects Within the Lexington to Chapman Reach

A major management consideration for piping plovers and interior least terns within Nebraska involves the restoration and/or establishment of channel conditions that would support successful nesting by these two target species on the river between Lexington and Chapman. See "Piping Plovers and Interior Least Tern" section in this chapter. The establishment of channel conditions that would support successful nesting is believed to require a change in flow patterns and a restoration of sediment balance.

Analysis within this reach relies heavily on output from the SEDVEG Gen3 model. Output is used to predict the potential of flows to build sandbars suitable for plover and tern nesting, and the number of inundation-free days that would be available for nesting—if sandbars are present—between May 1 (plovers) or May 20 (terns), and August 15.

Increases in flow potential to build sandbars and in available fledging days are predicted under the Governance Committee Alternative (see the “Piping Plovers and Interior Least Terns” section in this chapter). Potential increases in fledging days are predicted to be larger in areas associated with managed transects, as opposed to unmanaged areas, and predicted increases would be greater downstream from Kearney than upstream from Kearney.

The Governance Committee Alternative also proposes to increase the area of sandpits managed for plovers and terns in this river reach, and that action would benefit these birds. While tern and plover nesting on sandpits may serve to preserve the distribution of the species along the Central Platte River while efforts are made to improve river channel under the Program, artificial habitats such as sandpits cannot provide the full complement of essential habitat requirements for piping plovers and interior least terns over the long term and, therefore, cannot substitute for riverine habitat.

The turbidity of the river would increase somewhat under the Governance Committee Alternative, but the probability of July temperatures exceeding 90ºF would change very little from the Present Condition, although there is a slight improvement when looking at June, July, and August together. It is unlikely that either of these changes would elicit a measurable response in the forage fish communities (food base for interior least terns) of the Central Platte River.

In summary, if the SEDVEG Gen3 model analysis is realistic, conditions may improve to the point of supporting some channel nesting by plovers and terns in this reach. The magnitude of such potential nesting is unknown. It is also unknown whether it would represent an increase in birds or a shift from sites already in use. The Governance Committee Alternative—at least in terms of turbidity and temperature—would provide conditions very similar to, or slightly better than, the Present Condition. Measurable positive effects within this reach from the Governance Committee Alternative would also come from an increase in sandpit acres managed for plover and terns.

Effects Downstream From Chapman

The Lower Platte River or, more specifically, the reach from Columbus (Loup River) to the Missouri River is important to local populations of plovers and terns and is currently the major production area for interior least terns within the study area when both channel sites and sandpits are considered together.

Median July flows at Grand Island were evaluated for any significant change from the Present Condition. Although flows downstream from Columbus would be influenced by the Loup and Elkhorn Rivers, Platte River flows are an important component. It is assumed that a significant increase in July flows may have an adverse effect on plovers and terns nesting on sandbars in the Lower Platte River. July was selected because nests would be active, and any nest losses in July would not be replaced by renesting attempts.

July flows at Grand Island would be higher, but not significantly higher, than the Present Condition under the Governance Committee Alternative. It is, therefore, unlikely that the Governance Committee Alternative would affect plovers and terns using the Lower Platte River.

Conclusions

When the defined study area is considered by river reach, the Governance Committee Alternative would result in the following effects to resources used by piping plovers and interior least terns:

- **Lake McConaughy:** Some small increase in nesting substrate may occur. This could be a positive affect.
- **North Platte to Lexington:** Reduced spills are likely to result in further channel narrowing and the subsequent reduction in availability of food resources. This would be a negative effect.
- **Lexington to Chapman (Central Platte Habitat Area):** Some improvement in sandbar conditions and fledging days may occur. An increase in sandpit area managed for plovers and terns would occur, and this would be a positive effect.
- **Chapman to Missouri River:** An increase in July flows may occur. Likely to be no effect.

The analysis indicates the Governance Committee Alternative may provide some benefits to plover and tern habitat components at Lake McConaughy, and at managed sandpits within the Lexington to Chapman reach. It is likely the Governance Committee Alternative would adversely affect the availability of food for plovers and terns using the North Platte to Lexington reach. The Governance Committee Alternative would increase July flows (as measured at Grand Island) in the Chapman to Missouri River reach, but such increases would likely have no effect on plover and tern resources in the Lower Platte River.

Pallid Sturgeon

The Governance Committee Alternative does not provide significant benefits to the pallid sturgeon; that is, it does not create conditions significantly different from the Present Condition. The pallid sturgeon research plan does benefit the pallid sturgeon, but only in that it will provide information that can be subsequently acted upon to secure defined benefits to the species.

The Governance Committee Alternative produces several different benefits and adverse impacts to the pallid sturgeon (table 5-ALS-3). During the pallid sturgeon spawning period, a slight reduction in flow is anticipated in high water years. These high water years constitute the greatest opportunity for pallid sturgeon spawning in the Lower Platte River, and the small reduction in flow is anticipated to result in a correspondingly small decrease in the strength of the spawning cue. During the habitat formation and maintenance, and food base production period (which also encompasses the spawning period), similar small reductions in peak flow magnitude in high water years are anticipated, while some small increases in lower years may be realized. This is anticipated to result in slightly reduced hydrologic capacity to build and maintain habitats, which would be detrimental to pallid sturgeon in the Lower Platte River.

Table 5-ALS-3.—Effects of the Governance Committee Alternative on Pallid Sturgeon: Their Relative Importance and Magnitude

Indicator	Relative Importance	Beneficial Effects	Detrimental Effects
Spawning flows	Very high		Small
Habitat formation and maintenance flows	High		Small
Food base production	Moderate	Very small	
Summer flows	Low	Very small	
Sediment balance	Moderate	Potential moderate	
Research plan	Initially low; upon completion, high	Yes	

The food base is anticipated to respond to the reduction in high flow years (high food base productivity years), with a slight decrease in availability in those years. It is also anticipated to respond to the increase in low flow years (low productivity years), with a slight increase in availability in those years. The result of this slight leveling of food base availability under the range of conditions in the Lower Platte River, which taken relative to the baseline, may be very slightly beneficial to the pallid sturgeon. During the summer low flow period, small increases in flows are anticipated in moderate to dry years. This may produce some correspondingly small increases in habitat connectivity and some very slight moderation of high water temperature events. The Governance Committee Alternative is anticipated to result in a significant input to the Central Platte River, but it is unclear how long it will take this sediment to reach the pallid sturgeon habitat area and how long this sediment will remain resident in the Lower Platte River. Finally, the Governance Committee Alternative contains a robust monitoring and research component. While this, in itself, accrues no benefits directly to the species, the research is anticipated to provide the information necessary to identify future activities that would prove beneficial to the pallid sturgeon in its Lower Platte River habitat.

The Governance Committee Alternative will likely have a very small adverse impact on the species in the Lower Platte Habitat Area. The effects may or may not be detectable, given the very small magnitude of the changes. However, upon completion of significant parts of the pallid sturgeon monitoring and research component, information will have been gathered that can be anticipated to allow significant actions to take place, enhancing the species' Lower Platte Habitat Area and resulting in an overall benefit over the longer term.

OTHER LISTED SPECIES

The discussion of the impacts and effects of the Governance Committee Alternative is described in the "Other Federally Listed Species" section in this chapter and summarized in table 5-ALS-4.

Table 5-ALS-4.—Summary of Effects Determinations for Other Listed Species for the Preferred Alternative (Governance Committee Alternative)

Common Name	State	Effects Determinations
American burying beetle	Nebraska	May affect, not likely to adversely affect
Bald eagle	Wyoming, Colorado	May affect, not likely to adversely affect
Bald eagle	Nebraska	May affect, likely to adversely affect
Colorado butterfly plant	Wyoming, Colorado	May affect, not likely to adversely affect
Preble's meadow jumping mouse	Wyoming, Colorado	May affect, not likely to adversely affect
Ute ladies'-tresses orchid	Wyoming, Colorado	May affect, not likely to adversely affect
Western prairie fringed orchid	Nebraska	May affect, likely to adversely affect
Wyoming toad	Wyoming, Colorado	May affect, not likely to adversely affect
Designated Critical Habitat		
Preble's meadow jumping mouse	Wyoming, Colorado	May affect, not likely to adversely affect
Colorado butterfly plant	Wyoming, Colorado	May affect, not likely to adversely affect

STATE LISTED SPECIES AND SPECIES OF SPECIAL CONCERN

Issue: How would the action alternatives affect state-listed species or species of special concern?

Overview

SCOPE

The area of effect in Wyoming, Colorado, and Nebraska includes:

- **Land action area** (included in all alternatives)
  - Nebraska
    - Lexington to Chapman (Central Platte Habitat Area)

- **Flow management and water leasing action areas** (included in all alternatives)
  - Colorado
    - South Platte River – downstream of Greeley
  - Nebraska
    - South Platte River - Colorado State line to confluence of North and South Platte Rivers (near city of North Platte)
    - North Platte River - Wyoming State line to North Platte
    - Platte River - North Platte to the mouth of the Missouri River, and in the Missouri River close to the mouth
  - Wyoming
    - North Platte River - Seminoe Reservoir to the Nebraska State line

Impacts to these species were analyzed based on habitat type. Habitats analyzed for each alternative include:

- Riverine and wetland habitats
- Lakes and reservoirs
- Riparian woodlands
- Upland grasslands

INDICATORS

Impacts to state listed threatened, endangered, and species of special concern in the action area are determined based on:

- Locations of known populations
- Potential impacts to their habitats

SUMMARY OF IMPACTS

No significant adverse impacts are anticipated for any state listed species in Wyoming, Colorado, or Nebraska.

IMPACTS ANALYSIS

The actions of the alternatives alter riverflows and land habitat in the Central Platte Habitat Area. These actions also affect riverflows in the North and South Platte River Basin, and agricultural activities and water use (see "Agricultural Economics" in this chapter for changes in agricultural production and land use). These Program actions may affect other state listed species in these areas.

Impacts of action alternatives on state listed and species of special concern are discussed below by state and habitat type. Impacts of all action alternatives are discussed in general, except where noted.

Wyoming

- Western boreal toad
- Wood frog
- American white pelican
- American bittern
- Black tern
- Black-crowned night heron
- Caspian tern
- Common loon
- Forster's tern
- Lewis' woodpecker
- Snowy egret
- White-faced ibis
- Yellow-billed cuckoo
- Flathead chub
- Hornyhead chub
- Suckermouth minnow
- Vagrant shrew

Colonial Nesting Birds[13]

Except for some localized effects, management of main stem reservoirs and the concomitant fluctuation in reservoir levels and North Platte River flows would not have a significant adverse impact on colonial nesting birds or their habitats. While important breeding areas occur on smaller lakes within the North Platte River Basin (e.g., Bamforth Lake, Caldwell Lake, Rush Lake, Soda Lake, Webb Lake), the hydrology of those areas would not be impacted by main stem water management associated with the Program.

[13] Colonial nesting birds and cottonwood riparian species include: American bittern, black tern, black-crowned night heron, common loon, Forester's tern, or white-faced ibis.

Water leasing activities may result in localized impacts to riparian and wetland conditions associated with smaller canals and creeks in cases where:

- Return flows from farm irrigation were a significant contributor to the local water table and surface hydrology
- No other water users rely on the local return flows or canal deliveries to this site. In these cases, water tables could decline locally, and this could negatively impact local riparian vegetation and associated wetlands.

However, effects to hydrological processes from water leasing would occur only within localized segments of habitat and effects on hydrological processes would occur on a temporary basis, only during a few months of particular years.

Pathfinder Reservoir

Program impacts to Bird Island's avifauna primarily will come from increased predator access during low water levels during the nesting period. The ground-nesting birds—American white pelican, California and ring-billed gulls, Canada geese, and Caspian terns—attend nests or flightless young from early April through late July (Erlich, 1986). The Program increased the number of years that Bird Island becomes a peninsula during the nesting season to 25 of 48 years (52 percent of years), compared with 24 of 48 years (50 percent) under the Present Condition. This 2-percent increase is not expected to contribute significant negative impacts to avian species, and it likely falls within the margin of error for the hydrologic analysis.

Pathfinder National Wildlife Refuge

Other important terrestrial resources potentially affected by the Program are wetlands on the Pathfinder National Wildlife Refuge. Changes in pool elevation at Pathfinder Reservoir are not expected to be substantial enough to change the wetland vegetation and habitat values at the refuge.

Cottonwood-Riparian Species[14]

Management of main stem reservoirs and the concomitant fluctuation in reservoir levels and North Platte River flows would not have an adverse impact on species occupying cottonwood-riparian habitats, including Lewis' woodpecker, the yellow-billed cuckoo, or the vagrant shrew. It is possible that increased main stem and tributary flows from the Environmental Account and water leasing activities would increase water levels seasonally in side channel wetland and riparian habitats. This would aid in maintaining important riparian habitats that may otherwise die out from desiccation and increased channelization. While the current flow regime maintains the existing stands of riparian cottonwood, the channel is probably failing to provide suitable sites or hydrology for recruitment of younger stands. Recruitment appears limited to a narrow band along the current active channel. As the existing forest becomes increasingly decadent and dies off, it will not be replaced, and declines in the riparian forest should be expected.

[14]Colonial nesting birds and cottonwood riparian species include: American bittern, black tern, black-crowned night heron, common loon, Forester's tern, or white-faced ibis.

Water leasing activities may result in localized impacts to riparian and wetland conditions associated with smaller canals and creeks. However, effects to hydrological processes from water leasing would occur only within localized segments of habitat, and effects on hydrological processes would occur on a temporary basis, only during a few months of particular years.

In small tributaries, conversion of irrigation diversion to instream flow could lead to hydrologic conditions more similar to pre-development conditions. Stream channels could be more active locally, providing disturbance favorable to colonization by early successional plant species including willows. Overbank flooding would be more frequent, improving soil moisture on the flood plain. Increased riparian zone scour/erosion due to water leasing is highly unlikely. Increases in flow along tributary creeks and canals should remain well within the range of historic variations in flow. If anything, the tendency to increase flows in May or June of most years along certain main stem tributaries, at the expense of flows later in the irrigation season, should generally enhance the health of riparian zones relative to the Present Condition.

Colorado

Riverine and Wetland Habitats

- Northern river otter
- Common garter snake
- Boreal toad
- Northern leopard frog
- Northern cricket frog
- Wood frog
- Plains leopard frog
- Yellow mud turtle
- Brassy minnow
- Common shiner
- Iowa darter
- Lake chub
- Plains minnow
- Stonecat
- Suckermouth minnow

The Tamarack Project will elevate water tables in riparian meadows, increase groundwater return flows to the sloughs and river channels at the State Wildlife Areas (SWAs) (i.e., Tamarack Ranch SWA and Pony Express SWA), and generate open water surfaces at the recharge ponds. These hydrological changes will serve to maintain and enhance existing riparian and wetland habitats at the SWA in a manner that will benefit waterfowl and fish species of concern and will continue to contribute to creation of needed wetland and wet meadow complexes (CDOW, 1998).

Elevated groundwater levels will extend to the river, causing increased return flows into the river channels. The riparian meadow areas between the river and the upland areas where the recharge ponds are will experience elevated water tables with the resulting establishment of wetland characteristics. The enhanced wetland functionality resulting from these higher water tables under the riparian meadows will be used in creating wetland complexes. Wetlands created around recharge ponds and the warm groundwater supplied by wells provide open water surface at the recharge ponds, creating suitable environment and resting areas for waterfowl during migration and wintering.

Increased alluvial flows in the areas below new pond sites will enhance existing sloughs and riparian habitats for both aquatic and terrestrial species. The increased return flows of warm groundwater enlarge and enhance the warm water slough areas along the river, providing more waterfowl habitat. The increased return flows to the slough areas along the river channels also maintain and promote these habitats as an essential and natural component for the preservation of minnow species of concern. Wetlands in the riparian meadows will also provide nesting and brooding habitat for numerous waterfowl.

The northern river otter was reintroduced into the upper Cache La Poudre River drainage; however, their occurrence in the Lower South Platte River is very rare. Therefore, the northern river otter would not be adversely impacted by the proposed water activities.

Potential benefits of the Tamarack Projects to wildlife and wildlife habitat are significant. The creation of new ponds will have a positive impact on local wildlife populations. Responses to habitat changes by waterfowl and shore birds using the ponds will be most noticeable, but many other species from amphibians to big game will also benefit from the newly created wetlands. Increased alluvial flows in the areas below the new pond sites will enhance existing sloughs and riparian habitats for both aquatic and terrestrial species.

Construction of the project will have no negative impacts on any state threatened or endangered species or their habitats. Benefits to special status species from this project include enhancing and/or maintaining habitat for native Colorado fish species.

Water leasing (Full Water Leasing and Water Emphasis Alternatives) could adversely affect riparian habitats and species occupying habitats that depend on irrigation return flows to maintain water levels. Localized impacts to riparian and wetland conditions associated with smaller canals and creeks are possible in cases where:

- Return flows from farm irrigation were a significant contribution to the local water table and surface hydrology

- No other water users rely on the local return flows or canal deliveries to this site. In these cases, water tables could decline locally, and this could negatively impact local vegetation and associated wetlands.

However, no significant adverse impacts are anticipated for the common garter snake or the northern leopard frog habitats or populations in Colorado.

Lakes and Reservoirs

- Western snowy plover
- Greater sandhill crane

These two species are rarely observed in the action area. The snowy plover, a very rare migrant, is only known to breed in the San Luis Valley and plains reservoirs in southeastern Colorado. The greater sandhill crane is a rare summer resident in the parks of the Elkhead Mountains and Park Range in eastern Moffat, northern Routt, and western Jackson Counties.

Under the action alternatives, the Tamarack Projects would not adversely impact either of these species. The Full Water Leasing and Water Emphasis Alternatives could result in minor reductions in surface acreage for South Platte reservoirs. However, activities resulting in lower reservoir levels would likely have no adverse impact on either of these species.

Riparian Woodlands

- American peregrine falcon
- Western yellow-billed cuckoo

Peregrine falcons primarily nest on cliffs and forage over adjacent coniferous and riparian forests; rare spring and fall migrants are found in the foothills, lower mountains, mountain parks, and on the eastern plains. The western yellow-billed cuckoo inhabits lowland riparian forests and urban areas with tall trees in Colorado. It is a rare spring and fall migrant and summer resident on eastern plains west to Morgan and Otero Counties.

Under the action alternatives, neither of these species is expected to be affected.

Upland Grasslands

- Black-footed ferret
- Black-tailed prairie dog
- Swift fox
- Mountain plover
- Burrowing owl
- Ferruginous hawk
- Plains sharp-tailed grouse
- Greater sage grouse
- Long-billed curlew

With the exception of the greater sage grouse, the preferred habitat of these species is Colorado's eastern grasslands, primarily shortgrass prairies. Burrowing owls are a migratory species; they are a fairly common breeder in black-tailed prairie dog towns. The mountain plover is a rare to fairly common summer resident locally on eastern plains, with the greatest numbers occurring in northern Weld County. In Colorado, the ferruginous hawk is an uncommon breeder in shortgrass prairies and shrublands. The plains sharp-tailed grouse formerly nested over much of the northern two-thirds of the eastern prairie but the present population consists of only a few hundred birds in Douglas County. The long-billed curlew is a rare migrant and breeder in Colorado. The greater sage grouse is a fairly common local resident in sagebrush shrublands of northwestern Colorado, including Jackson and Larimer Counties. Under the action alternatives, the Tamarack Projects and any water leasing activities (Full Water Leasing and Water Emphasis Alternatives) would not adversely impact any of these state listed and species of special concern and their upland habitats. During migration and at the height of nesting in May and June, curlews could benefit from an increased availability of shoreline for feeding and drinking as a result of lower reservoir levels.

Nebraska

- American burying beetle
- Platte River caddisfly
- Finescale dace
- Lake sturgeon
- Northern redbelly dace
- Sturgeon chub
- River otter
- Western prairie fringed orchid
- Saltwort
- Massasauga rattlesnake

Invertebrates

Platte River Caddisfly

It is anticipated that the Platte River caddisfly would be negatively affected in all alternatives by the conversion of side channel and backwater habitat to main channel habitat. The extent of habitat loss is unknown because restoration activities are dependent on land management plans for future protected properties.

Fish

Finescale Dace/Northern Redbelly Dace

Flows for all alternatives tend to be low in the winter, increase in late spring, and achieve their highest levels during the irrigation season. Under all alternatives, with the exception of the Full Water Leasing Alternative, annual flows would decrease, due to the reductions in spills. Flows would be highest during the peak irrigation season (June through August) because the water released to meet irrigation demands exceeds the diversion capacity of the Sutherland Supply Canal and water is conveyed to its diversion point using the North Platte River. Only the Full Water Leasing Alternative is anticipated to provide increased flows during the April to June spawning period that is expected to increase preferred backwater and side channel habitats (see the “Water Resources” section in this chapter).

Lake Sturgeon

Lake sturgeon spawning generally takes place from April to June, during high water. Overall, the spawning period shows very little change from the Present Condition using either the high or low estimates under any of the alternatives (see “Pallid Sturgeon” in this chapter). While the absolute differences in flow may appear substantial, when viewed as a percent change, these differences are quite small. They would generally represent a change that, while mathematically calculable, would be difficult to measure in terms of biotic or abiotic effect. While each of the alternatives does produce some calculable effect on lake sturgeon spawning flows, the realistic effects are likely to be extremely slight. As a result, none of the alternatives exhibit an observable change in the most important and imperiled hydrologic requisite for continued species reproduction in the central part of the species range. The Full Water Leasing Alternative offers a net positive effect on spawning flows, while the remaining alternatives have a net negative impact on spawning flows.

Lake sturgeon habitat preference tends toward slower velocity habitats, and the availability of these habitats would be facilitated by high spring flows that build sandbars and submerged "dunes" that would serve as velocity breaks in the Platte River. As with the spawning period, changes in the habitat formation and maintenance and food base production periods are minimal for any alternative, using either the high or low estimates. The habitat formation and maintenance analysis focuses on the wetter exceedance intervals (wettest three-sixths) and, as such, shows almost no functional change. Examining the calculable differences, most alternatives remain essentially the same (slightly negative), except for the Full Water Leasing Alternative, which entails some small gains in habitat formation and maintenance flows (see "Pallid Sturgeon" in this chapter).

Sturgeon Chub

The Lower Platte River sturgeon chub population is likely driven by the availability of turbid sand bed habitat, with moderate to high current velocities, and by the high spring flows that cycle nutrients in the Platte, which, in turn, drives the aquatic ecosystem. Overall, the high spring flow time period shows very little change from the Present Condition using either the high or low estimates under any of the alternatives (see "Pallid Sturgeon" in this chapter). While the absolute differences in flow may appear substantial, when viewed as a percent change, these differences are quite small. They would generally represent a change that, while mathematically calculable, would be difficult to measure in terms of biotic or abiotic effect. While each of the alternatives does produce some calculable effect on pallid sturgeon spawning flows, the realistic effects are likely to be extremely slight. As a result, none of the alternatives exhibit an observable change in the most important and imperiled hydrologic requisite for habitat improvements in the Lower Platte River. The Full Water Leasing Alternative offers a net positive effect, and the remaining alternatives produce a net negative impact.

Mammals

Northern River Otter (Major Streams)

All action alternatives are anticipated to improve conditions for the river otter compared to the Present Condition within the North Platte River.

- **Average seasonal flows above Lake McConaughy during October through March:** No change from the Present Condition for all action alternatives

- **Percent change in average seasonal flows above Lake McConaughy during April through September**: Increases range from 4 percent (Governance Committee Alternative) to 8 percent (Water Emphasis Alternative)

Compared to the Present Condition, there were generally more months with flows greater than or equal to 1,200 cfs for all alternatives, particularly in June. All alternatives also had similar low probabilities of exceeding the various temperature levels among alternatives. There was an increase in the number of months out of the 48-year period with an average flow exceeding 1,200 cfs in June and July, but not in

August, when the temperature standard was exceeded most often. These results indicated that when the conditions were the poorest in terms of the temperature standard, the Governance Committee Alternative made conditions very slightly better.

The Full Water Leasing and Wet Meadow Alternatives gave similar results as the Governance Committee Alternative in June and July (see the "Central Platte Forage Fish" section in this chapter). In August, the only difference among alternatives was an increase of 1 year greater than 1,200 cfs compared to the Present Condition. The Water Emphasis Alternative showed an increase of 11 years in which the target flow was exceeded in June over the total of the Present Condition, which is the highest among the alternatives. The Water Emphasis Alternative also showed the same effects in July and August as the Governance Committee and Wet Meadow Alternatives.

The biological effects of this relative to the river otter food source are that under all action alternatives, a relative improvement in the health of the large fish fauna would occur relative to the Present Condition. However, the fisheries would still be subject to seasonal stresses, due to low habitat availability and a relatively high risk of high summer water temperature events.

Although a baseline for side channels and backwaters was not identified in the FEIS, it is anticipated that these habitats would be negatively affected by channel restoration and flow consolidation activities identified for all action alternatives. Both activities have the potential to convert side channel and backwater habitats into main channel habitats. The extent of habitat loss is not known because restoration activities are dependent on land management plans for future protected properties.

Plants

Saltwort (Wetlands)

It is not expected that conditions resulting from the implementation of any of the alternatives would result in negative impacts to the population of saltwort in Phelps County, Nebraska. None of the alternatives should result in surface flows over the site, or dilute the buildup of salinity, which is important to the survival of the population. Additional flows in the river should serve to help support the alkali flat/wet meadow, although the saline site itself is most likely a spring seep. Due to the very unique conditions under which the saltwort germinates, and its unusual occurrence in the flood plain of the Platte River, it is highly unlikely that actions implemented by any of the alternatives would result in positive or negative impacts to this species.

Reptiles

Massasauga Rattlesnake (Marshes and Moist Prairie Habitats)

A population of massasauga rattlesnake exists along the Lower Platte River. Because massasauga inhabit lowland grasslands, changes to the hydrology of the grassland could affect the massasauga population. The analysis of peak February through July flows show benefits accruing, particularly in drier intervals (see the "Pallid Sturgeon" in this chapter). These improvements could be expected to provide improved wet meadow quality in these drier years. The differences between alternatives are functionally quite small, but it is possible to determine calculable differences. In this respect, the Full Water Leasing and Water Emphasis Alternatives provide slightly greater benefits, primarily in drier years, followed by the Governance Committee and Wet Meadow Alternatives.

Other Species of Special Concern

Wood Frog, Boreal Toad, and Flathead Chub

The wood frog occurs in beaver ponds, small lakes, slow-moving streams, wet meadows, and willow thickets in the montane zone, usually at or near 9000 feet in elevation. Similarly, the boreal toad in the North Platte River Basin of Wyoming is found typically in spruce-fir forests and meadows in the Medicine Bow National Forest at 8000 to 11,000 feet in elevation. Therefore, neither of these species is likely to occur within portions of the North Platte River Basin impacted by water-related activities of the Program. The flathead chub spawns late in summer when rivers are lower, warmer, and the bottom is more stable. Program-related impacts to this species during this important stage of its life cycle are not expected to occur. Flow increases associated with Pathfinder Environmental Account management would occur in September, and other components of the Program would occur earlier in the year (spring and early summer) and would likely mimic conditions in which this species evolved.

Hornyhead Chub and Suckermouth Minnow

The hornyhead chub and suckermouth minnow currently are found in tributaries to the main stem North Platte River. Management of main stem reservoirs and the concomitant fluctuation in reservoir levels and North Platte River flows would not likely have a significant adverse impact on these fishes. However, water leasing for Program water in Converse, Platte, Goshen, Laramie, or Albany Counties could impact aquatic habitat. Water leasing activities may result in localized impacts to smaller tributary hydrology in cases where (1) return flows from farm irrigation were a significant contributor to the local water table and surface hydrology, and (2) no other water users rely on the local return flows or canal deliveries to this site. In these cases, water tables could decline locally, and this could negatively impact local fish populations.

Consequently, proposed water leasing activities that could potentially impact habitat for the hornyhead chub and suckermouth minnow should be evaluated on a case-by-case basis. Under specific terms and conditions for these activities, significant impacts to habitat can be avoided. For example,

- Taking land out of production for only 1 or 2 years at a time and closely monitoring habitat conditions to ensure mesic conditions of habitat
- Providing maintenance flows within drainages containing important habitat during the irrigation season, while cropland is out of production

- Avoiding water leasing activities in areas experiencing drought for several consecutive years until habitat conditions recover.

Other Fishes Native to Wyoming No Longer Extant in North Platte River

The shovelnose sturgeon (*Scaphirhynchus platorynchus*), goldeye (*Hiodon alosoides*), plains minnow (*Hybognathus placitus*), sturgeon chub (*Macrhybopsis gelida*), and sauger (*Stizostedion canadense*) are fishes native to Wyoming and historically found in the North Platte River. These species, however, have been extirpated from the North Platte in Wyoming since the early 1900s (Baxter and Stone, 1995). Their disappearance from the Basin in Wyoming is likely a result of several factors, which may include water development activities for agricultural irrigation and municipal water supply; main stem reservoir construction and concomitant changes in water quality (e.g., temperature), reduced sediment transport, and changes in substrate for feeding and spawning; increased predation by non-native species; and increased competition with non-native species. However, complete analysis of this complex of reasons, which may have led to the disappearance of these native fishes from the North Platte River in Wyoming, and potential measures by which these species may be reintroduced into this system, is beyond the purpose and need of the Platte Recovery Implementation Program, as well as the scope of this report. Rather, the emphasis here is on analyzing—and recommending mitigation for—impacts from the Program to fishes that currently are found within the North Platte River Basin in Wyoming.

SANDHILL CRANES

Issue: How would the action alternatives changes in riverflow and land/channel management affect sandhill crane habitat?

Overview

SCOPE

The immediate area of potential effect includes three reaches of the Platte River:

- From Clear Creek Wildlife Management Area, just upstream from Lake McConaughy, west about 2 miles
- Between Sutherland and North Platte, Nebraska
- Platte River channel between Lexington and Chapman, Nebraska

INDICATORS

This analysis assumes that the greater the abundance of habitat resources, the greater the number of sandhill cranes that can be supported at any unit area of interest. Indicators are:

- **Roosting suitability** as represented by:
  - Roosting depth abundance[15] at the site scale
  - Unobstructed channel width at the bridge segment scale
  - North Platte hydrology at the system scale
- **Food abundance** at the bridge segment scale is also evaluated.

Roosting Depth Abundance—Site Scale

Roosting depth abundance serves as an index to roosting habitat at the site scale in this analysis. Abundance is evaluated via median March flows under concepts for the Physical Habitat Simulation Methodology (PHABSIM) Model discussed in chapter 4, and mean transect length in the 3- to 9-inch depth range for SEDVEG Gen3 model output.

SEDVEG Gen3 model transects between Lexington and Chapman are grouped for comparisons with the Present Condition in two approaches. The first approach involves all channel widths greater than

[15] Measured by mean transect length within the 3-to-9 inch depth.

170 feet. In this approach, all transects from each alternative are first compared to all transect values under the Present Condition. Managed and unmanaged transects from each action alternative are then compared to corresponding transects under the Present Condition, under the assumption that management would increase roosting depth abundance. Current crane-use patterns indicate differences in channel resources above (upstream) and below (downstream) Kearney, and transects are grouped and compared to reflect this use pattern. Finally, transects within bridge segments 7 through 2, that currently support over 85 percent of nocturnal roosting, are compared to determine action alternative effects on this important reach.

In the second approach, only channels greater than 500 feet are evaluated for changes in roosting depth within the 3- to 9-inch depth range. The same groupings or transect categories described above are also used in this approach.

Unobstructed Channel Width—Bridge Segment Scale

Roosting suitability is evaluated at the bridge segment scale using Geographic Information Systems (GIS) database comparisons of channel area to determine changes in unobstructed channel width. Channel width is broken down into three categories: 501 to 750 feet, 751 to 1,000 feet, and greater than 1,000 feet. Cranes appear to use wider width channels, and wider channel width categories (greater than 501 feet) are the focus of management activities.

Output from the SEDVEG Gen3 model, known as “open view,” provided a second estimate of unobstructed channel width. Unobstructed channel width is presented as a percent change from the Present Condition for each of four reaches between Lexington and Chapman.

North Platte Hydrology—System Scale

Projected changes in flow are compared at various sites within the North Platte River Basin to appraise potential effects of alternatives on roosting suitability at the system scale where no transect data are available. Flow data are compared at the following sites:

- **Lewellen:** To appraise effects to cranes roosting above Lake McConaughy
- **Kingsley Dam (spills from Lake McConaughy):** To appraise effects to sites in the Sutherland to North Platte reach, and the Central Platte River channel
- **North Platte**: to appraise effects on birds using the Sutherland to North Platte reach

At Lewellen and North Platte, both the spring (February, March, and April) and the summer (May, June, and July) flow periods are compared to appraise effects on spring roosting depths, and summer cottonwood establishment (channel width), plus the median annual flows at both sites, are compared in terms of the Present Condition.

Food Abundance—Bridge Segment Scale

The abundance of food is evaluated in terms of cropping trends (see "Sandhill Cranes" in chapter 4) and projected changes in acreages from various land management plans associated with the action alternatives.

The abundance of invertebrate food in wet meadows is also evaluated via a comparison of riverflows during the February-March period, when sandhill cranes are using the Platte River between Lexington and Chapman. A detailed analysis of the relationships between riverflows and wet meadows occurs in the whooping crane section of this FEIS and is only summarized here as a comparison of median flows for sandhill cranes.

SUMMARY OF IMPACTS

In providing changes in riverflows, channel habitat, and wet meadow habitat for the target species, all of the proposed action alternatives would affect habitat used by sandhill cranes in Nebraska.

Roosting Suitability—Site Scale

Median March flows at Overton, Odessa, and Grand Island—for all action alternatives—would be numerically higher than Present Condition flows (table 5-SC-1). Median March flows under the Water Emphasis Alternative would be significantly higher than the Present Condition at all three gauges. Concepts developed under the PHABSIM analysis (see "Sandhill Cranes" in chapter 4) indicate that a reduction in roosting depth abundance would likely occur under higher projected March flows if the current channel configuration within the Lexington to Chapman reach remains unchanged.

Table 5-SC-1. Median February and March Flows at Overton, Odessa, and Grand Island (cfs)

Location and Time	Present Condition	Governance Committee Alternative	Full Water Leasing Alternative	Wet Meadow Alternative	Water Emphasis Alternative
Overton					
February	2177.3	2704.1	2739.7	2733.5	2747.6
March	1935.2	2100.7	2282.6	2217.7	**2537.4**
Odessa					
February	2192.9	2703.5	2833.1	2858.5	2862.2
March	1918.9	2344.6	2433.1	2399.2	**2587.9**
Grand Island					
February	2089.1	2806.7	2816.5	2807.4	2808.5
March	2141.4	2769.4	2757.3	2781.5	**2785.6**
Note: Bolded values indicate significant differences from the Present Condition.					

The SEDVEG Gen3 model analysis also indicates some reduction in future roosting depth abundance. Roosting depth abundance as represented by the mean transect length within the 3- to 9-inch depth range—for all channels greater than 170 feet—would be numerically increased for some transect categories under some alternatives and would be reduced in others (table 5-SC-2).

The analysis predicts a small (≤ 10 percent) reduction in roosting depth abundance in all transects categories for all alternatives, except the Wet Meadow Alternative. Managed transects are predicted to experience a moderate (11-40 percent) to large (41-70 percent) increase in roosting depth as compared to the Present Condition, while unmanaged transects may experience a small to moderate reduction. Transects upstream from Kearney may experience a small to moderate increase in roosting depth abundance, except under the Water Emphasis Alternative, which may experience a small reduction. Transects downstream from Kearney may experience a small to moderate reduction in roosting depth. Finally, transects within bridge segments 7 through 2 may experience small to moderate reductions or small increases in roosting depth abundance, depending on the alternative that is implemented.

Table-5-SC-2.−**Minimum 170-Foot Width:** Estimated Percent Change in the 3- to 9-Inch Depth Range* from the Present Condition**

	Governance Committee Alternative	Water Leasing Alternative	Wet Meadow Alternative	Water Emphasis Alternative
All Transects	-4.4	-2.2	2.6	-10.4
Managed Transects	38.3	25.7	53.6	17.7
Unmanaged Transects	-14.9	-9.0	-10.1	-17.4
Above Kearney	5.9	5.3	16.6	-3.3
Below Kearney	-10.6	-6.7	-6.0	-14.8
Bridge Segments 7 Through 2	-3.4	3.8	1.2	-11.1

* For each transect category and each alternative for SEDVEG Gen3 model simulations of all channels greater than 170 feet.
** See the "Sandhill Cranes" section in chapter 4 for a discussion of the 3- to 9-inch depth range for each transect category under the Present Condition.

The analysis also evaluated change in roosting depth abundance in channels greater than 500 feet. As indicated in table 5-SC-3 roosting depth in channels greater than 500 feet is predicted to experience some small to moderate increases under the action alternatives when all transects are considered. The exception would occur under the Water Emphasis Alternative which may experience a small reduction in roosting depth abundance.

Table-5-SC-3.−**Minimum 500-Foot Width:** Estimated Percent Change in the 3- to 9-Inch Depth Range* From the Present Condition**

	Governance Committee Alternative	Water Leasing Alternative	Wet Meadow Alternative	Water Emphasis Alternative
All Transects	3.7	10.5	12.9	-3.6
Managed Transects	54.3	41.1	75.1	19.2
Unmanaged Transects	-11.4	1.4	-5.5	-10.4
Above Kearney	11.3	7.0	22.5	4.0
Below Kearney	-1.7	-12.9	6.2	-9.0
Bridge Segments 7 Through 2	30.6	61.5	40.0	15.1

* For each transect category and each alternative for SEDVEG Gen3 model simulations of all channels greater than 500 feet.

** See the "Sandhill Cranes" section in chapter 4 for a discussion of the 3- to 9-inch depth range for each transect category under the Present Condition.

Managed transects may experience large to very large (71-100 percent) increases.

Unmanaged transects under three alternatives would all experience reductions in roosting depth (-5.5 to -11.4 percent) in channels greater than 500 feet. Unmanaged transects under the Full Water Leasing Alternative may experience a small increase in roosting depth abundance.

Transects upstream of Kearney would experience small to moderate increases in roosting depth, while transects downstream from Kearney would experience small to moderate losses, except for a small increase under the Wet Meadow Alternative. Finally, those transects within bridge segments 7 through 2 may experience moderate to large increases in roosting depth.

Obviously, these values are estimates of change, and the reader is encouraged to focus on relative changes (e.g., minor, moderate, large, etc.) between action alternatives and the Present Condition.

Roosting Suitability—Bridge Segment Scale

Unobstructed channel width would increase from the Present Condition under all alternatives, except the Full Water Leasing Alternative. Increases in unobstructed channel width using a GIS approach would range up to 21.1 percent for all bridge segments (table 5-SC-4).

Table 5-SC-4.−Increases in Unobstructed Channel Width (acres)

Present Condition	Governance Committee Alternative	Full Water Leasing Alternative	Wet Meadows Alternative	Water Emphasis Alternative
3,018	3,654	3,018	3,654	3,469

The SEDVEG Gen3 model analysis also predicts increases in unobstructed channel width in all 4 reaches. Estimated minimum increases in the 4 reaches range from 9 to 14 percent. Estimated maximum increases range from 27 to 60 percent, depending on alternative. See "River Geomorphology" in chapter 5 for a detailed treatment of open view width of the main channel.

Roosting Suitability—System Scale

Roosting suitability at the upper end of Lake McConaughy would be generally similar to the Present Condition for spring and summer flows under each proposed action alternative (table 5-SC-5). Some reduction in monthly volume passing Lewellen may occur in July under each of the proposed alternatives, but these differences are not statistically significant. Median annual flow at Lewellen would increase under each proposed action alternative, but, again, these increases are not significant.

Spills from Kingsley Dam would be reduced for all action alternatives. Reductions in spill magnitude would be significant for the Governance Committee, Wet Meadow, and Water Emphasis Alternatives. The frequency of spills would be reduced, and the size of the largest spills would be reduced, except under the Full Water Leasing Alternative.

Changes in monthly discharge on the North Platte River between Sutherland and North Platte would be similar to the Present Condition, with July experiencing some reduction in flows under some alternatives. Median annual flows at North Platte would be reduced, except under the Full Water Emphasis Alternative.

Table-5-SC-5.—North Platte hydrology system scale indicators
for the Present Condition and all proposed action alternatives (kaf)

North Platte Hydrology System Scale Indicators	Present Condition	Governance Committee Alternative	Water Leasing Alternative	Wet Meadow Alternative	Water Emphasis Alternative
Flows at Lewellen					
February	68.7	68.4	68.7	68.7	68.7
March	72.1	71.7	73.9	72.1	72.1
April	73.3	70.4	73.5	70.1	70.1
May	59.9	59.3	59.6	59.4	59.1
June	64.4	62.2	66.8	63.2	62.0
July	51.7	50.6	44.4	50.2	47.2
Median annual	879.4	908.4	902.0	946.3	950.6
Lake McConaughy spills					
Average annual	169.1	**95.3***	165.6	**82.3**	**102.2**
Frequency	0.6	0.3	0.5	0.3	0.4
Largest June spill	600.9	449.0	622.0	419.9	441.7
Largest single spill	600.9	535.5	622.0	536.1	539.4
Flows at North Platte					
February	21.5	22.0	22.0	21.9	22.7
March	24.9	24.6	24.9	25.2	25.2
April	23.4	23.1	23.5	23.6	23.4
May	24.7	24.5	24.7	24.2	25.1
June	33.5	30.9	30.0	32.6	30.2
July	91.1	87.3	78.8	89.9	83.2
Median annual	391.9	388.9	376.2	391.5	393.7
*Bolded values are statistically different from the Present Condition.					

Food Suitability—Bridge Segment Scale

Acres of corn would be reduced somewhat on some managed sites. Acres of corn and invertebrate food would be unchanged by the action alternatives at unmanaged sites. The most acres of corn potentially restored to lowland grassland (Wet Meadow Alternative) would still be less than 2.0 percent of the 1998 corn acreage within the Central Platte Habitat Area. Additional acres of irrigated corn would be lost under the action alternatives through water leasing agreements. See the "Agricultural Economics" section in this chapter for a detailed discussion of these losses. Because of the uncertainties that surround waste corn abundance and availability for sandhill cranes (see "Sandhill Cranes" in chapter 4), any reduction in waste corn abundance, as measured by acres of corn, should be avoided.

As discussed above, median March flows at Overton, Odessa, and Grand Island—for all action alternatives—would be numerically higher than flows under the Present Condition. February flows would be similar (table 5-SC-1). Higher flows in February and March may make soil invertebrates more accessible to sandhill cranes. See "Whooping Cranes" in chapters 4 and 5 for a detailed analysis of flows and their effects on wet meadows.

In summary, sandhill cranes using the Lexington to Chapman reach of the Platte River may benefit from some management activities (increased roosting depth abundance at some sites, increased unobstructed channel width, and increased lowland grassland) performed at specific sites for target species. However, there are indications that roosting depth abundance may be reduced at unmanaged transects. Those transects that currently support most night roosting below Kearney (bridge segments 7 through 2) indicate that roosting depth abundance may increase under all action alternatives. The validity of these projections, and their implications to sandhill cranes, should be a priority for research and monitoring studies under the adaptive resource management process.

Changes in flow regime within the Sutherland to North Platte reach may be problematic for sandhill cranes using these sites. Established survey sites exist within the Sutherland to North Platte reach, but these sites have not been surveyed since the early 1980s. Current survey information is needed for this reach. This reach should be a candidate for research and monitoring studies under the adaptive resource management process.

Crane roosting habitat above Lake McConaughy in and west of the Clear Creek Wildlife Management Area would likely be least affected by the action alternatives.

IMPACTS ANALYSIS

Roosting Suitability—Site Scale

The site-scale analysis focuses on the interaction of discharge with channel morphology to produce estimates of roosting depth abundance. Under the PHABSIM analysis, it is assumed that roosting depth abundance is maximized between 600 and 1600 cfs, depending on channel morphology (see "Sandhill Cranes" in chapter 4 for details). Projected March flows for each alternative are compared to the Present Condition to obtain estimates of change in roosting depth abundance.

The SEDVEG Gen3 model analysis makes use of transect data to obtain estimates of change in roosting depth abundance under the previously mentioned categories in two approaches; all channels greater than 170 feet, and channels greater than 500 feet in width.

Roosting Suitability—Bridge Segment Scale

Roosting suitability at the bridge segment scale is represented by an indicator known as unobstructed channel width. For channels wider than 500 feet, estimates of channel width are obtained from GIS coverages of the study area. The SEDVEG Gen3 model analysis also provides an estimate of unobstructed channel width based on an output known as open view. Open view is presented as a percent change from the Present Condition for each of four river reaches.

Roosting Suitability—System Scale

The assessment of roosting suitability at the system scale relies on the relationships between discharge and channel morphology introduced in chapter 4 and presented here in the appraisal of roosting depth abundance at the system scale. At the system scale, hydrology data are used to gain insight into the potential future of roosting depth abundance at sites along the North Platte River. Sites include Lewellen, Kingsley Dam, and North Platte. Sites are evaluated by selected monthly flow data and annual flow volumes.

Food Suitability—Bridge Segment Scale

Food suitability for sandhill cranes is evaluated through projections of land use plans under the various alternatives and analysis of median February and March flows.

Governance Committee Alternative

Roosting Suitability—Site Scale

Median March flows at Overton (2,100.7 cfs), Odessa (2,344.6 cfs), and Grand Island (2,769.4 cfs) would be numerically higher than under the Present Condition (1,935.2 cfs, 1,918.9 cfs, and 2,141.4 respectively) (table 5-SC-1). PHABSIM concepts—including a stable channel—would indicate a reduction in roosting depth abundance under these projected flows.

SEDVEG Gen3 model output for all channels greater than 170 feet indicates reduced roosting depth abundance (-3.4 to -14.9 percent) in the following transect categories: all transects, unmanaged transects, transects downstream from Kearney, and transects within bridge segments 7 through 2 (table 5-SC-2). Increases from 5.9 to 38.3 percent are projected for managed transects and transects upstream from Kearney.

SEDVEG Gen3 model output for channels greater than 500 feet predicts that the Governance Committee Alternative would increase roosting depth in the all transects category, managed transects, transects upstream from Kearney, and transects within bridge segments 7 through 2 (table 5-SC-3). Roosting depth is predicted to decline in unmanaged transects and transects downstream from Kearney.

Analysis of roosting depth under this alternative indicates that for most of the river channel between Lexington and Chapman (as represented by the all transects and unmanaged transects categories), some small reduction in roosting depth may occur (table 5-SC-2), although analysis of channels greater than

500 feet indicates a small increase for all transects (table 5-SC-3). These results are consistent with PHABSIM concepts that indicate increased flows (table 5-SC-1) would reduce roosting depth abundance. Reductions in roosting depth would occur at unmanaged transects—and perhaps in the all transects category, since most are unmanaged—because increased flows under channel configurations similar to the Present Condition would result in deeper water.

However, for sites near managed transects, sites upstream of Kearney, and sites in bridge segments 7 through 2, increases—and large increases in some cases —may occur in roosting depth abundance, especially at sites with channels greater than 500 feet. A potential increase in roosting suitability in bridge segments west of Kearney would be very important to crane habitat ecology if it would facilitate an increased use of these bridge segments.

Roosting Suitability—Bridge Segment Scale

Unobstructed channel width would increase at those sites receiving proposed island leveling channel management under the Governance Committee Alternative. For the purposes of analysis, channel width changes in nine transects (five bridge segments) were simulated, resulting in a 21.1-percent increase (over the Present Condition) between Lexington and Chapman in unobstructed channel width greater than 501 feet.

SEDVEG Gen3 model analysis of open view predicts an increase in unobstructed channel width for each of the four reaches evaluated. Unobstructed channel width would increase by the following percentages over the Present Condition: reach 1 equals 25 percent, reach 2 equals 21 percent, reach 3 equals 41 percent, and reach 4 equals 13 percent.

Both analytical approaches indicate an increase in unobstructed channel width, which would be beneficial to sandhill cranes.

Roosting Suitability—System Scale

Several components of discharge at the system scale were evaluated under this alternative in the North Platte River Basin. At the Lewellen gauge (used to represent flows at the Clear Creek Wildlife Management Area), February, March, and April median flows for the Governance Committee Alternative would be somewhat reduced when compared to the Present Condition (table 5-SC-3). May, June, and July flows would also be somewhat reduced from Present Condition levels. However, median annual flows at Lewellen would increase over the Present Condition.

Average volume of spills from Kingsley Dam would be significantly reduced under this alternative (table 5-SC-3). The frequency of spills would be reduced by 52 percent, and the size of the largest spills would be reduced.

North Platte River median annual discharge at North Platte, Nebraska, would be reduced under this alternative (table 5-SC-3). Median monthly spring flows in the Sutherland to North Platte reach would be similar to the Present Condition, while summer flows (mainly June and July) would be somewhat lower than the Present Condition. Median annual flows would be less than the Present Condition, except for the Water Emphasis Alternative.

These projected changes in flow indicate the possibility of further channel narrowing in the Sutherland to North Platte reach of the North Platte River. Any channel narrowing in this reach would likely reduce roosting depth abundance and negatively affect sandhill crane roosting suitability.

Food Suitability—Bridge Segment Scale

Feeding habitat (e.g., lowland grasslands) may increase at those sites (and bridge segments) receiving proposed upland management, while other food resources would be reduced. Corn acreage has increased between 1982 and 1998 (Present Condition), but that trend depends on weather and economics (see the "Sandhill Cranes" section in chapter 4) and cannot continue indefinitely. Some cropland (including corn acreage) would be converted to grasslands in attempts to provide invertebrate food, and some irrigated farmland (including corn acreage) would be lost under this alternative (see "Agricultural Economics" in this chapter).

For this analysis, conversion of various amounts of flood-plain cover types to lowland grasslands were simulated (see "Land Elements" in chapter 3). For the Governance Committee Alternative, these changes amounted to about a 14.9 percent increase in lowland grassland acreages over the Present Condition within the Lexington to Chapman study area.

Some increases in lowland grass acreages would occur from conversions of cropland, including corn. In the above example for conversions to lowland grasslands, corn acres could account for about 25.1 percent of the lands being converted.

Additional acres of corn would likely be lost as irrigated croplands are reduced. The exact acres or location of corn reduced under this alternative are unknown. However, because of the uncertainties that surround waste corn abundance and availability for sandhill cranes (see "Sandhill Cranes" in chapter 4), any reduction in waste corn abundance, as measured by acres of corn, should be avoided.

Median February and March flow under this alternative would increase over the Present Condition at each of the three gauging stations (table 5-SC-1). Such increases may increase access to soil invertebrates for sandhill cranes at existing wet meadows.

Full Water Leasing Alternative

Roosting Suitability—Site Scale

Median March flows at Overton (2,282.6 cfs), Odessa (2,433.1 cfs), and Grand Island (2,757.3 cfs) would be numerically higher than the Present Condition (1,935.2 cfs, 1,918.9 cfs, and 2,141.4 cfs respectively) (table 5-SC-1). PHABSIM concepts—including a stable channel—would indicate a reduction in roosting depth abundance under these projected flows.

SEDVEG Gen3 model output indicates that the Full Water Leasing Alternative would yield less transect length in the 3- to 9-inch depth range under some transect categories and more potential roosting depth under others, in a pattern similar to the Governance Committee Alternative (table 5-SC-2). Categories of all transects, unmanaged transects, and those transects located downstream from Kearney would have lower mean transect lengths of 3- to 9-inch depths (-2.2 to -9.0 percent) than the Present Condition. The managed transects, those transects located upstream of Kearney, and transects in bridge segments 7 through 2 may experience an increase in mean transect length in potential roosting depths (table 5-SC-2).

SEDVEG Gen3 model output for channels greater than 500 feet predicts that the Full Water Leasing Alternative would increase roosting depth in all transect categories except those transects located downstream from Kearney (table 5-SC-3). Roosting depth is predicted to decline somewhat (about 13 percent) in transects downstream from Kearney.

Analysis of roosting depth under this alternative indicates that for most of the river channel between Lexington and Chapman (as represented by the all transects and unmanaged transects categories), a small increase (all transects) or small reduction (unmanaged transects) in roosting depth may occur. This could be interpreted as no change. However, for sites near managed transects, sites upstream of Kearney, and sites in bridge segments 7 through 2, increases may occur in roosting depth abundance. Some increases may be substantial (table 5-SC-3). A potential increase in roosting suitability in bridge segments west of Kearney would be very important to crane habitat ecology if it would facilitate an increased use of these segments.

Roosting Suitability—Bridge Segment Scale

Unobstructed channel width would increase at sites (and bridge segments) receiving proposed island leveling channel management. For the purposes of analysis, channel width changes were simulated in nine transects that resulted in a 21.1-percent increase (over the Present Condition between Lexington and Chapman, Nebraska) in unobstructed channel width greater than 501 feet.

SEDVEG Gen3 model analysis of open view predicts an increase in unobstructed channel width for each of the reaches evaluated. Unobstructed channel width would increase by the following percentages over the Present Condition: reach 1 equals 22 percent, reach 2 equals 24 percent, reach 3 equals 60 percent, and reach 4 equals 14 percent.

Both analytical approaches indicate an increase in unobstructed channel width, which benefit sandhill cranes.

Roosting Suitability—System Scale

System discharge would also be affected by this alternative. At the Lewellen gauge, spring flows would be very similar to the Present Condition. Summer flows would increase somewhat in June and be reduced in May and July (table 5-SC-3). The median annual discharge under this alternative would be greater than the Present Condition.

Average annual spill volume from Kingsley Dam would be similar to the Present Condition, with a somewhat reduced frequency of spills, and the magnitude of the largest spill during the period of record would be increased under this alternative (table 5-SC-3).

Median monthly flow during the spring and early summer (May) would be similar to the Present Condition (table 5-SC-3). Discharge during the months of June and July, and the median annual discharge at North Platte, would all be less than under the Present Condition.

These projected changes in flow indicate the possibility of further channel narrowing in the Sutherland to North Platte reach of the North Platte River. Any channel narrowing in this reach would likely reduce roosting depth abundance and negatively affect sandhill crane roosting suitability.

Food Suitability—Bridge Segment Scale

Simulated conversions of cover types to lowland grassland for this alternative follow example acreages presented under the Governance Committee Alternative. For this alternative, these changes amounted to about a 14.9-percent increase in lowland grassland acres over the Present Condition within the Lexington to Chapman study area. These conversions could result in a loss of less than 1.0 percent of 1998 corn acreage within the study area. See “Illustrative Scenario for Program Lands Under the Governance Committee Alternative” in chapter 3.

Additional acres of corn would likely be lost as irrigated croplands are reduced. The exact acres or location of corn reduced under this alternative is unknown. However, because of the uncertainties that surround waste corn abundance and availability for sandhill cranes (see the “Sandhill Cranes” section in chapter 4), any reduction in waste corn abundance, as measured by acres of corn, should be avoided.

Median February and March flow under this alternative would increase over the Present Condition at each of the three gauging stations (table 5-SC-1). Such increases may increase access to soil invertebrates for sandhill cranes at existing wet meadows.

Wet Meadow Alternative

Roosting Suitability—Site Scale

Median March flows at Overton (2,217.7 cfs), Odessa (2,399.2 cfs), and Grand Island (2,781.5 cfs) would be numerically higher than the Present Condition (1,935.2 cfs, 1,918.9 cfs, and 2,141.4 cfs respectively) (table 5-SC-1). PHABSIM concepts—including a stable channel—would indicate a reduction in roosting depth abundance under these projected flows.

SEDVEG Gen3 model output indicates that the Wet Meadow Alternative would yield less transect length in the 3- to 9-inch depth range under some transect categories and more potential roosting depth under others (table 5-SC-2). Categories of all transects, managed transects, transects located upstream from Kearney, and those transects in bridge segments 7 through 2 may experience increases in roosting depth abundance. Unmanaged transects and transects downstream from Kearney may experience small reductions in roosting depth abundance when compared to the Present Condition.

SEDVEG Gen3 model output for channels greater than 500 feet for the Wet Meadow Alternative indicates increases in roosting depth abundance in all transect categories, except unmanaged transects where the reduction would be small (table 5-SC-3).

Analysis of roosting depth under this alternative indicates that like all other alternatives (except the Full Water Leasing Alternative), some reduction in roosting depth abundance may occur at unmanaged transects. However, predicted reductions are among the smallest of all three action alternatives. This alternative is predicted to provide the greatest increase in roosting depth abundance for managed transects of any proposed action alternative. This alternative may also produce the largest increases in roosting depths upstream from Kearney. A potential increase in roosting suitability in bridge segments west of Kearney would be very important to crane habitat ecology if it would facilitate an increased use of these segments.

Roosting Suitability—Bridge Segment Scale

Unobstructed channel width would increase at sites (and bridge segments) receiving proposed island leveling channel management. For this analysis, channel width changes were simulated in nine transects. This simulation resulted in a 21.1-percent increase (over the Present Condition between Lexington and Chapman, Nebraska) in unobstructed channel width greater than 501 feet.

SEDVEG Gen3 model analysis of open view predicts an increase in unobstructed channel width for each of the four reaches evaluated. Unobstructed channel width would increase by the following percentages over the Present Condition: Reach 1 equals 25 percent, reach 2 equals 22 percent, reach 3 equals 44 percent, and reach 4 equals 9 percent.

Both analytical approaches indicate an increase in unobstructed channel width, which would be beneficial to sandhill cranes.

Roosting Suitability—System Scale

At the system scale, spring and summer flows at Lewellen would be very similar to the Present Condition (table 5-SC-3). The median annual flow would be greater than the Present Condition.

Average annual volume of spills from Kingsley Dam would be significantly reduced (51.3 percent) from the Present Condition (table 5-SC-3). Both the largest June spill and the largest spill would be less than the Present Condition.

Median monthly spring and summer flows, and median annual flows at North Platte, would be similar to the Present Condition (table 5-SC-3).

These projected changes in flow indicate the possibility of further channel narrowing in the Sutherland to North Platte reach of the North Platte River. Any channel narrowing in this reach would likely reduce roosting depth abundance and negatively affect sandhill crane roosting suitability.

Food Suitability—Bridge Segment Scale

Feeding habitat (e.g., lowland grasslands) would increase at those sites receiving proposed upland management, while other food resources (e.g., corn) would be reduced. Corn acreage has increased between 1982 and 1998 (Present Condition), but that trend depends on weather and economics (see "Sandhill Cranes" in chapter 4) and cannot continue indefinitely. Some cropland (including corn acreage) would be converted to grasslands in an attempt to provide invertebrate food, and the acreages of corn lost would be small (less than 2.0 percent) when compared to total acres in corn within the study area. For the purposes of analysis, conversion of various amounts of floodplain cover types to lowland grasslands was simulated. For this alternative, these changes amounted to about a 29.0-percent increase in lowland grassland acreages over the Present Condition within the Lexington to Chapman study area.

Some increases in lowland grass acreages would occur from conversions of cropland, including corn. In the above example conversions to lowland grasslands, corn acres could account for about 37.2 percent of converted lands. This would account for less than 2.0 percent of 1998 corn acreage within the study area.

Additional acres of corn would likely be lost as irrigated croplands are reduced (see "Agricultural Economics" in this chapter). The exact acres or location of corn reduced under this alternative are unknown. However, because of the uncertainties that surround waste corn abundance and availability for sandhill cranes (see the "Sandhill Cranes" section in chapter 4), any reduction in waste corn abundance, as measured by acres of corn, should be avoided.

Median February and March flow under this alternative would increase over the Present Condition at each of the three gauging stations (table 5-SC-1). Such increases may increase access to soil invertebrates for sandhill cranes at existing wet meadows.

Water Emphasis Alternative

Roosting Suitability—Site Scale

Median March flows at Overton (2,537.4 cfs), Odessa (2,587.9 cfs), and Grand Island (2,785.6 cfs) would be significantly higher than the Present Condition (1,935.2 cfs, 1,918.9 cfs, and 2,141.4 cfs respectively) (table 5-SC-1). PHABSIM concepts—including a stable channel—would indicate a reduction in roosting depth abundance under these projected flows. SEDVEG Gen3 model output for all channels greater than 170 feet indicates reduced (-10.4 to -17.4 percent) roosting depth abundance in all transect categories except managed transects (table 5-SC-2). Managed transects are predicted to experience an increase in roosting depth abundance of about 17.7 percent.

SEDVEG Gen3 model output for channels greater than 500 feet predicts that the Water Emphasis Alternative would increase roosting depth in managed transects, transects upstream from Kearney, and transects within bridge segments 7 through 2 (table 5-SC-3). Roosting depth is predicted to decline in the all transects category, unmanaged transects, and transects downstream from Kearney.

Analysis of roosting depth under this alternative indicates that for most of the river channel between Lexington and Chapman (as represented by the all transects and unmanaged transects categories), a small reduction (all transects and unmanaged transects) in roosting depth may occur. However, for managed transects, sites upstream of Kearney, and sites in bridge segments 7 through 2, increases may occur in roosting depth abundance. This alternative has the smallest increases in managed transects of any action alternative may indicate little change in transects located within bridge segments 7 through 2.

Roosting Suitability—Bridge Segment Scale

Unobstructed channel width would increase at sites (and bridge segments) receiving proposed island leveling channel management. For the purposes of analysis, channel width changes were simulated in nine transects that resulted in a 15-percent increase (over the Present Condition between Lexington and Chapman, Nebraska) in unobstructed channel width greater than 501 feet.

SEDVEG Gen3 model analysis of open view predicts an increase in unobstructed channel width for each of the three reaches evaluated. Unobstructed channel width would increase by the following percentages over the Present Condition: reach 1 equals 27 percent, reach 2 equals 23 percent, reach 3 equals 15 percent, and reach 4 equals 12 percent.

Both analytical approaches indicate some increase in unobstructed channel width, which would be beneficial to sandhill cranes.

Roosting Suitability—System Scale

At the system scale, spring and early summer flows at Lewellen would be very similar to the Present Condition (table 5-SC-3). June and July flows would be somewhat reduced. The median annual flow would greater than the Present Condition.

Average annual volume and frequency of spills from Kingsley Dam would be reduced from the Present Condition (table 5-SC-3). Both the largest June spill and the largest spill would be less than the Present Condition.

Spring and early summer flows at North Platte would be very similar to the Present Condition (table 5-SC-3). June and July flows would be somewhat reduced. The median annual flow would be somewhat greater than the Present Condition.

These projected changes in flow indicate the possibility of further channel narrowing in the Sutherland to North Platte reach of the North Platte River. Any channel narrowing in this reach would likely reduce roosting depth abundance and negatively affect sandhill crane roosting suitability.

Food Suitability—Bridge Segment Scale

Simulated conversions of cover types to lowland grassland for this alternative follow examples presented under other action alternatives. For this alternative, these changes amounted to about a 10.5-percent increase in lowland grassland acres over the Present Condition within the Lexington to Chapman study area. These conversions could result in a loss of less than 0.3 percent of 1998 corn acreage within the study area.

Additional acres of corn would likely be lost as irrigated croplands are reduced (see "Agricultural Economics" in this chapter). The exact acres or location of corn reduced under this alternative are unknown. However, because of the uncertainties that surround waste corn abundance and availability for sandhill cranes (see the "Sandhill Cranes" section in chapter 4), any reduction in waste corn abundance, as measured by acres of corn, should be avoided.

Median February and March flow under this alternative would increase over the Present Condition at each of the three gauging stations (table 5-SC-1). Such increases may increase access to soil invertebrates for sandhill cranes at existing wet meadows.

NORTH PLATTE RIVER BASIN FISHERIES

Issue: How would the action alternatives affect the reservoir and stream fisheries in the North Platte River main stem from Seminoe Reservoir to Lake McConaughy in Nebraska?

Overview

SCOPE

The area of potential impact includes fisheries associated with the North Platte reservoirs from Seminoe downstream to Guernsey, and the North Platte River downstream of these reservoirs to Lake McConaughy. Panhandle tributaries to the North Platte River in Nebraska are also addressed.

INDICATORS

- **Reservoir storage** content (volume) and changes in elevation. Two reservoir volume levels have been defined by Wyoming Game and Fish Department (WG&F), representing the volume below which fisheries are adversely affected, and the level below which fisheries are critically affected. Critical levels are 50 kaf for Pathfinder and Seminoe Reservoirs and 63 kaf[16] for Glendo Reservoir.
- Percent change in the **total standing crop of fish** in each reservoir
- **Temperature and DO** levels in reservoirs and outflows
- **Riverflows** and changes in flows

SUMMARY OF IMPACTS

Compared to the Present Condition, the alternatives result in additional occurrence of drawdowns at Seminoe and Pathfinder Reservoirs below both the reservoir volumes identified by WG&F as providing good conditions for fisheries (200 kaf), and also a small number of additional drawdowns below the elevations identified as critical to the fishery (50 kaf). While drawdowns below the 200 kaf reservoir volume will have minimal to moderate adverse effects, catastrophic impacts to the lake fisheries are projected for Seminoe and Pathfinder Reservoirs when reservoir levels drop below critical levels. All alternatives would result in some thermal stress to the trout fishery during days of critically dry summers.

None of the alternatives have an effect on Alcova Reservoir fisheries. Overall, impacts in Guernsey Reservoir, compared to the Present Condition, are not considered substantial because the fishery in this reservoir is seasonal.

[16] The DEIS analysis was based on 64 kaf. However, after discussions with WG&F, the FEIS analysis is based on 63 kaf (WG&F, 2005, personal communication, Al Conder, Casper Regional Fisheries Supervisor).

Under the Present Condition, the North Platte River flows downstream of Kortes Dam do not fall to less than 500 cfs. All alternatives, except for the Full Water Leasing Alternative, had 4 to 6 months in the 48-year period of record where North Platte River flows were below this level. One time in March (1965), flows dropped to 355 cfs for the Governance Committee, Wet Meadow, and Water Emphasis Alternatives. This low flow could adversely affect rainbow trout spawning habitat. The year (1965) where flows dropped to 449 and 329 cfs in October and November under the Wet Meadow Alternative and 442 cfs in November under the Water Emphasis Alternative may adversely affect brown trout spawning habitat.

Downstream of Pathfinder Dam, the alternatives produced no additional periods of flow below 75 cfs relative to the Present Condition. There should not be any adverse effects to the fishery. Pathfinder Reservoir outlet temperatures for each alternative, compared to the Present Condition, do not indicate that water temperatures would be significantly raised by any alternative. Maximum release temperatures remain below 20°Celsius (°C) (68°F), a temperature at which the trout fishery should not be detrimentally affected.

For flows below Gray Reef Dam, there was little difference among alternatives, with the exception of the Full Water Leasing Alternative. The Present Condition and the Full Water Leasing Alternative flows were always above 500 cfs. For each of the other three alternatives, March flows are projected to drop below 400 cfs on one occasion (1965); the decreased flow would result in a significant reduction in rainbow trout spawning habitat. DO depletion below Gray Reef Dam should not be a problem because oxygen is generally at or above saturation during summer months. Also, increased summer temperatures should not be a problem. With one exception, summer temperatures downstream from Gray Reef Dam have always been less than 20°C (68°F). At times in which the flow drops below 1,000 cfs in the summer, excessive warming could occur in the river, resulting in a range of effects on trout, from minor stress to mortality.

There should be no effect on the riverine fisheries downstream from Glendo Reservoir because no alternatives drop below the established 25 cfs minimum flow level.

The existing fishery downstream from Guernsey Reservoir to the Wyoming-Nebraska State line is marginal. There is no officially established maintenance flow in this reach. Improved habitat conditions during months of increased flows may be offset by periods of decreased flows compared to the Present Condition.

Potentially reduced flows with the Full Water Leasing Alternative in the Nebraska Panhandle streams could result in reduced habitat for the trout populations. Water temperature impacts are not anticipated.

IMPACTS ANALYSIS

The changes in reservoir operations and levels described earlier in this chapter can affect the amount of habitat available for fisheries in the North Platte reservoir system, as well as in the intervening river reaches.

High reservoir levels of long duration usually result in the greatest fish abundance. High levels during the spawning season, and for several months afterward, enhance postspawning survival by inundating shoreline vegetation that provides refugia and abundant food for young-of-the-year fish. Reduced reservoir levels can impact lacustrine (lake) fish communities in the following ways[17]:

- Shallow nearshore spawning areas are left exposed. This change is important during spring and summer because this is when most reproduction of aquatic organisms occurs, especially spring (e.g., walleye spawn in April, May, and June).
- Exposed shoreline is subject to wind and water erosion, leading to:
  - Reduced spawning success from temperature effects, wind-caused turbidity and turbulence, predation, and food availability.
  - Habitat loss and mortality to eggs and young fish after exposure or suffocation by eroded sediments.
- Increased fishing pressure and predation in reduced reservoir volumes, resulting in reduced fish population numbers.
- Increased water temperatures and strengthened stratification, decreasing DO in lower levels of the reservoir during the summer.
- Nest desertion, poor egg survival, and disrupted spawning for species such as centrarchids, yellow perch, northern pike, common carp, and buffalo and gizzard shad that spawn in shallow water.
- Nearshore aquatic plants that support food sources for fish (i.e., bacteria, zooplankton, periphyton, and benthic invertebrates) and cover for small fish die off from exposure to air.
- Desiccation, freezing, and soil compaction of exposed shoreline, all of which reduce the densities of many aquatic plant species.
- Decreases in fish standing crop, due to an overall decrease in available aquatic habitat.

The following effects on riverine fisheries can occur with changes in reservoir outflows:

- Increases in flow can erode spawning gravels and wash away benthic invertebrates, which provide a primary food source for many fish species, or they can wash accumulated fines from the gravels and improve spawning habitat.
- Decreases in flow during spawning periods can desiccate incubating eggs and strand larval fish.
- Changes in physical and chemical regimes adversely affect the reproductive triggers for spawning or for survival of eggs and young fish.
- Reduced flows can allow a greater range of daily temperature and more warming in the summer; warmer water holds less DO. These factors could stress coldwater fish.

[17] Additional information on fishery impacts associated with each alternative is provided in the *North Platte River Basin Fisheries Appendix* in volume 3.

- ➢ Changes in depths, velocities, and cover can change available physical habitat for various life stages of fish.
- ➢ Reduced suspended sediment loads, nutrient enrichment, and regulated thermal regimes in some tailwaters immediately below dams often provide excellent fisheries (e.g., the "Miracle Mile" below Kortes Dam).

Impacts on Reservoir Fish Communities

Seminoe Reservoir

All alternatives, except the Full Water Leasing Alternative, had more months out of all 48 water years with elevations less than the 200-kaf flag level compared to the Present Condition.

Table 5-NPF-1 lists the number of times a month had volumes less than the flag level. April is when many fish species spawn, so it was chosen as the indicator month. In April under the Present Condition, 4 years out of 48 had reservoir volumes less than 200 kaf. This compares with:

- ➢ Full Water Leasing Alternative = 3 years
- ➢ Governance Committee and Water Emphasis Alternatives = 5 years
- ➢ Wet Meadow Alternative = 6 years

The Full Water Leasing Alternative had the fewest total number of months less than the flag level.

Table 5-NPF-1.—Summary of Elevations Less than 6,289 Feet (~200 kaf)
in Seminoe Reservoir (Number of Water Years Out of 48 by Month)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Present Condition	3	3	3	4	5	6	4	2	0	0	1	3	31
Governance Committee Alternative	6	6	6	6	6	6	5	3	0	1	2	4	51
Full Water Leasing Alternative	1	1	1	2	2	3	3	0	0	0	0	1	13
Wet Meadow Alternative	6	6	7	7	7	7	6	4	0	1	5	6	62
Water Emphasis Alternative	6	6	6	6	6	6	5	3	0	1	2	6	33

The number of total months over the period of record when volumes would be less than the 50 kaf (the critical level for a viable fishery) ranged from 0 for the Present Condition and the Full Water Leasing Alternative to 10 for the Wet Meadow Alternative (table 5-NPF-2). September was the only month that had an event with volumes less than the 50-kaf critical level more than once (and this was twice with the Wet Meadow Alternative). This analysis assumed that when Seminoe Reservoir volume fell below this critical level at any time, the trout and walleye fisheries suffered a catastrophic loss (WG&F, 2004). The trout fishery would require a minimum of 3 years to recover to its typical state after the first year of stocking. The walleye fishery would take longer to recover. Nearly 5 years are required for a walleye to reach 15 inches (WG&F, 2004). An additional 1 to 2 years is required for a forage base to establish in order to support walleye. Thus, 7 years would be required to provide a 15-inch walleye in Seminoe and 17 years to provide a trophy walleye.

Table 5-NPF-2.—Summary of the Total Months Below Minimum Volume (50,000 Acre-Feet) for a Viable Fishery in Seminoe Reservoir (Number of Water Years Out of 48 by Month)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Present Condition	0	0	0	0	0	0	0	0	0	0	0	0	0
Governance Committee Alternative	1	1	1	1	1	1	1	0	0	0	0	0	7
Full Water Leasing Alternative	0	0	0	0	0	0	0	0	0	0	0	0	0
Wet Meadow Alternative	1	1	1	1	1	1	1	0	0	0	1	2	10
Water Emphasis Alternative	1	1	1	1	1	1	1	0	0	0	0	0	7

Based on methods for estimating fish yield in lakes developed by Ryder (1965), and modified for Wyoming reservoirs by Facciani and Baxter (1977), fish standing crop estimates were developed for each of the North Platte River Basin reservoirs. The fish yield estimator consists of the average reservoir TDS divided by its mean depth (volume divided by area). The fish standing crop estimates are based on annual data. Table 5-NPF-3 shows projected changes in fish standing crop in the four North Platte reservoirs under each of the alternatives. The columns present the greatest decrease in any 1 year (decrease percent), the greatest increase in any 1 year (increase percent), and the net change (average) in the 34-year record (1961-1994) from the operations study that was used for the fishery impact analysis. The data in the increase percent column indicate that, under some circumstances, there could be an increase in fish standing crop in all reservoirs under any of the alternatives. The only exception to this is in Alcova Reservoir under the Full Water Leasing Alternative.

Table 5-NPF-3 shows projected changes in fish standing crop in the four North Platte reservoirs under each of the alternatives. The columns present the greatest decrease in any 1 year (decrease percent), the greatest increase in any 1 year (increase percent), and the net change (average) in the 34-year record (1961-1994) from the operations study that was used for the fishery impact analysis. The data in the increase percent column indicate that, under some circumstances, there could be an increase in fish standing crop in all reservoirs under any of the alternatives. The only exception to this is in Alcova Reservoir under the Full Water Leasing Alternative.

In Seminoe Reservoir, there would be a net decrease in the estimated fish standing crop under all of the alternatives, except the Full Water Leasing Alternative. The Full Water Leasing Alternative was the only alternative with the combination of lower TDS and greater depth than Present Condition; this combination results in a net increase in the estimated fish standing crop in Seminoe Reservoir. The Wet Meadow Alternative is projected to have the greatest adverse impact on fish standing crop among the action alternatives, with a decrease to over 30 percent (table 5-NPF-3). Of the alternatives with an adverse impact, the Governance Committee Alternative would have the smallest decrease, both on the average (1.4 percent) and at its maximum in any 1 year (16 percent), relative to the Present Condition. The average decrease in Seminoe Reservoir fish standing crop attributable to the Water Emphasis Alternative is intermediate between those of the Governance Committee and the Wet Meadow Alternatives (table 5-NPF-3).

Table 5-NPF-3.—Percent Difference in Estimated Annual Total Fish Standing Crop in North Platte Reservoirs from the Present Condition

Reservoir	Alternative	Decrease (percent)	Average (percent)	Increase (percent)
Seminoe	Governance Committee	-16.3	-1.4	3.7
	Full Water Leasing	-3.4	3.1	11.8
	Wet Meadow	-32.3	-5.3	4.8
	Water Emphasis	-17.0	-3.1	5.0
Pathfinder	Governance Committee	-11.6	-2.5	4.8
	Full Water Leasing	-5.8	4.2	14.3
	Wet Meadow	-19.3	-5.5	6.8
	Water Emphasis	-18.0	-4.4	7.1
Alcova	Governance Committee	-4.7	-0.5	2.3
	Full Water Leasing	-5.8	-2.0	0
	Wet Meadow	-3.4	0.9	4.1
	Water Emphasis	-4.7	-0.1	3.8
Glendo	Governance Committee	-7.1	-2.6	9.6
	Full Water Leasing	-5.9	-1.2	3.0
	Wet Meadow	-9.4	-2.9	6.1
	Water Emphasis	-8.6	-2.7	5.5

In summary, major impacts to the Seminoe Reservoir fisheries are expected with all alternatives, except the Full Water Leasing Alternative, compared to the Present Condition, based on the fact that reservoir volumes drop below the critical flagged level more often than under the Present Condition, and total fish standing crop would decrease through an overall loss of habitat. The fishery is projected to improve with the Full Water Leasing Alternative.

Pathfinder Reservoir

All alternatives, except the Full Water Leasing Alternative, had more months out of all 48 water years with storage contents (volumes) less than 200 kaf, compared to the Present Condition (table 5-NPF-4). In April under the Present Condition, 5 years out of 48 had reservoir volumes less than the flag level of 200 kaf. This compares with:

- Full Water Leasing Alternative = 4 years
- Governance Committee Alternative = 6 years
- Water Emphasis Alternative = 7 years
- Wet Meadow Alternative = 8 years

April was chosen as an impact indicator because it is a month when many fish species spawn.

Table 5-NPF-4.—Summary of Elevations Less Than 5,787 Feet (~200,000 kaf)
in Pathfinder Reservoir (Number of Water Years Out of 48 by Month)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Present Condition	5	6	6	4	4	4	5	3	0	3	6	7	53
Governance Committee Alternative	6	6	6	6	6	6	6	4	1	4	8	11	70
Full Water Leasing Alternative	4	3	3	3	2	3	4	2	0	2	3	5	34
Wet Meadow Alternative	10	9	8	7	7	8	8	5	2	5	12	12	93
Water Emphasis Alternative	7	7	6	6	6	6	7	5	1	5	8	12	68

The number of months during the 1947 through 1994 study period when volumes would be less than the 50-kaf level for a viable fishery ranged from 0 for the Present Condition and the Full Water Leasing Alternative to 11 for the Wet Meadow Alternative (table 5-NPF-5). These decreases below the critical pool level frequently occurred in the months of August and September, which coincides with what is often the minimum DO content of the reservoir. This analysis assumed that if Pathfinder Reservoir volume fell below this critical level at any time, the trout and walleye fisheries suffered a catastrophic loss (WG&F, 2004). The trout fishery would require a minimum of 3 years to recover to its typical state after the first year of stocking. The walleye fishery would take longer to recover. Nearly 5 years are required for a walleye to reach 15 inches (WG&F, 2004). An additional 1 to 2 years is required for a forage base to establish to support walleye. Thus, 7 years would be required to provide a 15-inch walleye in Pathfinder and 17 years to provide a trophy walleye (WG&F, 2004).

Table 5-NPF-5.—Summary of the Total Months Below Minimum Volume (50 kaf)
for a Viable Fishery in Pathfinder Reservoir (Number of Water Years Out of 48 by Month)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Present Condition	0	0	0	0	0	0	0	0	0	0	0	0	0
Governance Committee Alternative	0	0	1	1	1	1	0	0	0	0	2	2	8
Full Water Leasing Alternative	0	0	0	0	0	0	0	0	0	0	0	0	0
Wet Meadow Alternative	1	1	1	1	1	1	0	0	0	0	2	3	11
Water Emphasis Alternative	0	0	1	1	1	2	0	0	0	0	2	2	9

The years in which Pathfinder Reservoir is below the critical 50-kaf reservoir content in August and September, shown in table 5-NPF-5, occurred under the conditions represented by 1961 and 1964 in the NPRWUMEIS. To better refine the effects of the drawdown below the critical 50-kaf reservoir pool, a temperature model of Pathfinder Reservoir was constructed and the critical years of 1961 and 1964 were modeled (see the *Central Platte Fisheries Appendix* in volume 3 for details and complete results). Temperature profiles for early August 1964 are shown on figure 5-NPF-1 for each of the action alternatives and the Present Condition. The surface layer in each of the profiles on figure 5-NPF-1 exceeds the 20-ºC limit (maximum weekly allowable temperature), while the deeper water is not. The highest temperature among alternatives occurred on August 4, 1961, when the Water Emphasis Alternative reached 22ºC (figure 5-NPF-1). Because the deep water is cooler, it is also denser and is isolated from the warm surface water. If the deep layer has no (or low) DO, there will be no place in the reservoir that trout can survive. A separate analysis of oxygen levels in the deep layer indicated that the deeper layer would probably not be aerobic (be depleted of oxygen) in both 1961 and 1964.

Temperature profiles for each alternative, compared to the Present Condition in Pathfinder Reservoir, under various extremely dry summer scenarios (1961 and 1964) indicate that the 20ºC limit is exceeded many times near the surface under the Present Condition and with each alternative. Rainbow trout experience significant mortality at prolonged exposure to water temperatures greater than 24ºC, and temperatures over 27ºC are lethal (WG&F, 2004). All alternatives would result in at least some thermal stress to the trout fishery during some days of critically dry summers compared to Present Condition.

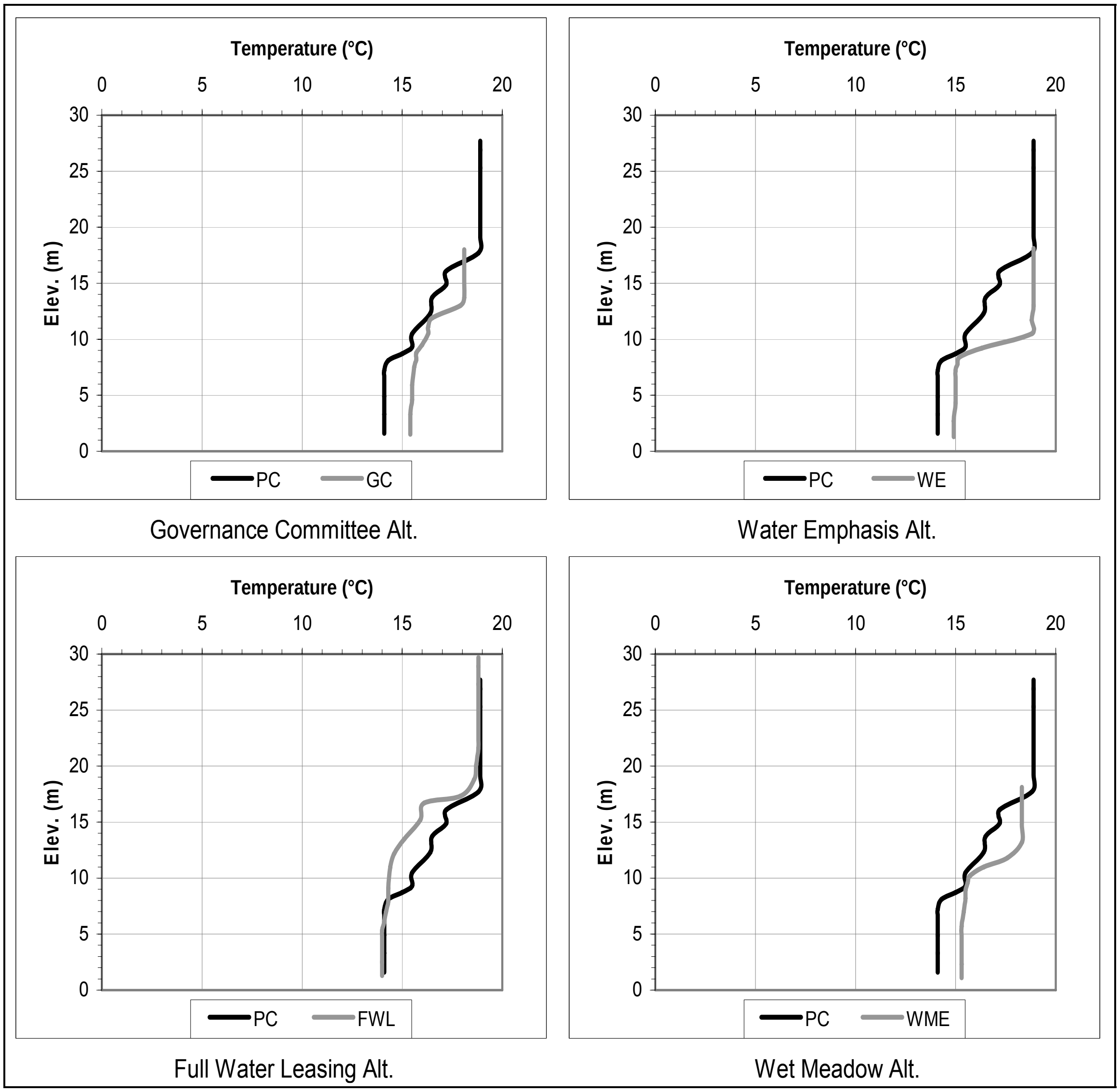

Figure 5-NPF-1.—Simulated temperature profiles in Pathfinder Reservoir on August 4, 1964, for the Present Condition and alternatives.

Table 5-NPF-3 also shows changes in fish standing crop in Pathfinder Reservoir for each action alternative relative to the Present Condition. The Full Water Leasing Alternative was the only alternative that showed an increase in fish standing crop, on the average, in comparison with the Present Condition. The Wet Meadow Alternative, as was the case in Seminoe Reservoir, showed the greatest decrease in fish

standing crop among the alternatives, while the Governance Committee Alternative showed the smallest decrease in fish standing crop of the alternatives that showed a decrease. The rank of the alternatives, with respect to their average decrease in fish standing crop in Pathfinder Reservoir, is the same as it was in Seminoe Reservoir; the same is true of the rank of the greatest decreases (minimum in table 5-NPF-3). In addition, just as was true of the Seminoe Reservoir results, each of the alternatives can show an increase over the Present Condition (maximum in table 5-NPF-3) under the right conditions.

Alcova Reservoir

Reservoir volumes never dropped below 150 kaf for any alternative, including the Present Condition. There is no year-to-year variation in mean depth. There is a similar lack of variation in area. The lack of variation in area and mean depth buffers any effect on fish standing crop due to the alternatives. Alcova Reservoir is operated as a semifixed reservoir (winter operating elevation of 5488 feet ±1 foot and summer operating elevation of 5498 feet ±1 foot). These reservoir elevations are maintained in all the alternatives. In summary, no significant effect on the fisheries in Alcova Reservoir would be expected from any alternative because reservoir volumes never drop below flagged levels and there is less than a 1-percent change, on the average, in estimated fish standing crop (table 5-NPF-3), with the exception of the Full Water Leasing Alternative, which in Alcova is projected to cause the greatest loss in fish standing crop (5.8 percent).

Glendo Reservoir

All alternatives had more months out of all 48 water years with volumes less than 100 kaf compared to the Present Condition (table 5-NPF-6).

However, between April and June, reservoir volumes never drop below 100 kaf for the Present Condition or any of the alternatives. This is the time period when most fish species spawn. However, declining water levels during these months can expose eggs, leading to desiccation. Table 5-NPF-7 shows the number of years out of the 48 years in the operations study that there are declining water levels in Glendo Reservoir during April through June. None of the alternatives show an increase in the number of years in which there are declining water levels during the spring in comparison with the Present Condition. The Governance Committee Alternative shows a decrease relative to the Present Condition during May only, which should lead to an improvement in spawning success. The largest decrease in the number of years with a spring drawdown would be with the Glendo operation under the Full Water Leasing Alternative, which shows a decrease in the number of years with a declining water level in all three of the months of concern. Falling reservoir levels will negatively impact walleye, perch, and forage fish spawning.

Glendo Reservoir is considerably shallower than either Seminoe or Pathfinder Reservoirs. It also sits considerably lower in the Basin than either of those reservoirs (see the basin map in chapter 2). As such, it is subject to somewhat warmer inflows than the preceding three reservoirs. Because of these considerations, the critical pool level has been set higher, at 63 kaf. Table 5-NPF-6 shows the minimum end-of-month (EOM) contents with each of the alternatives and the Present Condition. Table 5-NPF-6 indicates that the minimum reservoir level would not fall below 63 kaf in EOM content at any time with the Present Condition or any of the alternatives.

Table 5-NPF-6.—Summary of Storage Less Than 4,580 Feet (~100 kaf) in Glendo Reservoir

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Overall
Present Condition													
Minimum	101.5	136.8	167.5	200.5	235.8	278.3	285.6	292	219.2	210.1	80	63.1	63.1
Times < 100 kaf	0	0	0	0	0	0	0	0	0	0	4	6	10
Governance Committee Alternative													
Minimum	91.6	126.4	155.8	186	220	253.3	249.9	285.5	275.2	198.3	80	63.1	63.1
Times < 100 kaf	3	0	0	0	0	0	0	0	0	0	5	10	18
Water Emphasis Alternative													
Minimum	91.6	126.4	155.8	186	220	253.3	243.1	281.5	275.3	146.9	80	63.1	63.1
Times < 100 kaf	6	0	0	0	0	0	0	0	0	0	8	24	38
Full Water Leasing Alternative													
Minimum	91.6	126.6	158.2	201.6	237.6	283.6	290.9	252.5	300.9	241.3	80	63.1	63.1
Times < 100 kaf	2	0	0	0	0	0	0	0	0	0	3	13	18
Wet Meadow Alternative													
Minimum	91.6	126.4	155.8	186	220	252	243.1	284.9	271.7	90	80	63.1	63.1
Times < 100 kaf	6	0	0	0	0	0	0	0	0	1	8	22	37

Table 5-NPF-7.—Number of Years with Declining Water Levels During Spring in Glendo Reservoir

	Apr	May	Jun
Present Condition	16	17	23
Governance Committee Alternative	16	14	23
Full Water Leasing Alternative	14	11	22
Wet Meadow Alternative	15	16	23
Water Emphasis Alternative	16	13	21

Table 5-NPF-3 still indicates an overall loss in fish standing crop in Glendo Reservoir under all of the alternatives. On the average, the decreases for three of the alternatives are between 2.6 and 2.9 percent, while the decrease under the Full Water Leasing Alternative is 1.2 percent. The percent standing crop reduction in Glendo Reservoir with any of the alternatives would be less than in either Seminoe or Pathfinder; however, in absolute terms, the loss in fish would be higher than in Seminoe, but similar to Pathfinder Reservoir.

In summary, large-scale effects on the fishery in Glendo Reservoir are not expected with all alternatives because reservoir volumes rarely drop below flagged levels during the spring and summer months, but percent decreases in estimated fish standing crop over the 48-year period of record may be considered large.

Guernsey Reservoir

Historically, at the end of the irrigation season, Guernsey Reservoir is drained, and the reservoir remains essentially empty until the following spring. Consequently, Guernsey Reservoir only supports a seasonal fishery maintained through stocking. No change in this operation would occur with any of the alternatives. As a consequence, there would be no effect, either beneficial or adverse, on the Guernsey Reservoir fishery.

Impacts on Riverine Fish Communities

Kortes Reservoir Outflow (The Miracle Mile)

With the exception of the Full Water Leasing Alternative, the alternatives were similar in the overall effects, with small differences in formulation and results (tables 5-NPF-8 and 5-NPF-9). The Full Water Leasing Alternative resulted in fewest flow decreases from October through February, compared to Present Condition, and the most flow increases during this period (tables 5-NPF-8 and 5-NPF-9). Compared to the Present Condition, all alternatives, except the Full Water Leasing Alternative, had 4 to 6 months in the 48-year period of record where Platte River flows below Kortes Dam fell to less than 500 cfs, compared to the Present Condition, which had none (table 5-NPF-10). One time in March (1965), flows dropped to 355 cfs for the Governance Committee, Wet Meadow, and Water Emphasis Alternatives, which could adversely affect rainbow trout spawning habitat. The year (1965) where flows dropped to 449 and 329 cfs in October and November under the Wet Meadow Alternative, and 442 cfs in November under the Water Emphasis Alternative, may adversely affect brown trout spawning habitat. Flows below Kortes Dam fall below 500 cfs when the storage in Seminoe Reservoir reaches the inactive capacity of 31,200 acre-feet; the NPRWUMEIS passes only the available inflows, and the inflows are less than 500 cfs. This occurred in only 1 year in the 48-year study period.

Table 5-NPF-8.—Net Flow Decreases at Kortes Reservoir Outflow: Alternative Minus the Present Condition (Number of Water Years Out of 48 by Month)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Governance Committee Alternative	18	20	21	22	24	8	13	13	16	19	28	6
Full Water Leasing Alternative	11	5	4	5	6	8	25	27	25	18	37	10
Wet Meadow Alternative	22	26	27	26	30	10	15	7	15	22	23	7
Water Emphasis Alternative	22	25	24	27	27	10	13	6	15	22	32	6

Table 5-NPF-9.—Net Flow Increases at Kortes Reservoir Outflow: Alternative Minus the Present Condition (Number of Water Years Out of 48 by Month)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Governance Committee Alternative	12	16	18	19	17	29	27	25	23	11	15	20
Full Water Leasing Alternative	21	33	35	36	35	34	17	12	14	12	7	15
Wet Meadow Alternative	13	13	15	13	12	27	30	35	26	13	21	34
Water Emphasis Alternative	13	14	15	14	15	24	31	35	26	12	10	31

Table 5-NPF-10.—Monthly Flows Less Than 500 Cubic Feet Per Second for North Platte River at Kortes Reservoir Outflow (Number of Water Years Out of 48 by Month)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Present Condition	0	0	0	0	0	0	0	0	0	0	0	0
Governance Committee Alternative	0	0	1	1	1	1	0	0	0	0	0	0
Full Water Leasing Alternative	0	0	0	0	0	0	0	0	0	0	0	0
Wet Meadow Alternative	1	1	1	1	1	1	0	0	0	0	0	0
Water Emphasis Alternative	0	1	1	1	1	1	0	0	0	0	0	0

When Seminoe Reservoir drops below the 50-kaf critical pool level, the releases may be too warm or have DO concentrations too low to support coldwater fish. This would also adversely affect the trout fishery in the Miracle Mile reach of the North Platte River. Historic data indicate that the temperature in the Miracle Mile is related to that of the release from Seminoe Reservoir. The pool levels below the critical 50-kaf content in Seminoe Reservoir occur in months when the water is cool enough to support trout. Historic data also indicate that there is re-aeration of the releases between Seminoe Dam and the Miracle Mile. However, DO concentrations as low as 4 milligrams per liter have been observed in the Miracle Mile reach of the river and probably caused some stress to resident trout. Because the low pool levels in Seminoe Reservoir occur when it is mixed, the releases should be reasonably well aerated. DO concentrations below historic concentrations are not anticipated.

In summary, all alternatives, except the Full Water Leasing Alternative, result in some increases and decreases in Kortes Reservoir outflows, compared to the Present Condition, with a few months below 500 cfs. The occasions when flows drop below 500 cfs will adversely affect the riverine fisheries downstream from Kortes Reservoir. Flows never drop below 500 cfs in the Present Condition or under the Full Water Leasing Alternative.

Fremont Canyon Powerplant Bypass

A minimum 75 cfs of turbine bypass flow has recently been established at Pathfinder Dam. The 75-cfs bypass is met at all times with all alternatives. Higher bypass flows may occur at times under both the Present Condition and all alternatives when there are either spills or the need to deliver water in excess of the turbine capacity. Both of these events are relatively rare. Generally, there was little difference in flow impacts among alternatives; no alternative, including the Present Condition, resulted in flows less than 75 cfs during any months.

As was the case with Seminoe Reservoir, there has been concern over release temperatures and DO concentrations when Pathfinder Reservoir falls below the 50-kaf critical pool. Unlike Seminoe Reservoir, Pathfinder Reservoir is drawn down below its 50 kaf critical pool in the warmer months of August and September. In response to concerns over warm releases, a mathematical temperature model of Pathfinder Reservoir was constructed. Temperature model results that compare Pathfinder Reservoir outlet temperatures for each alternative do not indicate that water temperatures would be adversely affected by any alternative (see the *Water Quality Appendix* in volume 3). Maximum release temperatures remain below 20°C (68°F), which should support a trout fishery from the perspective of temperature. An analysis of the probability of an anoxic release indicates that it would remain low under most circumstances but could increase to over 50 percent during several years during the 1961 through 1965 period with the Governance Committee, Wet Meadow, and Water Emphasis Alternatives. Even so, given the nature of Fremont Canyon, re-aeration should be relatively rapid, and most of the canyon should continue to support a fishery in those years.

In summary, all alternatives result in some increases and decreases in Fremont Canyon Powerplant bypass flows, compared to the Present Condition, but there are no months with flow below 75 cfs. Because the bypass flow will be maintained at all times, there should be no effect on the riverine fishery downstream from the Fremont Canyon Powerplant. Some decrease in the available habitat for coldwater fish in the river reach immediately below the Pathfinder Dam could occur under conditions represented by those of 1961 through 1965 under the Governance Committee, Wet Meadow, and Water Emphasis Alternatives, due to low DO in those releases.

Alcova Dam/Gray Reef Outflows

Gray Reef Dam forms an afterbay for Alcova Powerplant. Figure 5-NPF-2 shows the temperature of the North Platte River downstream from Gray Reef Dam. The intake to the outlet of Alcova Dam is located at a depth of about 20 feet in the reservoir during the summer and 10 feet in the winter. With one exception, the North Platte River downstream from Gray Reef Dam has been below 20°C and is suitable for trout.

Figure 5-NPF-3 indicates that the DO of the river below Gray Reef is near or above saturation virtually all of the time. Consequently, there is little DO depletion in the Alcova release. The near-surface powerplant intake is favorable for maintaining a high concentration of DO in the releases to the river from Alcova Dam. Since the reservoir content (operation) will not be affected by any alternative, DO depletion below Gray Reef Dam should not be affected.

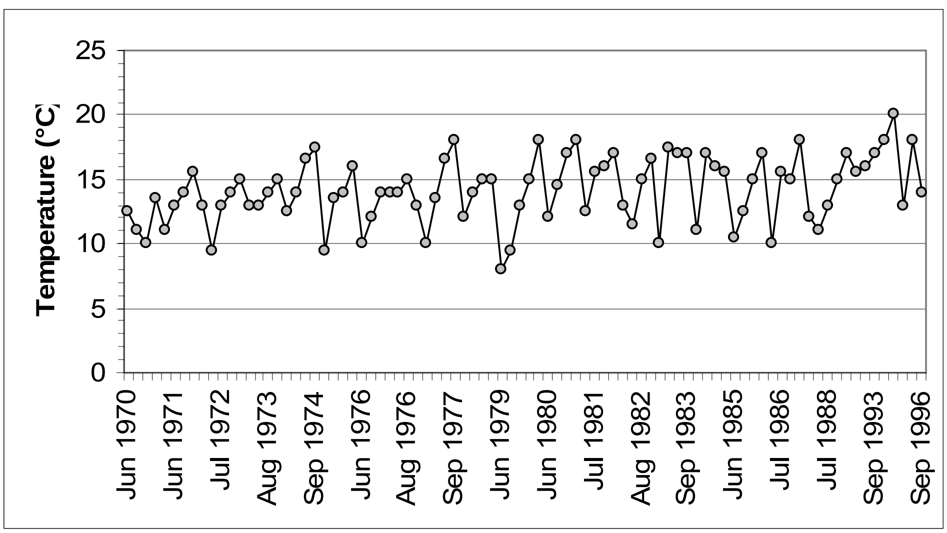

Figure 5-NPF-2.—Temperature in the releases from Alcova Dam.

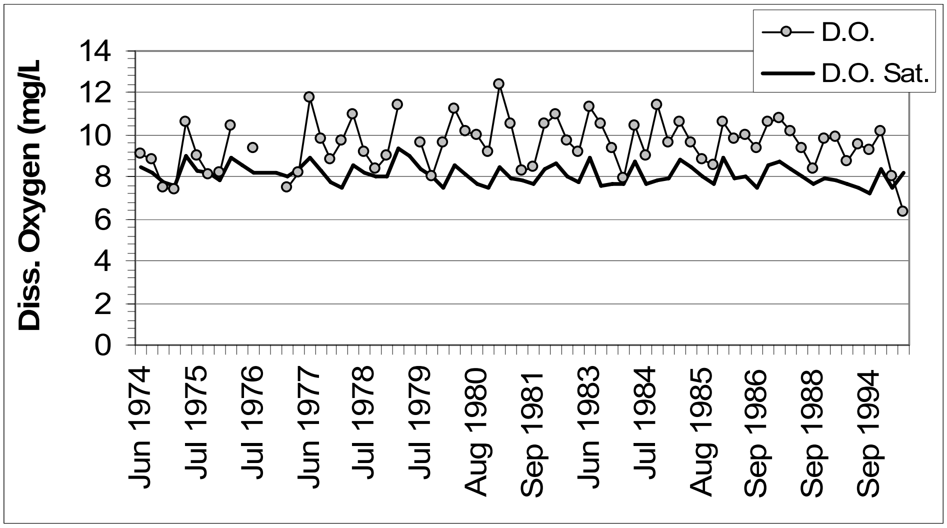

Figure 5-NPF-3.—Dissolved oxygen in the releases from Alcova Dam.

WG&F (2004) indicates that flows below 400 cfs in March would significantly impact rainbow trout spawning below Gray Reef Dam (WG&F, 2004, personal communication, Bill Wichers, Deputy Director). The flows were always greater than 500 cfs under the Present Condition and the Full Water Leasing Alternative. Once, (in March 1965), flows dropped below 400 cfs for the Governance Committee, Wet Meadow, and Water Emphasis Alternatives, which would result in a significant reduction in rainbow trout spawning habitat (WG&F, 2004 and Dey and Annear, 1993). Minimum March flows were 366, 363, and 359 cfs for the Governance Committee, Wet Meadow, and Water Emphasis Alternatives, respectively.

WG&F also stated that flows below 1,000 cfs below Gray Reef Dam during the summer months (June through September) were of greatest concern in the North Platte River (WG&F, 2005 [Gray Reef Dam flows], personal communication, Al Conder, Casper Regional Fisheries Supervisor). According to WG&F (2003), there was significantly more warming of the river in the reach between Gray Reef Dam and the Dave Johnson Powerplant at 500 cfs than there was when the release was 1,000 cfs.
Table 5-NPF-11 shows the percent of years that the flow was less than 500 cfs, between 500 and 1,000 cfs, and greater than 1,000 cfs in each of the 4 months. All of the alternatives show a decrease in the frequency of maintaining the 1,000-cfs flow during the months of July through August and an increase in the percentage in September. The decreases in the June through August period amount to 1 or 2 years out of the 48-year study period. The effects on the coldwater fishery under those circumstances will depend greatly on the ambient temperature present before warming occurs. The ambient temperature is a large factor in the final river temperature and the exact effect on trout. At a minimum, some degree of stress would be expected; at most, some degree of mortality could be expected if water temperatures exceed 24ºC for prolonged periods.

In summary, all alternatives result in some increases and decreases in Gray Reef Reservoir outflows, compared to the Present Condition, with a few events below 500 cfs. The occasions when flows drop below 500 cfs, particularly when rainbow trout are spawning, will result in an adverse effect on the riverine fisheries downstream from Gray Reef Reservoir. On occasions when the flow drops below 1,000 cfs in the summer, excessive warming could occur in the river, resulting in a range of effects on trout, from minor stress to mortality.

Table 5-NPF-11.—Frequency of Gray Reef Reservoir Outflow Meeting Goals for Temperature Maintenance in the North Platte River (Percent of Years Out of 48)

	Release	June (Percent)	July (Percent)	August (Percent)	September (Percent)
Present Condition	≥ 1,000 cfs	62.5	100.0	85.4	10.4
	≥ 500 and < 1,000 cfs	37.5	0.0	14.6	89.6
	< 500 cfs	0.0	0.0	0.0	0.0
Governance Committee Alternative	≥ 1,000 cfs	60.4	100.0	81.3	22.9
	≥ 500 and < 1,000 cfs	39.6	0.0	18.8	77.1
	< 500 cfs	0.0	0.0	0.0	0.0
Full Water Leasing Alternative	≥ 1,000 cfs	58.3	97.9	85.4	50.0
	≥ 500 and < 1,000 cfs	41.7	2.1	14.6	50.0
	< 500 cfs	0.0	0.0	0.0	0.0
Wet Meadow Alternative	≥ 1,000 cfs	60.4	97.9	87.5	72.9
	≥ 500 and < 1,000 cfs	39.6	2.1	12.5	25.0
	< 500 cfs	0.0	0.0	0.0	2.1
Water Emphasis Alternative	≥ 1,000 cfs	58.3	97.9	79.2	70.8
	≥ 500 and < 1,000 cfs	41.7	2.1	20.8	29.2
	< 500 cfs	0.0	0.0	0.0	0.0

Glendo Reservoir Outflow

Among alternatives, the Water Emphasis Alternative had the most number of months with Glendo Reservoir outflows less than the Present Condition, and the Governance Committee Alternative had most months with flows greater than the Present Condition, particularly during spring and summer months. No alternative, including Present Condition, had any months with flows less than 25 cfs.

In summary, all alternatives result in some increases and decreases in Glendo Reservoir outflows, compared to the Present Condition, with no events below 25 cfs. This should result in no effect on the riverine fisheries downstream from Glendo Reservoir.

Fish Community Downstream From Guernsey Reservoir to the State Line

The existing fishery downstream from Guernsey Reservoir to the Wyoming-Nebraska State line is marginal, and there is no official established maintenance flow. As was noted above, Guernsey Reservoir is drained after the irrigation season. No releases are made to the river. All flows during the nonirrigation season originate from local inflows and seepage. As long as this condition persists, the fishery, such as it is, would not change. None of the alternatives would change the operation of Guernsey Dam and would not greatly affect the fishery downstream.

Panhandle Streams

Chapter 4 describes the several streams that come out of the Sandhills, north of the North Platte River, in the Nebraska panhandle, in the Scotts Bluff area. These streams generally are fed by groundwater from the Sandhills at a fairly steady rate year round. As they continue southward toward the Platte, they cross under one of the main irrigation distribution canals associated with the North Platte Project and other local irrigation districts. Seepage from these canals, as well as return flows from irrigated fields, adds water to these streams during the irrigation season. As described in the "Water Quality" section in chapter 4 and the *Water Quality Appendix* in volume 3, this water is somewhat warmer than the groundwater that contributes to the year-round flow. Even so, where the native groundwater enters the stream, there should be cool water refugia for some of the fish.

The potential pathway for the Program to impact these streams is through leasing of water from area irrigation districts that would reduce irrigation return flows into the streams. The Governance Committee and Full Water Leasing Alternatives propose water leasing in Wyoming and Nebraska. The other two alternatives, Wet Meadow and Water Emphasis Alternatives, do not have this element and are not discussed here.

Governance Committee Alternative

The Governance Committee Alternative proposes water leasing in both Wyoming and Nebraska. However, as described in chapter 3, the most likely area for water leasing under this alternative in Wyoming is from the Casper-Alcova Irrigation District. Water leasing specifically from the North Platte Project in the Panhandle area has been judged unlikely under existing Wyoming law and institutional structures, primarily because of the large number of districts in this area that share water from Pathfinder Reservoir without having individual accounts. Because of this, water leasing from one or more of these districts would be highly impractical under current arrangements.

Under the Governance Committee Alternative, total average annual deliveries to the North Platte Project lands are reduced by 1 percent. This would not create any measurable change in agricultural runoff or canal seepage into the local streams or groundwater.

For this alternative, water leasing in Nebraska would most likely occur below Lake McConaughy with the objective of both securing additional water for the Program in the reservoir and reducing the demand for delivery of irrigation water through the North Platte chokepoint at North Platte, Nebraska. This is the area of water leasing that has been described in the Governance Committee Program Document: Attachment 5: Water Plan.

Full Water Leasing Alternative

The Full Water Leasing Alternative explores the effects of large-scale leasing of water in each state. To obtain such a large amount of water through leasing, it would be necessary for significant changes in state water laws and water administration arrangements. Under this alternative, and with these assumptions, it would be possible that a significant amount of water might be leased from irrigation districts in the Scotts Bluff area.

The scenario employed for this alternative results in a total reduction in irrigation deliveries to the North Platte Project lands of 20 percent. This would likely result in some reduction in irrigation runoff to the local streams. However, this would not affect baseflows originating from groundwater, primarily out of the Sandhills to the north, nor the peak flows which result from local storm runoff. Stream temperatures would be reduced somewhat as warmer irrigation runoff was reduced.

Wyoming State Mitigation Proposal

The Wyoming Water Development Commission has entered into an agreement to contribute up to $2 million to the WG&F during the Program's First Increment to support the restoration of fisheries in the main North Platte Reservoirs and river reaches, should they be significantly adversely affected by the Program.

NEBRASKA SPORT FISHERIES—LAKE MCCONAUGHY AND THE LOWER PLATTE RIVER

Issue: How would the action alternatives affect the health of the fisheries in Lake McConaughy and Lake Ogallala?

Overview

SCOPE

Lake McConaughy and Lake Ogallala are on the North Platte River near Ogallala, all in Nebraska. The scope also includes the Lower Platte River.

INDICATORS

- **Lake McConaughy Littoral Habitat:** Area of water within specific depth constraints—June through August
- **Lake McConaughy Open Water Habitat:** Area of water within specific depth constraints—June through August
- **Lake McConaughy Walleye:** Trend in water level in April and May, and 3255-foot elevation
- **Lake McConaughy White Bass:** North Platte flow threshold in May
- **Lake McConaughy Smallmouth Bass:** 3255-foot elevation, rocky shallow habitat availability
- **Lake McConaughy Channel Catfish:** Flow rate and flow changes in the North Platte River
- **Lake McConaughy Gizzard Shad:** 3250-foot elevation
- **Lake Ogallala Trout:** Temperature and oxygen levels
- **Lower Platte River:** Catfish and shovelnose sturgeon

SUMMARY OF IMPACTS

Littoral habitat present through the summer months in Lake McConaughy is reduced slightly in all alternatives except the Full Water Leasing Alternative, which leaves amounts of littoral habitat essentially unchanged from the Present Condition.

Walleye recruitment is expected to be reduced slightly from the Present Condition under the Full Water Leasing Emphasis Alternative and significantly reduced under all other alternatives.

Spawning of Lake McConaughy white bass in the North Platte River above the reservoir is not substantially changed under any of the alternatives. The frequency of optimum conditions is increased slightly under the Full Water Leasing Alternative and decreased slightly under all other alternatives.

All alternatives (except for the Full Water Leasing Alternative, which leaves conditions essentially unchanged from the Present Condition), substantially reduce the frequency that the optimum smallmouth bass spawning habitat is accessible and reduce the total amount of spawning habitat available in a given year.

All of the alternatives are expected to exhibit a slight adverse effect on channel catfish spawning conditions in the North Platte inlet to Lake McConaughy.

All alternatives (except for the Full Water Leasing Alternative, which leaves conditions largely unchanged from the Present Condition reduce occurrence of optimum reservoir elevations conducive for successful gizzard shad spawning significantly.

All alternatives (except the Full Water Leasing Alternative, which improves conditions slightly) reduce the frequency of conditions conducive to over-winter survival of gizzard shad significantly.

Under all alternatives, it is more likely that temperatures which support the Lake Ogallala trout fishery may be negatively affected.

IMPACTS ANALYSIS

The Program actions to provide improvements in riverflows through the Central Platte Habitat Area affect the operations and reservoir levels for Lake McConaughy in Nebraska in ways that may affect the fisheries in Lake McConaughy and Lake Ogallala.

Lake McConaughy Littoral Habitat Availability

Littoral habitat in this context is taken to be the layer of shallow water around the reservoir, in which light penetrates to the bottom. The shape of the reservoir is such that relatively little change occurs in littoral habitat availability in the operating ranges seen under any of the alternatives examined (figures 5-NSF-1, 5-NSF-2, and 5-NSF-3). Under the Full Water Leasing Alternative, no significant change is observed relative to the Present Condition. Under the Governance Committee and Wet Meadow Alternatives, a 2-percent to 3-percent average annual reduction in littoral habitat availability occurs. Under the Water Emphasis Alternative, a 2-percent average annual reduction in littoral habitat availability occurs.

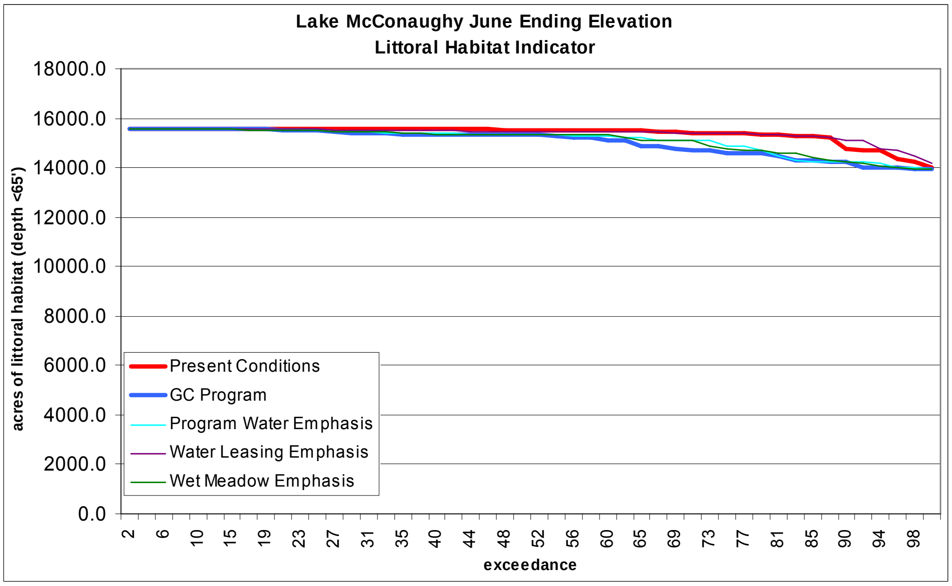

Figure 5-NSF-1.—Littoral habitat indicator: Lake McConaughy June ending elevation.

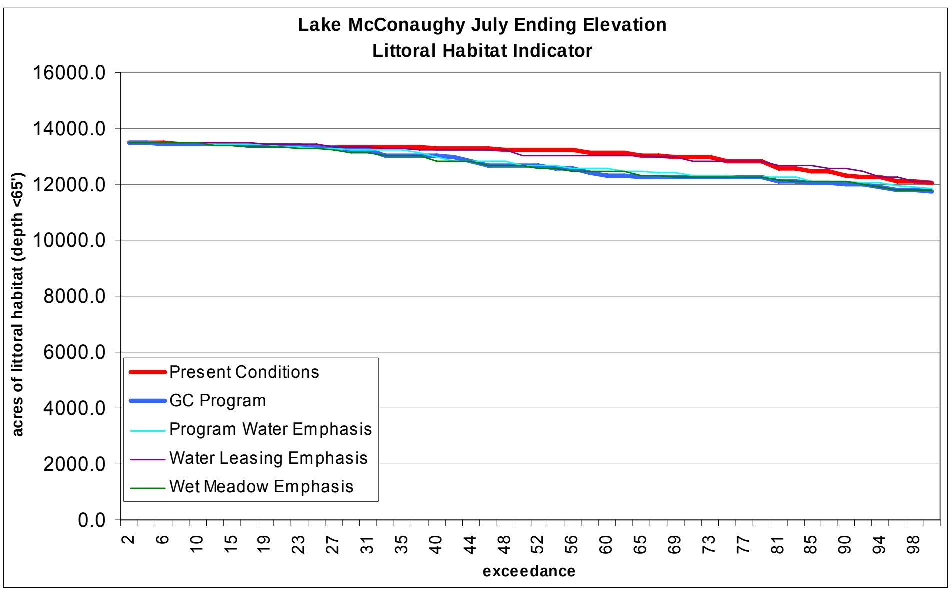

Figure 5-NSF-2.—Littoral habitat indicator: Lake McConaughy July ending elevation.

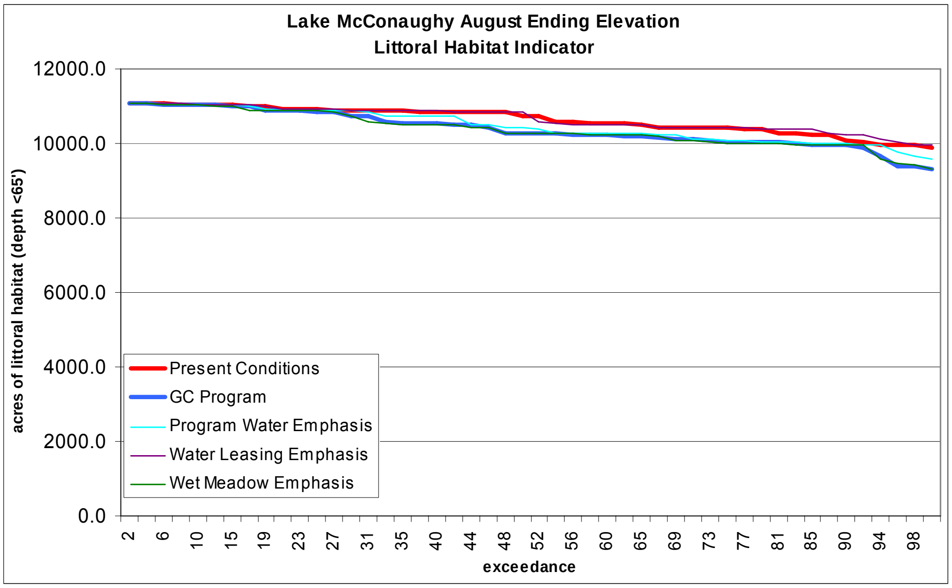

Figure 5-NSF-3.—Littoral habitat indicator: Lake McConaughy August ending elevation.

Lake McConaughy Open Water Habitat Availability

Open water habitat is taken to be that habitat where the reservoir bottom lies below the thermocline. In contrast to littoral habitat, the amount of open water habitat can fluctuate substantially with reservoir elevation (figure 5-NSF-4, 5-NSF-5, and 5-NSF-6). Under the Full Water Leasing Alternative, changes relative to the Present Condition range from a 1-percent increase to a 1-percent decrease in open water habitat availability. Under the Water Emphasis Alternative, an average annual reduction in open water habitat availability of between 6 percent and 8 percent occurs. Under the Governance Committee Alternative, a 10-percent to 11-percent average annual reduction in open water habitat availability occurs. Similarly, under the Wet Meadow Alternative, a 9-percent to 10-percent average annual reduction in open water habitat availability occurs.

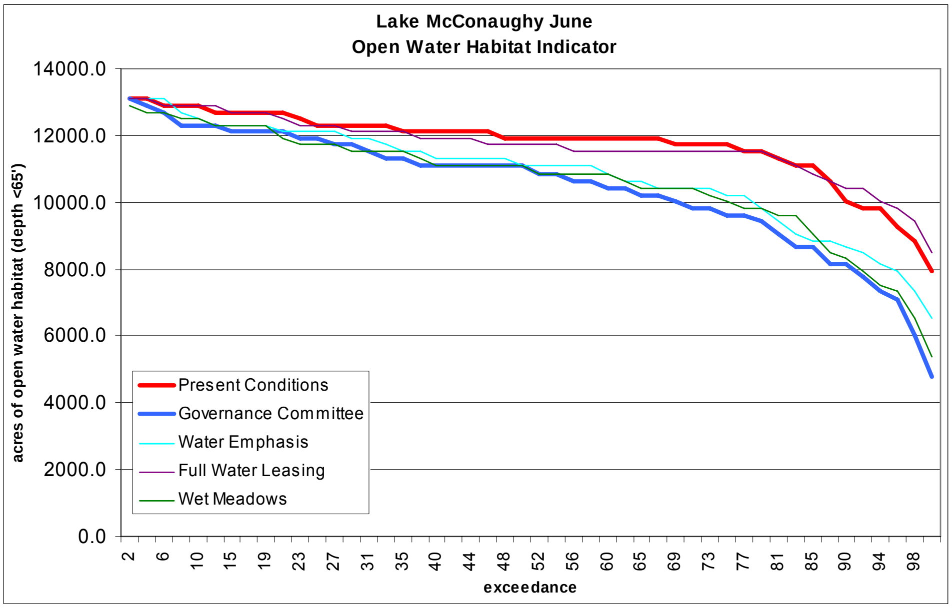

Figure 5-NSF-4.—Open water habitat indicator: Lake McConaughy June ending elevation.

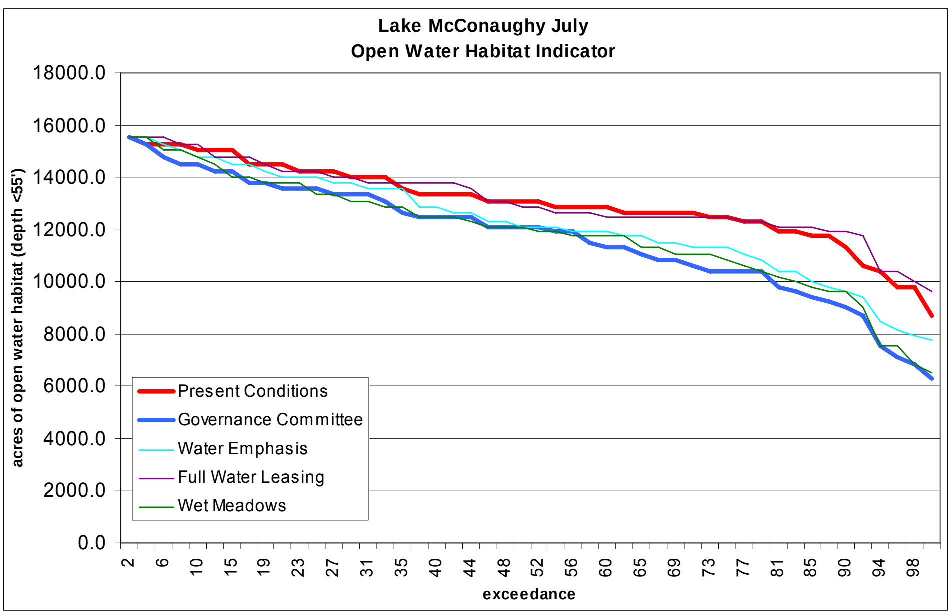

Figure 5-NSF-5.—Open water habitat indicator: Lake McConaughy July ending elevation.

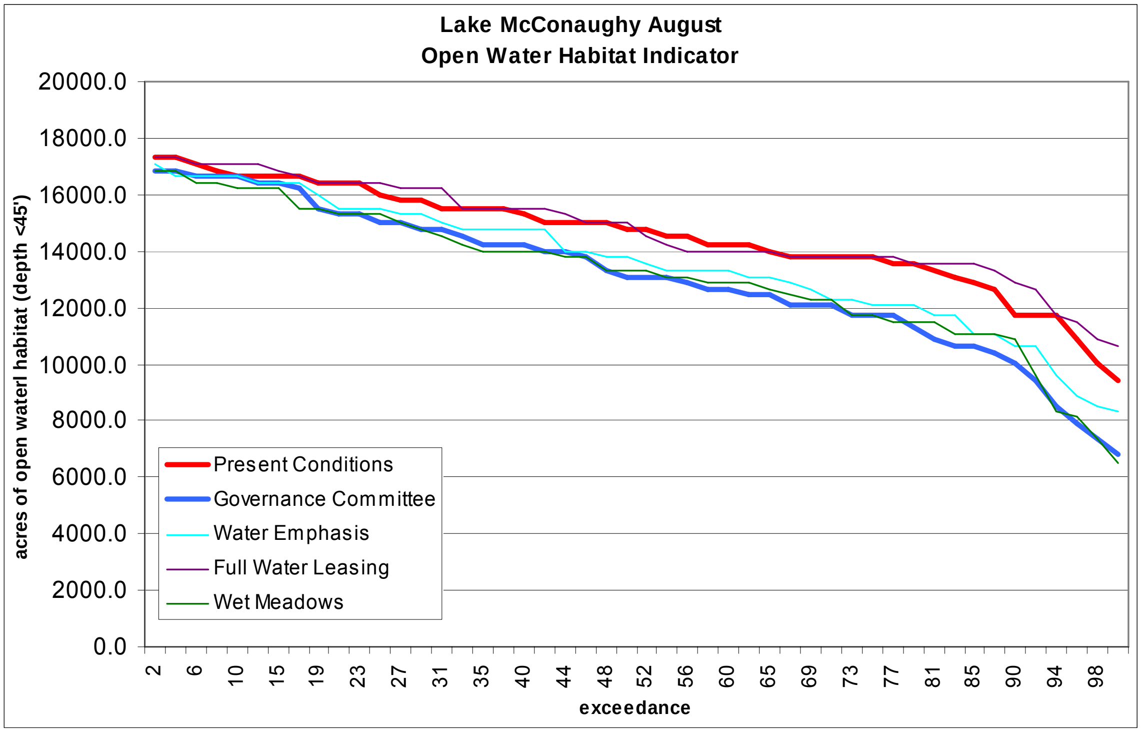

Figure 5-NSF-6.—Open water habitat indicator: Lake McConaughy August ending elevation.

Lake McConaughy Walleye Reproduction

Natural reproduction of walleye in Lake McConaughy currently accounts for approximately 25 percent of the total annual walleye recruitment in the reservoir. The remaining 75 percent of recruitment is through hatchery augmentation. As a result, when attempting to translate the data presented here to the total walleye population in the reservoir, differences from the Present Condition should be regarded as of secondary significance to hatchery augmentation.

Trends in water surface elevation from April to May, which affect natural walleye reproduction, are anticipated to be significantly impacted under most of the alternatives (figure 5-NSF-7). Under the Present Condition, reservoir elevations typically rise from April to May, making conditions conducive for successful walleye spawning in approximately 75 percent of years. Under the Governance Committee Alternative, this is reduced to 40 percent of years. Under the Full Water Leasing Alternative, it is reduced to 70 percent of years. Under the Wet Meadow Alternative, favorable reservoir water elevations are reduced to approximately 48 percent of years. And under the Water Emphasis Alternative, this frequency is reduced to 50 percent of years.

Similarly, minimum water surface elevation from mid-April to mid-May, which affects the availability of walleye spawning habitat, is significantly reduced (figure 5-NSF-8). Optimum spawning habitat is present at about 3255 feet above mean sea level. Under the Present Condition, this condition is met or exceeded in 85 percent of years. This frequency is reduced to 50 percent of years under the Governance Committee Alternative, 57 percent under the Wet Meadow Alternative, 60 percent under the Water Emphasis Alternative, and 80 percent under the Full Water Leasing Alternative.

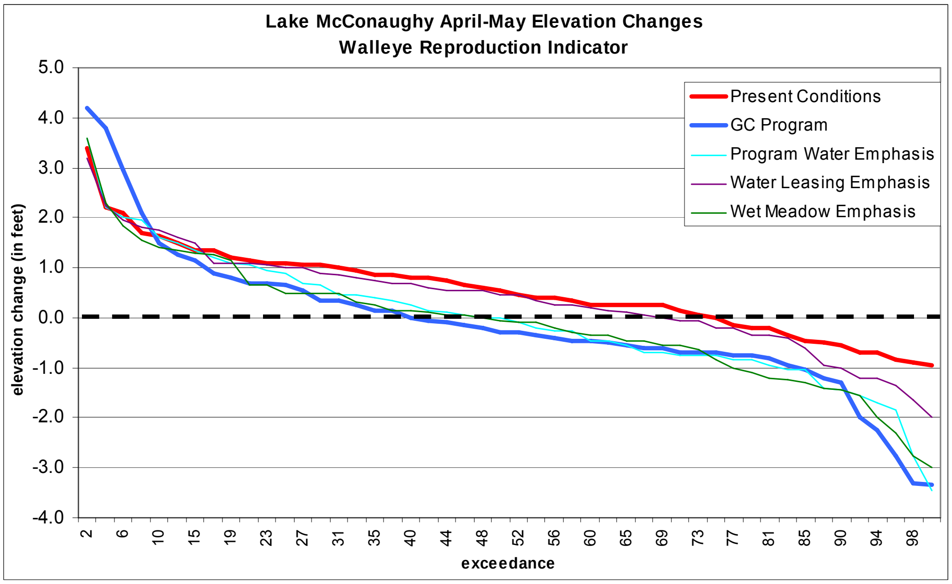

Figure 5-NSF-7.—Walleye reproduction indicator: Lake McConaughy April to May elevation changes.

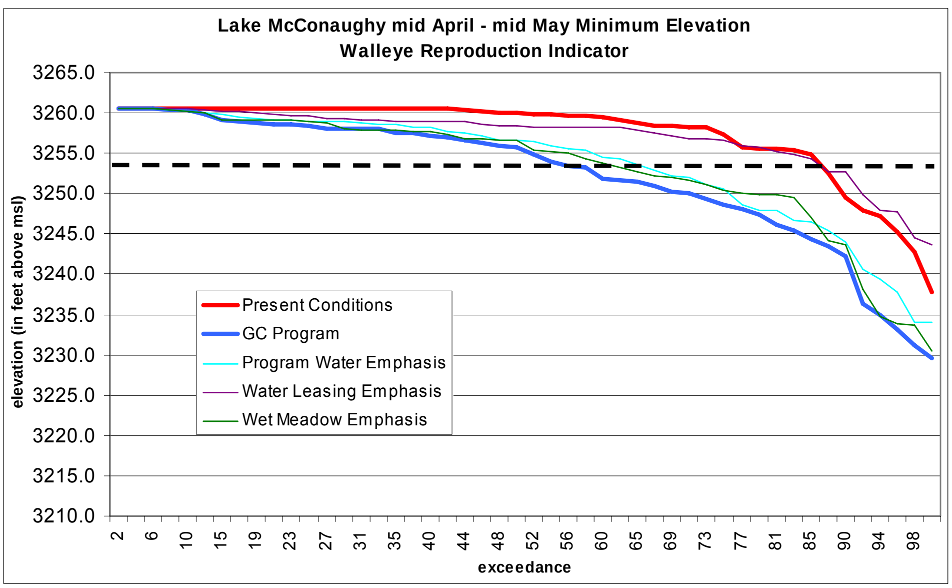

Figure 5-NSF-8.—Walleye reproduction indicator: Lake McConaughy mid-April to mid-May elevation.

Larval walleye can be flushed out of the reservoir during high releases in May and June (figures 5-NSF-9 and 5-NSF-10). While it is relatively uncommon for this to occur to substantial degrees during typical operations, it is a consideration when assessing walleye recruitment. Under the Governance Committee Alternative, average releases across all conditions are 11 percent higher in May but 10 percent lower in June. Under the Water Emphasis Alternative, average releases across all conditions are 7 percent lower in May and 21 percent lower in June. Under the Full Water Leasing Alternative, average releases across all conditions are 17 percent lower in May but 4 percent higher in June. And under the Wet Meadow Alternative, average releases across all conditions are 8 percent higher in May but 19 percent lower in June. The overall effect of this is difficult to determine, but the effects are most likely offsetting for the Governance Committee Alternative, slightly positive for the Full Water Leasing Alternative, slightly positive for the Wet Meadow Alternative, and positive for the Water Emphasis Alternative.

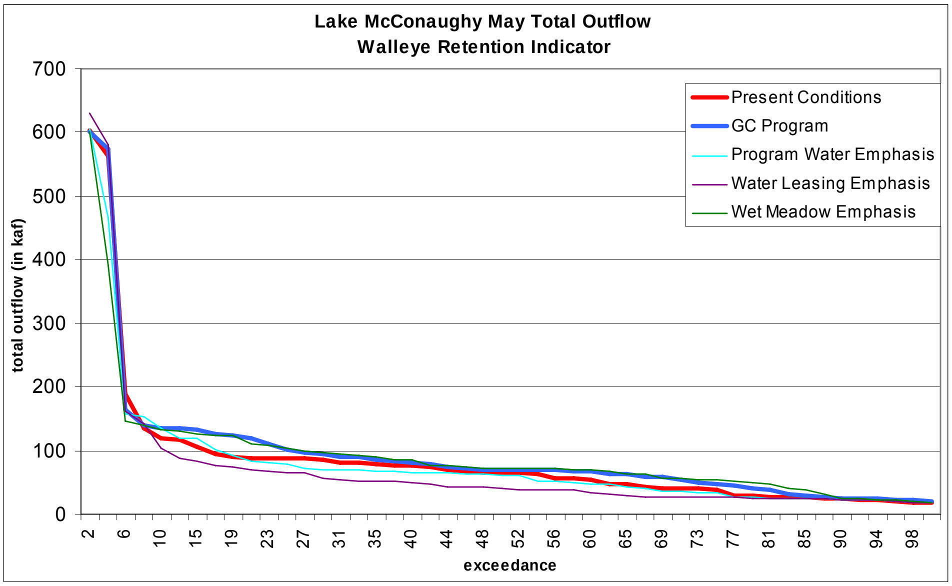

Figure 5-NSF-9.—Walleye reproduction indicator: Lake McConaughy May total outflow.

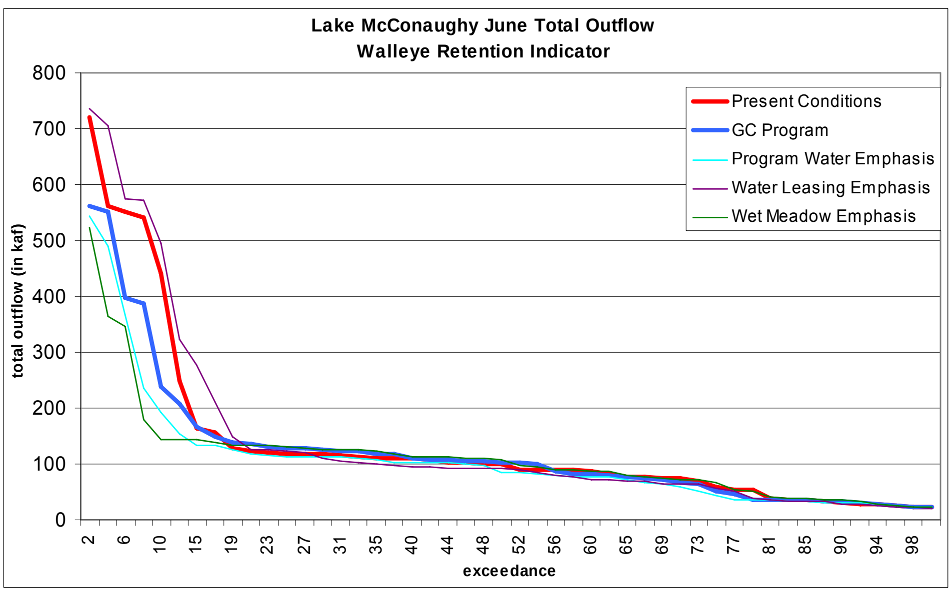

Figure 5-NSF-10.—Walleye reproduction indicator: Lake McConaughy June total outflow.

Lake McConaughy White Bass Reproduction

As white bass spawn primarily in the North Platte River rather than the reservoir; they are not subject to the same adverse impacts as walleye. Under the Present Condition, while white bass reproduction does take place across a range of conditions, reproduction is optimized in approximately 13 percent of years. Little change is seen when examining the alternatives. Under the Governance Committee Alternative, the Wet Meadow Alternative and the Water Emphasis Alternative, this is reduced to 12 percent of years. Under the Full Water Leasing Alternative, it is increased to 16 percent of years (figure 5-NSF-11).

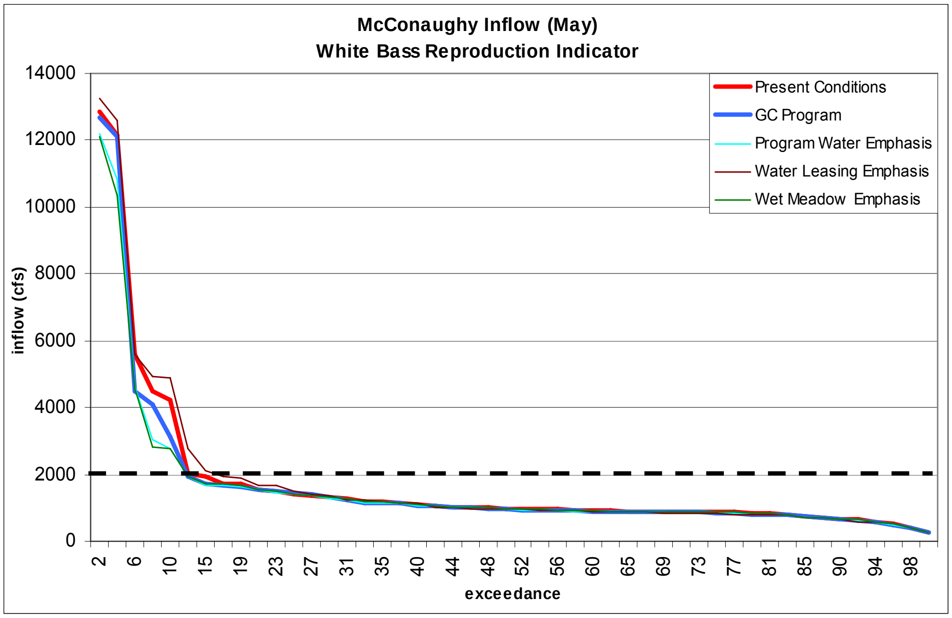

Figure 5-NSF-11.—White Bass reproduction indicator: Lake McConaughy May inflow.

Lake McConaughy Smallmouth Bass Reproduction

Smallmouth bass are impacted the most of all the species discussed in this section. Smallmouth bass spawn in the shallow rocky margins of the reservoir, particularly in Lemoyne Bay, on the reservoir's north side. As a result, they are subject to similar types of effects as walleye. New information on the availability of all rocky habitat at different elevations in the reservoir has been developed by Nebraska Game and Parks Commission (NGPC). However, as Lemoyne Bay provides the largest contiguous area of spawning habitat, it is still analyzed both as a part of the total rocky habitat and by itself.

Under the Present Condition, conditions are conducive to successful smallmouth bass reproduction in Lemoyne Bay in approximately 82 percent of years. The occurrence of these conditions is reduced to 36 percent under the Governance Committee Alternative, 38 percent under the Wet Meadow Alternative, and 50 percent under the Water Emphasis Alternative from the Present Condition (5-F-15). These conditions are the same under the Full Water Leasing Alternative as under the Present Condition.

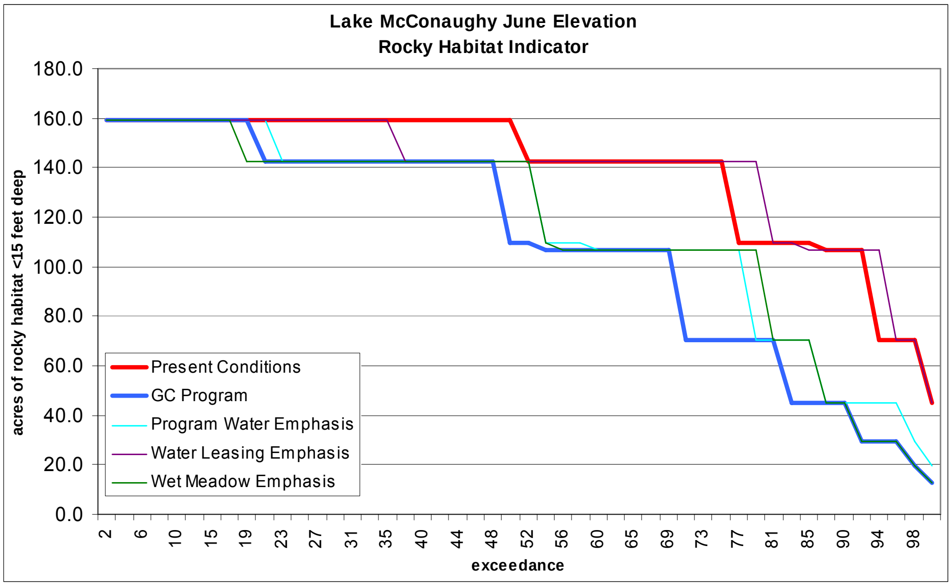

Figure 5-NSF-12.—Lake McConaughy smallmouth bass reproduction indicator: Lake McConaughy June elevation and acres of rocky habitat.

Rocky habitat for smallmouth bass spawning in the reservoir is defined as having a rocky substrate and water depths of less than 15 feet. No specific threshold has been established for a desirable level of rocky habitat. Availability of this type of habitat is unchanged under the Full Water Leasing Alternative, reduced by 16 percent under the Water Emphasis Alternative, reduced by 17 percent under the Wet Meadow Alternative, and reduced by 21 percent under the Governance Committee Alternative (figure 5-NSF-13).

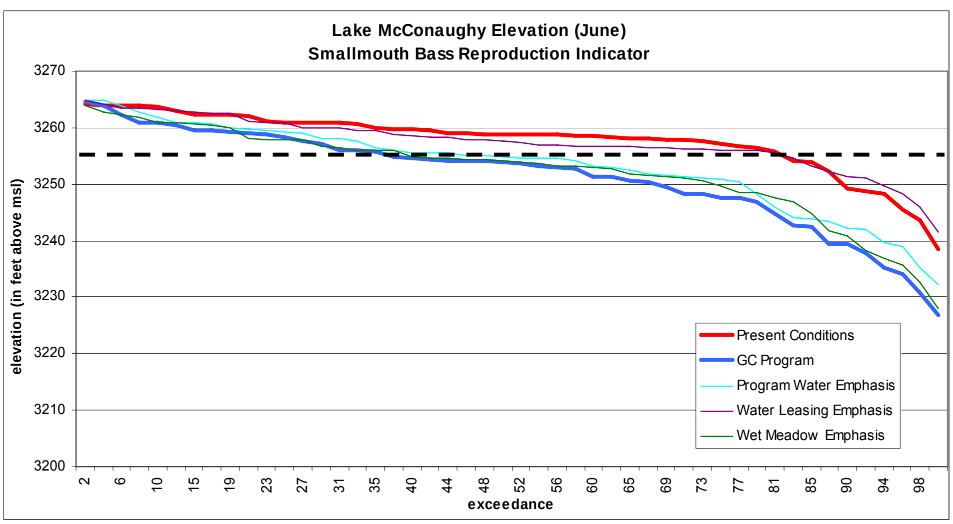

Figure 5-NSF-13.—Lake McConaughy smallmouth bass reproduction indicator: Lake McConaughy June elevation.

Lake McConaughy Channel Catfish Reproduction

Channel catfish reproductive needs are similar to those of white bass, in that they primarily spawn in the North Platte River above the reservoir, rather than in the reservoir itself. Channel catfish spawning may be triggered not only by total riverflow in the spring, but also by the relative change in riverflow (i.e., rising river conditions). Depending on local conditions, they typically begin staging between late March and early May and spawn between late April and early June. As a result, the different parameters analyzed were average riverflow for the months of April (figure 5-NSF-14), May (figure 5-NSF-15), and June (figure 5-NSF-16), as well as trends in river conditions from March to April (figure 5-NSF-17), and from April to May (figure 5-NSF-18).

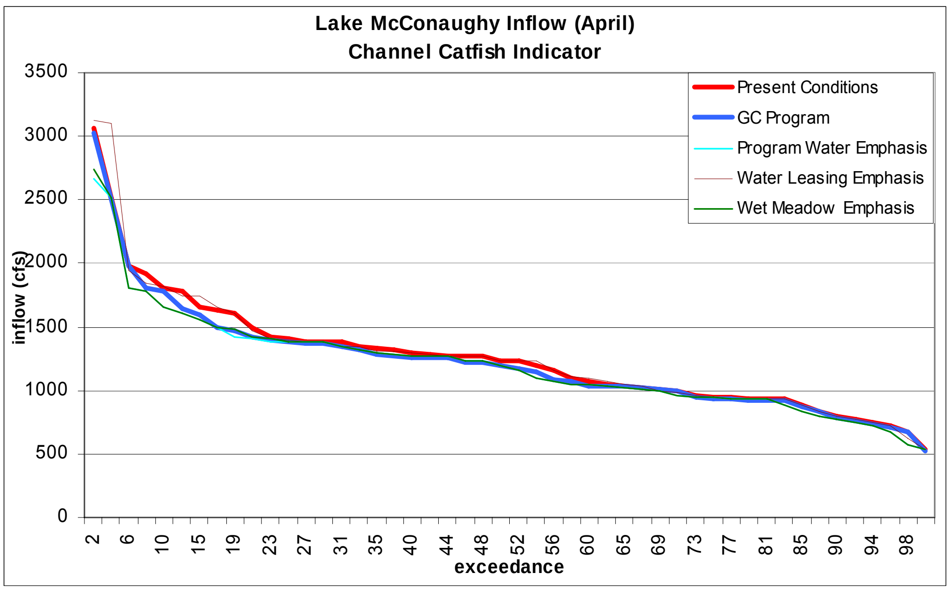

Figure 5-NSF-14.—Lake McConaughy Channel Catfish reproduction indicator: Lake McConaughy April inflow.

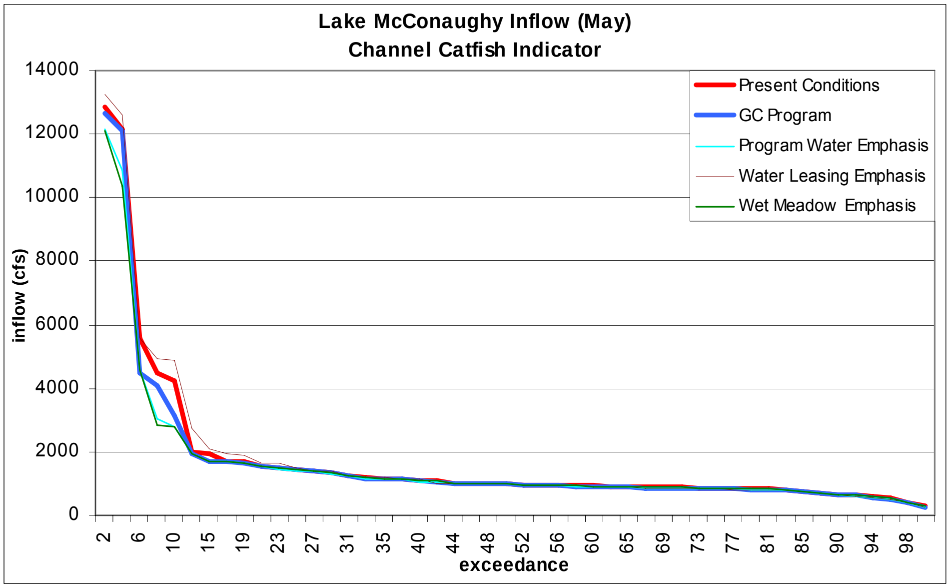

Figure 5-NSF-15.—Lake McConaughy channel catfish reproduction indicator: Lake McConaughy May inflow.

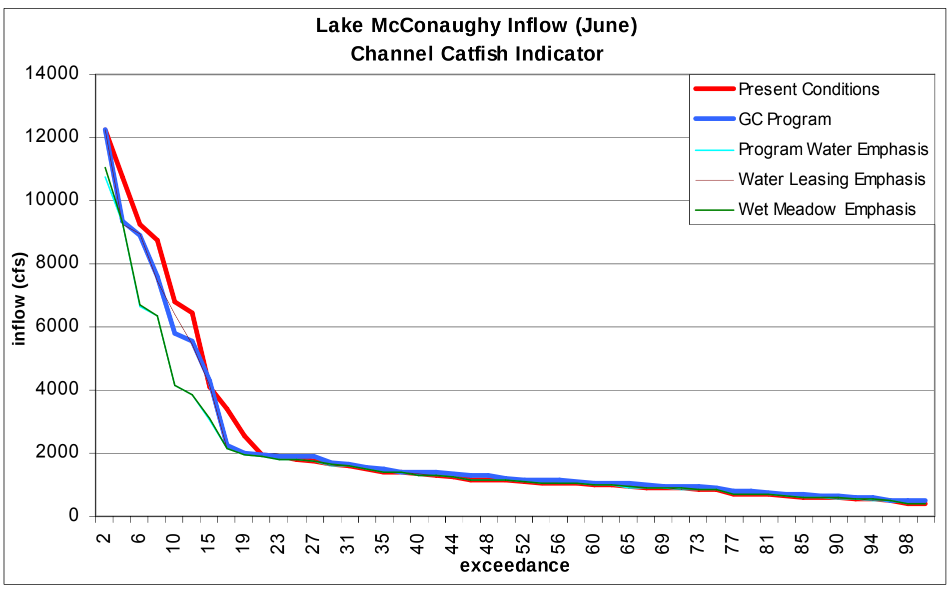

Figure 5-NSF-16.—Lake McConaughy channel catfish reproduction indicator: Lake McConaughy June inflow.

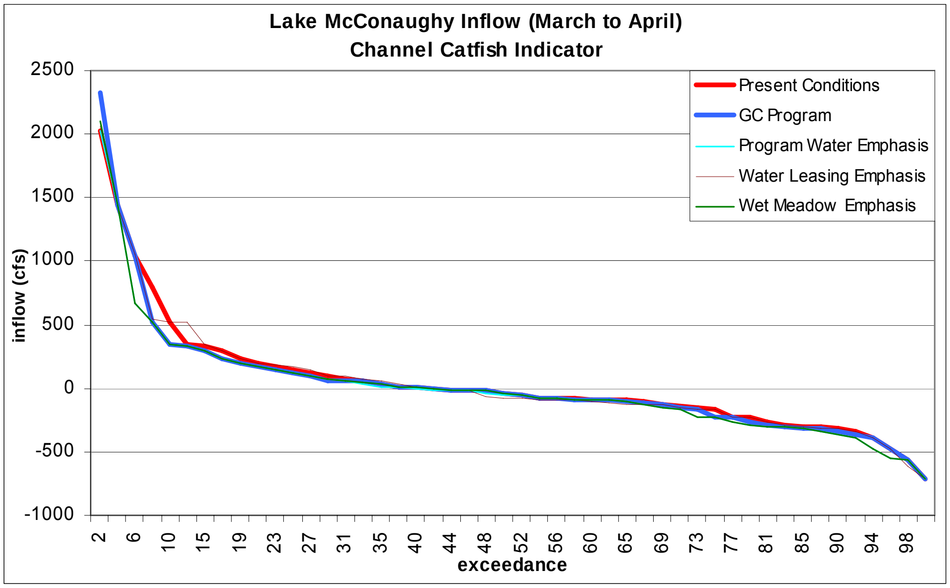

Figure 5-NSF-17.—Lake McConaughy channel catfish reproduction indicator: Lake McConaughy March to April inflow.

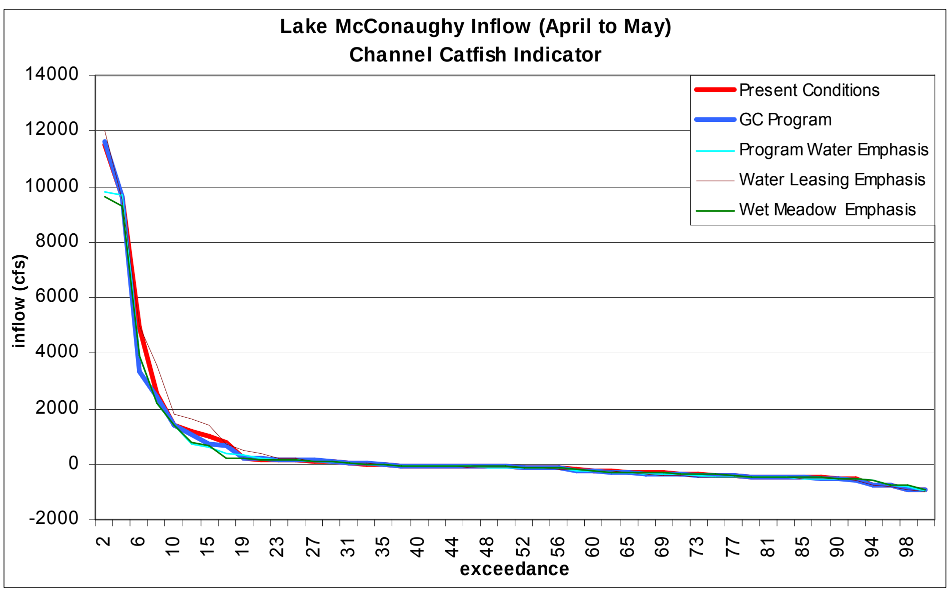

Figure 5-NSF-18.—Lake McConaughy channel catfish reproduction indicator: Lake McConaughy April to May inflow.

Under the Present Condition, channel catfish reproduction is known to take place across a range of conditions, albeit channel catfish reproduction appears more successful under higher riverflow conditions. As a result, no specific flow threshold has been established. Overall, little change is seen when examining the alternatives. Under the Governance Committee Alternative, riverflow increases relative to the Present Condition by 3 percent in April, 4 percent in May, and 3 percent in June. Under the Full Water Leasing Alternative, riverflow decreases relative to the Present Condition by 1 percent in April, 4 percent in May, and increases by 6 percent in June. Under the Wet Meadow Alternative, riverflow increases relative to the Present Condition by 4 percent in April, 8 percent in May, and 15 percent in June. Under the Water Emphasis Alternative, riverflow increases relative to the Present Condition by 4 percent in April, 9 percent in May, and 16 percent in June.

Changes in flow rate from March to April and from April to May act as staging and spawning cues, respectively. Little change is seen from the Present Condition for any of the alternatives in these areas, although some slight increase in level of change appears to occur between March and April under the Full Water Leasing Alternative.

Lake McConaughy Gizzard Shad Reproduction

Similar to the results observed for walleye and smallmouth bass, gizzard shad reproduction may be significantly impacted. Under the Present Condition, optimum reservoir elevations for successful gizzard shad spawning occur in approximately 88 percent of years. The occurrence of these conditions is reduced to 67 percent under the Governance Committee Alternative, 78 percent under the Water Emphasis Alternative, and 74 percent under the Wet Meadow Alternative. This occurrence is increased to 93 percent under the Full Water Leasing Alternative (figure 5-NSF-19).

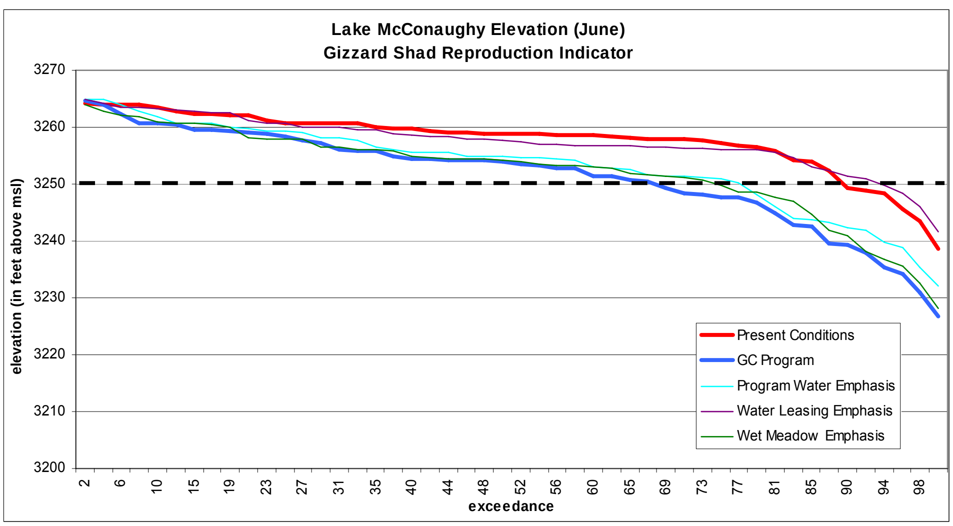

Figure 5-NSF-19.—Gizzard shad reproduction indicator: Lake McConaughy June elevation.

Lake McConaughy Gizzard Shad Overwintering Conditions

Gizzard shad overwintering is also subject to reservoir water surface elevations. Under the Present Condition, gizzard shad may be expected to overwinter well in 90 percent of years. The occurrence of these conditions is reduced to 78 percent under the Governance Committee Alternative, 82 percent under the Wet Meadow Alternative, and 85 percent under the Water Emphasis Alternative. This occurrence is increased to 96 percent under the Full Water Leasing Alternative (figure 5-NSF-20).

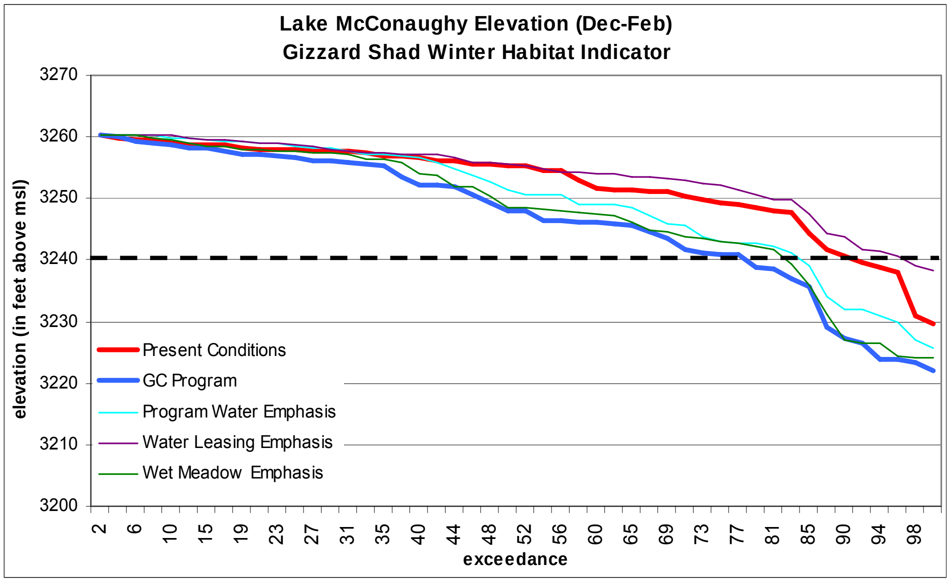

Figure 5-NSF-20.—Gizzard shad reproduction indicator: Lake McConaughy June elevation.

Lake Ogallala Trout Fisheries Support

Lake McConaughy discharges into Lake Ogallala. Effects of the alternatives on Lake McConaughy can also impact Lake Ogallala if they affect the characteristics of the discharged water.

The greatest influencing factor on water temperature in Lake Ogallala is reservoir surface elevation in Lake McConaughy. The hydropower intake through which the majority of water released through Kingsley Dam is drawn, is located very low on the dam face. As a result, the water drawn into the intake is deep water under most reservoir conditions and is normally cold. As the reservoir surface elevation declines over the course of the summer, the water being drawn into the intake gets incrementally warmer. Under low reservoir conditions, the temperature of this water can reach levels that result in stress to the trout fishery maintained in Lake Ogallala (about 18°C). Regression analyses were performed on historical data to determine monthly relationships between reservoir surface elevation and intake water temperature. These results were then used to calculate the monthly thresholds when there would exist a likelihood of exceeding the temperature threshold at which the fishery becomes stressed.

Under the Present Condition and all of the alternatives, June reservoir elevations are not anticipated that would result in temperature stress to the Lake Ogallala trout fishery (figure 5-NSF-21). Similarly, in July reservoir elevations are not anticipated to decline to levels that would result in temperature stress to the trout fishery under the Present Condition and the Full Water Leasing and Water Emphasis Alternatives (figure 5-NSF-22). However, under the Governance Committee Alternative, those conditions would be created in 6 percent of years, and under the Wet Meadow Alternative, those conditions would be created in 4 percent of years.

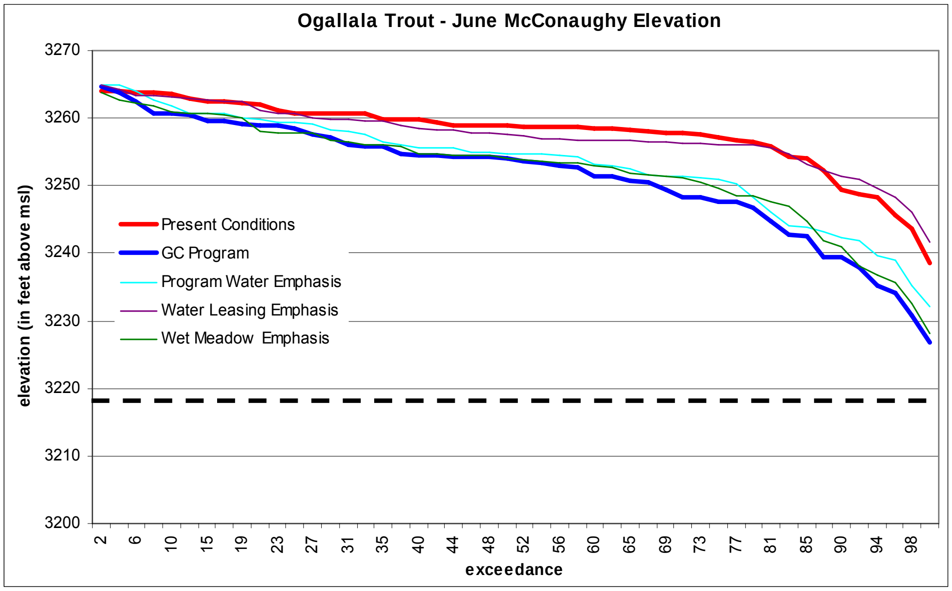

Figure 5-NSF-21.—Lake Ogallala trout indicator: Lake McConaughy June elevation.

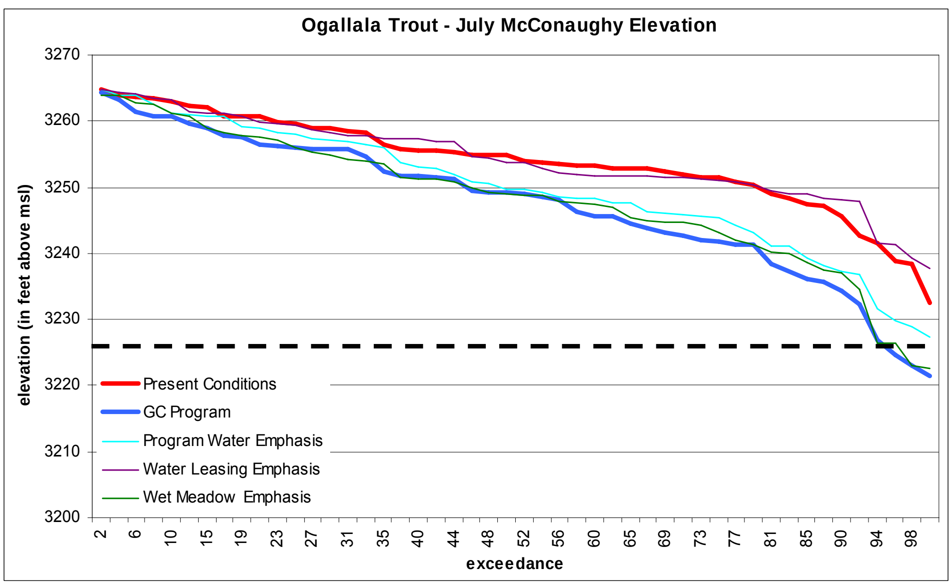

Figure 5-NSF-22.—Lake Ogallala trout indicator: Lake McConaughy July elevation.

In August (figure 5-NSF-23), reservoir levels that are expected to lead to temperature stress to the trout fishery are anticipated to occur in 4 percent of years under the Present Condition, 2 percent under the Full Water Leasing Alternative, 11 percent under the Wet Meadow Alternative, 12 percent under the Water Emphasis Alternative, and 19 percent of years under the Governance Committee Alternative.

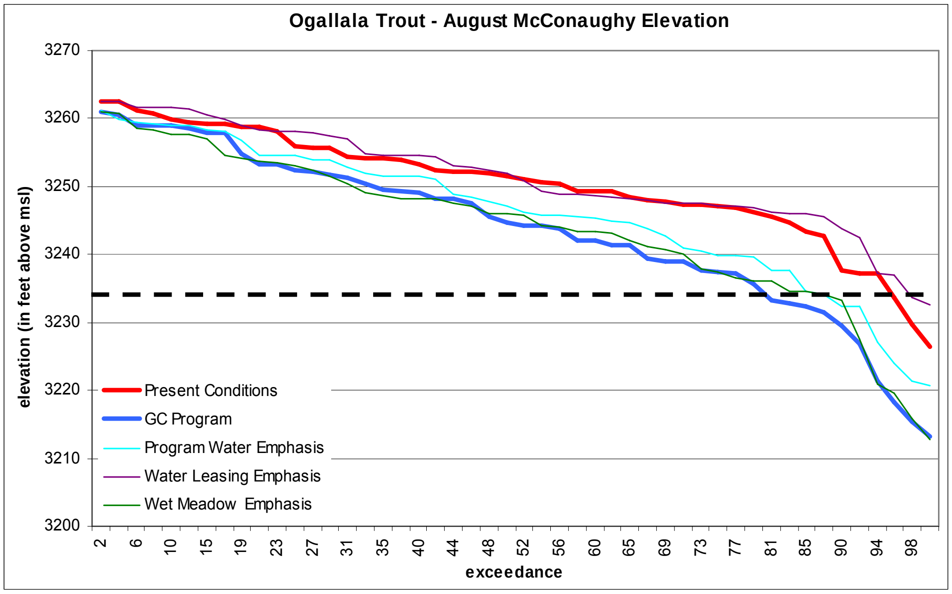

Figure 5-NSF-23.—Lake Ogallala trout indicator: Lake McConaughy August elevation.

In September, reservoir levels that are expected to lead to temperature stress to the trout fishery are anticipated to occur in 10 percent of years under the Present Condition, 6 percent under the Full Water Leasing Alternative, 16 percent under the Water Emphasis Alternative, 22 percent under the Wet Meadow Alternative, and 26 percent under the Governance Committee Alternative (figure 5-NSF-24).

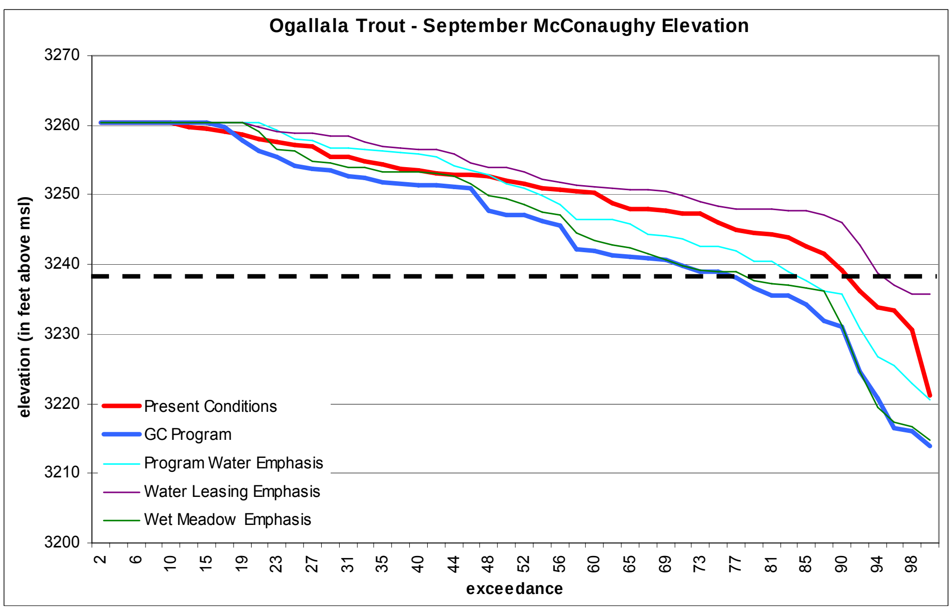

Figure 5-NSF-24.—Lake Ogallala trout indicator: Lake McConaughy September elevation.

Lower Platte River Catfish and Shovelnose Sturgeon Fisheries

Lower Platte River catfish and shovelnose sturgeon use the Lower Platte River to spawn. This species require diverse habitats and velocity breaks. The cue for spawning is driven by water temperature and increases in flow, while these same increases in flow are in part responsible for creation of the diversity of habitats and velocity breaks present in the Lower Platte River. No specific threshold has been examined for these resources; rather, a comparison of all conditions is made. All the alternatives provide similar effects on spring flows (figure 5-NSF-25). In the higher 50 percent of flow conditions, there is no change from the Present Condition for the Governance Committee Alternative or the Water Emphasis Alternative, a 3-percent increase under the Full Water Leasing Alternative, and a 1-percent decrease under the Wet Meadow Alternative. During the drier 50 percent of spring flow conditions, there are increases of 6 percent for the Governance Committee, Wet Meadow, and Water Emphasis Alternatives, and an 8-percent increase under the Full Water Leasing Alternative.

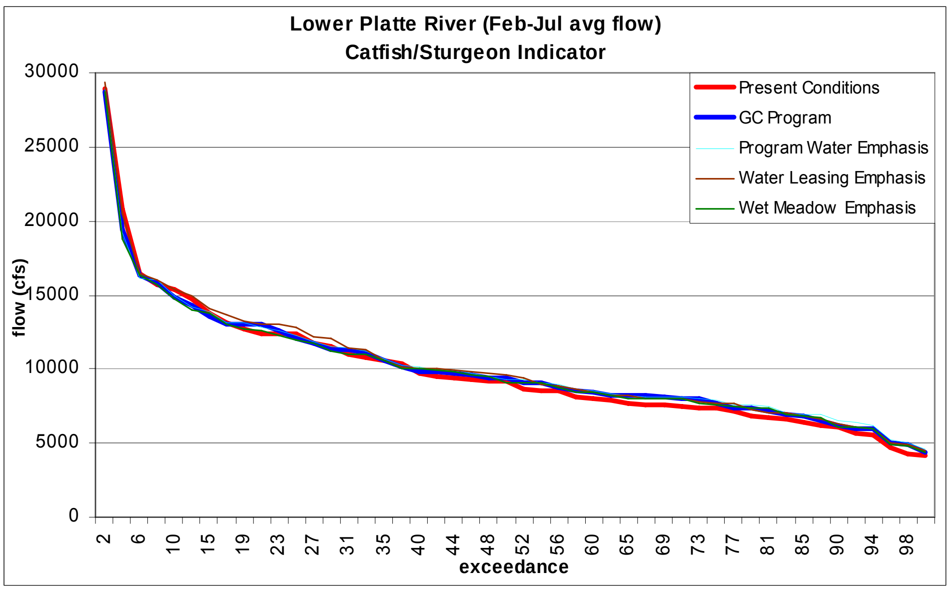

Figure 5-NSF-25.—Catfish and sturgeon indicator: Lower Platte River (February to July average flow)

CENTRAL PLATTE RIVER FISHERIES

Issue: How would the action alternatives affect the Central Platte fisheries?

Overview

SCOPE

One of the most important fish resources affected by the Program is located in the Central Platte River between Lexington and Grand Island, Nebraska, also known as the Big Bend Reach. Of particular importance are small fishes that provide forage for the endangered interior least tern and larger fish that supply forage for bald eagles.

INDICATORS

- **Physical habitat:** Monthly habitat duration curves for each alternative were compared to the Present Condition to determine percentage change in fish habitat. Positive and negative percent differences were interpreted as minor (<10 percent) (- or +), moderate (10-20 percent) (-- or ++), or major (>20 percent) (--- or +++), depending on the magnitude of change. Each positive and negative category was tallied to determine which alternative provided the most benefit to the fish community.

- **Stream channel changes:** SEDVEG Gen3 model was used to compare stream channel changes on forage fish habitat between alternatives and Present Condition.

- **Water temperature:** Assessment of summer water temperature impacts was a hydrologic analysis that involved calculating the percent of time 1,200 cfs was met or exceeded at Grand Island during June, July, and August for each alternative using monthly flows provided by the CPR model. Also, the probabilities of exceeding the 32ºC (90ºF) temperature standard were calculated.

- **Turbidity:** Monthly turbidity levels were compared between the Present Condition and alternatives.

SUMMARY OF IMPACTS

Based on the PHABSIM analysis, all alternatives resulted in similar and generally better fish habitat compared to the Present Condition, but the Water Emphasis Alternative would provide slightly more benefit for the fish community among alternatives at Overton. The Governance Committee and Full Water Leasing Alternatives would provide slightly more benefit for the fish community at Grand Island.

Based on the SEDVEG Gen3 modeling, the Wet Meadow Alternative had the largest summer channel widths (461.5 feet).

On the basis of daily flows, there was a small difference in the probability of exceeding the Nebraska temperature standard and the number of times that the 1,200-cfs flow target was exceeded among alternatives during the summer.

Turbidity analysis (discussed above) showed that no significant change in turbidity would occur due to any alternatives compared to Present Condition.

IMPACTS ANALYSIS

Physical Habitat—PHABSIM

The Physical Habitat Simulation System (PHABSIM) measures fish habitat suitability in response to changes in depths and velocities associated with varying flows. The output from PHABSIM is a measure of "weighted useable area," or habitat, versus flow.

Overton

Based on the PHABSIM habitat analysis, all alternatives are similar and generally better than the Present Condition for the forage fishery resource. The Water Emphasis Alternative ranked highest among alternatives for most positive benefits (table-5-CPF-1). All alternatives had similar major habitat gains. October and March had the most negative habitat losses for all alternatives. September had the only major positive habitat gains for all alternatives. Given this analysis, all alternatives resulted in similar and generally better impacts compared to the Present Condition, but the Water Emphasis Alternative would provide slightly more benefit for the fish community at Overton.

Table-5-CPF-1.—Summary of Impacts for Fish Habitat at Overton
(Sum of Each Value for All Months and All Exceedance Levels)

Value	Governance Alternative	Full Water Leasing Alternative	Wet Meadow Alternative	Water Emphasis Alternative
Minor loss -	17	24	19	13
Moderate loss --	1	3	1	2
Major loss ---	0	1	0	1
No change	0	0	0	0
Minor gain +	21	17	24	26
Moderate gain ++	9	3	3	5
Major gain +++	0	0	1	1

Alternative rankings for most positive benefits:

- Water Emphasis Alternative - 32
- Governance Committee Alternative - 30
- Wet Meadow Alternative - 28
- Full Water Leasing - 20

Alternative rankings for most major habitat gains:

- Water Emphasis Alternative - 1
- Wet Meadow Alternative - 1
- Governance Committee Alternative - 0
- Full Water Leasing Alternative - 0

Grand Island

Based on the PHABSIM analysis, all alternatives (except for the Full Water Leasing Alternative) were similar and generally better than the Present Condition for the fishery resource at Grand Island. September had the most major increases in habitat for all flow exceedances compared to the Present Condition (table-5-CPF-2). June had positive habitat gains for all alternatives at all exceedance levels. March had the most negative impacts on fish habitat for all alternatives. Given this analysis, all alternatives had similar and generally beneficial impacts compared to the Present Condition except that the Governance Committee and Water Emphasis Alternatives would provide slightly more benefit for the fish community than the Full Water Leasing or Wet Meadow Alternatives.

Table-5-CPF-2.—Summary of Impacts for Fish Habitat at Grand Island
(Sum of Each Value for All Months and All Exceedance Levels)

Value	Governance Alternative	Full Water Leasing Alternative	Wet Meadow Alternative	Water Emphasis Alternative
Minor loss -	11	24	19	15
Moderate loss --	1	3	1	2
Major loss ---	0	1	0	1
No change	0	0	0	0
Minor gain +	25	14	21	21
Moderate gain ++	7	4	5	5
Major gain +++	4	2	2	4

Alternative rankings for most positive benefits:

- Governance Committee Alternative - 36
- Water Emphasis Alternative - 30
- Wet Meadow Alternative - 28
- Full Water Leasing Alternative - 20

Alternative rankings for most major habitat gains:

- Governance Committee Alternative - 4
- Water Emphasis Alternative - 4
- Wet Meadow Alternative - 2
- Full Water Leasing Alternative - 2

SEDVEG Gen3 Model

Table-5-CPF-3 shows the extent of optimum depth habitat for interior least tern forage fish using the SEDVEG Gen3 model. The data were generated from averaging channel widths during the 48-year hydrologic baseline (Murphy et al., 2005). Channel widths within optimum depth criteria identified for forage fish in summer and nonsummer periods are displayed in this table for the Present Condition and each alternative.

Most increases occurred during summer after each increment. All alternatives showed minimal change in summer channel widths over Present Condition. More impact occurred during nonsummer. Among alternatives, the Wet Meadow Alternative had the largest summer channel widths (795.1 feet) (table-5-CPF-3).

Table-5-CPF-3.—SEDVEG Gen3 Model Summary of Channel Widths for Each Alternative that Meets Forage Fish Depth Criteria* (48-Year Average)

	Average Transect Widths (feet)		**Percent Difference From Present Condition**	
	Non-summer	**Summer**	**Non-summer**	**Summer**
Present Condition	115.8	749.5		
Governance Committee Alternative	112.6	755.3	-2.8	0.8
Full Water Leasing Alternative	105.4	745.5	-8.9	-0.5
Wet Meadow Alternative	97.9	795.1	-15.4	6.1
Water Emphasis Alternative	89.8	768.5	-22.5	2.5
*Depth criteria: Nonsummer equals 3-10 centimeters Summer equals 3-20 centimeters				

Water Temperature

Elevated water temperatures affect fish in a variety of ways. Fish physiology can be altered during high water temperature conditions influencing survival rates, growth rates, embryonic development, and susceptibility to parasites and diseases. Elevated temperatures can also affect metabolism, fluid-electrolyte balance, and the acid-base relationship within fish (Lantz, 1970 and Islam and Strawn, 1975). Fish behavior can also be altered with respect to habitat use activities, distribution, and species interactions (Crawshaw, 1977; Matthews and Hill, 1979; Adams et al., 1982; and Stauffer et al., 1984). Changes in water temperature can also affect timing of spawning, duration of incubation, and timing of gonadal maturation (Fry, 1971; Matthews and Maness, 1979; and Armour, 1991). Water quality of a stream is influenced by changes in water temperature which affect solubility of dissolved gases, deoxygenation rates, and synergistic toxicity (Theurer et al., 1984).

The Nebraska water temperature standard of 32.0ºC (90ºF) is for summer. A comparison of alternatives relative to water temperature at Grand Island during June, July, and August is presented in the "Water Quality" section in this chapter. The sub-subsection "Water Quality, Impacts Analysis, Central Platte River" in chapter 5, discusses and shows the tabulation of days with flow greater than 1,200 cfs for each of the alternatives. Results indicate that about half the days in June (744 of 1,440 or about 15 days in June per year) had a flow greater than 1,200 cfs under existing conditions. The Governance Committee Alternative would increase the number of days with flows greater than 1,200 cfs to 799 days out of the period of record (or about 17 days in June per year), least among alternatives. The Full Water Leasing Alternative had the greatest number of days >1,200 cfs in June among alternatives. The July comparison showed a decrease from 486 days among the 1,488 in the record in the Present Condition to between 461 days with the Governance Committee Alternative (from 33 percent to 31 percent of the days in the record for July). The Wet Meadow Alternative had the greatest number of days >1,200 cfs in July among alternatives. The number of days in August with the Governance Committee Alternative at or above 1,200 cfs increased from 106 to 115, which was similar to the other alternatives. In summary, on the basis of daily flows, there was a small difference in the probability of exceeding the Nebraska temperature standard and the number of times that the 1,200 cfs flow was exceeded among alternatives during the summer (see the "Water Quality" section in this chapter).

Water Quality

Other impacts to forage fish in the Central Platte River are water quality related. Recently, high selenium levels have been found in fish tissues (see the *Water Quality Appendix* in volume 3). The source of these high levels is suspected to be from groundwater sources through the food chain. The Governance Committee and Water Emphasis Alternatives incorporate the groundwater mound as an element at this time. The Governance Committee Alternative contains an element that could transport drainage water from the groundwater mound area to the river. Depending upon how these elements are implemented, there is the potential to import additional selenium to the river and possibly impact forage fish. Impacts on water quality standards for each alternative are discussed in the *Water Quality Appendix* in volume 3.

Turbidity analysis (see the "Water Quality" section in chapter 5) showed that in the Central Platte River near Grand Island, higher turbidity levels would occur with each alternative compared to the Present Condition. This impact may slightly reduce visibility for fish and affect their ability to capture prey or escape predators.

HYDROPOWER

Issue: How would the action alternatives affect hydropower generation?

Overview

SCOPE

The immediate area of effect includes five hydropower generation facilities in the Central Platte River Basin and six in the North Platte River Basin (facilities in the South Platte River Basin are outside the area of impact). Although the economic effects are far-ranging, they are confined to the Western Electricity Coordinating Council (WECC) and Midwest Reliability Organization (MRO) regions of the United States.

INDICATORS

Effects were measured by:

- Amount of **electrical generation**
- **Dependable capacity**
- **Economic value** of the hydropower produced

SUMMARY OF HYDROPOWER IMPACTS

Table 5-H-1 summarizes impacts for hydropower indicators.

Table 5-H-1.—Summary of the Hydropower Impacts Relative to the Present Condition*

Alternative	Scope	Change in Generation (Megawatt Hours)	Change in Economic Value (2002 Dollars)	Change in Dependable Capacity (Megawatts)**	
				Summer	Winter
Governance Committee Alternative	NP***	5,376	304,881	-13.93	-0.02
	CP	17,693	272,788	-3.45	-2.24
Full Water Leasing Alternative	NP	1,160	-133,614	-16.21	3.12
	CP	27,403	441,700	-4.85	9.23
Wet Meadow Alternative	NP	10,456	689,874	-8.62	-0.54
	CP	26,498	631,097	-1.08	-6.20
Water Emphasis Alternative	NP	11,643	760,275	-15.08	-0.54
	CP	30,139	507,042	-3.50	11.70

* Expected annual effects assume full program implementation and are evaluated using 2002 avoided costs.
**Calculated using the 90-percent exceedance method as described in the *Economics, Hydropower Appendix* in volume 3.
*** NP is North Platte hydropower system; CP is Central Platte hydropower system.

All of the alternatives reduce summer dependable capacity in the North Platte hydropower system, the largest effects being a reduction of 16.21 megawatts (-7.5 percent) for the Full Water Leasing Alternative. The Governance Committee and Wet Meadow Alternatives reduce dependable winter capacity, the Full Water Leasing Alternative increases dependable winter capacity, and the Water Emphasis Alternative decreases in the North Platte hydropower system and increases in the Central Platte hydropower system.

The alternatives also reduce summer dependable capacity in the Central Platte hydropower system, by as much as 4.8 megawatts (-5.4 percent) under the Full Water Leasing Alternative. The effects of the alternatives on winter dependable capacity are both positive and negative depending on the alternative.

The reductions in dependable capacity are a result of the generally lower reservoir levels discussed in the "Water" section, earlier in this chapter, which reduce the maximum amount of power that can be produced on a highly reliable basis.

Most of the alternatives increase overall power generation and economic value of power produced, due to the increased volume of waters being moved through the powerplants each year.

IMPACTS ANALYSIS

All of the action alternatives change both reservoir levels and releases through hydroelectric powerplants, both in the North and Central Platte hydropower systems. These changes can affect hydropower generation and capacity (see table 5-H-1).

Governance Committee Alternative

North Platte Hydropower System

The annual generation under the proposed Program is increased by 5,376 megawatt hours (+0.77 percent) over the Present Condition. Calculated using the 90-percent exceedance method, the dependable summer capacity is decreased by 13.93 megawatts, and the dependable winter capacity is decreased by 0.02 megawatts. The expected change in annual economic value of electricity production is $304,881 (2002 dollars).

Central Platte Hydropower System

The annual generation under the proposed Program is increased by 17,693 megawatt hours (+3.80 percent) over the Present condition. Calculated using the 90-percent exceedance method, the dependable summer capacity is decreased by 3.45 megawatts, and the dependable winter capacity is reduced by 2.24 megawatts. The expected change in annual economic value of electricity production is $272,788 (2002 dollars).

Full Water Leasing Alternative

North Platte Hydropower System

The annual generation under the Full Water Leasing Alternative is increased by 1,160 megawatt hours (+0.17 percent) over the Present Condition. Calculated using the 90-percent exceedance method, the dependable summer capacity is decreased by 16.21 megawatts, and the dependable winter capacity is increased by 3.12 megawatts. The expected change in the annual economic value of electricity production is -$133,614 (2002 dollars).

Central Platte Hydropower System

The annual generation under the Full Water Leasing Alternative is increased by 27,403 megawatt hours (+5.88 percent) over then Present condition. Calculated using the 90-percent exceedance method, the dependable summer capacity is decreased by 4.85 megawatts, and the dependable winter capacity is increased by 9.23 megawatts. The expected change in annual economic value of electricity production is $441,700 (2002 dollars).

Wet Meadow Alternative

North Platte Hydropower System

The expected annual generation under the Wet Meadow Alternative is increased by 10,456 megawatt hours (+1.49 percent) over the Present Condition. Calculated using the 90-percent exceedance method, the dependable summer capacity is decreased by 8.62 megawatts, and the dependable winter capacity is decreased by 0.54 megawatts. The expected change in annual economic value of electricity production is $689,874 (2002 dollars).

Central Platte Hydropower System

The annual generation under the Wet Meadow Alternative is increased by 26,498 megawatt hours (+5.69 percent) over the Present Condition. Calculated using the 90-percent exceedance method, the dependable summer capacity is decreased by 1.08 megawatts, and the dependable winter capacity is decreased by 6.20 megawatts. The expected change in annual economic value of electricity production is $631,097 (2002 dollars).

Water Emphasis Alternative

North Platte Hydropower System

The annual generation under the Water Emphasis Alternative is increased by 11,643 megawatt hours (1.66 percent) over the Present Condition. The 90-percent exceedance dependable summer capacity is decreased by 15.08 megawatts, and the dependable winter capacity is decreased by 0.54 megawatts. The expected change in annual economic value of electricity production is $760,275 (2002 dollars).

Central Platte Hydropower System

The annual generation under the Water Emphasis Alternative is increased by 30,139 megawatt hours (+6.47 percent) over the Present Condition. The 90-percent exceedance dependable summer capacity is decreased by 3.50 megawatts, and the dependable winter capacity is increased by 11.70 megawatts. The expected change in annual economic value of electricity production is about $507,042 (2002 dollars).

ANALYSIS BY WESTERN AREA POWER ADMINISTRATION

The impact on customers served by Western Area Power Administration (Western) may differ from the larger economic impacts described for the Western Electricity Coordinating Council Region. Interested readers are referred to the Financial Impacts to Pick-Sloan Firm Power Customers in volume 2, provided by Western on December 5, 2005, for a discussion of some of the potential financial, capacity, and load following impacts which may be incurred by this subset of electricity users. The EIS team has not reviewed the analysis contained in this report.

RECREATION

Issue: How would the action alternatives affect recreation?

Overview

SCOPE

The scope of this analysis is the recreation areas in each state that would most likely be affected by the action alternatives.

INDICATORS

Each of the action alternatives is compared to the Present Condition in terms of recreation visitation and economic value where data are available. See the "Recreation" section in chapter 4 for a detailed discussion of areas and indicators.

SUMMARY OF IMPACTS

Wyoming

- **Wyoming main stem reservoirs.** On a statewide basis, and under average hydrologic conditions, the impacts on general recreational use at Glendo, Guernsey, and Seminoe reservoirs in Wyoming are minor for all alternatives. The changes attributable to any one of the alternatives amount to approximately 6,000 annual recreation visits at the three reservoirs in total. These total changes are less than 3 percent of the annual total identified in the Present Condition.

  - **Average condition.** The Full Water Leasing Alternative results in increased anglers at Pathfinder and Seminoe reservoir fisheries and slight decreases in anglers for Glendo reservoir fishery under average conditions. The other three alternatives have minimal negative impacts (-0.9 to -5.9 percent change from the Present Condition) to angler visitation at the Wyoming reservoirs.

  - **Fisheries elimination scenario.** All alternatives except the Full Water Leasing Alternative could result in lowering reservoir levels and eliminating fisheries at Pathfinder Reservoir and possibly at Seminoe Reservoir under severe drought conditions. These fisheries recover in 2 to 7 years, depending on the species. Under this scenario, the average annual impacts are minimal or moderate for trout anglers and substantial for walleye anglers.

  - **Stream fisheries.** Wyoming stream fisheries would be the same under any of the alternatives as under the Present Condition—either in average years or in a severe drought.

- **Wyoming North Platte Reservoirs boat ramp access.** All of the alternatives, except the Full Water Leasing Alternative increase the number of seasons slightly (ranging from 1 to 7 seasons) that individual boat ramps at Pathfinder and Seminoe Reservoirs are not usable due to low water, at some time from May to September. The Full Water Leasing Alternative improves conditions somewhat. The impacts on the use of Glendo boat ramps are very minor.

Colorado

In Colorado, impacts to recreation visitation and associated value are not quantifiable with the currently available data. Under the Water Emphasis and Full Water Leasing Alternatives, water leasing from South Platte reservoirs is expected to reduce reservoir areas by -2.3 percent to -9 percent earlier in the summer than those same reductions would otherwise occur for delivering irrigation water. Depending on design, locations and operation, the implementation of the Tamarack Projects may result in some (unquantified) increase in recreational use and value due to increased opportunity and habitat for waterfowl hunting.

Nebraska

- **Lake McConaughy recreation visits:** For all action alternatives, except the Full Water Leasing Alternative, Lake McConaughy in Nebraska experiences declines in surface area of -3.3 percent to -5.6 percent under the alternatives and recreational losses of less than 2 percent based on the Present Condition figure of 711,644 recreational visits. The Water Emphasis Alternative results in the least amount of change in surface area and thus, the least amount of decline in recreation visits and economic value. The Full Water Leasing Alternative results in an overall increase in average surface area, resulting in slight increases in recreation visits and economic value.

- **Lake McConaughy boat ramp access:** As shown in table 5-REC-20, different boat ramps are available different percentages of the time, depending on the elevation of the particular ramp. Under the Present Condition, the availability of boat ramps all summer ranges from 21 percent to 100 percent depending on the ramp, and the availability for at least one month in a summer ranges from 52 percent to 100 percent. Under the alternatives, availability of boat ramps for the entire summer ranges from zero percent to 8 percent up to 100 percent depending on first alternative, then ramp. The availability for at least 1 month in a given summer ranges from 23 percent to 52 percent up to 100 percent depending on alternative and ramp. The overall effect of this is that some of the higher-elevation boat ramps will become functionally unusable under most conditions, while some of the lower elevation boat ramps will see relatively few effects.

- **Panhandle:** Only the Full Water Leasing Alternative could significantly change water deliveries thru the Inland Lakes and to irrigated areas in the Nebraska panhandle. The Full Water Leasing Alternative could reduce somewhat the water deliveries in this area, which would reduce the amount or duration of storage in the Inland Lakes and the seepage and runoff into the coldwater streams that cross through the irrigated areas. This is not expected to affect the local fisheries. More precise estimates of the effects of water leasing must wait until a specific water leasing plan is developed.

Tables 5-REC-1, 5-REC-2, 5-REC-3, 5-REC-4, and 5-REC-5 show the summary of impacts for Wyoming, Colorado, and Nebraska.

Table 5-REC-1.–Summary of Annual Impacts on Reservoir Recreation Not Including Anglers: Changes and Percent Change in Measurement Indices as Compared to the Present Condition.

		Governance Committee Alternative		**Full Water Leasing Alternative**		**Wet Meadow Alternative**		**Water Emphasis Alternative**	
		Change	Percent of Change	Change	Percent of Change	Change	Percent of Change	Change	Percent of Change
Glendo Reservoir	Surface area (acres)	-365.9	-4.18	-241.1	-2.76	-606.3	-6.93	-518.9	-5.93
	Recreation visits	-2,985	-2.30	-1,959	-1.51	-4,985	-3.85	-4,253	-3.28
	Economic value	-$72,704	-2.30	-$47,714	-1.51	-$121,431	-3.85	-$103,608	-3.28
Guernsey Reservoir	Surface area (acres)	-1.6	-0.11	11.3	0.81	-6.6	-0.47	-5.5	-0.40
	Recreation visits	-41	-0.06	192	0.30	-121	-0.19	-103	-0.16
	Economic value	-$1,104	-0.06	$5,197	0.30	-$3,284	-0.19	-$2,782	-0.16
Seminoe Reservoir	Surface area (acres)	-310.5	-2.36	667.5	5.06	-1,028.5	-7.80	-650.2	-4.93
	Recreation visits	-315	-0.91	664	1.93	-1,063	-3.09	-666	-1.93
	Economic value	-$7,665	-0.91	$16,166	1.93	-$25,897	-3.09	-$16,218	-1.93
Pathfinder Reservoir	Surface area (acres)	-338.8	-2.50	948.4	6.99	-1,273.2	-9.39	-862.4	-6.36
	Recreation visits / Economic value	Not available							
Wyoming Totals	**Surface area (acres)**	**-1,016.7**	**-2.76**	**1,386.0**	**3.76**	**-2,914.5**	**-7.90**	**-2,037.0**	**-5.52**
	Recreation visits	**-3,340**	**-1.47**	**-1,103**	**-0.49**	**-6,169**	**-2.72**	**-5,022**	**-2.21**
	Economic value	**-$81,473**	**-1.43**	**-$26,351**	**-0.46**	**-$150,613**	**-2.64**	**-$122,608**	**-2.15**

Table 5-REC-2.—Wyoming: Summary of Total and Average Annual Impacts on Fisheries Recreation: Changes and Percent of Change in Measurement Indices as Compared to the Present Condition under Average Conditions

		Governance Committee Alternative		**Full Water Leasing Alternative**		**Wet Meadow Alternative**		**Water Emphasis Alternative**	
		Change	Percent of Change	Change	Percent of Change	Change	Percent of Change	Change	Percent of Change
Cardwell Fishery, Miracle Mile, North Platte River below Gray Reef Reservoir		No impact							
Pathfinder Reservoir (trout)	Total first increment visits	-3,848	-1.00	13,468	3.50	-17,303	-4.50	-11,544	-3.00
	Average annual recreation visits	-296	-1.00	1,036	3.50	-1,331	-4.50	-888	-3.00
	Total first increment economic value	-$148,533	-1.00	$519,865	3.50	-$667,896	-4.50	-$445,598	-3.00
	Average annual economic value	-$11,426	-1.00	$39,990	3.50	-$51,377	-4.50	-$34,277	-3.00
Pathfinder Reservoir (walleye)	Total first increment visits	-988	-1.00	3,471	3.50	-4,459	-4.50	-2,977	-3.00
	Average annual recreation visits	-76	-1.00	267	3.50	-343	-4.50	-229	-3.00
	Total first increment economic value	-$38,137	-1.00	$133,981	3.50	-$172,117	-4.50	-$114,912	-3.00
	Average annual economic value	-$2,934	-1.00	$10,306	3.50	-$13,240	-4.50	-$8,839	-3.00
Seminoe Reservoir (trout)	Total first increment visits	-2,977	-1.00	5,967	2.00	-8,944	-3.00	-5,967	-2.00
	Average annual recreation visits	-229	-1.00	459	2.00	-688	-3.00	-459	-2.00
	Total first increment economic value	-$114,912	-1.00	$230,326	2.00	-$345,238	-3.00	-$230,326	-2.00
	Average annual economic value	-$8,839	-1.00	$17,717	2.00	-$26,557	-3.00	-$17,717	-2.00
Seminoe Reservoir (walleye)	Total first increment visits	-1,199	-0.90	2,675	2.00	-4,020	-3.00	-2,681	-2.00
	Average annual recreation visits	-92	-0.90	206	2.00	-309	-3.00	-206	-2.00
	Total first increment economic value	-$46,296	-0.90	$103,240	2.00	-$155,187	-3.00	-$103,501	-2.00
	Average annual economic value	-$3,561	-0.90	$7,942	2.00	-$11,937	-3.00	-$7,962	-2.00

		Governance Committee Alternative		Full Water Leasing Alternative		Wet Meadow Alternative		Water Emphasis Alternative	
		Change	Percent of Change	Change	Percent of Change	Change	Percent of Change	Change	Percent of Change
Glendo Reservoir	Total first increment visits	-15,691	-2.30	-19,097	-2.80	-40,248	-5.90	-22,516	-3.30
	Average annual recreation visits	-1,207	-2.30	-1,469	-2.80	-3,096	-5.90	-1,732	-3.30
	Total first increment economic value	-$605,673	-2.30	-$737,144	-2.80	-$1,553,573	-5.90	-$869,118	-3.30
	Average annual economic value	-$46,590	-2.30	-$56,703	-2.80	-$119,506	-5.90	-$66,855	-3.30
Wyoming Fisheries Totals	**Total first increment visits**	**-24,703**	**-0.89**	**6,484**	**0.23**	**-74,974**	**-2.71**	**-45,685**	**-1.65**
	Average annual recreation visits	**-1,900**	**-0.89**	**499**	**0.23**	**-5,767**	**-2.71**	**-3,514**	**-1.65**
	Total first increment economic value	**-$953,550**	**-0.89**	**$250,268**	**0.23**	**-$2,894,011**	**-2.71**	**-$1,763,456**	**-1.65**
	Average annual economic value	**-$73,350**	**-0.89**	**$19,251**	**0.23**	**-$222,616**	**-2.71**	**-$135,650**	**-1.65**

Table 5-REC-3.—Wyoming: Summary of Total and Average Annual Impacts on Fisheries Recreation: Changes and Percent of Change in Measurement Indices as Compared to the Present Condition under the Fisheries Elimination Scenario

		Governance Committee Alternative		Full Water Leasing Alternative	Wet Meadow Alternative		Water Emphasis Alternative	
		Change	Percent of Change	No impact	Change	Percent of Change	Change	Percent of Change
Cardwell Fishery, Miracle Mile, and North Platte River below Gray Reef Reservoir		No impacts						
Pathfinder Reservoir (Trout)	Total first increment visits	-15,044	-3.91	No impact	-15,044	-3.91	-15,044	-3.91
	Average annual recreation visits	-1,157	-3.91		-1,157	-3.91	-1,157	-3.91
	Total first Increment economic value	-$580,698	-3.91		-$580,698	-3.91	-$580,698	-3.91
	Average annual economic value	-$44,660	-3.91		-$44,660	-3.91	-$44,660	-3.91
Pathfinder Reservoir (Walleye)	Total first Increment visits	-61,161	-61.67		-61,161	-61.67	-61,161	-61.67
	Average annual recreation visits	-4,705	-61.67		-4,705	-61.67	-4,705	-61.67
	Total first increment Economic value	-$2,360,815	-61.67		-$2,360,815	-61.67	-$2,360,815	-61.67
	Average annual economic value	-$181,613	-61.67		-$181,613	-61.67	-$181,613	-61.67
Glendo Reservoir		No impacts						

		Governance Committee Alternative		Full Water Leasing Alternative	Wet Meadow Alternative		Water Emphasis Alternative	
		Change	Percent of Change	No impact	Change	Percent of Change	Change	Percent of Change
Seminoe Reservoir (Trout)	Total first Increment visits	-2,145	-0.81	No impact	-2,145	-0.81	-2,145	-0.81
	Average annual recreation visits	-2,680	-11.68		-2,680	-11.68	-2,680	-11.68
	Total first increment economic value	-$82,797	-0.81		-$82,797	-0.81	-$82,797	-0.81
	Average annual economic value	-$103,448	-11.68		-$103,448	-11.68	-$103,448	-11.68
Seminoe Reservoir (Walleye)	Total first increment visits	-73,087	-61.27		-73,087	-61.27	-73,087	-61.27
	Average annual recreation visits	-6,404	-62.14		-6,404	-62.14	-6,404	-62.14
	Total first increment economic value	-$2,821,158	-61.27		-$2,821,158	-61.27	-$2,821,158	-61.27
	Average annual economic value	-$247,194	-62.14		-$247,194	-62.14	-$247,194	-62.14
Wyoming Fisheries Totals	**Total first increment visits**	**-151,437**	**-5.57**		**-151,437**	**-5.57**	**-151,437**	**-5.57**
	Average annual recreation visits	**-14,946**	**-7.02**		**-14,946**	**-7.02**	**-14,946**	**-7.02**
	Total first increment economic value	**-$5,845,468**	**-5.57**		**-$5,845,468**	**-5.57**	**-$5,845,468**	**-5.57**
	Average annual economic value	**-$576,916**	**-7.02**		**-$576,916**	**-7.02**	**-$576,916**	**-7.02**

Table 5-REC-4. − Colorado: Summary of Annual Impacts on Recreation:
Changes in Surface Acres and Percent Change in Measurement Indices as Compared to the Present Condition

	Governance Committee Alternative	**Full Water Leasing Alternative**		**Wet Meadow Alternative**	**Water Emphasis Alternative**	
		Change	**Percent of Change**		**Change**	**Percent of Change**
Empire Reservoir	No impacts	-51.5 acres	-2.3	No impacts	-51.5 acres	-2.3
Jackson Lake State Park		-48.2 acres	-2.3		-48.2 acres	-2.3
North Sterling Reservoir		-190.4 acres	-9.0		-190.4 acres	-9.0
Prewitt Reservoir		-102.9 acres	-5.7		-102.9 acres	-5.7
Julesburg Reservoir		-70.2 acres	-5.6		-70.2 acres	-5.6
Riverside Reservoir		-74.6 acres	-2.6		-74.6 acres	-2.6

Table 5-REC-5. − Nebraska: Summary of Annual Impacts on Recreation:
Changes and Change in Measurement Indices as Compared to the Present Condition

		Governance Committee Alternative		**Full Water Leasing Alternative**		**Wet Meadow Alternative**		**Water Emphasis Alternative**	
		Change	**Percent of Change**	**Change**	**Percent of Change**	**Change**	**Percent of Change**	**Change**	**Percent of Change**
Lake McConaughy	Surface area acres)	-1,650.7	-5.60	239.5	0.81	-1,378.2	-4.67	-962.6	-3.26
	Recreation visits	-13,609	-1.91	5,883	0.83	-8,935	-1.26	-1,378	-0.19
	Economic value	-$336,000	-1.91	$145,240	0.83	-$220,613	-1.26	-$34,016	-0.19

IMPACTS ANALYSIS

Governance Committee Alternative

Wyoming

Main Stem Reservoir General Recreation

Changes in demands and deliveries from Seminoe, Glendo, Guernsey, and Pathfinder reservoirs in Wyoming will reduce the surface areas of the reservoirs available for recreation. These reductions translate into approximately 3,340 fewer recreation visits annually at the three reservoirs where general recreation visitation is measured—an average decrease of 1.5 percent. An associated loss of net value of approximately $81,000 also occurs.

Reservoir Fisheries

No significant impact is expected for Alcova, Guernsey, Glendo and Kortes reservoirs.

Average Conditions

When evaluated over the 48-year hydrologic baseline, the average annual impacts on the reservoir fisheries are minimal. The decline in reservoir fisheries under average conditions was estimated by using the percent changes in recreation visits from the recreation model for Seminoe and Glendo reservoirs. The change at Pathfinder Reservoir is represented by the relationships between recreation visits and surface area for Glendo, Guernsey, and Seminoe reservoirs since changes in recreation visitation for Pathfinder Reservoir cannot be estimated from available data. Table 5-REC-6 shows the annual visitation and economic value for Wyoming Reservoir fisheries under the Governance Committee Alternative.

Table 5-REC-6.—48-Year Average Annual Visitation and Economic Value for Wyoming Reservoir Fisheries under the Governance Committee Alternative

	Fishery	Visitation	Percent Change in Visitation from Present Condition	Value in $
Reservoir Fisheries	Pathfinder Reservoir fishery	36,844	-1	1,422,179
	Seminoe Reservoir fishery	32,925	-1	1,270,905
	Glendo Reservoir fishery	51,269	-2.3	1,978,983

Fisheries Elimination Scenario

Under extreme drought conditions, the Governance Committee Alternative may reduce reservoir levels to the point that fisheries will likely be eliminated at Pathfinder Reservoir and possibly Seminoe Reservoir. The number of years required to reestablish the fishery if this elimination occurs and the probability of this occurring under the Governance Committee Alternative during the Program's First Increment and is discussed in "Fisheries Elimination Scenario, Reservoir Fisheries, Wyoming, Method, Recreation" in chapter 4. If reservoir fisheries are eliminated during the Program's First Increment, under the severe drought scenario, the average annual impacts for the Program's First Increment on Pathfinder and Seminoe reservoirs are minimal or moderate for trout anglers but substantial for walleye anglers as shown in table 5-REC-7.

Table 5-REC-7.—WY Reservoir Fisheries Average Annual Angler Visitation and Value Under the Fisheries Elimination Scenario Under the Governance Committee Alternative

	Fishery	**Visitation**	**Change in Number of Visits**	**Value in $**	**Percent Change in Value from the Present Condition**
Reservoir Fisheries	Pathfinder Reservoir fishery— trout	28,430	-1,157	1,097,398	-3.9
	Pathfinder Reservoir fishery— walleye	2,924	-4,705	112,866	-61.7
	Seminoe Reservoir fishery— trout	20,260	-2,680	782,036	-11.7
	Seminoe Reservoir fishery—walleye	3,902	-6,404	150,617	-62.1

Stream Fisheries

Under both average and drought (fisheries elimination scenario) conditions, Wyoming stream fisheries (Cardwell, Miracle Mile, and the North Platte River below Gray Reef Dam) would be the same as under the Present Condition.

Colorado

In the Governance Committee Alternative, the Tamarack Projects, are developed, which may result in increased visitation and economic value from increased opportunity and habitat for waterfowl hunting depending on design, locations, and operation of the projects. No final designs and features have been developed for these phases, so no recreation analysis is made.

No water leasing in Colorado occurs under this alternative, so no impacts will occur on the six identified reservoirs.

Nebraska

Lake McConaughy

In Nebraska, the alternatives will cause adjustments to the volume and timing of flows reaching Lake McConaughy and cause changes in the volume and timing of releases from the lake. As a result, the average area of the lake available for recreation will be reduced by 5.6 percent. Lower lake levels will result in some facilities (such as restrooms and picnic areas) being further from the water's edge. This average annual reduction in surface area causes an average annual decrease in visitation at the lake of 13,609 recreation visits and the annual economic value of recreation is reduced by approximately $336,000 (see "Recreation" in the *Economics Appendix* in volume 3).

Panhandle Inland Lakes and Cold Water Streams

It is not expected that significant amounts of water leasing will occur in the Scotts Bluff area under the Governance Committee Alternative (see "Description of the Alternatives" in chapter 3). Therefore, no impacts are expected on these resources or associated recreation.

Conclusion

The average impacts to visitor use and economic value for Wyoming reservoirs are minor or negligible, approximately 1.5 percent for all three combined. However, average annual angler visits to reservoir fisheries could be reduced by nearly 15,000 anglers at Pathfinder and Seminoe if reservoir levels fall below 50 kaf during the Program's First Increment under a severe drought condition.

This alternative has no effects on the six reservoirs in Colorado. At the Tamarack Project there are some expected but unquantifiable impacts to recreational use and value depending on design, locations and operation.

Visitor use at Lake McConaughy would decline by less than 2 percent, which causes a loss in economic value of $336,000.

The Governance Committee Alternative would implement changes in water storage and delivery for the duration of the Program's First Increment and it is likely that these changes would be effective well into the future. Therefore, these changes in recreation are considered long term and permanent.
Table 5-REC-8 summarizes the Governance Committee Alternative's recreational impacts.

Table 5-REC-8.—Governance Committee Alternative Recreational Impacts—Changes From the Present Condition

State	Recreation Sites	Change in Surface Area (Acres)	Surface Area Percent Change	Change in Recreation Visits	Recreation Visits Percent Change	Change in Net Value (Dollar Value)	Net Value Percent Change
Wyoming	Glendo Reservoir	-365.9	-4.2	-2,985	-2.3	-$72,700	-2.3
	Guernsey Reservoir	-1.6	-0.11	-41	-0.06	-$1,100	-0.06
	Seminoe Reservoir	-310.5	-2.4	-315	-0.9	-$7,700	-0.9
	Pathfinder Reservoir	-338.8	-2.5	Not available			
	Six fisheries under the fisheries elimination scenario	Not applicable		-14,946	-7.0	-$577,000	-7.0
Colorado	Tamarack Project	Not applicable		Not estimated			
	Six reservoirs	No impacts expected					
Nebraska	Lake McConaughy	-1,650.7	-5.6	-13,609	-1.9	-$336,000	-1.9

Full Water Leasing Alternative

Wyoming

Main Stem Reservoir General Recreation

The actions of the Full Water Leasing Alternative would result in a net increase of 1,386 surface acres for the four reservoirs of Wyoming, which is the only increase among the alternatives. The loss of 241.1 acres at Glendo Reservoir is offset by the increases in surface area at Seminoe, Guernsey, and Pathfinder reservoirs. Although there is a net increase in surface area for 4 reservoirs, there is a net decrease of 1,103 recreation visits when compared to the Present Condition. Net economic value declines correspondingly by $26,000. Table 5-REC-9 shows the average annual visitation and value for Wyoming reservoir fisheries.

Table 5-REC-9.−48-Year Average Annual Visitation and Value for
Wyoming Reservoir Fisheries under the Full Water Leasing Alternative

	Fishery	Visitation	Percent Change in Visitation from the Present Condition	Value in $
Reservoir Fisheries	Pathfinder Reservoir fishery	38,519	+3.5	1,486,834
	Seminoe Reservoir fishery	33,911	+2	1,308,964
	Glendo Reservoir fishery	51,007	-2.8	1,968,870

Reservoir Fisheries

No significant impact is expected for Alcova, Guernsey, Glendo and Kortes reservoirs.

Average Conditions

When evaluated over the 48-year hydrologic baseline, the average annual angler visitation increases slightly for Seminoe and Pathfinder reservoirs and decreases for Glendo Reservoir.

Under average conditions, it is assumed that angler visitation and value would increase slightly for two of the reservoir fisheries during the Program's First Increment. The change in reservoir fisheries was estimated by using the percent changes in recreation visits from the recreation model for Seminoe and Glendo reservoirs. The change at Pathfinder Reservoir is represented by the relationships between recreation visits and surface area for Glendo, Guernsey and Seminoe reservoirs since changes in recreation visitation for Pathfinder cannot be estimated from available data.

Fisheries Elimination Scenario

There is zero probability for the elimination of fisheries at Seminoe and Pathfinder Reservoirs under the Full Water Leasing Alternative. Therefore, under extreme drought conditions where reservoirs fall below 50 kaf, the Full Water Leasing Alternative produces no impacts.

Stream Fisheries

Under both average and drought (fisheries elimination scenario) conditions, Wyoming stream fisheries (Cardwell, Miracle Mile, and the North Platte River below Gray Reef Dam) would be the same as under the Present Condition.

Colorado

Only the Tamarack Project, Phase II occurs under the Full Water Leasing Alternative. No recreation impacts are estimated for this project, as designs and locations have not been determined.

Under the Full Water Leasing Alternative, the assumed distribution of total leased reservoir water for leasing is shown in table 5-REC-10. Although the Full Water Leasing Alternative would lease twice the amount of water than the Water Emphasis alternative, the illustrative scenario of leased water from South Platte reservoirs is the same. This is because it is assumed that the other half of the water will be leased from ditches and/or canals, thereby minimizing impacts to Colorado reservoirs.

Table 5-REC-10.−Illustrative South Platte Reservoir Water Leasing Distribution (kaf)

Riverside	8
Empire	4
Jackson	8
Prewitt	10
N. Sterling	30
Julesburg	10
Total	**70**

As illustrated in table 5-REC-10, the majority of leased water would come from North Sterling Reservoir and the smallest amount of leased water would come from Empire Reservoir. The leased amounts will cause drawdown of the reservoirs earlier in the summer than would occur under the Present Condition as water is released for late summer irrigation. Elements of the Water Emphasis Alternative to be implemented in Colorado are expected to decrease the surface area of the six affected reservoirs from between 2.3 percent at Empire and Jackson Lake to 9.0 percent at North Sterling Reservoir. Changes in associated visitor use and economic value would be expected but are unquantifiable using currently available data. Changes in this range would be considered minor to moderate.

Nebraska

Lake McConaughy

The average surface area for Lake McConaughy would increase by 239.5 acres (0.8 percent) under the Full Water Leasing Alternative. An increase of 5,883 recreation visits (0.8 percent) would be expected. Approximately $145,000 in economic value would be gained.

Panhandle Inland Lakes and Cold Water Streams

Of the alternatives, only the Full Water Leasing Alternative has the potential to result in substantial amounts of water leasing in the Panhandle area. This alternative might reduce somewhat the volumes of water being moved through the Interstate Canal and the Inland Lakes, which also may reduce somewhat the agricultural runoff and canal seepage entering the streams north of the town of Scottsbluff. These changes are unlikely to affect the baseflow of the streams or the fish populations.

Under this alternative, and with these assumptions, it would be possible that a significant amount of water might be leased from irrigation districts in the Scotts Bluff area. If water is leased from lands near the coldwater streams in this area, there may be some reduction in irrigation runoff to the streams. The amount of reduction cannot be estimated absent a specific plan for water leasing, which would be based on voluntary participation from water users. The likely effect would be some reduction in flow volume. However, this would not affect the baseflows which originate from groundwater, nor the peak flows which result from local storm runoff. Stream temperatures would be reduced somewhat as warmer irrigation runoff was reduced.

Conclusion

Wyoming experiences minor decreases in recreational visitor use at Glendo Reservoir and minor to moderate increases in recreational visitor use at Seminoe and Guernsey reservoirs. Pathfinder and Seminoe reservoirs show moderate increases in surface area. Seminoe and Pathfinder reservoir fisheries would experience slight increases in angler numbers under average conditions during the Program's First Increment. In Colorado, impacts on recreation are expected but are unquantifiable using currently available data. Changes in recreation use at Lake McConaughy are positive but negligible.

The Full Water Leasing Alternative would implement changes in water storage and delivery for the duration of the Program's First Increment, and it is likely that these changes would be effective well into the future. Therefore, these changes in recreation are considered long term and permanent.
Table 5-REC-11 summarizes recreation impacts under the Full Water Leasing Alternative.

Table 5-REC-11.—Full Water Leasing Alternative Recreational Impacts—Changes From the Present Condition

State	Recreation Sites	Change in Surface Area (Acres)	Surface Area Percent Change	Change in Recreation Visits	Recreation Visits Percent Change	Change in Net Value (Dollar Value)	Net Value Percent Change
Wyoming	Glendo Reservoir	-241.1	-2.8	-1,959	-1.5	-$47,700	-1.5
	Guernsey Reservoir	11.3	0.8	192	0.3	$5,200	0.3
	Seminoe Reservoir	667.5	5.1	664	1.9	$16,200	1.9
	Pathfinder Reservoir	948.4	7.0	Not available			
	Six fisheries under the fisheries elimination scenario**	Not applicable		No impacts expected			
Colorado	Tamarack Project	Not applicable		Not estimated			
	Six reservoirs	-48.2 to -190.4	-2.3 to -9.0	Not estimated			
Nebraska	Lake McConaughy	239.5	0.8	5,883	0.8	$145,240	0.8

Wet Meadow Alternative

Wyoming

Main Stem Reservoir General Recreation

This alternative would result in a decline of 2914.5 surface acres for the Wyoming four reservoirs. This is the biggest decrease of all the alternatives. This reduction in area results in a decrease of 6,169 recreation visits when compared to the Present Condition. Economic value declines correspondingly by approximately $151,000 annually. Table 5-REC-12 summarizes recreation changes for Wyoming reservoir fisheries under the Wet Meadow Alternative.

Table 5-REC-12: 48-Year Average Annual Visitation and Value for Wyoming Reservoir Fisheries under the Wet Meadow Alternative

	Fishery	**Visitation**	**Percent Change in Visitation from the Present Condition**	**Value in $**
Reservoir fisheries	Pathfinder Reservoir fishery	35,542	-4.5	1,371,922
	Seminoe Reservoir fishery	33,249	-3	1,244,811
	Glendo Reservoir fishery	49,380	-5.9	1,906,068

Reservoir Fisheries

No significant impact is expected for Alcova, Guernsey, Glendo and Kortes reservoirs.

Average Conditions

Under average conditions, it is assumed that angler visitation and value would remain constant over the Program's First Increment for stream fisheries, minimally decline for Pathfinder, Seminoe, and Glendo reservoir fisheries. The change in reservoir fisheries was estimated by using the percent changes in recreation visits from the recreation model for Seminoe and Glendo reservoirs. As changes in recreation visitation for Pathfinder Reservoir were not estimated, the change at Pathfinder Reservoir is represented by the relationships between recreation visits and surface area for Glendo, Guernsey and Seminoe reservoirs.

Fisheries Elimination Scenario

Under extreme drought conditions, the Wet Meadow Alternative may reduce reservoir levels to the point that fisheries will likely be eliminated at Pathfinder Reservoir and possibly Seminoe Reservoir. The number of years required to reestablish the fishery if this elimination occurs and the probability of this occurring under the Wet Meadow Alternative during the Program's First Increment and is discussed in "Fisheries Elimination Scenario, Reservoir Fisheries, Wyoming, Method, Recreation" in chapter 4.

If reservoir fisheries are eliminated during the Program's First Increment, the average annual impacts on Pathfinder and Seminoe reservoirs are minimal or moderate for trout anglers but substantial for walleye anglers as shown in table 5-REC-13.

Table 5-REC-13.−Wyoming Reservoir Fisheries 48-Year Average Annual Angler Visitation and Value under the Fisheries Elimination Scenario under the Wet Meadow Alternative

Fishery	Visitation	Change in Visits	Value in $	Percent Change in the Present Condition
Pathfinder Reservoir Fishery-Trout	28,430	-1,157	1,097,398	-3.9
Pathfinder Reservoir Fishery-Walleye	2,924	-4,705	112,866	-61.7
Seminoe Reservoir Fishery-Trout	20,260	-2,680	782,036	-11.7
Seminoe Reservoir Fishery-Walleye	3,902	-6,404	150,617	-62.1

Stream Fisheries

Under both average and drought (fisheries elimination scenario) conditions, Wyoming stream fisheries (Cardwell, Miracle Mile, and the North Platte River below Gray Reef Dam) would be the same as under the Present Condition.

Colorado

The Tamarack Project, Phase I, may result in some increase in recreation use. The impacts are not quantifiable but it is expected to be minor locally (Sedgwick County) depending on design, locations, and operation of the Phase I. Final designs and locations have not been developed, so no recreation analysis is made.

The Wet Meadow Alternative does not cause any change in the surface area of any of the six reservoirs because water leasing would not occur under this alternative.

Nebraska

Lake McConaughy

Implementing the Wet Meadow Alternative decreases the average surface area of Lake McConaughy. An average annual decrease of 1,378.2 acres (4.7 percent) results in a decline of 8,935 recreation visits (1.3 percent) at Lake McConaughy. A loss of over $220,000 in associated economic value also occurs.

Panhandle Inland Lakes and Cold Water Streams

This alternative will not affect operations of the inland lakes. It is not expected that significant amounts of water leasing will occur in the Scotts Bluff area under the Wet Meadow Alternative (see "Description of the Alternatives" in chapter 3), therefore no impacts are expected on these resources or associated recreation.

Conclusion

Wyoming receives negligible changes in recreation visits and economic value at Guernsey and minor negative impacts at Seminoe and Glendo reservoirs under the Water Emphasis Alternative. However, Wyoming fisheries would be reduced by nearly 15,000 anglers total if the fisheries were eliminated in the first increment. At the Tamarack Project there are some expected but unquantifiable impacts to recreational use and value depending on design, locations and operation. Changes in recreation use at Lake McConaughy are minor.

The Wet Meadow Alternative would implement changes in water storage and delivery for the duration of the Program's First Increment and it is likely that these changes would be effective well into the future. Therefore, these changes in recreation are considered long term and permanent. Table 5-REC-14 summarizes recreation impacts under the Wet Meadow Alternative.

Table 5-REC-14.—Wet Meadow Alternative
Recreational Impacts—Changes From the Present Condition

State	Recreation Sites	Change in Surface Area (Acres)	Surface Area Percent Change	Change in Recreation Visits	Recreation Visits Percent Change	Change in Net Value (Dollar Value)	Net Value Percent Change
Wyoming	Glendo Reservoir	-606.3	-6.9	-4,985	-3.9	-$121,400	-3.9
	Guernsey Reservoir	-6.6	-0.5	-121	-0.2	-$3,300	-0.2
	Seminoe Reservoir	-1,028.5	-7.8	-1,063	-3.1	-$25,900	-3.1
	Pathfinder Reservoir	-1,273.2	-9.4	Not available			
	Six fisheries under the fisheries elimination scenario**	Not applicable		-14,946	-7.0	-$577,000	-7.0
Colorado	Tamarack Project	Not applicable		Not estimated			
	Six reservoirs	No impacts expected					
Nebraska	Lake McConaughy	-1,378.2	-4.7	-8,935	-1.3	-$221,000	-1.3

Water Emphasis Alternative

Wyoming

Main Stem Reservoir General Recreation

Implementing the Water Emphasis Alternative would result in a average annual (48-year) decline of 2,037 surface acres for the four reservoirs of Wyoming. This reduction results in a decrease of 5,022 recreation visits. Annual economic values decline correspondingly by approximately $123,000.

Reservoir Fisheries

No significant impact is expected for Alcova, Guernsey, Glendo and Kortes reservoirs.

Average Conditions

When evaluated over the 48-year hydrologic baseline, the average annual impacts on the reservoir fisheries are minimal. Under average conditions, it is assumed that angler visitation and value would remain constant over the Program's First Increment for stream fisheries but minimally decline for reservoir fisheries. The decline in reservoir fisheries was estimated by using the percent changes in recreation visits from the recreation model for Seminoe and Glendo reservoirs. The change at Pathfinder is represented by the relationships between recreation visits and surface area for Glendo, Guernsey, and

Seminoe reservoirs since changes in recreation visitation for Pathfinder Reservoir cannot be estimated from available data. Table 5-REC-15 shows the average annual visitation for Wyoming Reservoir fisheries under the Water Emphasis Alternative.

Table 5-REC-15: 48-Year Average Annual Visitation and Value for Wyoming Reservoir Fisheries under the Water Emphasis Alternative

	Fishery	Visitation	Percent Change in Visitation from the Present Condition	Value in $
Reservoir Fisheries	Pathfinder Reservoir fishery	36,099	-3	1,393,421
	Seminoe Reservoir fishery	32,581	-2	1,257,627
	Glendo Reservoir fishery	50,744	-3.3	1,958,718

Fisheries Elimination Scenario

Under extreme drought conditions, the Water Emphasis Alternative may reduce reservoir levels to the point that fisheries will likely be eliminated at Pathfinder Reservoir and possibly Seminoe Reservoir. The number of years required to reestablish the fishery if this elimination occurs and the probability of this occurring under the Water Emphasis Alternative during the Program's First Increment and is discussed in "Fisheries Elimination Scenario, Reservoir Fisheries, Wyoming, Method, Recreation" in chapter 4.

If reservoir fisheries are eliminated during the Program's First Increment, the average annual impacts on Pathfinder and Seminoe reservoirs are minimal or moderate for trout anglers but substantial for walleye anglers as shown in table 5-REC-16.

Table 5-REC-16.− Wyoming Reservoir Fisheries Average Annual Angler Visitation and Value under the Fisheries Elimination Scenario under the Water Emphasis Alternative

Fishery	Visitation	Change in Visits	Value in $	Percent Change in Value from the Present Condition
Pathfinder Reservoir fishery-trout	28,430	-1,157	1,097,398	-3.9
Pathfinder Reservoir fishery-walleye	2,924	-4,705	112,866	-61.7
Seminoe Reservoir fishery-trout	20,260	-2,680	782,036	-11.7
Seminoe Reservoir fishery-walleye	3,902	-6,404	150,617	-62.1

Stream Fisheries

Under both average and drought (fisheries elimination scenario) conditions, Wyoming stream fisheries (Cardwell, Miracle Mile, and the North Platte River below Gray Reef Dam) would be the same as under the Present Condition.

Colorado

In the Water Emphasis Alternative, the Tamarack Projects are developed, which may result in increased visitation and economic value from increased opportunity and habitat for waterfowl hunting depending on design, locations, and operation of the projects. No final designs and features have been developed for these phases, so no recreation analysis is made.

Under the Water Emphasis Alternative, an illustrative scenario of total leased reservoir water is shown in table 5-REC-17.

Table 5-REC-17.−Illustrative South Platte Reservoir
Water Leasing Distribution (kaf)

Riverside	8
Empire	4
Jackson	8
Prewitt	10
N. Sterling	30
Julesburg	10
Total	**70**

As illustrated in table 5-REC-17, the majority of leased water would come from North Sterling Reservoir and the smallest amount of leased water would come from Empire Reservoir. The leased amounts will cause drawdown of the reservoirs earlier in the summer (usually May) than would occur for the Present Condition, under which this water is released later in the summer for irrigation. Elements of the Water Emphasis Alternative to be implemented in Colorado are expected to decrease the surface area of the six affected reservoirs from between 2.3 percent at Empire and Jackson Lake to 9.0 percent at North Sterling Reservoir. Changes in associated visitor use and economic value are not quantifiable with currently available data.

Nebraska

Lake McConaughy

Under the Water Emphasis Alternative, the average surface area of Lake McConaughy decreases by 962.6 acres. Implementing this alternative reduces recreation visits by 1,378 (or 0.2 percent of the reservoir's Present Condition amount) for Lake McConaughy.

Panhandle Inland Lakes and Cold Water Streams

This alternative will not affect operations of the inland lakes. It is not expected that significant amounts of water leasing will occur in the Scotts Bluff area under the Water Emphasis Alternative (see chapter 3"Description of the Alternatives"), therefore no impacts are expected on these resources or associated recreation.

Conclusion

Wyoming receives negligible changes in recreation visits and economic value at Guernsey Reservoir and minor negative impacts at Seminoe and Glendo reservoirs under the Water Emphasis Alternative. However, average annual angler visitation to Wyoming fisheries would be reduced by nearly 15,000 anglers total if the fisheries were eliminated in the first increment. At the Tamarack Project there are some expected but unquantifiable impacts in recreational use and value depending on design, locations and operation. On average, loss of recreation visits to Lake McConaughy would be -0.2 percent annually.

The Water Emphasis Alternative would implement changes in water storage and delivery for the duration of the Program's First Increment and it is likely that these changes would be effective well into the future. Therefore, these changes in recreation are considered long term and permanent. Table 5-REC-18 summarizes recreation impacts under the Water Emphasis Alternative.

Table 5-REC-18.—Water Emphasis Alternative
Recreational Impacts—Changes From the Present Condition

State	Recreation Sites	Change in Surface Area (Acres)	Surface Area Percent Change	Change in Recreation Visits	Recreation Visits Percent Change	Change in Net Value (Dollar Value)	Net Value Percent Change
Wyoming	Glendo Reservoir	-518.9	-5.9	-4,253	-3.3	-$103,600	-3.3
	Guernsey Reservoir	-5.5	-0.4	-103	-0.2	-$2,800	-0.2
	Seminoe Reservoir	-650.2	-4.9	-666	-1.9	-$16,200	-1.9
	Pathfinder Reservoir	-862.4	-6.4	Not available			
	Six fisheries under the fisheries elimination scenario	Not applicable		-14,946	-7.0	-577,000	-7.0
Colorado	Tamarack Project	Not applicable		Not estimated			
	Six reservoirs	-48.2 to -190.4	-2.3 to -9.0	Not estimated			
Nebraska	Lake McConaughy	-962.6	-3.3	-1,378	-0.2	-$34,000	-0.2

Wyoming North Platte Reservoirs Boat Ramp Access

As shown in table 5-REC-19, all of the alternatives increase the number of years that individual boat ramps at Pathfinder and Seminoe Reservoirs are not usable due to low water, at some time during the May to September recreation season. Depending upon the reservoir and the boat ramp, the increase ranges from 1 to 7 additional seasons when the ramp may become unusable at some time during the summer. The exception is the Full Water Leasing alternative, which improves conditions somewhat. The impacts on the use of Glendo boat ramps are very minor.

Table 5-Rec-19.—Summary of Years (Out of 48) When Wyoming Reservoirs' Elevations Are Too Low to Launch a Boat in Summer (May–Sept)

	Pathfinder		Seminoe						Glendo					
	Bishop Point	**Natrona County Marina**	**Boat Club**	**Medicine Bow**	**North Red Hills 1**	**North Red Hills 2**	**North Red Hills 3**	**South Red Hills**	**Bennet Hill**	**Elk Horn**	**Glendo Marina**	**Indian Point**	**Reno Cove**	**Whiskey Gulch**
Lowest Elevation that allows boat launch	5805	5788	6314	6324	6323.6	6309.9	6300.9	6312.6	4610	4623	4570	4610.9	4560	4570
Present Condition	21	9	15	20	20	11	9	13	47	48	0	47	0	0
Governance Committee Alternative	22	13	17	23	23	15	11	17	47	48	0	47	0	0
Water Emphasis Alternative	22	14	19	24	23	17	12	19	48	48	0	48	0	0
Full Water Leasing Alternative	17	8	11	18	18	10	6	11	48	48	0	48	0	0
Wet Meadow Alternative	22	14	22	24	24	19	14	21	48	48	0	48	0	0

Lake McConaughy Boat Ramp Analysis

As shown in table 5-REC-20, different boat ramps are available different percentages of the time, depending on the elevation of the particular ramp. Under the Present Condition, the availability of boat ramps all summer ranges from 21 percent to 100 percent depending on the ramp, and the availability for at least one month in a summer ranges from 52 percent to 100 percent. Under the alternatives, availability of boat ramps for the entire summer ranges from zero percent to 8 percent up to 100 percent depending on first alternative, then ramp. The availability for at least 1 month in a given summer ranges from 23 percent to 52 percent up to 100 percent depending on alternative and ramp. The overall effect of this is that some of the higher-elevation boat ramps will become functionally unusable under most conditions, while some of the lower elevation boat ramps will see relatively few effects.

Table 5-REC-20.—Boat Ramp Availability at Lake McConaughy

	Elevation:	**3257.9**	**3259.9**	**3251.7**	**3246.4**	**3244.2**	**3244.9**	**3244.2**	
	Ramp:	**Otter Creek Flume**	**Omaha Beach**	**Spring Park**	**Spillway Bay Back**	**Lemoyne Bayside**	**Arthur Bay**	**Martin Bay North**	**North Shore**
Percent of years ramp is usable all 5 months (May-Sep)	Present Condition	21	6	48	71	79	75	79	0
	Governance Committee Alternative	6	0	23	44	50	46	50	0
	Full Water Leasing Alternative	23	8	50	79	88	88	88	0
	Wet Meadow Alternative	2	0	23	44	52	50	52	0
	Water Emphasis Alternative	13	0	29	48	58	54	58	0
Percent of years ramp is usable at least 1of 5 months (May-Sep)	Present Condition	81	52	88	94	98	96	98	0
	Governance Committee Alternative	31	23	67	81	83	83	83	0
	Full Water Leasing Alternative	69	38	92	98	98	98	98	0
	Wet Meadow Alternative	35	29	71	85	85	85	85	0
	Water Emphasis Alternative	38	31	73	83	90	88	90	0
Percent of years ramp is not usable May-Sep	Present Condition	19	48	13	6	2	4	2	0
	Governance Committee Alternative	69	77	33	19	17	17	17	0
	Full Water Leasing Alternative	31	63	8	2	2	2	2	0
	Wet Meadow Alternative	65	71	29	15	15	15	15	0
	Water Emphasis Alternative	63	69	27	17	10	13	10	0

	Elevation:	3241.3	3237.8	3235.9	3234.5	3234.7	3229.5	3219.9	3207
	Ramp:	Otter Creek Bay	Cedar Vue Bay	Martin Bay South	Cedar Vue Lake	Spillway Bay Front	Lemoyn e Lakeside	Divers Bay	Kingsley
Percent of years ramp is usable all 5 months (May-Sep)	Present Condition	88	88	92	92	92	98	100	100
	Governance Committee Alternative	58	71	77	77	77	88	94	100
	Full Water Leasing Alternative	92	92	94	96	96	100	100	100
	Wet Meadow Alternative	60	71	81	81	81	90	92	100
	Water Emphasis Alternative	69	79	81	83	83	92	100	100
Percent of years ramp is usable at least 1of 5 months (May-Sep)	Present Condition	100	100	100	100	100	100	100	100
	Governance Committee Alternative	88	92	94	98	96	98	100	100
	Full Water Leasing Alternative	100	100	100	100	100	100	100	100
	Wet Meadow Alternative	92	94	98	98	98	98	100	100
	Water Emphasis Alternative	94	98	98	98	98	100	100	100
Percent of years ramp is not usable May-Sep	Present Condition	0	0	0	0	0	0	0	0
	Governance Committee Alternative	13	8	6	2	4	2	0	0
	Full Water Leasing Alternative	0	0	0	0	0	0	0	0
	Wet Meadow Alternative	8	6	2	2	2	2	0	0
	Water Emphasis Alternative	6	2	2	2	2	0	0	0

AGRICULTURAL ECONOMICS

Issue: How would the action alternatives affect agricultural acreage, production, and farm revenues?

Overview

SCOPE

The effects of the action alternatives on agricultural production are assessed for eight multicounty subregions of the Basin (see the "Agricultural Economics" section in chapter 4 for details).

INDICATORS

Indicators used to determine how much each alternative affects the agricultural economy in the Basin economic impact regions are:

- Deliveries of irrigation water
- Irrigated Acres
- Cropping patterns and crop production
- Agricultural revenues

SUMMARY OF IMPACTS

In general, each of the alternatives analyzed is expected to cause a slight decrease in the amount of irrigation water consumptively used by farms within the Basin. All impacts are measured on an average annual basis. Reduced irrigation water deliveries are expected to reduce both irrigated acres and the value of agricultural commodities produced. The Wet Meadow Alternative has the least impact (a reduction of just under 4 kaf), while the Full Water Leasing Alternative has the greatest (a reduction of over 145 kaf). Corresponding decreases to irrigated acres are expected in the range of 1,500 to 85,000 acres, depending on how individual farmers respond to the change in available irrigation water. The change in the amount of agricultural commodities produced is estimated to cause a decrease in farm revenues of from about $160,000 (under the Wet Meadows Alternative) to more than $28,000,000 (under the Full Water Leasing Alternative).

With the exception of the Wet Meadow Alternative (where the impacts are projected to occur only in the Scotts Bluff and North Platte Headwaters areas), the impacts to farm revenues will probably be spread throughout a large area of the Basin. However, under the three other alternatives analyzed (Governance Committee, Full Water Leasing and Water Emphasis Alternatives), farm revenue impacts are expected to be greatest in the Central Platte Habitat Area. The Governance Committee Alternative reduces the farm revenue impacts in three regions (Central Platte Habitat Area, North Platte River Headwaters, and eastern Wyoming), but revenues in the Lake McConaughy, Scotts Bluff, and eastern Colorado areas are not affected. Under the Water Emphasis Alternative, the Lake McConaughy area is the second most impacted region, followed by the Scotts Bluff area, eastern Central Colorado area, and North Platte Headwaters. Under the Full Water Leasing Alternative, farm revenue impacts are greater in the Scotts Bluff area than the Lake McConaughy area, with the order of the other economic regions remaining the same. As each alternative was analyzed to determine the effects of various actions, it was determined that two of the identified impact regions (South Platte Headwaters and Denver, Colorado, metro area) incurred no economic impacts, regardless of alternative. Consequently, these two regions are not included in the presentation of economic effects. The remaining regions are shown below in table 5-AE-1. Definition of these economic regions is described in the "Agricultural Economics" section in chapter 4.

Table 5-AE-1.—Platte River Economic Regions and County Groupings

Economic Region	Counties Included
Central Platte Habitat Area	Adams, Buffalo, Dawson, Gosper, Hall, Hamilton, Kearney, Merrick, and Phelps in Nebraska.
Lake McConaughy area	Arthur, Cheyenne, Custer, Deuel, Garden, Keith, Lincoln, and McPherson in Nebraska. Logan and Sedgwick in Colorado.
Scotts Bluff area	Banner, Kimball, Morrill, Scotts Bluff, and Sioux in Nebraska. Goshen in Wyoming.
Eastern Wyoming	Albany, Laramie, and Platte in Wyoming.
North Platte headwaters	Carbon, Converse, Fremont, and Natrona in Wyoming. Jackson in Colorado.
Eastern Colorado	Larimer, Morgan, Washington, and Weld in Colorado.

IMPACTS ANALYSIS

The effect of the alternatives on agriculture production and economics in the Basin is projected using the Generalized Algebraic Modeling System (GAMS), adapted for modeling farm economics by the Bureau of Reclamation (Reclamation). The Platte River Agricultural Model (PRAM) is a regional model of irrigated agricultural production and economics that simulates the decisions of agricultural producers (farmers) in the Basin in Wyoming, Colorado, and Nebraska. The model assumes that farmers maximize profit subject to resource, technical, and market constraints. Based upon changes in the available irrigation water supply associated with each alternative, the model calculates the changes in farm operations that would likely occur (e.g., changes in irrigated acres, cropping patterns, farm income and expenditures, etc.) and the resulting effect on agricultural production and revenues.

All of the action alternatives change irrigation water deliveries as a result of changes in reservoir operations, storage, and voluntary water leasing. As the conditions and assumptions of each alternative change the amount of irrigation water delivered to area farms, additional changes are expected to occur to the other indicators. Farmers will adapt to these changes in water supply in a number of ways. They may change the amount of land that they irrigate. They may produce crops that require less water or just not apply as much water to the same type of crops they are currently growing. Each of these farmer responses will probably affect the amount of crops produced (either through a change in yields or in the number of acres planted to certain crops). Such changes in crop production are expected to affect onfarm revenues received by irrigators—as both income and expenses are likely to change. Ultimately, it is these changes to farm income that is used to measure the direct impacts of a specific alternative to the agricultural economy in each of the economic impact regions identified in the Basin.

IRRIGATION WATER DELIVERIES

Three different hydrology models were used to estimate water deliveries for each of the three subbasins of the Basin, and each model expresses water delivery results somewhat differently. To maintain consistency of input data used in the agricultural model, the irrigation water output from each of the hydrology models was converted to acre-feet of water consumptively used onfarm. Therefore, changes in the amount of irrigation water deliveries mentioned in this section are expressed as onfarm consumptive use (onfarm consumptive use).

Average irrigation deliveries and onfarm consumptive use are predicted to decline in five economic impact areas under two of the analyzed alternatives (Full Water Leasing and Water Emphasis Alternatives). The Wet Meadow Alternative affects only the North Platte Headwaters and the Scotts Bluff impact areas. The Governance Committee Alternative primarily affects the Central Platte Habitat Area, North Platte Headwaters, and eastern Wyoming areas. Economic impacts occur as a result of two general types of activities that will be implemented to accomplish the objectives of the Co operative Agreement:

- **Water acquisition.** These activities include, but are not limited to, purchasing water rights, water banking, water marketing, dry-year leasing, etc.

- **Operating changes of Platte River storage and diversion facilities.** Changing the timing and amount of releases from various facilities along the Platte River to improve habitat conditions for the target species (such as from the Pathfinder and McConaughy EAs) is expected to result in periodic reductions in irrigation deliveries and onfarm consumptive use in some areas.

As was noted in chapter 3, "Description of the Alternatives," it is assumed for this analysis that when water is leased by farmers to the Program, the Program will require that other sources of water not be used to replace the leased supply, to avoid any secondary impacts on groundwater and riverflows.

Changes in onfarm consumptive use range from a total decrease of 3,800 acre-feet under the Wet Meadow Alternative to a total reduction of 145,400 acre-feet under the Full Water Leasing Alternative. Table 5-AE-2 shows the irrigation shortages estimated to occur in each impact area as a result of the combined effects of all the actions implemented under each alternative. Figure 5-AE-1 illustrates the changes in irrigation consumptive use.

Table 5-AE-2.—Average Annual Changes in Consumptive Use of Irrigation Water From the Present Condition (acre-feet)

Alternative	Central Platte Habitat Area	Lake McConaughy Area	Scotts Bluff Area	Eastern Wyoming	North Platte Headwaters	Eastern Colorado
Governance Committee Alternative	-15,900	100	-100	-1,500	-7,200	0
Full Water Leasing Alternative	-53,900	-30,000	-40,200	0	-7,500	-13,800
Wet Meadow Alternative	0	100	-1,700	0	-2,200	0
Water Emphasis Alternative	-27,000	-21,300	-9,900	0	-6,400	-9,800

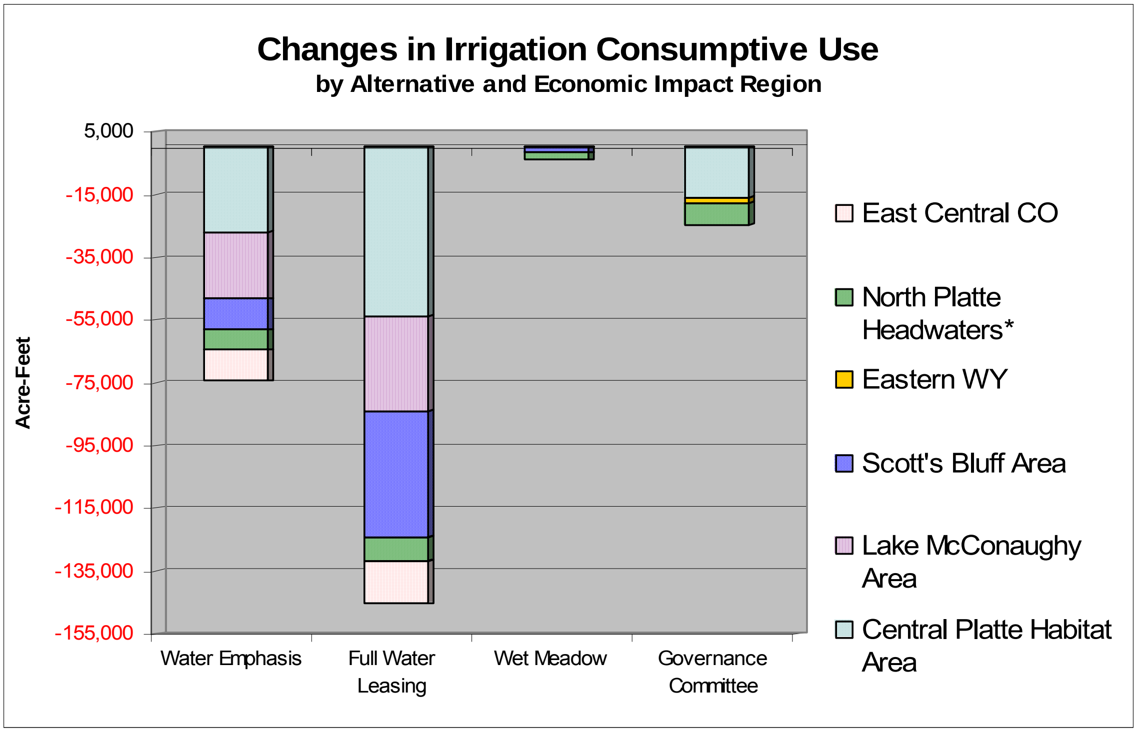

Figure 5-AE-1.—Average annual changes in irrigation consumptive use by alternative and economic impact region.

For the entire Basin, these reductions in irrigation water range from about two-tenths of 1 percent less water for the Wet Meadow Alternative to approximately 6 percent less water for the Full Water Leasing Alternative. The Governance Committee Alternative has a reduction of about 1 percent.

Some of the impact areas are affected more than others.[18] Even though the Central Platte Habitat Area has the largest overall reduction for three of the alternatives, the reductions predicted to occur under the Governance Committee and Water Emphasis Alternatives are less than 7 percent of the 50-year average irrigation water supply. The reduction predicted under the Full Water Leasing Alternative is almost 14 percent. The Lake McConaughy area irrigation supply receives the largest percentage reduction of all impact areas under the Water Emphasis Alternative at more than 21 percent. The largest reduction in water that occurs in the eastern Colorado area is a reduction of almost 14,000 acre-feet under the Full Water Leasing Alternative, but it is less than 1.5 percent of the 50-year average of onfarm consumptive use. The Scotts Bluff area reduction of 40,200 acre-feet and 9,900 acre-feet for the Full Water Leasing and Water Emphasis Alternatives, respectively, translates to 9.2 and 2.3 percent.

[18] Note that the precise distribution of effects across regions depends upon where elements like water leasing will be focused. While the analysis of these alternatives represents one set of assumptions, the actual distribution of water leasing will be under the direction of each state and depend on the participation of willing lessors, and may differ from this analysis.

Irrigated Acres and Cropping Patterns

Given the changes to irrigation deliveries and onfarm consumptive use expected to occur as a result of implementing each of the alternatives, a corresponding change to irrigated acres is predicted for each of the economic impact regions. The changes are expected to affect both the total number of irrigated acres within each economic impact region as well as the proportion of each irrigated crop as a percent of the total land irrigated.

Acreage values used in the agricultural model were based on the 10-year average of harvested acres from 1988 to 1997. The total acreage of irrigated crops included in the model is almost 11 million acres. Of this total value:

- Wyoming has 1.23 million acres, or 11.3 percent
- Colorado has 2.70 million acres, or 24.8 percent
- Nebraska has 6.98 million acres, or 63.9 percent

Table 5-AE-3 shows the total irrigated acreage of each state included in the PRAM by crop modeled.

Table 5-AE-3.—Irrigated Crop Acres, 10-Year Average (1988-1997)

Crop	Platte River Basin Data				Total State Data			
	Wyoming	**Colorado**	**Nebraska**	**Totals**	**Wyoming**	**Colorado**	**Nebraska**	**Totals**
Alfalfa hay	192,800*	191,090	180,260	564,150	436,350	706,900	391,800	1,535,050
All other hay	209,060	120,140	0	329,200	482,000	467,600	0	949,600
Barley	15,150	21,350	0	36,500	100,500	96,700	0	197,200
Corn - grain	41,490	356,000	2,018,620	2,416,110	49,060	811,900	5,210,000	6,070,960
Corn - silage	21,470	70,870	51,310	143,650	34,400	104,600	138,000	277,000
Dry beans	20,380	65,780	108,980	195,140	37,600	138,550	193,900	370,050
Oats	0	5,080	0	5,080	16,850	20,750	0	37,600
Potatoes	0	1,560	13,690	15,250	0	76,722	0	76,722
Sorghum	0	0	156,190	156,190	0	49,333	94,889	144,222
Soybeans	20,799	42,621	46,190	109,610	0	0	799,700	799,700
Sugar beets	0	24,680	15,870	40,550	61,950	44,050	68,850	174,850
Wheat	9,590	42,700	28,570	80,860	14,830	184,620	78,900	278,350
Totals	**530,739**	**941,871**	**2,619,680**	**4,092,290**	**1,233,540**	**2,701,725**	**6,976,039**	**10,911,304**
* Numbers have been rounded.								

Two different responses were modeled to estimate the range of potential impacts to farmed acres in each of the economic impact regions. The first response is based on the assumption that no dryland conversion occurs when irrigation deliveries and onfarm consumptive use are reduced. In other words, when irrigation water supplies are reduced, irrigated land is taken completely out of production. This response represents the maximum direct impact to the agricultural economy. The impacts of this response are shown in table 5-AE-4 and figure 5-AE-2. The second response assumes that, where feasible, irrigated land is converted to dryland agricultural production when irrigation deliveries and onfarm consumptive use are reduced. This conversion of irrigated land to dryland represents the minimum economic impact predicted in each impact area. The minimum range of impacts is shown in table 5-AE-5 and figure 5-AE-3.

Table 5-AE-4.—Average Annual Changes in Farmed Acres by Alternative and Economic Region Without Substituting Dryland Farming

Alternative	Central Platte Habitat Area	Lake McConaughy Area	Scotts Bluff Area	Eastern Wyoming	North Platte Headwaters	Eastern Colorado
Governance Committee Alternative	-10,700	0	0	-1,000	-4,900	0
Full Water Leasing Alternative	-38,300	-16,100	-21,800	0	-5,100	-4,100
Wet Meadow Alternative	0	0	-300	0	-1,500	0
Water Emphasis Alternative	-18,800	-10,900	-4,900	0	-4,300	-2,100

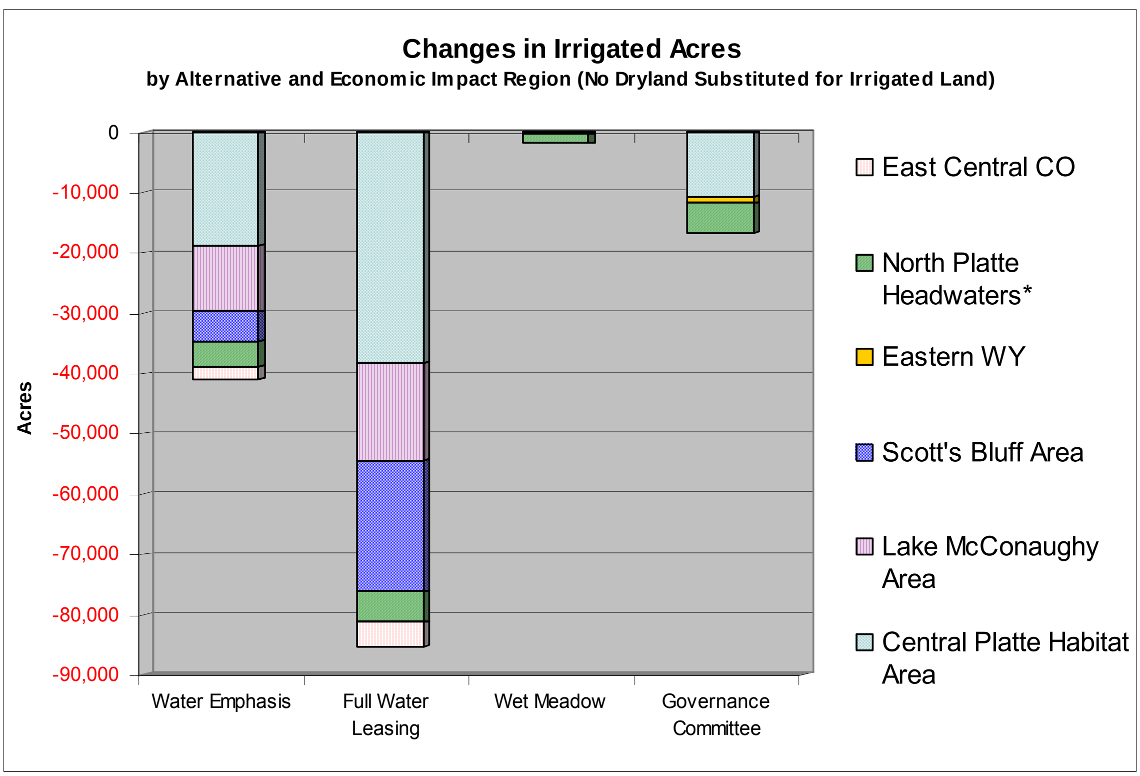

Figure 5-AE-2.—Average annual changes in irrigated acres by alternative and economic impact region without substituting dryland farming.

Table 5-AE-5.—Average Annual Changes in Farmed Acres by Alternative With Substituting Dryland Farming for Irrigation

Alternative	Central Platte Habitat Area	Lake McConaughy Area	Scotts Bluff Area	Eastern Wyoming	North Platte Headwaters	Eastern Colorado
Governance Committee Alternative	0	0	0	-1,000	-4,900	0
Full Water Leasing Alternative	0	0	0	0	-5,100	0
Wet Meadow Alternative	0	0	0	0	-1,500	0
Water Emphasis Alternative	0	0	0	0	-4,300	0

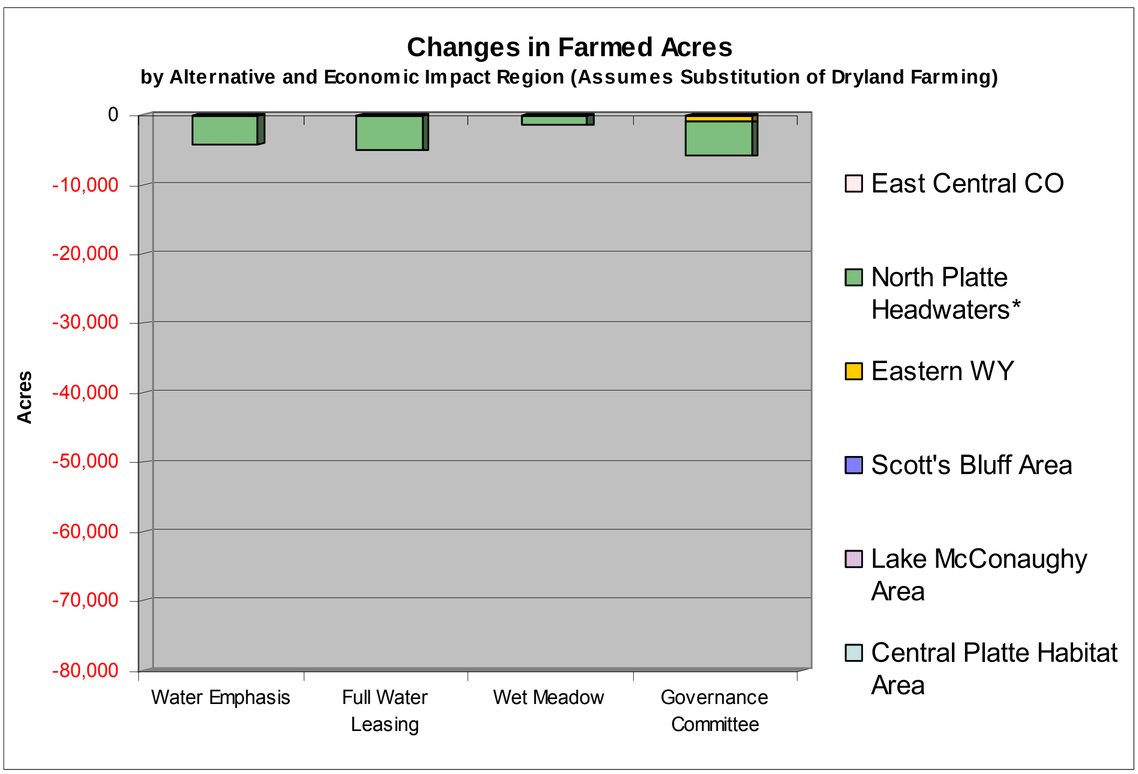

Figure 5-AE-3.—Average annual changes in irrigated acres by alternative and economic impact region with substituting dryland farming.

When substitution of nonirrigated crops for irrigated crops is assumed, land is still projected to be lost from agricultural production in the eastern Wyoming and the North Platte Headwaters areas. This is based on the assumption that without irrigation water, lands in these areas would revert to dry rangeland with essentially no capability to produce any type of crop. This assumption was reinforced by the lack of available data for nonirrigated crops, such as crop census data or enterprise budgets, in these areas. The other four impact areas were assumed to be suitable for producing at least some crops without irrigation water. The largest impact to acres under agricultural production occurs under the Governance Committee Alternative with a loss of almost 6,000 acres or less than two-tenths of 1 percent of the total land in agriculture. Even when these acres are concentrated in the North Platte Headwaters area, the impact is still less than 2 percent of farmland in the area.

Even when farmland is taken out of production entirely rather than being converted to dryland farming, the Scotts Bluff area is the only area that sees a decline of greater than 3 percent in farmed area. This reduction of almost 5 percent occurs under the Full Water Leasing Alternative. For the Basin as a whole, the maximum reduction in farmed acres was just over 85,000 acres, or 2.1 percent.

Agricultural Revenues

The various alternatives analyzed in this FEIS affect the quantity of irrigation water delivered to each of the economic impact areas. Such changes to irrigation deliveries and onfarm consumptive use result in corresponding changes to the amount and type of crops produced and, ultimately, in the revenues generated by farms within the impact areas. Revenue changes occur when the production of irrigated crops varies due to changes in the supply of irrigation water. Crop production and farm revenues vary as previously irrigated farmland is converted from irrigation to dryland farming, or when it is removed entirely from agricultural production. Table 5-AE-6 and figure 5-AE-4 present the maximum direct economic impact predicted to occur to the agricultural economy of each impact area under each alternative.

Table 5-AE-6.—Average Annual Changes in Gross Agricultural Revenues by Alternative and Economic Region ($1,000) Without Substituting Dryland Farming

Alternative	Central Platte Habitat Area	Lake McConaughy Area	Scotts Bluff Area	Eastern Wyoming	North Platte Headwaters	Eastern Colorado
Governance Committee Alternative	-4,421	0	8	-115	-560	0
Full Water Leasing Alternative	-15,476	-5,138	-5,509	0	-583	-1,853
Wet Meadow Alternative	0	0	-17	0	-174	0
Water Emphasis Alternative	-7,642	-3,448	-1,198	0	-496	-1,123

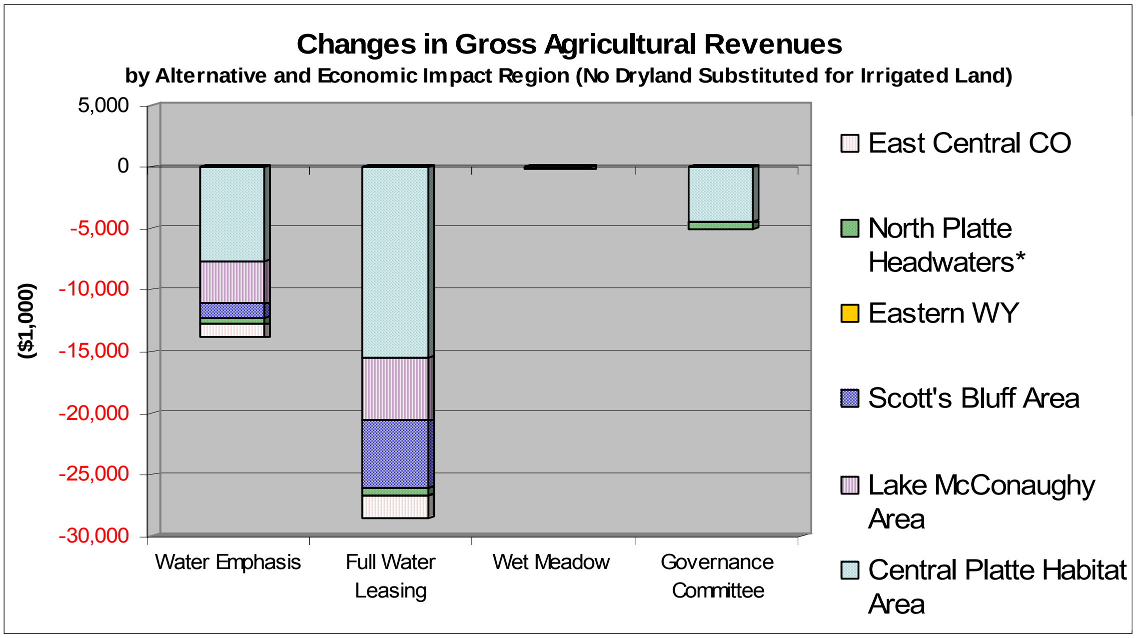

Figure 5-AE-4.—Average annual changes in gross agricultural revenues by alternative and economic impact region without substituting dryland farming.

Note that under the Governance Committee Alternative, revenues increase very slightly in the agricultural economy in the Scotts Bluff area. This is due to the projected change in the cropping pattern of irrigated crops in this area. The agricultural model predicts a substitution of irrigated crops with a lower consumptive use requirement for those crops currently being grown with a higher consumptive use requirement. The increase in acres of crops that require less water generates slightly more revenue than is lost by the decrease in acres of crops with a higher water requirement. This substitution effect is most likely to occur when predicted changes in water deliveries and consumptive use are fairly small, as in the situation mentioned above.

When land is retired from agriculture, the reduction in agricultural revenue is approximately $29 million for the Full Water Leasing Alternative and almost $14 million for the Water Emphasis Alternative with the majority of those amounts occurring in the Central Platte Habitat Area. When measured as a percent of total agricultural revenues, the Scotts Bluff area bears the largest proportion of impacts with a 3.2 percent reduction under the Full Water Leasing Alternative. Under the Governance Committee Alternative, the only area that sustains a revenue reduction greater than 1 percent is the North Platte Headwaters area at 1.1 percent.

As mentioned in the "Irrigated Acres and Cropping Patterns" section above, a range of direct impacts to the agricultural economy was predicted. The values shown in table 5-AE-6 above are estimated assuming that a reduction in irrigation water requires farmers to take land out of production completely. This provides an estimate of the maximum impact to the agricultural economy of the Basin. The values shown in table 5-AE-7 and figure 5-AE-5 are estimated assuming that farmers will produce nonirrigated crops in those areas where conditions are suitable for dryland agriculture. These values provide the minimum estimate of the range of direct impacts to the agricultural economy. In areas where climatic conditions will not support nonirrigated agriculture, the minimum and maximum impacts are the same.

Table 5-AE-7.—Average Annual Changes in Gross Agricultural Revenues by Alternative and Economic Region With Substituting Dryland Farming for Irrigation ($1,000).

Alternative	Central Platte Habitat Area	Lake McConaughy Area	Scotts Bluff Area	Eastern Wyoming	North Platte Headwaters	Eastern Colorado
Governance Committee Alternative	-2,356	0	8	-115	-560	0
Full Water Leasing Alternative	-8,127	-3,049	-3,361	0	-583	-1,369
Wet Meadow Alternative	0	0	14	0	-174	0
Water Emphasis Alternative	-4,038	-2,024	-711	0	-496	-879

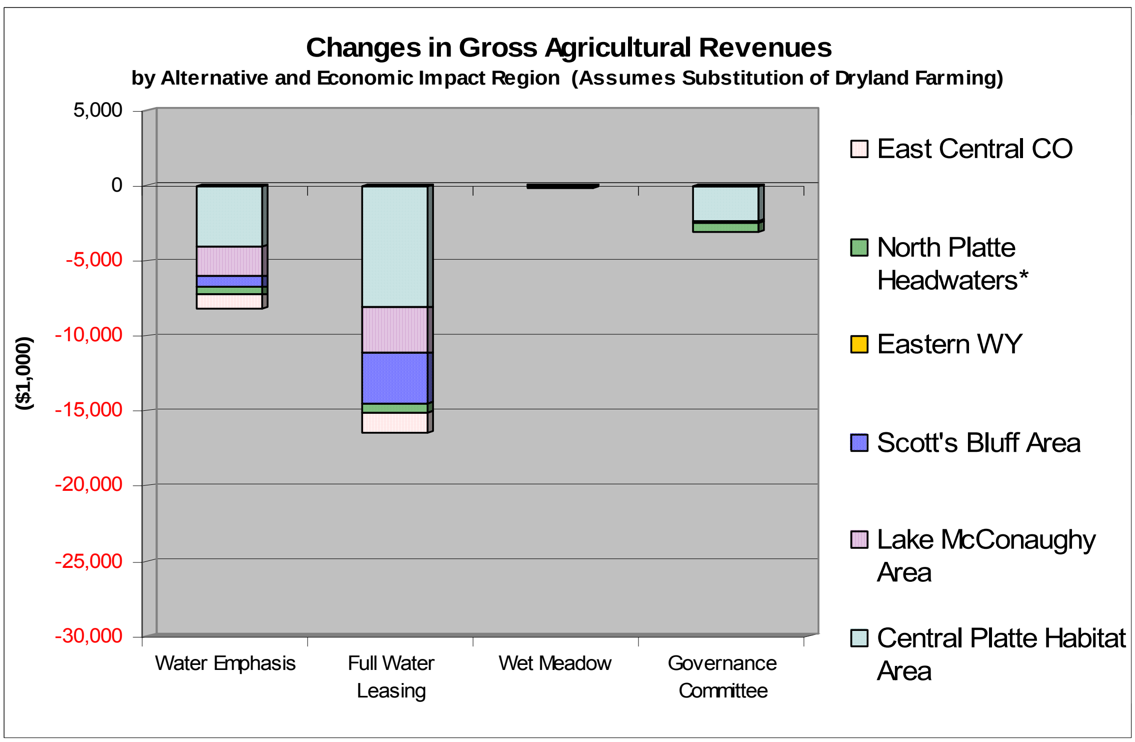

Figure 5-AE-5.—Average annual changes in Gross Agricultural Revenues by Alternative and Economic Region With Substituting Dryland Farming for Irrigation ($1,000)

When nonirrigated crops are substituted for irrigated crops, where appropriate, the impacts to agricultural revenues are reduced by about 40 percent. Only the Wet Meadow Alternative remains essentially the same whether dryland substitution occurs or not. Figure 5-AE-6 shows the range of impacts to total agricultural revenues in the Basin for each alternative modeled.

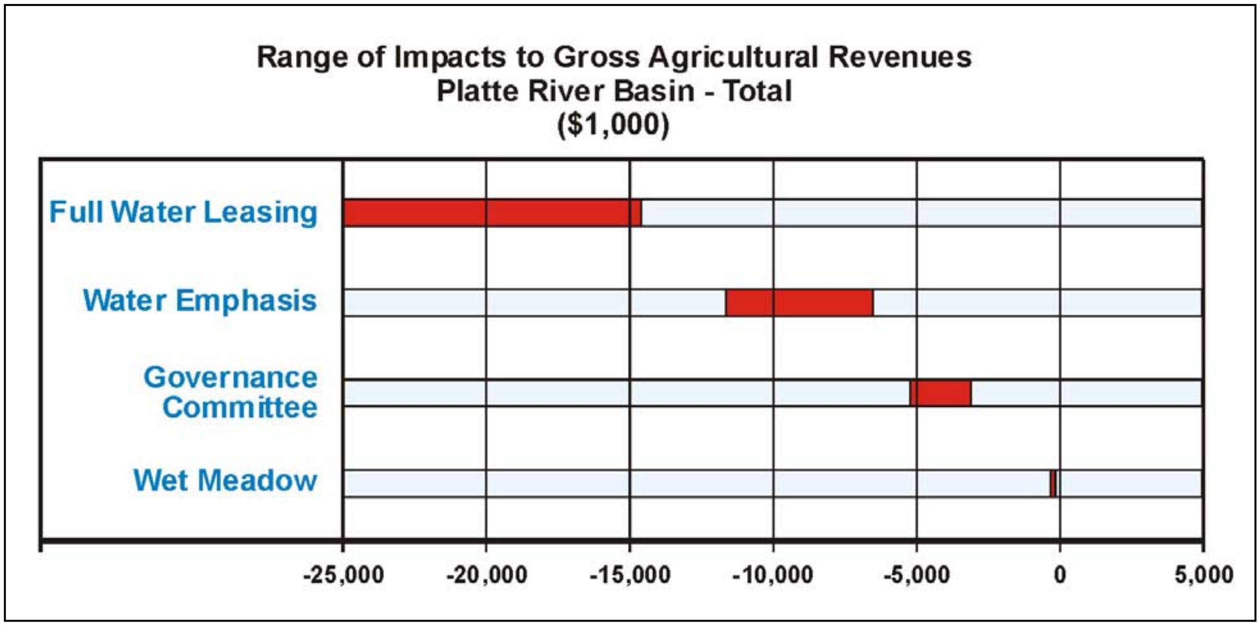

Figure 5-AE-6.—Range of average annual impacts in gross agricultural revenues by alternative.[19]

Habitat Acquisition and Management Effects

Efforts to acquire and manage specific tracts of land to provide improved habitat for the target species are expected to impact the agricultural economy of only the Central Platte Habitat Area. In addition, based on the current land uses and types of vegetation expected to exist on lands that would be suitable for habitat, the impacts are expected to be much smaller than those projected to occur from changes to irrigation deliveries and onfarm consumptive use. Tracts of land assumed to be typical of those that would be suitable to acquire and manage for habitat were selected to estimate potential changes to existing land covers, including agricultural production. Converting some existing cover types to those specifically required for habitat areas could require eliminating some of the more intensive agricultural cropping practices. On the other hand, establishing additional acres of grasslands within the habitat management areas could provide additional agricultural production and revenues from grazing or haying activities.

Grazing and hay production yields on habitat lands were estimated using information on the type of management practices and average yields in the study area. It was assumed that grazing and hay production would be used to manage habitat areas restored as wet meadows or natural grassland and would be employed on a rotational production schedule. Under this schedule, pastureland would be hayed or grazed, burned, or rested on an annual basis. Grazing and hay production were assumed to commence on program lands 2 years after restoration when natural grasses are established. A summary of the estimated changes in crop acres and corresponding changes to farm income is provided in table 5-AE-8.

[19] Note that this figure shows ranges by $1,000. The Y axis is not used.

Table 5-AE-8.—Habitat Acquisition and Management Program Summary of Changes to Agricultural Area and Revenues by Alternative (Net Area Change—Gains Minus Losses)

	Governance Committee Alternative		**Full Water Leasing Alternative**		**Wet Meadow Alternative**		**Water Emphasis Alternative**	
IMPLAN Sector	**Acres**	**Gross Revenue**	**Acres**	**Gross Revenue**	**Acres**	**Gross Revenue**	**Acres**	**Gross Revenue**
Forage	3,533	304,899	4,248	367,177	7,447	643,447	774	68,264
Feed grains	-1,564	-592,956	-1,835	-696,037	-3,233	-1,226,049	-216	-82,033
Food grains	-	0	-	0	-	0	-	0
Vegetables	-	0	-	0	-	0	-	0
Oil crops	-145	-42,269	-170	-49,617	-300	-87,398	-20	-5,848
Sugar crops	-	0	-	0	-	0	-	0
Total	**1,823**	**-330,325**	**2,242**	**-378,476**	**3,912**	**-670,000**	**538**	**-19,617**

REGIONAL ECONOMICS

Issue: How would the action alternatives affect regional economics?

Overview

SCOPE

The alternatives have effects on the regional economies in several parts of the Basin. The affected areas of the Basin have been divided into economic areas (see “Regional Economics” in chapter 4).

INDICATORS

- **Regional sales**
- **Regional income**
- **Regional indirect business taxes**
- **Regional employment**

SUMMARY OF IMPACTS

All of the projected economic impacts from all alternatives are less than or equal to one-tenth of 1 percent of the economic activity in the associated region.

All of the alternatives bring money into the economic regions through construction investments, payments for land, or payments for water. Together, these investments and payments constitute the economic benefits of the Program alternatives.

Regional economic losses are created primarily in two ways:

- **Water leasing:** When water users or land owners lease or sell water or land to the Program, agricultural production is reduced. Individuals would likely participate in the Program only if Program payments for water or land equal or exceed the income they would otherwise have received from the land or water. So, at the individual level, these transactions create an economic benefit. However, the Program payments to individuals for water and land are not all spent in the respective economic region and, therefore, do not fully offset decreases in agricultural production and the associated local expenditures.

- **Instream flows:** Adding environmental instream flows to the existing demands on the Basin water supplies reduces lake levels at several Basin reservoirs, producing losses in recreation visitation and expenditures for certain activities.

In general, the alternatives which acquire or lease the most water, the Full Water Leasing and Water Emphasis Alternatives, produce negative effects on a regional level, due to reductions in agricultural production that filter throughout the other sectors in the economy. Payments to irrigators and landowners may offset impacts to irrigated agricultural production, so overall impacts may be positive even though impacts on many agricultural sectors would be negative. In addition, if there are investments from construction or recreation in the region, these help to offset these negative impacts, and overall effects could be positive. The Wet Meadow Alternative in the habitat region creates the greatest economic benefits because it does not take water out of irrigation due to leasing and puts the most money into habitat restoration.

IMPACTS ANALYSIS

The action alternatives affect regional economics in several ways. The Program pays willing participants for land easements, leasing, or acquisition, and for water acquisition or leasing. The Program also invests locally in construction of significant Program features and facilities and in land restoration and management, affecting both local income and business receipts. As some water is shifted to flows for the target species, some reduction in irrigated acreage occurs. This affects crop revenues and agricultural expenditures, which in turn affect the agricultural support sectors of the economy.

Program Economic Inputs to the Regions

The direct effects associated with each alternative are displayed in table 5-RE-1. This is the amount of money spent in the regions from the various elements or the direct economic benefits or losses generated by program actions. These effects will generate the indirect and induced impacts when run through the regional economic model.

Table 5-RE-1.—Direct Economic Effects by Alternative*

Element*	Governance Committee	Full Water Leasing	Wet Meadow	Water Emphasis
Central Platte groundwater mound - conjunctive use				$4,725,000
Central Platte offstream reservoir	$7,350,000			
Dawson and Gothenburg Canal groundwater recharge	$848,000			
Dry Creek/Fort Kearney Cutoff	$399,000			
Groundwater management (groundwater mound)	$716,000			
Island leveling/sand moving	$3,350,000	$3,350,000	$6,734,000	$2,136,000
Land acquisition payments	$8,720,000	$8,720,000	$17,536,000	$5,563,000
Legal and admin fees associated with land acquisition and management activities	$1,960,000	$1,960,000	$3,942,000	$1,250,000
North Platte channel capacity restoration		$1,000,000	$1,000,000	$1,000,000
Pathfinder Modification Project	$2,243,000		$2,243,000	$2,243,000
Habitat land restoration and management	$10,750,000	$10,750,000	$16,040,000	$8,856,000
Riverside drains				$10,426,000
Tamarack Projects, construction	$7,868,000		$3,434,000	$7,868,000

Element*	Governance Committee	Full Water Leasing	Wet Meadow	Water Emphasis
Water leasing payments - Colorado		$54,600,000		$27,300,000
Water leasing payments - Nebraska	$9,750,000	$46,800,000		$23,400,000
Water leasing payments - Wyoming	$8,970,000	$58,890,000		$15,600,000
Water management incentives	$4,500,000			
Lake McConaughy recreation (change in average annual visitor days)	-13,609	5,883	-8,935	-1,378
North Platte fisheries (change in average annual angler days)	-14,946	0	-14,946	-14,946
Glendo Reservoir recreation (change in average annual visitor days)	-2,985	-1,959	-4,985	-4,253
Guernsey Reservoir recreation (change in average annual visitor days)	-41	192	-121	-103
Seminoe Reservoir recreation (change in average annual visitor days)	-315	664	-1,063	-666
Agriculture with dryland (average annual)	-$3,024,000	-$16,489,000	-$160,000	-$8,149,000
Agriculture without dryland (average annual)	-$5,088,000	-$28,560,000	-$192,000	-$13,907,000
* Program's First Increment costs (for the 13 years) are rounded to the nearest $1,000 unless otherwise stated.				

Regional Impacts

Direct, indirect, induced, and total impacts are reported in terms of sales or industry output which represents the value of an industry's total production; income, which includes employee compensation (wages and salaries of workers and benefits such as health and life insurance and retirement payments), plus proprietary income (self-employed workers payments); indirect business taxes, which consist of excise taxes, property taxes, fees, licenses, and sales taxes paid by businesses; and employment, which includes full- and part-time workers.

When looking at regional impacts, it is important to note that the impacts are not additive across regions because of leakages that may occur in the different areas, as explained in detail in the "Regional Economics" section in the *Economics Appendix* in volume 3. In addition, the agricultural impacts were analyzed under the assumption that dryland crops would or would not be substituted for irrigated crops. The actual impacts from an alternative are expected to be somewhere in the range between the two possibilities (table 5-RE-2).

Under all assumptions, the effect of each alternative in an economic region is equal to or less than one-tenth of 1 percent of the economic activity (sales, income, taxes, or employment) in that region.

Table 5-RE-2.—Average Annual Impacts in Each Economic Impact Area (Direct, Indirect, and Induced in 2002 Dollars)

	Central Platte Habitat Area		Lake McConaughy		Eastern Wyoming		North Platte Headwaters		Eastern Colorado		Scotts Bluff	
	With Dryland	**Without Dryland**	**With Dryland**	**Without Dryland**	**With Dryland**	**Without Dryland**	**With Dryland**	**Without Dryland**	**With Dryland**	**Without Dryland**	**With Dryland**	**Without Dryland**
Governance Committee Alternative												
Sales	$1,776,223	($693,089)	$243,906	$243,906	($180,215)	($180,215)	($584,543)	($584,543)	$0	$0	$8,541	$8,541
Income	$455,423	($47,533)	($57,451)	($57,451)	($56,067)	($56,067)	($228,067)	($228,067)	$0	$0	$3,109	$3,109
Indirect business taxes	$35,617	($53,395)	($19,345)	($19,345)	($12,779)	($12,779)	($63,434)	($63,434)	$0	$0	($43)	($43)
Employment	14.6	(5.0)	(4.0)	(4.0)	(3.0)	(3.0)	(13.4)	(13.4)	0.0	0.0	0.1	0.1
Full Water Leasing Alternative												
Sales	($2,857,199)	($11,647,154)	$464,206	($1,906,725)	($75,784)	($75,784)	$33,173	$33,173	($148,355)	($762,315)	$1,011,005	($1,545,852)
Income	($307,399)	($2,097,759)	$241,650	($168,393)	($26,522)	($26,522)	$35,998	$35,998	($16,693)	($126,453)	$230,238	($262,315)
Indirect business taxes	($100,490)	($417,343)	$33,679	($48,335)	($6,514)	($6,514)	$5,029	$5,029	($5,346)	($28,107)	$42,167	($54,042)
Employment	(33.3)	(103.0)	10.3	(13.0)	(1.5)	(1.5)	1.2	1.2	5.9	(3.8)	13.0	(17.0)
Wet Meadow Alternative												
Sales	$3,833,335	$3,833,335	$152,185	$152,185	($217,415)	($217,415)	($922,093)	($922,093)	$0	$0	$12,687	($24,921)
Income	$897,682	$897,682	($29,646)	($29,646)	($76,012)	($76,012)	($323,314)	($323,314)	$0	$0	$13,706	$6,461
Indirect business taxes	$91,332	$91,332	($10,709)	($10,709)	($18,662)	($18,662)	($81,161)	($81,161)	$0	$0	($2,725)	($4,140)
Employment	39.9	39.9	(2.2)	(2.2)	(4.2)	(4.2)	(17.0)	(17.0)	0.0	0.0	0.6	0.2
Water Emphasis Alternative												
Sales	$475,495	($3,835,468)	$60,332	($1,555,802)	($185,469)	($185,469)	($906,810)	($906,810)	($329,410)	($638,323)	$274,153	($304,902)
Income	$138,471	($739,597)	$34,829	($244,674)	($64,843)	($64,843)	($304,115)	($304,115)	($71,581)	($127,193)	$70,278	($41,272)
Indirect business taxes	($21,621)	($177,019)	($6,147)	($62,051)	($15,920)	($15,920)	($78,517)	($78,517)	($15,954)	($27,407)	$8,817	($12,972)
Employment	(4.3)	(38.4)	1.7	(14.2)	(3.6)	(3.6)	(16.4)	(16.4)	5.0	0.1	3.7	(3.1)
Total average annual impacts represent less than one-tenth of 1 percent of total economic activity in each region.												

Summary

The range of direct impacts produces a range of indirect and induced impacts, depending on the amount of expenditures flowing into the regions and where these expenditures occur.

Governance Committee Alternative

Under the Governance Committee Alternative, the Central Platte Habitat Area economic region is the only region that shows a difference between with dryland substitution and without dryland substitution. The habitat region also has the greatest increase in the four indictors (with dryland) and the greatest decrease in the four indicators (without dryland) of all regions in this alternative. The four indicators are positive for the Central Platte Habitat Area with dryland substitution, 3 (sales, income and employment) are positive for Scotts Bluff and only 1 (sales) for Lake McConaughy. All other indicators for this alternative are negative or zero (for eastern Colorado).

Full Water Leasing Alternative

Water leasing puts a large amount of payments for water into the regional economies, which may offset the economic changes in agricultural production that occur under the Full Water Leasing Alternative. Farming without substituting dryland produces greater negative impacts than with dryland substitution. The North Platte Headwaters, Lake McConaughy with dryland substitution, and Scotts Bluff with dryland substitution regions show annual increases in the four indicators due to the water leasing payments and increased recreation visitation offsetting the negative changes to agricultural production. As the greatest amount of changes to irrigated agriculture are in habitat region, this alternative produces the greatest negative impacts out of all the regions. The most positive impacts in this alternative occur in the Scotts Bluff region with dryland substitution due to the large amount of water leasing payments offsetting the small changes in agricultural production.

Wet Meadow Alternative

The Wet Meadow Alternative does not contain a water leasing element, so agricultural production is not reduced due to leasing and the focus is shifted to land acquisition (which assumes that 50 percent of payments to land owners are spent in the region). For the Wet Meadow alternative, the Central Platte Habitat Area region with and without dryland substitution produces the greatest positive impacts under the four indictors while the North Platte Headwaters region produces the greatest negative impacts with and without dryland substitution.

Water Emphasis Alternative

Under the Water Emphasis Alternative, the Central Platte Habitat Area, Lake McConaughy, eastern Colorado and Scotts Bluff regions show differences between with dryland substitution and without dryland substitution. Only eastern Wyoming and North Platte Headwaters are the same under with and without dryland substitution. The greatest negative impacts in the Water Emphasis Alternative occur in the habitat region without dryland substitution due to decreased irrigated agriculture and the greatest positive impacts occur in the Habitat region with dryland substitution for sales and income due to payments to landowners and construction expenditures which offsets the smaller amount of reduced agricultural production.

South Platte Headwaters and Denver Metropolitan Area

There are no impacts to the South Platte Headwaters or Denver metropolitan area regions under any of the proposed alternatives because no elements are located in or affect either of these regions.

Central Platte Habitat Area Economic Region

The Wet Meadow Alternative produces the highest amount of sales, income, indirect business taxes and employment impacts in the Central Platte Habitat Area economic region. These positive impacts are a result of no losses in agricultural production due to water leasing and payments to landowners. The Full Water Leasing Alternative produces negative impacts under all four indicators, and, without dryland substitution, produces the least desirable impacts. These negative impacts are a result of the agricultural production being lost to water leasing. Both the Governance Committee Alternative and Water Emphasis Alternative produce positive impacts in the Central Platte Habitat Area economic region under all four indicators with dryland substitution and negative impacts without dryland substitution.

Lake McConaughy Area Economic Region

Under the Governance Committee Alternative, increased annual sales but decreased annual income such that occur in the Lake McConaughy region are most likely due to impacts from the sale of construction materials used for riverside drains and the groundwater mound and losses in income from decreased irrigated agricultural production.

The Full Water Leasing Alternative provides the most positive and negative impacts with and without dryland substitution, respectively.

Under the Wet Meadow Alternative, increased average annual sales but decreased average annual income occurs in the Lake McConaughy region—most likely due to impacts from the sale of construction materials used for Tamarack and losses in income from decreased visitation at Lake McConaughy.

Eastern Wyoming Area Economic Region

Eastern Wyoming experiences negative impacts under all of the alternatives. The Full Water Leasing Alternative with and without dryland substitution shows the least amount of negative impacts in eastern Wyoming. The Wet Meadow Alternative produces the greatest amount of negative impacts in eastern Wyoming. Under the Wet Meadow and Water Emphasis Alternatives, recreation visitation losses in eastern Wyoming account for the decreases in sales, income, employment, and indirect business taxes in the region. Having no dryland substitution produces greater negative impacts than with dryland substitution.

North Platte Headwaters Area Economic Region

The North Platte Headwaters region experience negative impacts under all of the alternatives except for the Full Water Leasing alternative. North Platte Headwaters fares best under the Full Water Leasing Alternative with and without dryland substitution. The greatest negative impacts in this region are under the Wet Meadow Alternative with and without dryland substitution. This is due to losses in agricultural production as well as recreational visitation losses at Seminoe Reservoir and angler visitation decreases at Seminoe and Pathfinder fisheries.

Eastern Colorado Area Economic Region

Eastern Colorado shows zero impacts under the Governance Committee and Wet Meadow alternatives. Eastern Colorado region's impacts are negative under the Water Emphasis and Full Water Leasing alternatives. Note that there is positive employment under the Full Water Leasing alternative due to increased employment in the grain farming sector offsetting other employment losses.

Scotts Bluff Area Economic Region

Under the Full Water Leasing Alternative, the Scotts Bluff experiences the highest positive impacts for all four indicators with dryland substitution and the greatest negative impacts without dryland substitution. Under the Wet Meadow Alternative, changes in agriculture production produce mixed results in the Scotts Bluff region due to the small amount of changes in gross agricultural revenues. The Governance Committee Alternative produces slightly positive impacts to sales, income and employment both with and without dryland substitution. The Water Emphasis Alternative produces positive impacts with dryland substitution and negative impacts without dryland substitution.

Indirect and Induced Impacts

The range of direct impacts produces a range of indirect and induced impacts, depending on the amount of expenditures flowing into the regions and where these expenditures occur.

The Central Platte Habitat Area economic region experiences positive impacts in sales, income, indirect business taxes and employment under the Governance Committee Alternative with dryland substitution because of the large amount of spending from construction that is taking place. However, the Central Platte Habitat Area economic region experiences positive impacts in sales, income, indirect business taxes and employment under the Wet Meadow Alternative due to payments to landowners. All four economic indicators under the Wet Meadow Alternative (with and without dryland substitution) are positive in the Central Platte Habitat Area economic region because of the large amount of water leasing taking place in that region and there are no changes in irrigated agricultural production.

PRIMARY PROGRAM COSTS

Table 5-PPC-1 presents the primary Program costs associated with the alternatives. The costs in the table do not represent a full Program budget. That is, they do not include project permitting costs, administrative costs, taxes, mitigation costs, or monitoring and research which have been estimated by the Governance Committee to total $50 to $60 million in the Program's First Increment. The costs below do not include the value of contributed land and water (for which Program payment is not made). The costs shown below are for the primary Program actions having environmental effects for the Program's First Increment. The shaded cells are costs from the Reconnaissance-Level Water Action Plan (Boyle Engineering, 2000) unless otherwise noted. The remaining costs are provided by the EIS Team.

Table 5-PPC-1.—Primary Project Costs

	Governance Committee Alternative	Full Water Leasing Alternative	Wet Meadow Alternative	Water Emphasis Alternative
Central Platte groundwater mound conjunctive use				$4,725,000
Central Platte power interference	$1,790,000			$1,790,000
Central Platte offstream reservoir	$7,350,000			
Dawson and Gothenburg Canal groundwater recharge	$848,000			
Dry Creek/Fort Kearney Cutoff	$399,000			
Glendo Reservoir (water leasing)	$1,988,000			
Glendo new water right (100 kaf)			$100,000	$100,000
Central Platte groundwater management (Water Action Plan, option 1)	$716,000			
Net controllable conserved water	$3,965,000			
North Platte channel capacity restoration	$1,000,000	$1,000,000	$1,000,000	$1,000,000
Pathfinder Modification Project	$2,243,000		$2,243,000	$2,243,000
Pathfinder Wyoming Account (leasing)	$2,280,000			
Riverside drains				$10,426,000
Tamarack Project, Phase I			$3,434,000	
Tamarack Project, Phase III	$7,868,000			$7,868,000
Water leasing, Colorado[2]		$109,200,000		$54,600,000
Water leasing, Nebraska	$19,500,000	$93,600,000		$46,800,000
Water leasing, Wyoming	$17,940,000	$117,780,000		$31,200,000
Water management incentives	$9,000,000			
Island leveling/sand moving	$3,350,000	$3,350,000	$6,734,000	$2,136,000
Land acquisition	$17,440,000	$17,440,000	$35,072,000	$11,126,000
Legal and admin fees associated with land acquisition and management activities	$1,960,000	$1,960,000	$3,942,000	$1,250,000
Habitat restoration and maintenance	$10,750,000	$10,750,000	$16,040,000	$8,856,000
Total	**$100,387,000**	**$355,080,000**	**$68,565,000**	**$184,120,000**

Details are provided in the *Economics Appendix* in volume 3. A full Program budget for the preferred alternative can be found in the Governance Committee Program Document: Attachment 1: Draft Finance Document and Program Budget.

SOCIAL ENVIRONMENT

Issue: How would the action alternatives affect population/demographics, income, employment, health concerns, flooding, and land use?

Overview

SCOPE

The area of effect includes 8 counties in the North Platte River Basin in Wyoming, 18 counties in the South Platte River Basin in Colorado, and 22 counties in the Central Platte River Basin in Nebraska. The area of primary effect includes the Central Platte Habitat Area, including the following nine counties in Nebraska: Dawson, Gosper, Phelps, Buffalo, Kearney, Hall, Adams, Merrick, and Hamilton.

INDICATORS

- **Population and demographics**
- **Human health concerns**
- **Changes in flooding patterns**
- **Land use trends**
- **Income and employment**

SUMMARY OF IMPACTS

Compared with the Present Condition, the action alternatives would not significantly affect population and demographic trends, health risk factors, flooding, land use, or income and employment.

IMPACTS ANALYSIS

Social impacts are discussed broadly since the specific locations and impacts of each component of the alternatives, such as water leasing, are unknown at this time. Additional site-specific NEPA analysis will be carried out for specific program land and water actions when they are identified to assess local effects, including social effects.

During the scoping and planning processes, the public and interest groups raised social, socioeconomic, or third-party-impact concerns that included potential changes to agriculture, income, taxes, employment, population growth, future development, human health, flooding, and land use. Income and employment are generally considered socioeconomic indicators and, for this reason, are analyzed in this section as well as in the "Regional Economics" section, earlier in this chapter. Since the alternatives are expected to have negligible effects on these factors, the following impact analysis focuses on the Central Platte Habitat Area in Nebraska—the area where the largest proportion of program element impacts would occur.

Population And Demographics

In terms of population projections from year 2000 to the year 2020, table 5-SOC-1 shows that there is estimated to have been about 3.5 million people living in the Basin in the year 2000 which is expected to grow to about 4.8 million by the year 2020. The Program would not influence population change in the Basin and is expected to have negligible effects on new or additional water supply uses. For a more detailed discussion about the Program and future water supplies and demands, see "New Water Use in Each State" subsection in the "Water Uses" section in chapter 4 and chapter 5.

Table 5-SOC-1.—Population Projections by Year and the Annual Average Percent Change from 2000 to 2020

	2000	**2005**	**2010**	**2015**	**2020**	**Annual Average Percent Change 2000 - 2020**
Wyoming portion of the North Platte River Basin	264,992	270,478	274,969	277,633	277,668	0.2
Colorado portion of the South Platte River Basin	2,958,954	3,198,587	3,502,284	3,839,659	4,175,091	1.7
Nebraska portion of the Central Platte River Basin	306,959	318,301	331,142	345,903	361,778	0.8
Platte River Basin Total	3,530,905	3,787,366	4,108,395	4,463,195	4,814,537	1.6
Sources: U.S. Bureau of the Census, Wyoming Department of Administration and Information, Economic Analysis Division, Colorado Department of Local Affairs, Colorado Demography Section, and The Nebraska Department of Economic Development.						

Although about 1.3 million more people are expected to be in the Basin by 2020; that growth rate is generally about the same or slower for the North and South Platte River Basins that in the past, and slightly higher (a difference of five-tenths of 1 percent) for the Central Platte River Basin on an average annual basis. The South Platte River Basin is expected to grow about half the rate (1.7 percent) more that it did between 1940 and 2000, the Central Platte River Basin is projected to than in the past 60 year period at 0.8 percent, and the North Platte River Basin may slow to almost no growth (.002 percent). The slower projected growth of the Denver metropolitan area is the primary reason for a slower Basinwide forecast of 1.6 percent annually. Despite slower growth expected in the South Platte River Basin and North Platte River Basin, the top six highest population counties in the Central Platte River Basin—Hall, Buffalo, Scotts Bluff, Lincoln, Adams, and Dawson—are expected to grow slightly faster than in the past 60 years (roughly one-half of 1 percent), at approximately 1 percent annually between the year 2000 and 2020.

Human Health

Based on the analysis of land use changes, the action alternatives are not likely to create new habitat that would promote increases in mosquito populations that could, in turn, carry human disease or create habitat that would encourage increases in resident goose and migratory waterfowl (e.g., geese and ducks) populations. Thus, no increases are expected in health risks from mosquito-borne disease, waterfowl diseases, or waterfowl contamination of surface waters.

Mosquito-Borne Diseases

Concerns about possible increases in mosquito-borne disease focused on several related forms of encephalitis, three forms of which have been reported from Nebraska: Western equine encephalitis, St. Louis encephalitis, and West Nile virus.

Program alternatives would restore wet meadows and as lowland grasslands for the target species in the Central Platte Habitat Area. Increases in wet meadows in the Program area are estimated to be 7 to 19 percent over the amount now found on the Central Platte Habitat Area. Wet meadows include areas of heavy vegetation with soil that is damp most of the year due to shallow groundwater levels but seldom have standing water.

An earlier study examined three existing wet meadows in the Central Platte Habitat Area: Elm Creek, Rowe Sanctuary, and Crane Meadows (Henszey and Wesche, 1993). Mosquito breeding season is in summer. Only 1 percent of the Elm Creek wet meadow had standing surface water during two brief periods at the highest groundwater levels in spring and early summer. For the same periods, 4 percent of the Rowe Sanctuary and 46 percent of the Crane Meadows were covered briefly by standing water. Median summer water measurements were zero for surface water at all of the sites.

In addition, the Lake McConaughy EA may be used to augment summer low flows in the river. Through EA releases, the proposed Program may seek to reduce periods when late summer riverflows are very slow or nonexistent, which may reduce ponding and standing water favorable for mosquito breeding.

Urban or Nuisance Resident Geese Problems and Water Contamination

The program will not create nesting habitat in the Central Platte River valley that would produce increases in either the resident or the migratory population of waterfowl. Generally, areas in and along the Platte River and, to some extent, rural agricultural lands are used briefly in spring (usually mid-February to mid-March) by migratory geese and other waterfowl on their way to the Northern U.S. and Canada where they breed. Research indicates that droppings from free-ranging migratory birds do not greatly affect nutrient levels in water, (Service, 2004, personal communication, Matt Hogan, Acting Director, U.S. Fish and Wildlife Service). The small increase in roosting waterfowl habitat in and along the Platte River would serve to spread migratory goose (and other waterfowl) populations throughout more area, which reduces likelihood of waterfowl diseases. On the other hand, urban landscapes encourage geese to become year-round residents, which can become a problem in cases of urban water bodies that have high concentrations of sedentary Canada geese. The Program will not affect urban areas.

A peak of about 750,000 waterfowl stop over in the Central Platte River valley in mid-February on their way to breeding grounds in the Northern U.S. and Canada, usually leaving by the time 400,000 cranes arrive in mid-March. Previous research indicated that a complete turnover of migrant Canada geese can occur in 1 week. Therefore, at any one time, far fewer than the 750,000 stopover total inhabit the Central Platte River valley and nearby areas combined at one time.

Increases in wet meadows in the project area are estimated to be 7 to 19 percent over present wetlands now found on the Central Platte River. The types of habitat restoration associated with the Program along the Central Platte River are not habitat preferred by resident geese. These wet meadow habitats would not receive the protection from predators and do not have the abundant food sources associated with urban parks and golf courses or waste grain from agricultural lands.

Research regarding the effects of waterfowl feces on agricultural landscapes is limited, but effects likely vary with species and densities of birds, foods they consume, and time of year. Studies have shown that fecal input from geese was of little importance to nutrient dynamics of soils; in some instances, fecal matter appeared to have no influence, whereas in others, it seemed to stimulate plant growth. Also, research generally has found that droppings from free-ranging migratory birds do not greatly affect nutrient levels in water. The risk of contamination is likely influenced by the factors mentioned above as well as the dilution capacity of the wetland. Streams are less likely to have increased nutrient loads than isolated wetlands because of constant water flow (i.e., inputs are more effectively diluted). This is likely what occurs for birds using the Platte River. Nutrient levels are more likely to increase as birds become highly concentrated on small water bodies for extended periods of time, such as occurs in small urban ponds with abundant resident geese. In contrast, most birds using borrow pits along the Platte River are migratory and leave the area by mid-March (U.S. Fish and Wildlife Service, 2004, personal communication).

Similarly, the impact of waterfowl feces on human health (water contact activities) likely varies by the species present and other environmental variables. Although some water bodies, primarily in highly urbanized areas, have been closed due to high counts of coliform bacteria linked to Canada geese, the EIS team is not aware of any such instances occurring in the more rural landscapes of Nebraska.

The Program also does not increase habitat suitable for waterfowl nesting or breeding. Therefore, Program land restoration is not expected to increase numbers of resident Canada geese, migrant Canada geese, or other waterfowl. As a consequence, there would be no increased risk of water contamination or nuisance problems due to the Program.

Surface Water Flooding

All alternatives provide additional flood control in the Platte River below Lake McConaughy, as lake elevations are reduced and flood storage space is increased, thus diminishing the frequency, extent, and duration of significant out-of-bank flooding. There are presently 9 years of the 48 years modeled with flows above floodflow (10,800 cfs) at Overton. This is reduced to 7 years for all of the action alternatives.

The number of occurrences of out-of-bank flooding at Grand Island, Nebraska, in the 48-year period of record is shown in table 5-SOC-2 for the Present Condition and by alternative. Years with flows greater than 10,000 cfs are expected to be fewer with the action alternatives. Floodflow amounts would be from about 200 to 5,800 cfs lower than the Present Condition, depending on the alternative.

Table 5-SOC-2.—Out-of-Bank Flooding Summary by Alternative

	Present Condition	Governance Committee Alternative	Full Water Leasing Alternative	Wet Meadow Alternative	Water Emphasis Alternative
Years with flows greater than 10,000 cfs at Grand Island, Nebraska	13 years	11 years	12 years	10 years	12 years
Maximum floodflows (greater than 10,000 cfs) at Grand Island, Nebraska	28,172 cfs	24,547 cfs or a change of 3,625 fewer cfs	27,974 cfs or a change of 198 fewer cfs	22,379 cfs or a change of 5,793 fewer cfs	23,651 cfs or a change of 4,521 fewer cfs

Groundwater Levels

At present, during wet years when riverflows are at the highest levels, groundwater levels also rise within roughly 500 to 1,000 feet from the river. Program alternatives reduce the highest peak surface flows through the Central Platte Habitat Area reach of the Central Platte River. As a result, surface flows are not as high under the action alternatives, and groundwater levels near the river (1,000 feet or less away) are also reduced by up to 3 inches for the wettest years and the highest flood periods.

During normal or dry years when surface flows are at average or low levels, the Program alternatives would augment surface flows in the spring for periods of 3 to 30 days. As a result, Program alternatives would raise groundwater levels about 3 inches for periods of 3 to 30 days during years when surface and groundwater levels are normal or low.

Land Use Changes

Potential social impacts from the Program's First Increment land acquisition component of the action alternatives are expected to be minimal, for the following reasons:

- ➢ The 10,000 acres of the Program's First Increment represents 2.3 percent (or 1.5 percent) of the entire Central Platte Habitat Area, which consists of about 434,199 acres.
- ➢ It is Program policy that all lands acquired for the Program will be on a willing seller/willing lessor basis; there will be no land condemnation (Land Action Committee, Good Neighbor Policy, Land Plan).[20]

[20]See the Governance Committee Program Document: Attachment 4, Land Plan, for the Land Plan cited in these bullets.

- ➢ On the 10,000 acres managed by the Program, it is expected that many of the existing lands uses (for example, grazing, hunting, and most other uses) would be allowed to continue (Land Plan).
- ➢ It is Program policy that any tax burden associated with Program will not be shifted to landowners (Land Action Committee, Good Neighbor Policy, Land Plan).
- ➢ If there are adverse effects, the Program will have local representatives readily accessible so that the nature and cause of any problem can be quickly determined and corrective actions can be taken in a timely manner (Land Plan).
- ➢ The Program will require its contractors to carry appropriate insurance to cover documented damage claims directly resulting from their actions (Governance Committee Program Document).

Sand and Gravel Mining Operations

A concern has been expressed that the Program land component would negatively impact the sand and gravel mining industry by acquiring lands for habitat that might be needed for sand and gravel extraction. It is difficult to project future growth or decline in demand for sand and gravel. Ninety percent of the sand and gravel mined in Nebraska is used in asphalt and concrete for highway construction (Nebraska State Geological Survey, 2001).

If it is assumed that demand for highway construction and sand and gravel increases slightly within the next 50 years, it can also be assumed that the need for acres of land in sand and gravel production also will increase slightly. Due to the high cost of transport, it is difficult for gravel operations to economically supply construction at significant distances from the mines. This is reflected in the fact that sand and gravel operations occur in 78 out of 94 counties in Nebraska.

For the Program's First Increment, the Program seeks to acquire 10,000 acres of land for habitat. Already acquired are 2,650 acres of Cottonwood Ranch and 470 acres of the Wyoming Property, leaving 6,880 acres to be acquired. Within a 3.5-mile corridor of the Platte River, where the Program seeks to acquire land for habitat, there are approximately 395,000 acres of wetland-type habitat and agriculture. This means that the Program would acquire less than 2 percent of the available acreage in that area from willing sellers. In addition to acquiring such a small percentage of land in that area, the Program will focus on restoring habitat away from bridges and roads where mining activities are naturally located to reduce the cost of pit development and transport of material.

It is notable that several existing sand and gravel operations have become involved in providing nesting habitat for terns and plovers on unused areas of the mines employing various methods to control predation and disturbance of nests. There appears to be significant opportunity for the program to collaborate with sand and gravel operators to develop and protect channel habitat.

Income and Employment

Findings in the economic analysis showed that the largest average annual decreases in regional employment would occur in the Central Platte Habitat Area under the Full Water Leasing Alternative (loss of 33 jobs with dryland farming or 103 without) and Water Emphasis Alternative (loss of 4 jobs with dryland farming and 38 without), each with a loss of 103 or fewer jobs. The economic analysis also showed the largest decreases in income would occur in the Central Platte Habitat Area (without dryland farming). Under the Full Water Leasing Alternative, income would decrease roughly $2.1 million from current levels (on an average annual basis), and nearly $740,000 for the Water Emphasis Alternative (without dryland farming). The impacts (positive and negative) represent less than one-tenth of 1 percent of the total economic activity in the region (for additional information by alternative, see the "Regional Economics" section in this chapter). Impacts of this magnitude would be very difficult to detect.

CULTURAL RESOURCES

Issue: How would the action alternatives affect cultural resources?

Overview

SCOPE

The area of effect focuses on major water features in the North and South Platte River Basins, and water features and land areas in and near the Central Platte River in the Platte River Basin.

INDICATORS

- **Reservoir elevations:** Changes in reservoir elevations that would expose or erode new lands.
- **Water level fluctuations:** Fluctuations in water levels and releases that are wider or more rapid than the Present Condition ranges.
- **Ground disturbances:** Activities that disturb ground potentially containing cultural resources.

SUMMARY OF IMPACTS

The action alternatives could result in construction at a historic property in the North Platte River Basin, could expose unspecified cultural resources at one project area reservoir during prolonged drought periods, could disturb unspecified cultural resources as a result of:

- Construction of groundwater recharge ponds, pipelines, pumps, and canals near the South Platte River in Colorado as part of the Tamarack Projects
- Construction of an offstream reservoir, groundwater recharge pits, or installation of Riverside drains in the Central Platte valley area
- Habitat restoration in the Central Platte Habitat Area.

The minimum water surface elevation at Seminoe Reservoir for all but one of the alternatives would be lower than the minimum water surface elevation projected for the Present Condition, which may expose lands and any archaeological sites, if any exist. The Pathfinder Modification Project would modify the spillway, but it will not affect any historic structures at the Pathfinder Dam. Construction of a new offstream reservoir in the Central Platte valley, with possible land disturbances, and other land disturbances from habitat restoration could potentially cause negative impacts to cultural resource sites. Cultural resource impacts are summarized in table 5-CR-1.

Table 5-CR-1.—Summary of Cultural Resource Impacts

Resources and Factors	Present Condition	Governance Committee Alternative	Full Water Leasing Alternative	Wet Meadow Alternative	Water Emphasis Alternative
North Platte Basin					
Pathfinder Reservoir					
Historic Preservation and National Register of Historic Places	Dam is listed as an historic property on the National Register of Historic Places. A total of 7 sites eligible for National Register of Historic Places.	No impact	Not applicable	No impact	
Seminoe Reservoir					
Minimum elevation – potentially exposing sites	6,265 feet	Could be as much as 26 feet lower	Could be as much as 6 feet higher	Could be as much as 26 feet lower	
Glendo Reservoir					
Maximum elevation may be exceeded, but is within authorized operating range of flood pool	4,647 feet	Could be as much as 8.2 feet higher	Could be as much as 2.5 feet higher	Could be as much as 6.5 feet higher	Could be as much as 7.7 feet higher
South Platte Basin					
Tamarack Project, Phases I and III					
Physical modifications – potential impacts to surface and sub-surface archaeological sites	Some features are already in place	Construction of recharge ponds, pipelines, pumps, and canals would cause ground disturbance	Not applicable	Construction of recharge ponds, pipelines, pumps, and canals would cause ground disturbance	
Central Platte Basin					
Lake McConaughy					
May go below minimum (rarely)	3,249 feet	Could be as much as 7 feet lower	Could be as much as 1 foot higher	Could be as much as 7 feet lower	Could be as much as 4 feet lower
Central Platte Offstream Regulatory Storage Reservoir (CNPPID) Re-regulation Reservoir					
Construction of a new, offstream reservoir	No impact	Construction would cause extensive ground disturbance	Not applicable		
Land Acquisition in the Central Platte Habitat Area					
Land acquisition and management	No impact	About 4,632 acres could be disturbed. .		About 8,574 acres could be disturbed	About 3,246 acres could be disturbed.

Resources and Factors	Present Condition	Governance Committee Alternative	Full Water Leasing Alternative	Wet Meadow Alternative	Water Emphasis Alternative
Groundwater Management in the Central Platte Groundwater Mound					
Physical modifications – potential impacts to sub-surface archaeological sites	No impact	Construction of new wells, well pads, and pipelines expected to disturb localized areas	Not applicable		Construction of new wells, well pads, and pipelines expected to disturb localized areas
Riverside Drains					
Physical modifications – potential impacts to sub-surface archaeological sites	No impact	Not applicable		Laying underground piping may affect cultural resources	

IMPACTS ANALYSIS

Fluctuations in reservoir water levels and releases that are wider than the Present Condition ranges or that are more rapid can impact archaeological materials through erosion and may expose cultural resource sites to looting, vandalism, and erosion. Proposed actions also involve habitat restoration that will result in ground-disturbing activities that may affect surface or underground cultural resources.

Because of the programmatic nature of this FEIS, the discussion of impacts to cultural resources is general in nature. A more detailed, site-specific evaluation of effects will be required in the future in conjunction with individual Federal actions that also require compliance with the National Historic Preservation Act (NHPA). This will include further consultation with affected American Indian Tribes/Tribal Nations concerning cultural resources, including traditional cultural properties. Before action is taken, a class III survey should be completed for all lands that would be disturbed during construction, and NHPA Section 106 consultations would occur to identify the most appropriate actions, if necessary. For this programmatic FEIS, as part of Section 106 compliance, programmatic agreements among government agencies, State Historic Preservation Officers (SHPOs), and interested Tribes will be developed to guide cultural resource consultation and mitigation when Program actions appear likely to cause impacts. This agreement would cover assessment of potential impacts, survey work, and any needed mitigation, once site-specific Program actions are proposed that have the potential to affect cultural resources.

The alternatives were evaluated by indicators cited in chapter 4, "Affected Environment and the Present Condition," and generally fall into two broad categories—effects of changes in reservoir elevations, and physical modifications to existing lands or structures. Changes in reservoir elevations could affect cultural resources that are located within the reservoir pool, at its margins, or downstream.

Effects of Changes in Reservoir Elevations

Most impacts do not vary by alternative; and the variation is relatively small for the ones that do. For this reason, impacts are generally discussed for all action alternatives, and exceptions are noted. For a complete display of impacts by alternatives (and the Present Condition), see table 5-CR-1.

North Platte River Basin

Reservoir minimum and maximum elevation changes were projected for the alternatives using the NPRWUMEIS which analyzed changes based on the 48-year period of hydrologic record. The alternatives' minimum and maximum elevations were compared to the Present Condition lows and highs for the period 1947 to 1994 to determine whether lands that had not been inundated would be inundated, or if lands that had not been exposed would be uncovered, potentially flooding or exposing cultural resources.

Pathfinder Reservoir

All of the action alternatives include (except the Full Water Leasing Alternative) a Pathfinder Modification Project, raising the spillway height at Pathfinder Reservoir to increase reservoir capacity by about 54 kaf to recapture storage space lost to sediment. There is expected to be no change in the reservoir's available maximum or minimum elevation as a consequence of the Pathfinder Modification Project and other Program actions for any alternatives. Although the Pathfinder Modification Project is designed to restore the original storage capacity of the reservoir, the maximum water surface during a flood event will not increase because the raised spillway crest would consist of a more efficient ogee crest weir, which provides improved discharge capabilities at higher elevations. Therefore, neither the maximum potential land inundated, nor the time that the reservoir is at the maximum water elevation, is expected to increase.

Alcova Reservoir

Reservoir levels would not change beyond the Present Condition elevations.

Seminoe Reservoir

Under the alternatives, reservoir levels would not exceed the Present Condition maximum elevation. However, under all of the alternatives except the Full Water Leasing Alternative, the reservoir would be drawn down below the Present Condition minimum by about 26 feet, thereby exposing lands that are normally inundated. The frequency of this occurrence would be rare since it would happen only during a period of extended low inflows.

Initial indications show that 530 acres have previously been subjected to class III surveys. A total of 33 cultural resource sites have been recorded; 13 of those sites have been determined eligible for the National Register of Historic Places (NRHP) or are listed on the NRHP, 10 sites have been determined ineligible for the NRHP, and no determination of eligibility has been made regarding the remaining

10 sites. However if sites do exist, it is unknown if any would be visible at the lower reservoir elevations, or if they would be buried under silt deposited since the construction of the reservoirs. Before changing reservoir operations, Reclamation would conduct consultations under Section 106 of the NHPA to determine appropriate actions to take if the reservoir does fall below historic minimum levels. The actions identified through consultation, to take if reservoir elevations drop below Present Condition levels, may include for example:

- An initial reconnaissance of exposed areas to determine if cultural resource inventory would be worthwhile (that is, determine if original landforms are intact and not buried under recently deposited silt).
- Cultural resource inventory of some or all of the exposed areas if inventory is determined to be worthwhile.
- If cultural resources are identified in the exposed areas, actions to prevent looting or vandalism such as monitoring, patrols, signs, public service announcements, or other public education efforts should be taken.

Glendo Reservoir

Hydrologic analysis of the alternatives indicate that, under all of the alternatives, maximum water elevations would be higher than the Present Condition maximum by between 2.5 and 8.2 feet, depending on the alternative. The increase in reservoir elevation associated with these alternatives is within the authorized operating range of the Glendo Flood Pool.

Guernsey Reservoir

Reservoir levels would not change beyond the Present Condition elevations.

Central Platte River Basin

Lake McConaughy's reservoir would be drawndown by as much as 7 feet below the Present Condition minimum under all alternatives (except for the Full Water Leasing Alternative), but only under very severe drought conditions. If cultural resources are identified in the exposed areas, actions to prevent looting or vandalism such as monitoring, patrols, signs, public service announcements, or other public education efforts should be taken.

South Platte River Basin

All of the action alternatives would include physical modifications associated with the Tamarack Project, Phases I and III, including construction of recharge ponds, pipelines, and possibly some canals. Some recharge ponds are already in place, but more would be added. Under the enlarged Tamarack Project, Phase III, an even greater number of ponds, pipelines, and pumps would be installed for the Governance Committee and Water Emphasis Alternatives. These ground-disturbing activities all would have the potential to impact surface and sub-surface archaeological sites. The amount of survey work necessary would be determined in the NHPA Section 106 consultation process with the Colorado SHPO during the site-specific evaluation of the sites.

Effects of Construction and Habitat Restoration

North Platte River Basin

The Governance Committee, Wet Meadow, and Water Emphasis Alternatives include the Pathfinder Modification Project consisting of the Pathfinder EA and a Wyoming Municipal Account, to be created by raising the Pathfinder spillway height to restore the original capacity of the reservoir. This action would raise the spillway roughly 2 feet by constructing a low weir on top of the bedrock spillway. However, the spillway is carved out of bedrock some distance to the side from the dam itself. Thus, the spillway is apart from and not connected to the historic dam in any way. Therefore, this action is not expected to alter the appearance or function of the historic dam in any way.

Central Platte River Basin

Central Platte Offstream Regulatory Storage Reservoir

Construction of a reservoir would involve extensive ground disturbance with the Governance Committee Alternative. The likelihood of potential adverse impacts to any existing cultural resources would be high. Less than 1 percent of the region where a reservoir would likely be located (in the Brady to Lexington reach of the river) has been the subject of a class III survey. The amount of survey work necessary would be determined during future site-specific analysis.

Habitat Restoration in the Central Platte Habitat Area

Active management of acquired lands for target species could include physical modifications that have the potential to affect cultural resources. Activities to improve habitat that involve ground disturbance would also have the potential to impact cultural resources.

A preliminary class I survey was included in the analysis for this area. The research was conducted using literature and archival searches from the Nebraska SHPO on January 16, 2003, for Central Platte Habitat Area lands. The search identified that less than 1 percent of the total area searched has been the subject of other recent class III surveys. Consultation with the applicable SHPOs will continue as the NEPA process progresses. Once more site-specific and detailed information exists for the Program, class III surveys would be required for assessing potential impacts to existing cultural resources.

Groundwater Management in the Groundwater Mound

Ground-disturbing activities associated with this portion of the Governance Committee and Water Emphasis Alternatives include the drilling of new wells and the installation of above-ground and/or below-ground piping to carry groundwater to farm irrigation systems. The wells would be about 50 feet deep, and associated well pads would disturb approximately 100 square feet of ground. Wells would be drilled on ½-mile grids in existing farm fields that have been previously plowed. Groundwater recharge may entail the digging of pits or installation of subsurface pipe drains.

Riverside Drains

The installation of riverside drains under farm fields in the primary and secondary flood plains of the Central Platte River and some of its tributaries would involve ground disturbance in an approximately 100-foot-wide corridor under the Water Emphasis Alternative. Twelve-inch piping would be laid about 8 feet underground in a trench that is about 2 feet wide at the bottom. The remaining width of the corridor would be used to move and place equipment and gravel piles. Although activities would occur in farm fields where ground disturbance has already occurred, there is the potential to affect subsurface sites.

Sacred Sites

To date, the FEIS investigations and consultations have not identified any American Indian sacred sites that might be affected by the alternatives. The Program is analyzed broadly in this Programmatic FEIS, and separate analyses for specific areas of potential effect will occur in the future when more information about specific actions and locations are known. During initial consultations, Tribes have not indicated that sacred sites exist in the Basin. Early file research and consultations with SHPOs did not reveal the existence of sacred sites.

ANALYSIS OF CUMULATIVE EFFECTS

INTRODUCTION

This section considers actions outside of the Program that might affect land and water habitat for the target species, potentially increasing or decreasing the Program's accomplishments. This section also discusses cumulative impacts on water availability, land prices, and local economies. The regulations implementing NEPA and ESA both require an analysis of cumulative effects. The regulations implementing NEPA require that the cumulative effects analysis consider the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions, regardless of the agency (Federal or non-Federal) or person undertaking the action.

The regulations implementing the ESA require an evaluation of the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action that is the subject of ESA consultation. The regulations implementing the ESA do not require including Federal actions in the cumulative effects analysis because Federal actions that have already completed consultation become part of the environmental baseline and those that have not will require some level of consideration and/or consultation in the future.

Both requirements are considered in this section.

In general, it should be noted that the Program is designed to address many of the impacts that would normally be considered under "cumulative effects." Often, proposed Federal actions may create adverse environmental impacts or impacts to habitat for endangered species, and the analysis of cumulative effects is thereby concerned with cumulative effect to the environment or the species that results from both the Federal action and other ongoing Federal and non-Federal actions that may be having similar adverse consequences.

In contrast to that typical condition, this Program is a habitat restoration program for the target species; it seeks to make improvements in many areas of species habitat. Because of this, the focus of the cumulative effects analysis is not on assessing the additive adverse effects of the proposed action combined with other actions, but rather strictly on those other actions outside the Program.

Another typical concern for cumulative impacts is the case where the Federal action analyzed is one of many similar actions taking place in a geographic area, all of which can affect the resources or species of concern. In that case, the cumulative effects analysis seeks to determine the net effect of that Federal action taking into consideration reasonably foreseeable actions throughout a geographic region (such as a river basin) that also affect the resources of concern.

This Program, however, seeks to offset the effects of water development activities throughout the three-state Basin (above the Loup River) as those actions, Federal and non-Federal, affect the species and their habitat. It is a primary objective of the Program to address those Basinwide cumulative effects.

This Program incorporates measures to track future actions above the Loup River which may deplete riverflows and affect the species and their habitat and to offset certain portions of those future depletions.

New and expanded use of groundwater occurring after January 1, 2006, will be offset insofar as that new use affects Platte River flows upstream of Chapman, Nebraska.

Together, these aspects of the Program substantially reduce the extent of Federal or non-Federal actions above the Loup River having a significant net adverse effect on the species.

In addition, and most importantly, as discussed in the “New Water Uses in Each State” section in chapter 5, Nebraska has implemented a new law, LB962, which requires that river basins in Nebraska be assessed and classified as Not Fully Appropriated, Fully Appropriated, or Overapproriated. Under LB962, the NDNR has designated nearly all of the Platte River above the Kearney Canal diversion as overappropriated and most of the Basin above Columbus as fully appropriated. This process of Nebraska State water law administration substantially limits new depletions in the Basin above the Central Platte Habitat Area.

Two major sources of depletions remain unaddressed by the Program. First, the Loup River Basin and the Elkhorn River Basin in Nebraska have not been found to be Fully Appropriated or Overappropriated. Therefore, additional water development activities, surface and groundwater, is permitted in these Basins, subject to other state law and regulation. The potential for this to affect the Lower Platte Habitat Area is discussed below.

Second, while the Program participants agree to offset or avoid any future depletions to species and annual pulse flow targets, depletions to peak flows are not protected under the Program. This potential impact is discussed below.

Also discussed is the potential for impacts to the target species and their habitat from hydrocycling out of CNPPID facilities and the potential for new land development in the Central Platte River valley to affect the Central Platte Habitat Area.

CUMULATIVE EFFECTS OF FUTURE WATER DEVELOPMENT ACTIVITIES ON PLATTE RIVER FLOWS

The proposed Program seeks to improve riverflows in the Central and Lower Platte Rivers that benefit the target species. As described in chapter 3, “Description of the Alternatives,” the Service’s species and annual pulse flow targets (typically expressed as monthly flow targets) serve as a benchmark for the Program’s First Increment to measure progress toward improved flow conditions. The Program seeks to make improvements toward the Service’s species and annual pulse flow targets.

If activities outside the Program were to diminish flows at critical times of the year, flow improvements created by the Program could be undermined. This fact is the reason that each state and the Federal Government have developed, under the Cooperative Agreement, depletion management plans. The purpose of these plans is to offset or prevent additional depletions to species and annual target flows, using the July 1997 levels of water use as the baseline (see the depletion management plans in the Governance Committee Program Document: Attachment 5: Water Plan).

The analysis in this FEIS identifies activities that are included in the respective depletion management plans. The analysis also assumes these plans are effective in preventing reductions in achieving species and annual target flows that might be caused by future water development activities.

However, other than the level of potential impact and depletion replacement described in each plan, the parties to the Cooperative Agreement have not agreed to prevent further depletion of flows that are in excess of the Service's species and annual pulse flow targets. Generally, these are flows in late fall and winter and annual high flows that exceed approximately 4,000 cfs.

The Service's instream flow recommendations include recommendations for:

- Maintaining the occurrence of natural flood peaks for the beneficial effect they have on maintaining a wide and open channel
- Building sandbars for roosting and nesting
- Maintaining sloughs and wet meadows

These flows (above approximately 4,000 cfs) are not explicitly protected by the depletion management plans (see the Governance Committee Program Document: Attachment 5: Water Plan, Section 11: Water Plan Reference Materials).

An issue of cumulative effect, then, is the question of future water development activities in the Basin and its effect on flows in excess of species and annual flow targets that play an important role in creating and maintaining habitat.

The potential for these depletions to peak flows are discussed for each state and for the Federal Government below.

Wyoming

The North Platte River Decree (1945 and amended 1953) and the Final Settlement Stipulation reached between the States of Wyoming and Nebraska in November 2001 limit the amount of lands that can be irrigated and total consumptive use from the Basin in Wyoming. Relatively little additional irrigation can be undertaken above the 1997 baseline. This, plus the intervening effect of Lake McConaughy, make it unlikely that new water development activities in Wyoming would significantly reduce the larger flows that occur in the Central Platte River.

Colorado

The Front Range cities of Colorado that sit in the Basin, roughly from Fort Collins to Castle Rock, have been among the fastest growing areas in the Nation in the last decade. Early in the Cooperative Agreement process, the Colorado representatives developed a water-demand/water-use model to forecast the net effects that future Colorado growth would have on flows measured at the Julesburg gauge at the state line (State of Colorado, 1998).

The analysis projected how population growth would increase demand for water[21] and how those demands would be met in three geographical regions from a mix of five sources: additional transbasin

[21] Colorado's depletion management plan also tracks changes in irrigated lands. However, increases in water use for irrigation are not anticipated to be significant.

diversions into the South Platte, additional use of South Platte River native flows, additional use of groundwater that is not connected to the South Platte, water conservation and reuse, and conversion of agricultural water supplies to municipal uses. The model then projected how future changes in population and water use would affect flows at Julesburg that, in turn, would create periods of net depletion and net accretion at the Julesburg gauge. Colorado's plan is to re-regulate net accretions in some periods (usually August-April) into periods of net depletions (usually May-July) so that the Program's achievement of target flows at Grand Island is not undermined.

The Tamarack Project, Phase II, was designed to offset, as needed, any future changes in flows at Julesberg that would reduce achievement of species and annual target flows, as part of Colorado's depletion management plan. However, to the extent that future water needs in the South Platte River Basin are met by development of new storage capacity or diversions, peak flows in the South Platte might be affected and could reduce peak flows at Grand Island.

To address concerns about potential impacts to peak flows in the Platte River, Colorado agreed that initial ESA coverage for Colorado projects under the Program will be limited with respect to the magnitude of new water supplies derived from sources that have the potential to impact peak flows. As described in its Plan for Future Depletions:

> *"New water-related activities would not be covered by this plan if the average annual water supply to serve Colorado's population increase from "Wastewater Exchange/Reuse" and "Native South Platte Flows" exceeds 98,000 acre feet during the February through July period as described below. The 98,000 acre-feet figure represents gross water deliveries (supplies) to meet new demands for an average hydrologic year, and is not a consumptive use or diversion limitation. In analyzing proposed new water-related activities that have supplies derived from the storage of native South Platte flows or wastewater exchange or reuse, only those supplies resulting from diversions to storage or exchange/reuse during the period from February through July will be counted toward the 98,000 acre-feet. In the event that a new water- related activity is not covered by Colorado's plan pursuant to this subsection I.H.3, Colorado and the activity's proponent can consider amendments that will allow Colorado's Plan to provide ESA compliance for the activity as provided in Section E of the Program document."*

(Governance Committee Program Document:
Attachment 5: Water Plan, Section 9: Colorado's Plan for Future Depletions)

The period of February through July is specified because the Service identified these as the months of greatest concern from its perspective of potential peak flow impacts to the Program target species and habitat.

To evaluate potential impacts on peak flows within the "umbrella" of coverage described above, five South Platte River Basin water supply development components were conceptualized that are within this magnitude and are believed representative of the kinds of projects most likely to be implemented during the Program's First Increment. The likely fate of historic South Platte River flows (1947 through 1994) was analyzed assuming that these new water projects were in place. Several assumptions were adopted erring on the side of overestimating impacts to high flows.

From this analysis, estimated maximum daily reductions in flow in the South Platte River at Julesburg, Colorado, associated with only these projects were aggregated into monthly estimated flow reductions.

These reductions were then adjusted upward to reflect Colorado's commitment to maintain or increase long-term average flows at Julesburg in each month of the year. This includes the effects of other anticipated water development activities that was not explicitly modeled but which would be accretive to flows in the South Platte River.

The product of the above steps was a new table of monthly flows for the South Platte River at Julesburg, adjusted from "Present Condition" flows. While long-term average flows at Julesburg were not reduced in any of the 12 months of the year, the distribution of monthly flows over the 48-year modeled period changed somewhat, with many high-flow months manifesting reductions in flow and most low-flow months showing increases (figure 5-CE-1). Differences between the Present Condition and the "buildout" simulation reflect both projected Program's First Increment water development activities in Colorado, and Colorado's commitment to maintain long-term average flows at Julesburg in each month of the year through re-regulation or other means. This analysis of potential effects on peak flows was then incorporated into the analysis of the Program alternatives.

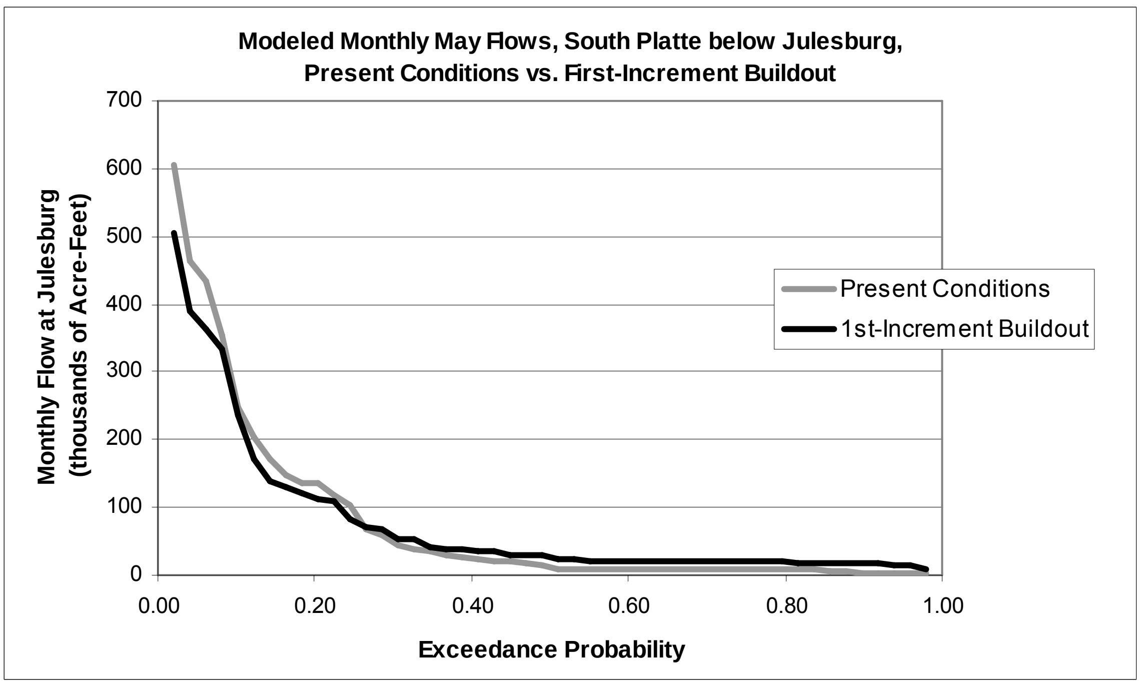

Figure 5-CE-1. Modeled effect of projected water development activities on flows in the South Platte River at Julesburg in the month of May, within the parameters of Colorado's Plan for Future Depletions.

Nebraska

The state's depletion management plan will track and offset or prevent new depletions to species and annual pulse flow targets caused primarily by groundwater pumping which affects flows upstream of Chapman, Nebraska. New depletions caused by surface water uses are also addressed. Increased use of the Platte River and connected waters in Nebraska has some potential to reduce peak flows in the Central Platte River. However, increased use of water from the Platte River, or from groundwater that is interconnected to the Platte River, has been substantially limited in Nebraska through implementation of new state laws.

In Nebraska, the most important influence on the development of new water uses is the recent passage of Legislative Bill 962 (LB962) and the processes that it puts in place to manage surface and groundwater rights in an integrated fashion. Shortly before the July 2004 effective date for LB962, the NDNR adopted a formal moratorium on new surface water uses in the Basin down to Columbus, Nebraska. On that effective date, most of the North Platte and all of the South Platte, Twin Platte, and Central Platte Natural Resources Districts were declared to be "fully appropriated" by operation of law. As a result, much of the area subject to the moratorium on new uses of surface water also became subject to stays on such new surface water uses, and stays were added on new uses of groundwater in much of the Basin above Columbus. Two months later, following a review of existing water rights, demands, and supply, the NDNR designated the Basin above the Kearney Canal Diversion, the North Platte River Basin, including Pumpkin Creek, and the South Platte River Basin, including Lodgepole Creek as "overappropriated." The September 15 Order designating the overappropriated Basins includes a description of the geographic area within which the NDNR has determined that surface water and groundwater are hydrologically connected for purposes of those overappropriated designations and the criteria used to make that determination. As a result of that order, some Basin lands that were not made subject to the stays on new groundwater uses because of the fully appropriated designations became subject to such stays in September of 2004.

LB962 also requires the NDNR to make an annual assessment of all other river Basins in the state to determine if they are fully appropriated. That assessment is to be based on an analysis of the combined supply of surface water and hydrologically connected groundwater to determine whether that supply can support additional development. The first assessments are expected to be completed by January 2006. The 2006 or any subsequent assessment could result in the designation as fully appropriated of additional Basin area, including portions of the Tribasin, Little Blue, and Upper Big Blue NRDs that are upstream of Columbus. Following any such determination, the same kinds of stays that were described earlier would be applied to the newly designated area.

Whenever land area in Nebraska is designated as "fully appropriated" and/or as "overappropriated," the NDNR and each of the affected Natural Resources Districts must jointly develop an Integrated Management Plan for surface and groundwater use The goals and objectives of such a plan must have a purpose of "sustaining a balance between water uses and water supplies" for the area. Such plans also must be sufficient to "ensure that the state will remain in compliance with any formal state contract or agreement pertaining to surface water or groundwater use or supplies" (e.g., any agreement to implement the Program). Also, the controls and incentives adopted for implementation of an Integrated Management Plan for either a fully appropriated or overappropriated area must ". . .*protect. . . the surface water appropriators (and river recharge-dependent groundwater users). . . from streamflow depletion caused by surface water uses and groundwater uses begun after the date the river Basin, subbasin, or reach was designated. . ..*" [LB962].

For the overappropriated areas (upstream of the Kearney Canal diversion), sustaining a balance between water use and water supply will not be possible without an increase in supply or a reduction in use. The long-term goal for those areas is to restore them to the fully appropriated status, but there is also a short-term, Program's First Increment goal for those areas. That short-term goal, which is for the first 10 years of the Integrated Management Plan, requires the NDNR and the Natural Resources Districts in the overappropriated area to address the impact of streamflow depletions caused by water uses initiated after July 1, 1997.

Thus, for most of the Basin in Nebraska down to Columbus, new uses are now restricted. Even without a Platte River Program, most new uses of surface water and of hydrologically connected groundwater in this area likely will need to be based upon acquisition or transfer of existing uses.

As mentioned above, the Loup and the Elkhorn Basins have not been designated as fully or overappropriated and, therefore, are subject to additional development of ground and surface water without corresponding requirements under LB962 to address their depletive effects (if any).

Since 1997 (the hydrologic baseline for this FEIS), 2,109 new irrigation wells have been installed in the Loup and Elkhorn Basins. To the extent that these new wells are pumping groundwater, which is hydrologically connected to the Loup or Elkhorn Rivers, they create new depletions to the Platte that can affect the Lower Platte Habitat Area for the pallid sturgeon. It may be possible to quantify these depletive effects in the future, when COHYST studies are completed.

Federal

The Federal depletion management plan is a component of the proposed Program and addresses:

- New water storage facilities, impoundments, and consumptive water uses at NWRs, waterfowl production areas, and national fish hatcheries.
- New consumptive water uses at national forests, parks, monuments, and historic sites, including recreational, habitat improvement, administrative, and emergency uses.
- New depletions associated with activities at Federal facilities which provide benefits that are primarily national in scope, such as national defense, national security, or national research and development activities (e.g., Rocky Mountain Arsenal, National Renewable Energy Laboratory, Rocky Flats).

None of these activities is anticipated to adversely affect peak flows through the Central Platte River. However, some Federal activities associated with Bureau of Land Management, Natural Resources Conservation Service, and U.S. Army Corps of Engineers actions are not included in the Federal depletion management plan and may have potential to reduce peak flows. Because all such activities involve Federal agencies, all actions that potentially could affect Program benefits, Program target flows, or peak flows would be subject to ESA consultation and the development of offsetting measures.

As discussed in chapter 2, headwater forests in the Basin have been increasing in density and coverage over the last 100 years, leading to an estimated 11- to 13-percent reduction in runoff from the national forest lands in the North Platte River Basin and unknown reductions in the South Platte River Basin. This trend may be nearing a cyclical maximum in forest cover and density. Levels of timber harvest in the headwater forests have been steady or increasing in the past few years, and forest fires and disease outbreaks have risen, suggesting a possible adjustment toward less forest cover.

HYDROCYCLING FROM THE CENTRAL NEBRASKA PUBLIC POWER AND IRRIGATION DISTRICT JOHNSON-2 POWERPLANT

Under normal and above-normal water supply conditions, CNPPID generally releases sufficient water from Lake McConaughy during the nonirrigation season to divert 1,200 cfs or more into its canal system at the Tri-County Diversion Dam and produce power through its series of powerplants along the canal. Under these conditions, diverted water is passed through the hydropower turbines and returns to the Platte River near Lexington out of a canal below the Johnson-2 powerplant with relatively limited fluctuations and generally in the range of 1,000 to 2,000 cfs.

During dry years when water supplies are low, CNPPID diverts lesser volumes of water into its canal system. Hydroelectric turbines are constructed to have a point of peak efficiency such that flows above or below this level result in less efficient power generation. Increasingly lower flows may subject the equipment to undesirable stress, cavitation, and vibration. As a result, CNPPID regulates canal flows in Johnson Reservoir and the canal system until sufficient volume is available to release flows at higher and more efficient rates, typically operating in an on-and-off manner over repeated cycles of 24 hours or more (“hydrocycling”).

The onset of drier Basin conditions in winter 2001-2002 highlighted the periodic practice of hydrocycling at the Johnson-2 powerplant, resulting in the Service taking a closer look at potential adverse effects to the target species. CNPPID had implemented hydrocycling at the Johnson-2 powerplant in previous years (for example, in the late 1980s and in 1990).

Recently, discussions between the Service and CNPPID have been initiated to develop an agreement to address the potential effects of hydrocycling on the avian target species in the Central Platte River by avoiding and/or minimizing effects to listed species and Program benefits. Discussions include potentially addressing documentation through a supplemental incidental take statement for FERC Project No. 1417 to the Service’s July 25, 1997, biological opinion (Service, 1997 [Kingsley]) for FERC Projects No. 1417 and 1835. CNPPID’s practice of hydrocycling is not part of this Federal action (i.e., the proposed Program) and is related to a different Federal action (i.e., the license for FERC Project No. 1417). Resolution or mitigation for possible adverse impacts is not a responsibility of the Program, although the Program will collect relevant data, some of which may improve the understanding of hydrocycling effects.

Figure 5-CE-2 shows a typical pattern of variable flow over 24 hours at the Overton stream gauge (roughly 9 miles downstream of the Johnson-2 powerplant) during nonirrigation-season hydrocycling in a dry year. This general pattern is based on analysis of the individual cycling events found in the 2001-2004 provisional flow records. As suggested by the figure, hydrocycling can produce a change in flow in the Platte River at Overton of more than 1,400 cfs within a period of 24 hours.

Overton

Hour	CFS
1	**343**
2	**901**
3	**1467**
4	**1657**
5	**1746**
6	**1827**
7	**1857**
8	**1803**
9	**1417**
10	**904**
11	**660**
12	**507**
13	**444**
14	**426**
15	**393**
16	**387**
17	**364**
18	**356**
19	**345**
20	**337**
21	**323**
22	**321**
23	**316**
24	**315**

Daily mean: 809 CFS

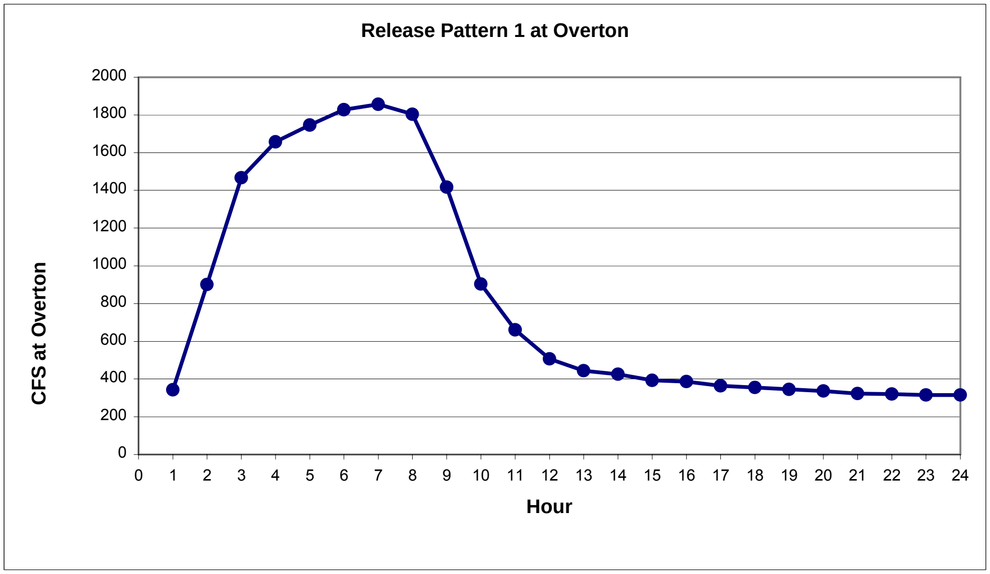

Figure 5-CE-2.—Dry-year pattern of hydrocycling from the Johnson-2 Return Powerplant, as manifested in riverflows downstream at the Platte River gauge near Overton, Nebraska.

The Service is concerned that this pattern of power generation may have adverse effects on some of the target species and their habitat in the Central Platte Habitat Area downstream from the Johnson-2 Return Canal. For example, the current hydrocycling operations could affect whooping cranes in several ways, including the potential to flush birds from their roosts at night and expose them to potential injury. The Service and CNPPID are discussing the extent and significance of these possible adverse impacts and are exploring ways to modify hydrocycling to avoid potential adverse impacts to the listed species and designated habitat.

ANALYSIS OF HYDROLOGIC IMPACTS

Observational data to directly establish the effects of hydrocycling patterns on crane roosting are not available. Only 1 of 18 confirmed Platte River whooping crane sightings during 2000-2004 occurred in the Johnson-2 Return to Kearney reach where hydrocycling effects are most prominent. An analysis was therefore undertaken to examine the physical effects of flow changes on channel hydraulics and other habitat characteristics at locations downstream of the Johnson-2 Return, including three PHABSIM sites previously established to investigate channel habitat/flow relationships:

- **Site 2:** South channel of Jeffrey Island about 4 miles below Johnson-2 Return (RM 243-244)
- **Site 4a:** Two miles downstream of Kearney Canal Diversion and midway between Overton and Kearney (RM 228)
- **Site 6:** Audubon Sanctuary near Gibbon (RM 206-207)

All three sites lie within the upper portion of the Central Platte Habitat Area prioritized for Program habitat recovery. The latter two sites represent segments of the 54-mile critical habitat reach where whooping crane sightings over the last two decades have been most common.

The hydrology data used are based on general hourly representations of historic hydrocycling patterns under unusually dry conditions and when subsequent cycles do not occur until the flows of one cycle have completely passed. Flow amplitudes (i.e., the difference between high and low flows) of the hydrocycling periods are commonly in the range of 1,000 to 1,500 cfs at Overton and from 650 to 900 cfs at Kearney (Service, 2005, personal communication, Don Anderson, hydrologist). The rate of rise commonly reaches a maximum of around 200 to 350 cfs per hour at Overton and 100 to 200 cfs per hour at Kearney. The maximum rate of recession is normally somewhat less.

In the next step of the analysis, flow-cycle fluctuations at PHABSIM sites were interpolated from those at upstream and downstream gauging stations and translated to river stage fluctuations using site-specific hydraulic calibrations. Stage fluctuations were estimated to range from about 1.6 to 2.1 feet (49 to 64 centimeters) at RM 243-244 near Overton; from 0.5 to 0.8 foot (15 to 23 centimeters) at RM 228 near Odessa; and from 0.25 to 0.33 foot (8 to 10 centimeters) at RM 206-207 at the Audubon Sanctuary. This analysis assumed that lesser stage fluctuations downstream of the Audubon Sanctuary would not significantly impact roosting cranes.

Estimated flow and stage fluctuations are presented in table 5-CE-1. As indicated in the table, the magnitude of change in river stage attenuates downstream. Therefore, the potential effects of current hydrocycling operations are greatest in the Johnson-2 Return to Kearney reach of the river.

Table 5-CE-1.—Changes in Flow and River Stage Estimated to Occur at Three PHABSIM Sites During Hydrocycling

PHABSIM Site Location	RM 243-244	RM 228	RM 206-207
Flow difference (cfs)	1,000 to 1,600	850 to 1,250	550 to 800
Stage difference (feet)	1.6 to 2.1	0.5 to 0.8	0.25 to 0.33
Stage difference (centimeters)	49 to 64	15 to 23	8 to 10

To estimate impacts of hydrocycling on potential interior least tern and piping plover nesting habitat, three representative flow patterns were examined (representing approximately 25-, 50-, and 75-percentile amplitudes of observed hydrocycling events) to determine minimum and maximum flows during hydrocycling under a range of conditions. These minimum and maximum flows were then applied to channel transects at six Instream Flow Incremental Methodology study sites to determine the change in the amount of the channel inundated during hydrocycling at the study sites (i.e., between minimum and maximum flows). The results indicate that hydrocycling increases the area of river channel inundated, but that the amount of potential nesting habitat inundated cannot be quantified at this time.

Impacts on Whooping Cranes and Sandhill Cranes

Current hydrocycling operations may affect cranes in several ways, including the potential to flush birds from their roosts at night, cause restless roosting behavior, and increase exposure to predators. The extent of potential effects depends on base flows in the river, the amplitude of hydrocycling, and the geographic location. Migrating cranes may occupy the Platte River at various times of day and are observed to retreat from fields to Platte River roosts during severe storms. However, the primary concern is the potential impact during nightly roosts. Cranes stand in shallow slow-moving water to roost. Stage changes relative to water depths generally used by roosting cranes and the rapidity of those changes under current hydrocycling operations could potentially force cranes from their roosts when hydrocycling occurs. Collision with utility lines is a significant cause of sandhill crane injury and mortality along the Platte River (Ward and Anderson, 1992) and is the principal known cause of direct injury and mortality to migrating whooping cranes (Service, 1994 [Whooping Cranes]).

Current hydrocycling operations could diminish Program benefits for whooping cranes. However, given the limited data on hydrocycling, it is not possible to determine by how much. Discussions are currently underway between the Service and CNPPID to develop an agreement on modified hydrocycling operations to avoid and/or minimize effects to whooping cranes.

IMPACTS ON INTERIOR LEAST TERNS AND PIPING PLOVERS

When suitable sandbars are present, interior least terns and piping plovers may nest on the Central Platte River. Suitable sandbars are those that are high enough to provide expanses of dry sand and avoid nest inundation during rain events, but are low enough to be part of the active channel and avoid vegetation encroachment. The practice of hydrocycling raises water levels in a cyclic pattern and may potentially inundate areas of sandbars and nests, if present.

Based on observations from 1999 to 2004, under some conditions the practice of hydrocycling overlaps the beginning of the nesting seasons of the piping plover and interior least tern. By inundating sandbar areas during nesting season, the practice of hydrocycling potentially decreases the availability of interior least tern and piping plover nesting habitat in the Central Platte River. However, hydrocycling may also cause the birds to nest higher on the sandbars and be less susceptible to rainfall events. Reductions in availability of potential nesting habitat due to inundation of sandbar and/or beach areas during nesting season could adversely affect the species. The repeated short-term rise and fall in river stage from hydrocycling may accelerate sandbar losses to erosion and steepen the beach profile of otherwise suitable sandbars. Because it is expected that potential Program sandbar habitat will be ephemeral and renewed periodically, some adverse impacts of hydrocycling may occur for only a limited time. Changes in the dimensions and profiles of ephemeral sandbars providing suitable interior least tern and piping plover habitat over time will be monitored during the Program's First Increment through the adaptive management process. Any assessments of the effects of hydrocycling will occur in the context of evaluating the effects of flow variation generally (controlled and uncontrolled).

Hydrocycling may diminish Program benefits for interior least terns and piping plovers. However, given the limited data on hydrocycling, it is not possible at this time to quantify the potential effects to interior least terns and piping plovers. Discussions are currently underway between the Service and CNPPID to develop an agreement on modified hydrocycling operations to avoid and/or minimize adverse effects to the target avian species and Program benefits.

CUMULATIVE EFFECTS OF FUTURE DEVELOPMENT ON PLATTE RIVER HABITAT LANDS

The Program seeks to improve riverine and land habitat in the Central Platte Habitat Area. An important consideration is the likelihood that actions outside the Program will decrease or increase the extent or value of these habitats during the life of the Program. Two aspects of land habitat must be considered: riverine (channel and near-channel) habitat and wet meadow and lowland grassland habitat within the Central Platte Habitat Area.

Channel restoration focuses on restoring areas of channel that have become narrower, deeper, and vegetated with shrubs and trees, all reducing the channel's value as roost or nest habitat for whooping cranes, interior least terns, or piping plovers. As described in chapter 4, "Affected Environment and the Present Condition," the current trend is toward slow additional channel incision and narrowing, due to erosion and coarsening of riverbed sands.

Processes that would increase loss of channel habitat in the future are further reduction in flows that would lead to more vegetation encroachment or further incision of the channel bed (due to further reductions in sediment supply or increases in clear water flows into the Central Platte Habitat Area, deepening and narrowing the channel further.

Further reductions in sediment supply would probably be caused by new water diversion or storage structures on the main stem, which are not likely. It is likely that, without a Program, current trends toward gradual channel incision will continue.

Another action that could diminish habitat value in the future is land development near the river. Construction of homes, roads, or other activities near the river that cause disturbance to the bird species could reduce habitat value in the future. Examination of these types of land use in the Central Platte Habitat Area, for 1982 and 1998 (using the Platte EIS Geographic Information System database), shows over the entire habitat area a slight decline in land area used for residential and commercial development, roads, powerlines, and sand and gravel operations. Due to some differences in the manner in which these land uses were defined for the 1982 (Western Energy Land Use Team, 1983) and 1998 (Friesen et al., 2000) databases, this analysis can only be considered approximate; but it suggests that there are no strong trends toward increased development along the river corridor in the last two decades.

A similar analysis of trends from 1982 to 1998 focused on counting the number of developed parcels of land rather than acreage of development (table 5-CE-2). The total number of developed parcels declined, while developed areas increased in the more populated areas of bridge segments 8 and 9 (near Kearney) and segment 3 (near Grand Island).

Table 5-CE-2.—Number of Developed Land Parcels in the 1998 and 1982 Environmental Impact Statement Geographic Information System Database

Segment	1982	1998
Segment 1	48	22
Segment 2	25	27
Segment 3	20	34
Segment 4	19	22
Segment 5	36	15
Segment 6	24	16
Segment 7	15	12
Segment 8	19	33
Segment 9	10	52
Segment 10	13	7
Segment 11	25	10
Segment 12	8	3
Total	**262**	**253**

There is discussion among residents in central Nebraska of a trend in purchase of accretion lands[22] for recreation purposes, primarily for waterfowl hunting clubs. This trend has increased the purchase price of these lands (that otherwise have fairly limited agricultural value) to the point that some counties in the Central Platte valley area have considered creating a new tax classification so that the purchase prices for "recreation" lands will not affect the assessed valuation of adjacent agricultural lands.

To the extent that these recreation lands are used primarily for waterfowl and other hunting (e.g., deer), these uses would not significantly reduce the habitat value of nearby river channel and wet meadow habitat. In fact, the Program might partner with these owners to create habitat improvements that would benefit both the target species and hunters.

There are a number of activities outside the Program that are improving habitat lands in the Central Platte Habitat Area. Several agencies and organizations are working, outside the Program, to improve habitat for the three bird species that nest or roost on the Central Platte River, among them the National Audubon Society, the Whooping Crane Maintenance Trust, The Nature Conservancy, Nebraska Game and Parks Commission, the State of Wyoming, and the Service as well as other Federal agencies, such as the Natural Resources Conservation Service. Habitat improvement actions involving funding or assistance from the Service would likely require some level of consultation under the ESA.

Roughly 11,000 acres in the Central Platte Habitat Area are currently owned and/or managed to benefit the target bird species. Some of these organizations continue to seek additional habitat lands. The Service's Partners for Wildlife Program, which partners with private landowners to improve river habitat, carries out clearing of vegetation from the river channel and other habitat improvement actions on roughly 100 acres of land per year. This Federal program will continue to pursue partnerships for habitat enhancement in the Central Platte valley and will likely require some level of consultation under the ESA.

[22]Accretion lands are lands that were formerly active river channel (and, therefore, not in private ownership), but are now wooded or pasture and have been "accreted" to the closest deeded lands for tax and boundary purposes.

Cumulative Effects of the Program on Water Use and Agriculture

Water Availability

The FEIS sections on hydrology describe how the Program (under various alternatives) would affect water supplies and water deliveries over a fairly long period of hydrologic record. Because this period of record (1947 to 1994) contains significant, multiyear droughts and also unusually wet periods, the analysis provides a good picture of the effect of the Program on water use.

However, as the water year 2002 demonstrated, conditions more extreme than this FEIS 48-year hydrologic record are possible. The water year 2002 was, throughout the Basin, one of the driest on record, in many areas breaking all records. In 2005, reservoir levels and riverflows remained extremely low.

It is not possible to forecast just how Program waters would be managed under severe drought. In some cases, Program waters may be used to keep some water in the river during a drought. This would preserve aquatic life, but would lower lake levels. On the other hand, it is likely that Program waters would be held in storage during severe droughts because with very low or dry rivers, most water released would not reach the Central Platte Habitat Area. In this case, the Program would tend to offset reservoir drawdown in the driest periods, compared to average conditions, by holding Program water in the reservoir.

The Program also has the flexibility to lease, or not to lease, water from farmers in drought periods. For some farmers facing a limited irrigation supply during a drought, leasing of their water shares to the Program may be advantageous compared to raising a partial or no crop.

The "New Water Uses in Each State" sections in chapters 4 and 5 describe how the Program affects the development of new water use in each state. The fundamental conclusion is that the Program will not affect the development of new water use in a significant way in any part of the Basin, because the availability of new water for development in Wyoming and Nebraska is already severely limited, and those supplies in Colorado which are available for future development are unrelated to and unaffected by the actions taken under the Program.

Price of Land

Some have raised concerns that a Program that leases or purchases lands in the Central Platte Habitat Area will create upward pressure on land prices. Generally, farm land prices in the Central Platte River area have been increasing for several years, and the market for land has been sound. During the recent drought, farm land prices state-wide dipped slightly, while land prices in central Nebraska increased 4 percent. According to the Nebraska Farm Real Estate Market Survey, Nebraska Cooperative Extension, during the past 16 years only 1999 and 2003 saw a decrease in land prices on a statewide basis (University of Nebraska, 2003).

Given the general upward trend in prices, and given the Program must budget for land leasing or purchases several years in advance (in order to obtain funds through each state and Federal legislature), it seems unlikely that the Program will "lead" land prices. Also to be considered is the fact that the

Program will acquire or lease, in the Program's First Increment, roughly 7,000 acres of land (3,000 acres of land currently being developed for habitat is already designated for the Program). This represents roughly 1.5 percent of the 440,000 acres in the Central Platte Habitat Area.

Lastly, the Program will be focusing on land acquisition in and along the Platte River channel. Most of these lands are either channel or accretion lands rather than croplands. The various alternatives considered acquire or lease from 200 to 3,500 acres of cropland; this represents at most 1 percent of the cropland in the Central Platte Habitat Area.

Local Economies

As described in the "Regional Economics" section, earlier in this chapter, the positive or negative impacts on regional sales, income, jobs, and business taxes are less than or equal to one-tenth of 1 percent of the region's economic activity. While these areas are subject to the same economic up and downturns as the rest of the Nation, many of the rural areas are experiencing a general gradual decline in population and economic activity. Many are seeking ways to diversify their economies. While the Program may both create minor economic losses for some areas as well as economic opportunities in others, it is unlikely that the effects of the Program will be noticeable or even measurable at a regional scale.

RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY, AND IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

NEPA [section 102(2)(c)(iv) and 40 CFR 1502.16] requires that the relationship between local short-term uses of the human environment be compared with the maintenance and enhancement of long-term productivity. Section 102(2)(c)(v) of NEPA and 40 CFR 1502.16 require a discussion of irreversible and irretrievable commitment of resources. Irreversible commitments are decisions affecting such renewable resources as soils, wetlands, and waterfowl habitat. Irretrievable commitment of natural resources means the loss of production or use of resources as a result of a decision and represents foregone opportunities for the period of time the resource cannot be used. At the programmatic level, the Program involves the following short- and long-term productivity trade-offs and irretrievable commitments of resources.

WATER

The action alternatives would store and re-regulate the flow of water in the Basin for the purpose of making both short- and long-term improvements in the Central Platte Habitat Area for the target species. These actions can be changed on an annual basis and are not irretrievable. On a short-term basis, water that is released for the target species in some cases represents a reduction in supply for irrigators in the Basin above Grand Island. The effects of these short-term water transfers are described in this chapter. Some of these waters are used downstream by other water users, including municipalities, before contributing to Missouri River flow.

LAND

Most of the Program's land actions involve restoring native habitats lost over than past 100 years. In general, these actions are reversible. For example, conversion of cropland to wet meadows can be reversed in a manner similar to the way historic wetlands were converted to croplands. An undetermined amount of prime farmland along the Central Platte River may be converted to wet meadows and lowland grasslands. Site-specific NEPA compliance activities will strive to minimize irreversible conversion of prime farmlands to nonagricultural uses (Farmland Protection Policy Act (FPPA)—Subtitle I of Title XV, Section 1539-1549).

The only land action that is largely irreversible involves potential construction of an off-channel reservoir in the Central Platte River area. Restoration of the reservoir site to its original croplands and pasture, while technically possible, is unlikely. Prime farmlands may be irreversibly impacted by inundation and reservoir operation.

AGRICULTURAL PRODUCTION

Agricultural production is reduced slightly in the Platte River Basin primarily due to leasing of water by farmers to the Program, as well as due to the conversion of some croplands to habitat for the target species in the Central Platte Habitat Area. The conversion of cropland to habitat may involve prime farmlands and will be fairly long-term under either long-term lease or acquisition. In the Central Platte Habitat Area, converted cropland amounts to roughly one percent of existing cropland.

Water leasing for the action alternatives also can temporarily reduce acreage in production. The largest effect occurs under the Full Water Leasing and Water Emphasis Alternatives for which the Basinwide reduction in irrigated acreage is less than 50,000 acres or about one percent of existing cropland. As described in the "Agricultural Economics" section earlier in this chapter, some reduction in irrigated agriculture will likely be offset by temporary conversion to dryland farming.

While the overall reduction in irrigated acreage would stay roughly constant during the Program, most of the Program water acquisition will likely be through short-term leases. Thus, changes in cropping and production will not be permanent in any location and will shift from year to year.

ENERGY PRODUCTION

All alternatives increase total hydroelectric energy production in the North and Central Platte River system; and, as with water management, these actions are highly flexible and reversible.

SPECIES HABITAT

Central Platte Habitat Area

The primary purpose of the Program is to restore and improve the productivity of riparian and nearby habitats used by the target species. Long-term increases in available habitat and species use are expected. Minor long-term reductions in habitat for some species results as croplands, woodlands, and shrublands are restored to river channel and riparian habitat. In general, these actions are reversible.

Lake McConaughy Fisheries

Changes in reservoir operations for the Program tend to lower water levels and reduce habitat value for several game fish species in Lake McConaughy. Some adverse effects may also occur on the fishery in Lake Ogalalla. While these changes in operations are reversible, the reductions in fish habitat quality will continue while the Program is in operation.

North Platte River Fisheries

Changes in reservoir operations for the Program tend to lower water levels and reduce, somewhat, habitat value for several game fish species primarily in Seminoe and Pathfinder Reservoirs. While these changes in operations are reversible, the reductions in fish habitat quality will continue while the Program is in operation.

RECREATION

Changes in reservoir operations for the Program tend to lower water levels and reduce recreation value slightly in some of the North Platte River reservoirs in Wyoming and moderately at Lake McConaughy in Nebraska. These changes in operations are reversible. However, as long as the Program continues, these effects on recreation value will continue.

ECONOMIC AND SOCIAL

Sale or lease of water or land to the Program is voluntary and, hence, represents a short-term financial advantage on the level of the individual who chooses to participate. At a regional level, the economic effects of the Program will be very slightly positive or very slightly negative depending upon the geographic region and how the Program is administered. These effects will likely be too small to reliably measure at the regional level; hence, significant short- versus long-term tradeoffs are not apparent. The regional economic effects would disappear if the Program ceases.

Investments in land restoration would be foregone if the Program terminated, although some habitat benefit would remain in the long term even without ongoing habitat maintenance. Most water leasing would be relatively short term; hence, less investment is at risk.

The value of some of the investment in Program facilities would be lost if the Program ceased, although the costs of both Program lands and land improvements, like hunting and bird watching blinds, would likely be regained through sale. The largest individual investments are in the Pathfinder Modification Project, to regain storage capacity at Pathfinder Reservoir, and the construction of a new offstream reservoir in the Central Platte River area. If the Program was terminated, it is likely that these investments would be sold to water agencies in the region and used to increase supply and operational flexibility of the existing systems. Potential elements like the Riverside drains and the groundwater mound conjunctive use system may have less general value for existing water users, and the value of these investments may be substantially lost.

Changes in land use patterns are also minor on a regional scale. The Program will provide some minor flood control benefits in the Central Platte River area that will persist as long as the Program is in operation.

Chapter 6

Consultation and Coordination

This chapter describes the United States (U.S.) Department of the Interior's (Interior) public involvement and consultation and coordination activities to date for this Final Environmental Impact Statement (FEIS).

PUBLIC INVOLVEMENT

Public involvement is a process for including interested and affected individuals, organizations, agencies, and governmental entities in an agency's decision process. In the process of preparing this FEIS, Interior has encouraged both formal and informal input.

This section on public involvement also serves as the public involvement summary report for this FEIS.

SCOPING PROCESS

The Draft Environmental Impact Statement (DEIS) scoping process was initiated in early 1998 to receive public input on the scope of the Platte River Programmatic Environmental Impact Statement (EIS), consistent with the requirements of the National Environmental Policy Act (NEPA) and its implementing regulations. The Federal Register Notice of Intent to prepare a Programmatic EIS and schedule for the scoping meetings was published February 10, 1998.

The purposes of scoping were to:

- Inform the public about the background, purpose, and features of the Platte River Recovery Implementation Program (Program).

- Solicit suggestions regarding ways to improve the proposed Program, alternatives for implementing the proposed Program, and types of impacts from the alternatives that should be addressed in this FEIS.

In February, March, and April of 1998, 11 scoping meetings were held in Wyoming, Colorado, and Nebraska and approximately 500 persons attended (table 6-1).

Table 6-1.—Scoping Meetings Held in Wyoming, Colorado, and Nebraska

Date	Place	Number of Attendees
February 25, 1998	Loveland, Colorado	39
March 2, 1998	Scottsbluff, Nebraska	37
March 3, 1998	North Platte, Nebraska	29
March 4, 1998	Grand Island, Nebraska	52
March 5, 1998	Lincoln, Nebraska	35
March 11, 1998	Kearney, Nebraska	70
March 17, 1998	Saratoga, Wyoming	73
March 18, 1998	Casper, Wyoming	35
March 19, 1998	Torrington, Wyoming	46
March 26, 1998	Sterling, Colorado	35
April 7, 1998	Denver, Colorado	33

For further details regarding the scoping process, see the *Final Summary of Scoping Input*, July 1998, which can be found on the Platte River Endangered Species Partnership (PRESP) Web site at <http://www.platteriver.org>.

GOVERNANCE COMMITTEE AND SUBCOMMITTEE PUBLIC MEETINGS[1]

Following the signing of the Cooperative Agreement in July 1997, a Governance Committee was formed to oversee activities related to the Cooperative Agreement and the formulation of the Governance Committee's proposal for a recovery implementation program. Several subcommittees to the Governance Committee were also formed. These subcommittees have diverse representation from the three states, local landowners, water users, environmental organizations, and Federal agencies. Descriptions of these committees appear below. Governance Committee and subcommittee meetings were all open to the public and meeting schedules, including agendas, were posted on the PRESP Web site.

Notice of the Land Committee meetings (which addressed potential acquisition and management of habitat lands in central Nebraska) were also mailed to the Land Committee's mailing list of local landowners and interested parties.

From September 1997 to fall 2005, more than 65 Governance Committee meetings were held in the three states, specifically in the cities of Denver, Lakewood, and Sterling, Colorado; Cheyenne, Wyoming; and Gering, Kearney, Lincoln, North Platte, and Ogallala, Nebraska.

[1]A complete listing of the dates and locations of the Governance Committee and subcommittee meetings can be found on the PRESP Web site at <http://www.platteriver.org>.

Water Management Subcommittee

The Water Management Subcommittee, chaired by John Lawson (Reclamation) coordinated each state's development of a means to track new water depletions or accretions to ensure mitigation of impacts from new water diversions and proper crediting for water conservation. The Water Management Subcommittee also developed policies and procedures for managing Program water. From October 1997 to present, almost 60 meetings of the Water Management Subcommittee were held in the three states.

Water Action Plan Subcommittee

The Water Action Plan Subcommittee, chaired by John Lawson (Reclamation), conducted a Basinwide study of potential water conservation and supply projects and also developed a draft Water Action Plan for review and approval by the Governance Committee. The Water Action Plan, along with the three state projects (Pathfinder Modification Project, Wyoming; Tamarack Project, Colorado; and Lake McConaughy Environmental Account, Nebraska) serves as the water component of the Governance Committee Alternative, which is evaluated in this FEIS.

From July 1999 to fall 2005, approximately 15 meetings of the Water Action Plan Subcommittee were held in the three states.

Land Subcommittee Meetings

The Land Subcommittee, co-chaired by Jim Lundgren and Dr. Joe Jeffrey (Lexington, Nebraska, area businessmen and landowners), and later co-chaired by Vernon Nelson and Rhodell Jameson (both Central Platte area landowners), developed guidelines for land habitat management, leasing, and acquisition; developed the Good Neighbor Policy; and directed a study of the potential impact of the Land Action Plan on local economies. The subcommittee works closely with local communities and landowners to determine the most appropriate ways to cooperatively achieve the habitat goals.

From October 1997 to fall 2005, more than 35 Land Subcommittee meetings were held, mostly in Central Platte communities in Nebraska.

Technical Subcommittee Meetings

The Technical Subcommittee (initially known as the Monitoring and Research Subcommittee), chaired by Jay Maher (Central Nebraska Public Power and Irrigation District) and later by Paul Tebbel (Rowe Sanctuary, National Audubon Society), developed the framework for habitat and species monitoring and research, as well as a peer review process for scientific studies. The Technical Subcommittee has been instrumental in preparing the Integrated Monitoring and Research Plan.

From November 1997 to present, more than 50 meetings of the Technical Subcommittee were held, mostly in Central Platte communities in Nebraska, but also in Wyoming and Colorado.

Other Environmental Impact Statement Public Meetings/Briefings

Other meetings and briefings held by the EIS Team included:

- March 17, 1998—EIS presentation to Carbon County Commissioners, Saratoga, Wyoming
- September 2, 1998—EIS public forum, Cheyenne, Wyoming
- September 24, 1998—EIS public forum, Kearney, Nebraska
- September 25, 1998—EIS public forum, Sterling, Colorado
- November 16, 1998—EIS presentation to Central Platte Area Counties, Kearney, Nebraska
- October 14, 2004—EIS presentation to the Colorado Water Congress

In addition to general informational/briefing meetings, the EIS Team met with individual groups to address specific issues. Some examples are:

- Briefing to the Nebraska Governor's Advisory Committee on the Platte Cooperative Agreement, Lexington, Nebraska, 2002.
- April 8, 2004—Hydropower impacts briefing for Loveland Area Customers Association
- June 8, 2004—Hydropower impacts briefing for Midwest Power Customers Association
- September 10, 2004—Alternative analysis briefing for Carbon County public officials

PUBLIC REVIEW OF THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

The DEIS was filed with the U.S. Environmental Protection Agency (EPA) on January 23, 2004, and a Federal Register notice of availability was published January 26, 2004. Persons on the DEIS distribution list were mailed a hard copy and/or compact disc (CD) of the DEIS and/or the Executive Summary as requested.

Public Hearings

During July and August 2004, approximately 339 persons attended 10 public hearings in different locations of Wyoming, Colorado, and Nebraska (table 6-2). The purpose was to provide the public with an opportunity to present written or oral testimony on the DEIS. To help the public, if needed, in their understanding and further DEIS review, hard copies and CDs of the DEIS and Executive Summary were available as well as many related technical reports. Participants were also given the opportunity to submit written questions, which were answered on the Platte River Endangered Species Partnership Web site at <http://www.platteriver.org>. Testimony received, including oral testimony from 34 persons, has been addressed in this FEIS.

Table 6-2.—Public Meetings Held in Wyoming, Colorado, and Nebraska

Date	Place	Number of Attendees
July 26, 2004	Saratoga, Wyoming	37
July 27, 2004	Casper, Wyoming	25
July 28, 2004	Torrington, Wyoming	34
July 29, 2004	Gering, Nebraska	35
August 2, 2004, afternoon	Kearney, Nebraska	38
August 2, 2004, evening	Kearney, Nebraska	34
August 3, 2004	Lincoln, Nebraska	41
August 4, 2004	Sterling, Colorado	35
August 9, 2004	Berthoud, Colorado	43
August 10, 2004	Denver, Colorado	17

Public Comments

The official public comment period began January 26, 2004, and, at the request of the states, was extended twice by Federal Register notice on March 31, 2004, and May 26, 2004. Both extensions were to allow the public time to review the DEIS along with a draft of the National Academy of Sciences report titled, *Endangered and Threatened Species in the Platte River Basin*, which was released in May 2004 (see National Research Council, 2005, for final). The public was invited to submit comments by electronic mail (e-mail), letter, or facsimile. The comment period concluded September 20, 2004.

More than 7,000 comment submissions, written and oral, were received and addressed during the finalization process of the Programmatic EIS. These included submissions from 17 Federal, state, local, and city agencies; 21 irrigation, power, and conservation districts, electric power organizations, and water user organizations; 9 miscellaneous local organizations; 16 environmental and conservation groups; and 27 private citizens. Of the total comments, close to 7,000 postcards, e-mails, and letters were received through conservation groups, including the National Wildlife Federation and American Rivers. More detailed information on the comments received and responses can be found in the *Public Comments on the DEIS and Responses From the EIS Team* in volume 2.

AGENCY COORDINATION AND CONSULTATION

FEDERAL COOPERATING AGENCIES

Coordination and consultation meetings were held with representatives from the Federal cooperating agencies (listed below) on three occasions: December 2, 1997; April 7, 1998; and August 29, 2000. These meetings provided a general orientation of the Programmatic EIS, along with focused discussions on issues such as measures for offsetting channel erosion. The following agencies attended each of these meetings:

- U.S. Forest Service
- U.S. Natural Resources Conservation Service
- U.S. Army Corps of Engineers
- Western Area Power Administration
- U.S. Geological Survey
- EPA

All of these cooperating agencies were provided advance copies of the DEIS for review and comment prior to public review. After the release of the DEIS, discussions and meetings have been held with individual Federal cooperating agencies on specific issues, such as forest management and wetlands.

OTHER COOPERATING AGENCIES

In addition to the Federal cooperating agencies, the Board of County Commissioners of Carbon County, Wyoming, requested that they be granted Cooperating Agency status with regard to the Programmatic EIS. A Memorandum of Agreement (MOA) between Reclamation, U.S. Fish and Wildlife Service (Service), and Carbon County, Wyoming, was signed on August 10, 1999. Under the terms of the MOA, Carbon County was provided with information regarding potential effects of the Programmatic EIS alternatives on water supplies and allocations in the North Platte system of reservoirs. In turn, Carbon County provided comments and analysis to the EIS Team regarding the potential effects of any changes in North Platte water supplies on the economies, taxes, and land uses in Carbon County.

FISH AND WILDLIFE COORDINATION ACT

The Fish and Wildlife Coordination Act (FWCA) requires Federal agencies to coordinate with the Service and state wildlife agencies during the planning of new projects, or for modifications of existing projects, so that wildlife resources receive equal consideration and are coordinated with other project objectives and features. Compliance with FWCA requires the following:

- Consultation.
- Opportunity for the Service and state wildlife agencies to report their recommendations.
- Consideration of FWCA report recommendations.
- Incorporation of the FWCA report as an integral part of the decisionmaking process.

Coordination for the Program under the FWCA has been an ongoing process. Staffs from each of the Service's state offices are members of the EIS Team. Discussions of alternatives and possible impacts to states' wildlife resources have been held with each state's wildlife agency. Information needs and approaches to analysis have been provided by these offices to the EIS Team. Resulting analyses of the EIS alternatives have been shared with the state wildlife agencies which, in turn, have provided comments and suggestions.

The final FWCA report is a culmination of this coordination. It describes the resulting analyses of potential impacts to wildlife and habitat in each state from implementation of the preferred alternative. It also provides recommendations for each state regarding Program implementation.

ENDANGERED SPECIES ACT, SECTION 7 CONSULTATION

Section 7 consultation of the Endangered Species Act (ESA) prohibits Federal agencies from authorizing, funding, or carrying out activities that are likely to jeopardize the continued existence of a listed species or destroy or adversely modify its critical habitat. This FEIS serves as the final Biological Assessment of the potential impact of the alternatives on the target species and other listed species. Based upon this analysis, the Service will prepare its Biological Opinion on whether the Governance Committee Alternative jeopardizes the continued existence of the target or other listed species, and whether the alternative can serve to provide ESA compliance for water-related activities in the Platte River Basin (Basin) for the first 13 years of implementation of the proposed Program (Program's First Increment).

NATIONAL HISTORIC PRESERVATION ACT AND OTHER CULTURAL RESOURCE PROTECTION LAWS

Federal law requires Federal agencies to consider the effects of their undertakings on cultural resources. The National Historic Preservation Act (NHPA) of 1966 (36 CFR 800), as amended, is the basic Federal law governing preservation of cultural resources of national, regional, state, and local significance. Specifically, Section 106 of the NHPA requires each Federal agency to consider the effect of its actions on any district, site, building, structure, or object that is included in, or eligible for inclusion in, the National Register of Historic Places. Furthermore, an agency must give the Advisory Council on Historic Preservation an opportunity to comment on any undertakings that could affect historic properties.

The NHPA and other Federal legislation require consultation with American Indian Tribes and Nations, and the protection of historic and archeological resources by the Federal Government. Among these laws are the Archeological Resources Protection Act, the Native American Graves Protection and Repatriation Act, NEPA, the American Indian Religious Freedom Act, and Executive Order (EO) 13007.

In terms of consultations, regulations require that Federal agencies consult with State Historic Preservation Officers (SHPOs) and identify American Indian Tribes and Nations that "might attach religious and cultural significance to historic properties in the Area of Potential Effect" (36 CFR 800.3[4][f][2]). As part of this process, 41 Tribes were informed in a letter, dated August 14, 2000, that the DEIS was being prepared and comments regarding cultural resources were requested. A response from the Pawnee Nation, dated August 30, 2000, stated that while it had no objections to the Program, it acknowledged that there might be burial sites in the area. In a letter dated December 4, 2000, the Rosebud Sioux Tribe encouraged DEIS preparers to provide any cultural resource survey work that may be completed for their review and comment. On October 10, 2003, a letter was mailed to the Pawnee Nation and Rosebud Sioux Tribe transmitting a working draft version of the DEIS with highlighted cultural resources findings and requested comments. No comments were returned.

On January 22, 2004, a letter was mailed to the 41 Tribes transmitting the DEIS with a summary of cultural resource findings and a request for any comments. On March 13, 2004, a letter was mailed to the Tribes notifying them of the Federal Register notice and that the comment period on the DEIS was extended. The Southern Ute Indian Tribe responded in several letters with the comments that it did not believe there are any known impacts to the areas specifically tied to the Tribe. However, if during implementation there is an inadvertent discovery of artifacts or remains, the Tribe would like to be notified. On August 5, 2004, the Crow Tribe responded in a letter in which it requested consultation on all matters in its 1851 Treaty area.

Concerning cultural resources survey work, due to the programmatic nature of the DEIS, a definite Area of Potential Effect cannot yet be completely delineated, which means that, although some class I survey work was completed, the majority of the survey work will be completed later. In 2000, the SHPOs were informed about the Program in a letter and were consulted during the class I survey process. On January 22, 2004, the DEIS was transmitted to the SHPOs for comment. On February 10, 2004, the Colorado SHPO responded in a letter stating that its office concurs that class III surveys would be required and that the Section 106 and NEPA processes should be conducted concurrently. In addition, it advised that the Section 106 review process be completed prior to issuing the Finding of No Significant Impact (FONSI) or Record of Decision (ROD). For further details, see the "Cultural Resources" section in chapter 4.

INDIAN TRUST ASSET CONSULTATIONS

Indian trust assets (ITAs) are legal interests in property held in trust by the U.S. for Indian Tribes or individuals. The Secretary of the Interior (Secretary) is the trustee for the U.S. on behalf of Indian Tribes, and all Interior agencies share the Secretary's duty to act responsibly to protect and maintain ITAs. This policy was stated in 64 Stat. 1262 and issued in Secretarial Order 3175.

The potential existence and location of ITAs were assessed in consultation with the Bureau of Indian Affairs (BIA) and Tribes/Tribal Nations that had aboriginal claims to the Basin, which included the Cheyenne, Arapaho, Sioux, Pawnee, Omaha, and Otoe-Missouria Tribes/Tribal Nations. Research was also conducted using treaties, statutes, EOs, and other mandates. Today, these Tribes exist as 21 different Nations or Tribes.

In September 2000, the Platte River EIS Office wrote to the Regional Director of the BIA Great Plains Regional Office in Aberdeen, South Dakota, explaining the Program and requesting any ITA information about the Basin. In a September 24, 2001, BIA response, the agency confirmed that there are judicially established Indian land areas within the Basin that were determined by the U.S. Indian Claims Commission.

On November 13, 2000, letters were sent to the 21 American Indian Tribal and Nation Chairmen and Presidents informing them of the intent of the Program, that a DEIS would be prepared, and asking if there are any ITAs in the Basin. A response was received from the Rosebud Sioux Tribe on December 4, 2000, stating that the southern border of the Sioux Nation Treaty area includes the North Platte River and, as a result, the Sioux Nation may have water rights issues to be addressed. For further details on the analysis, see the "Indian Trust Assets" section in chapter 4.

On October 10, 2003, letters were mailed to the two Tribes, Pawnee Nation and Rosebud Sioux Tribe, that had responded and commented earlier about the Program. The letters transmitted a working draft version of the DEIS, highlighted cultural resources findings and ITA results, and requested comments. No comments were received.

On January 22, 2004, a letter was mailed to the 21 Tribes transmitting the DEIS with a summary of ITA findings and a request for any comments. On March 13, 2004, a letter was sent to the Tribes notifying them of the Federal Register notice and that the comment period on the DEIS was extended. The Southern Ute Indian Tribe responded in several letters with the comments that it did not believe there are any known impacts. On August 5, 2004, the Crow Tribe responded in a letter in which it requested consultation on all matters in its 1851 Treaty area.

Chapter 7

Environmental Commitments

FEDERAL LAWS

The following is a list of environmental commitments that would be undertaken by the Platte River Recovery Implementation Program (Program), as appropriate, when carrying out Program activities. All Program activities which are undertaken with Federal funds, or which require Federal permits or involve Federal facilities, will be considered Federal actions and subject to Federal environmental laws, such as the National Environmental Policy Act (NEPA), Endangered Species Act (ESA), and the Clean Water Act.

These environmental commitments generally are intended to either avoid, minimize, or compensate for adverse environmental effects that would otherwise occur as a result of Program implementation activities. In some cases, these commitments help ensure that such activities are conducted in accordance with applicable laws and guidelines. Some actions may require compliance with other Federal laws and regulations not listed here.

NATIONAL ENVIRONMENTAL POLICY ACT

As described in the “Need for the Program” and “Program Purposes” sections in chapter 1, this Programmatic Final Environmental Impact Statement (FEIS) covers the regional- and system-wide effects of the Program alternatives, as far as they can be foreseen. If a Program is adopted, feasibility studies will be undertaken for several Program facilities and individual projects selected. Also, procedures will be established to solicit offers for habitat land and Program water supplies that may be purchased or leased for the Program in whole, or in part, with Federal funds. These actions may require evaluation and appropriate documentation under NEPA, tiered off of this Programmatic FEIS.

The following is a list of future Program activities, for the preferred alternative, that likely will require further NEPA analysis:

- Pathfinder Modification Project, site-specific impact analysis.
- Water Action Plan projects undertaken with Federal funds, including water leasing (site-specific impact analysis).
- Program land restoration with Federal funds which is likely to affect the environment (site-specific analysis).

FISH AND WILDLIFE COORDINATION ACT

The Fish and Wildlife Coordination Act (FWCA) provides that “whenever the waters or channel of a body of water are modified by a department or agency of the U.S., the department or agency first shall consult with the U.S. Fish and Wildlife Service and with the head of the agency exercising administration over the wildlife resources of the state where construction will occur, with a view to the conservation of wildlife resources. The Act provides that land, water, and interests may be acquired by Federal construction agencies for wildlife conservation and development. In addition, real property under jurisdiction or control of a Federal agency and no longer required by that agency, can be utilized for wildlife conservation by the state agency exercising administration over wildlife resources upon that property."

The specific reports and recommendations of the Secretary of the U.S. Department of the Interior and the state agency on the wildlife aspects of such projects must be made part of the responsible Federal agency's report. It is intended that the reports and recommendations be based on surveys and investigations to determine possible damage to wildlife resources and measures that should be adopted to prevent their loss or damage. Federal agencies must give full consideration to the reports.

It is likely that some of the specific Program implementation activities will trigger consultation under the FWCA, including:

- Pathfinder Modification Project, site-specific impact analysis.
- Water Action Plan projects undertaken with Federal funds, including water leasing (site-specific impact analysis).

CLEAN WATER ACT

The habitat restoration activities proposed under the preferred alternative are likely to involve significant efforts to restore river channel and wet meadow habitat in the Central Platte Habitat Area. Specific plans will be developed once the Program begins acquiring interests in habitat lands. The "Wetlands" section in chapter 5 describes the programmatic analysis that has been completed for illustrative land plans associated with the alternatives. The programmatic analysis projects that the preferred alternative would lead to a significant increase in wetlands that fall under the Clean Water Act, Section 404, jurisdiction.

When Program lands are acquired and plans developed for river channel and wet meadow restoration, Section 404 permits will be needed before undertaking restoration activities which may require discharge of dredge or fill material to waters of the U.S., such as moving river sand perched on islands back into the active river channel. Permits are also likely to be required if the Program proposes, following feasibility studies, to construct an offstream reservoir in the Central Platte valley as part of the Water Action Plan.

Where such actions are undertaken, specific proposals will be developed and subject to analysis under the Clean Water Act, Section 404, provisions to support a request for a permit. The development and analysis of these proposals will be coordinated with appropriate offices of the U.S. Army Corps of Engineers (Corps) and the U.S. Environmental Protection Agency (EPA).

The following process is anticipated for obtaining site-specific Section 404 permits for the channel and wet meadow restoration efforts in the Central Platte Habitat Area:

- Land and channel restoration activities may be subject to local, state, and Federal permitting processes. Upon acquisition of Program lands, the Program will develop management plans to describe the appropriate restoration, maintenance, and other management activities. Generally, parcel-specific management plans are expected to be approved and implementation is to begin within 1 year of acquisition.

- Management activities will be subject to Clean Water Act, Section 404, permitting and development of these plans will require close coordination with the Corps in Omaha, Nebraska. Concurrently, site plans will be submitted to Federal, state, and local regulatory agencies for a final determination of permit requirements and necessary approvals. Information to be included in the pre-construction review phase will include:

  - Statement of site restoration goals and objectives
  - Pre-construction site characterization
  - Description of restoration treatments and management plans
  - Description of site's anticipated response
  - Specification of performance standards, monitoring protocols, and identification of remedial management prescriptions should performance standards and project targets be deficient
  - Documentation of site protection measures and maintenance methods
  - Documentation of final assurances (financial obligations, responsible parties, and schedules)

The Pathfinder Modification Project, which seeks to restore the storage capacity of Pathfinder Reservoir lost to sediment accumulation, is not expected to require a site-specific Section 404 permit. The anticipated modification involves raising the existing spillway crest by constructing a short wall and spillway on top of the existing bedrock spillway. No dredge or fill of materials into existing waters or wetlands would occur. Existing road access leads immediately to the construction site.

The Governance Committee Alternative's Water Action Plan includes construction of a small offstream reservoir in the Central Platte region. As with all of the Water Action Plan elements, feasibility investigations of each element must occur prior to the element being adopted by the Program. Therefore, a specific reservoir site has not been proposed at this time. If the Program chooses to proceed with this element, site-specific NEPA analysis will be undertaken. If wetland impacts are likely, a site-specific analysis of wetland will be undertaken as part of the NEPA analysis of alternatives, to support application for a site-specific Section 404 permit.

ENDANGERED SPECIES ACT

All site-specific Program actions that could affect listed species or their habitat will be assessed under the ESA prior to implementation. The Program will evaluate the potential impact of Program site-specific activities on other listed species when Program activities are proposed and prior to implementation. The Program will take appropriate actions if, and when, adverse effects to other listed species and/or designated critical habitats are identified. Any adverse effects will be avoided or offset based upon consultation with the Service.

MIGRATORY BIRD TREATY ACT

The Migratory Bird Treaty Act prohibits the take of migratory birds. Executive Order (EO) 13186 requires Federal agencies to avoid impacts to migratory birds. Under the Program, the clearing of woods and shrubs from riparian areas to restore river channel habitat and wet meadows will reduce migratory bird habitat and could result in unintentional take of these species. In compliance with EO 13186, such activities will be restricted to those periods of the year when nesting activities do not occur, to minimize the chances of unintentional take. Each site-specific NEPA analysis tiered to this Programmatic FEIS will examine potential methods to reduce impacts on migratory birds and implement those methods found to be reasonable.

NATIONAL HISTORIC PRESERVATION ACT

Where site-specific Program actions may affect cultural resources or sites and structures listed on the National Register of Historic Places, consultation will be undertaken with the State Historic Preservation Officer and the Advisory Council on Historic Preservation, and appropriate surveys will be undertaken and incorporated into site-specific planning and evaluation. Some aspects of the preferred alternative, such as the Pathfinder Modification Project, occur at or near historic structures and site-specific consultation and analysis is planned. For other Program actions, such as land restoration and the construction of an off-channel reservoir in the Central Platte, the location of the action is not yet known. Programmatic agreements will be implemented with each state and interested Tribes, providing a process for consultation and mitigation, when these Program actions and others are found likely to affect cultural or historic resources.

FARMLAND PROTECTION POLICY ACT—SUBTITLE I OF TITLE XV, SECTION 1539-1549

For each site-specific NEPA compliance analysis for Program actions, the Program will coordinate with the Natural Resources Conservation Service to identify prime farmlands that might, through Program actions, be permanently converted to nonagricultural uses and to consider conversion of these lands when deciding where to pursue construction and habitat restoration actions. The Program will strive to minimize unnecessary and irreversible conversion of prime farmlands.

MONITORING

The preferred alternative incorporates an extensive program of resource monitoring and research. The Integrated Monitoring and Research Plan (IMRP) will monitor key resource features and provide ongoing feedback to Program decisionmakers about both trends in environmental and species conditions, as well as the effect of Program actions on those resources. The IMRP can be found in the Governance Committee Program Document: Attachment 3: Adaptive Management Plan.

Two additional items have been identified during the FEIS analysis that will be incorporated into the IMRP:

- **Selenium:** As described in the "Water Quality" section in chapter 5, two elements of the Governance Committee Alternative (Groundwater Management in the Central Platte Groundwater Mound Area and Dry Creek/Fort Kearney Cutoffs) have the potential to increase inputs of selenium to the Central Platte River. If these elements, or similar elements, are pursued by the Program, the associated feasibility studies should carefully assess, and avoid where possible, the risk of increasing selenium inputs to the river. Where Program actions ultimately may affect selenium concentrations in the river, monitoring of this element will be added to the Program IMRP.

- **Copper, Lead, and Nickel:** The "Water Quality" analysis in chapter 5 indicates that levels of copper, lead, and nickel exceeding EPA advisory levels exist in the Central Platte River sediments. Monitoring of these constituents in sediment, water, and biota will be added to the Program IMRP to track the effects of channel management activities in the preferred alternative (vegetation clearing, island leveling, sediment augmentation).

ENVIRONMENTAL COMMITMENTS BY STATES

The State of Wyoming Water Development Commission has entered into an agreement to contribute up to $2 million to the Wyoming Game and Fish Department during the first 13 years of implementation of the proposed Program (Program’s First Increment) to support the restoration of fisheries in the main North Platte reservoirs and river reaches should they be significantly, adversely affected by the Program.

GLOSSARY

abutment. A structure that supports the ends of a dam or bridge.

accretion. (for water) The gradual increase in flow of a stream due to seepage from bank storage; (for land) The addition of dry, noninundated lands to the banks of a river, either as the river narrows or shifts location.

accretion lands. Lands that were formerly active river channel (and, therefore, not in private ownership), but are now wooded or pasture and have been "accreted" to the closest deeded lands for tax and boundary purposes.

acre-foot. A volume of water that would cover 1 acre to a depth of 1 foot (325,850 gallons, 43,560 cubic feet, 1,233.5 cubic meters).

active channel width. The portion of the width of the river channel within its banks that is not vegetated by perennial or woody vegetation. The active channel generally consists of the barren sandy bed above water combined with the portion of the channel inundated by water.

adaptive management. A series of scientifically driven actions that use monitoring and research results (including peer review) to test predictions and assumptions, and use the resulting information to improve those predictions, assumptions, and program actions.

aggradation. Geologic process wherein streambeds and flood plains and the bottom of water bodies are raised in elevation by the addition of material; the opposite of degradation.

alluvial. Relating to mud and/or sand deposited by flowing water. Alluvial deposits may occur after a heavy rain storm.

alluvium. Material transported and deposited by running water, such as clay, silt, sand, and gravel.

anabranched. Multiple, braided channels within a stretch of river that has a greater extent of wooded islands and sand bars.

artifact. A human-made object.

basic yield concept. Fishery managed to provide anglers with the opportunity to harvest fish.

bed material. Unconsolidated material of which a streambed is composed.

bedload. Coarse sediments carried along near the bottom of the river.

bedrock. The solid rock at the surface or underlying other surface materials.

benthic. The bottom of a body of water. The term is often used when referring to organisms that live along the bottom of a body of water.

bioaccumulation. The accumulation of a substance, such as a toxic chemical, in various tissues of a living organism.

biodiversity. Diversity of organisms in biological communities.

biological opinion. A document which states the opinion of the Fish and Wildlife Service as to whether a Federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of critical habitat.

Jeopardy opinion **-** Fish and Wildlife Service or National Marine Fisheries Service opinion that an action is likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat. The opinion includes reasonable and prudent alternatives, if any.

No jeopardy opinion **-** Fish and Wildlife Service or National Marine Fisheries Service opinion that an action is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat.

biota. Plant and animal life.

bridge segment. The Central Platte Habitat Area was divided into 13 river reaches, roughly 5-10 miles long, each separated by bridge crossings on either side. The designation was created mainly for convenience of analysis and compatibility with earlier land cover databases.

buffer area. A buffer area is used to shield wet meadow or channel habitat areas from potential disturbances and may be one component of a “habitat complex.”

buteo. Large hawk.

candidate species. Plant or animal species not yet officially listed, but which are undergoing a status review as published in the *Federal Register* by the U.S. Fish and Wildlife Service, are candidates for possible addition to the list of threatened and endangered species.

capacity (electrical generation). The amount of electrical power that a generation facility can produce on a highly reliable basis, often 90 percent of the time. Also known as dependable capacity.

Central Flyway. An important international migration route for many birds, going generally from the Gulf of Mexico north through the central U.S. to breeding grounds in the northern U.S. and Canada.

Central Platte Habitat Area. An area of land and river that includes the reach of the Central Platte River from Lexington to Chapman, Nebraska, that is about 7 miles wide. This area is the focus of the Program’s habitat restoration efforts for the three target bird species.

channel. Portion of the river which conducts flow with a definite bed and banks to confine and conduct continuously or periodically flowing water.

channel dynamics. Changes in the river and channel geomorphology that include such variables as river discharge, vegetation levels, erosion and deposition of sediment, bed material size gradations, average channel widths, and stage-discharge relationships.

channel habitat. Habitat conditions needed by the four target endangered species to recover. Generally, a wide, shallow river channel is needed for the crane migration seasons to avoid predation, as well as the emergence gence of dry sand bars during the tern and plover summer nesting season.

channel profile. A side or sectional elevation view of the channel.

channel width or total channel width. A measurement of the total width of the river channel from bank to bank.

consumptive use. A use which lessens the amount of water available for another use (e.g., water that is used for development and growth of plant tissue or consumed by humans or animals). Also, the amount of water lost to a river system through diversion and evaporation, plant evapotranspiration, industrial or municipal consumption, or conversion, or to the ground, and which does not return to the river through return flows.

conveyance loss. Water lost in conveyance (pipe, channel, conduit, ditch) by leakage or evaporation.

Cooperative Agreement. An agreement signed by the U.S. Department of the Interior and the States of Nebraska, Wyoming, and Colorado in 1997, promising to pursue a Basinwide, cooperative effort to improve and maintain habitat for endangered species in the Platte River Basin.

core habitat area. A wet meadow or channel habitat area; a component of a "habitat complex."

crediting. Land parcels or complexes and water projects and activities that meet Program criteria will be credited towards the Program's long-term objectives, with approval of the managing entity.

critical habitat. Defined in Section 3(5)(A) of the Endangered Species Act as: (1) The specific areas within the geographical area occupied by the species at the time it is listed, on which are found those physical and biological features (a) essential to the conservation of the species and (b) which may require special management considerations for projection; and (2) Specific areas outside the geographical area occupied by a species at the time it is listed upon a determination by the Secretary of the Department of Interior that such areas are essential for the conservation of the species.

cubic foot per second (cfs). As a rate of streamflow, a cubic foot of water passing a reference section is 1 second of time. A measure of a moving volume of water (1 cfs = 0.0283 m^3/s).

cultural resource. Any building, site, district, structure, or object significant in history, architecture, archeology, culture, or science.

D50. Median sand or sediment grain size in a sediment sample.

dead storage. Storage in a reservoir that cannot be released by the dam.

deciduous. Perennial plants, trees, and shrubs that shed their leaves at some time of the year, particularly in the fall.

deep percolation. Percolation of irrigation water past the plant root zone to regions of deeper groundwater aquifers. Water that goes below the plant root zone and may supply water to shallow aquifers, deep aquifers, irrigation induced wetlands, phreatophytic vegetation, or return flows to surface water.

degradation. Process wherein the elevation of streambeds, sandbars, and flood plains is lowered by erosion. The opposite of aggradation.

demand (energy). Rate at which electric energy is used, expressed in kilowatts, whether at a given instant or averaged over any designated period of time.

depletion. To permanently remove water from a system for a specific use.

deposition. Material settling out of the water onto the streambed. Occurs when the energy of the flowing water is unable to support the load of suspended sediment.

discharge. Volume of water that passes a given point within a given period of time.

discharge capacity. The maximum amount of water that a dam can safely release.

diversion (water). Removal of water from its natural channels for human use.

diurnal. Daily.

dorsolateral folds. Lines of raised glandular skin in an area between the back and the sides.

dorsum The upper surface.

drainage. A technique to improve the productivity of some agricultural land by removing excess water from the soil; surface drainage is accomplished with open ditches, while subsurface drainage uses porous conduits (drain tile) buried beneath the soil surface.

dynamic equilibrium. Within dynamic equilibrium, the channel exhibits patterns of erosion and deposition but there is no net change in the input and output of materials. The state is stable, but features may change over time.

easement. Voluntary restrictions in perpetuity or for a term of years that limit development or use of the parcel(s) of land to protect conservation values as part of the Program. The easement is a recorded restriction in the property deed and, therefore, applies to all subsequent owners and to lessors. The nonprofit or other entity that is granted the easement can monitor and enforce its terms.

electrofishing. The practice by biologists of temporarily stunning fish using an electric shock in order to count, weigh, measure, tag, or otherwise inspect fish and collect data on populations.

emergent vegetation. Aquatic plants having most of the vegetation parts growing above water.

endangered species. A species or subspecies whose survival is in danger of extinction throughout all or a significant portion of its range.

Endangered Species Act (ESA) compliance. The ESA of 1973 (P.L. 93-205), Section 7, requires Federal agencies to ensure that all federally associated activities do not have adverse impacts on the continued existence of threatened or endangered species or on designated areas (critical habitats) that are important in conserving the species. The Service has established a system of consultation procedures with other agencies that concludes with completion by the Service of a Biological Opinion.

Environmental Account. Under the Program, a quantity of water designated for environmental purposes that is stored in a specified reservoir to be released based upon the amounts needed at certain times of the year by the target species in the Habitat Area of the Central Platte River.

ephemeral. Streams that contain running water only for brief periods of time in direct response to precipitation.

eutrophication. Overenrichment of a body of water with nutrients, resulting in excessive growth of organisms and depletion of oxygen.

evapotranspiration. The combined processes of evaporation and transpiration. It can be defined as the sum of water used by vegetation and water lost by evaporation.

exceedance interval. A specified range of conditions (e.g., the wettest quarter of the time, or 75-percent to 100-percemt exceedance interval).

exceedance level. A condition that is exceeded a specified percentage of the time (e.g., the 80-percent exceedance level is the condition surpassed 80 percent of the time on average).

excess flows. In the context of the Program, streamflows that are in excess of Platte River species and annual target flows.

extirpated. A species of plant or animal that is no longer found in a particular area.

Executive Director. The head of the Program's paid staff, reporting to the Program's Governance Committee.

fair share. The Department of the Interior and states have agreed that Federal contribution and the collective State contributions should be as equal as possible.

fallow. Cropland idled with the vegetation controlled by a combination of tillage and/or chemicals. Land plowed and tilled and left unplanted.

fee simple. Ownership of all rights in a piece of real estate.

firm energy or power. Non-interruptible energy and power guaranteed by the supplier to be available at all times, except for uncontrollable circumstances.

First Increment. The Program will be implemented in increments. The Program's First Increment begins with the signing of the Program Agreement by the Department of the Interior and the three states, and shall continue for 13 years from that date or until any later date agreed upon by the Governance Committee in approval of an extension, subject to appropriations.

fish assemblage. Roughly interchangeable with the species composition, relative abundance, and overall abundance of the fish community.

Fish and Wildlife Coordination Act (FWCA) of 1958 (P.L. 85-624). Whenever a Federal agency other than the Service proposes to impound, divert, channelize, or otherwise alter or modify any stream, river, or other body of water for any purpose, it must first consult and coordinate its actions and projects with the Service and appropriate State fish and game agency(ies). The consultation and coordination process must address ways to conserve wildlife resources by preventing their loss and damage, as well as to further improve the resources. Compliance with the FWCA must be completed before the DEIS is filed. The Service is authorized to survey, investigate, prepare reports, and recommend methods to prevent any potential loss or damage to wildlife resources, and recommendations are to be included in the FEIS.

flood plain. Nearly level land, susceptible to floods, that forms the bottom of a valley.

flow augmentation. The release of water stored in a reservoir or other impoundment to increase the natural flow of a stream.

focus exceedance interval. The exceedance intervals that the analysis/analyses in question use (or focus on).

forage fish. Small fish that produce prolifically and are consumed by predator fish or other species (e.g., terns).

forebay. Impoundment immediately above a dam or hydroelectric plant intake structure. The term is applicable to all types of hydroelectric developments (storage, run-of-river, and pumped storage).

fry. Life stage of fish between the egg and fingerling stages. Depending on the species of fish, fry can measure from a few millimeters to a few centimeters.

future depletions. The Program seeks to ensure that future water-related actions do not reduce achievement of target flows. State and Federal agencies are developing plans to mitigate or avoid any future depletions that increase shortages to the species and annual pulse flow targets or otherwise undermine Program flow improvements.

gauge or **gauging station**. Specific location on a stream where systematic observations of hydrologic data are obtained through mechanical or electrical means.

generation (energy). Process of producing electric energy by transforming other forms of energy; also, amount of electric energy produced, expressed in kilowatthours.

generator. Machine that converts mechanical energy into electrical energy.

GIS. Geographic Information System typically refers to a database related to an electronic mapping system.

Governance Committee. Group of signatory and nonsignatory members representing the three states (Nebraska, Wyoming, and Colorado), water users, environmental groups, and two Federal agencies (Reclamation and the U.S. Fish and Wildlife Service) that was established to implement the Cooperative Agreement.

grain size or bed-material size. The size of sand and sediment particles found in the riverbed.

groundwater. Water stored underground in rock crevices and in the pores of geologic materials that make up the earth's crust.

guild. Group of species that exploit the same class of environmental resources in a similar way.

habitat complex. Wet meadows, channel areas, and buffers.

head. Differential of pressure causing flow in a fluid system, usually expressed in terms of the height of a liquid column that pressure will support.

herbaceous. Refers to vegetation growing close to the ground that does not develop persistent woody tissue, usually lasting for a single growing season.

hydraulic gradient. The slope of the hydraulic grade line. This is the slope of the water surface in an open channel, the slope of the water surface of the groundwater table, or the slope of the water pressure for pipes under pressure.

hydrocycling. A cyclic pattern of water release through a power-generation system (for example, on-and-off cycles repeated over 24-hour intervals) for purposes of maximizing system efficiencies and/or avoiding physical damage to system facilities.

hydroelectric power. Electrical energy produced by flowing water.

hydrograph. A graph showing the discharge, stage, velocity, or other property of water with respect to time for a given point in a stream or river.

hydrologic. Pertaining to the quantity, quality, and timing of water.

hydrophytic plants. Plants rooted in soils saturated by water for all or part of the annual growing season.

hypolimnion. The lowermost, noncirculating layer of cold water in a thermally stratified lake or reservoir that remains perpetually cold and is usually deficient of oxygen.

in-channel habitat. Habitat qualities in the channel for the target species.

infiltration rate. Quantity of water (usually measured in inches) that will enter a particular type of soil per unit time (usually 1 hour).

inflow. Water that flows into a body of water.

instream flows. Waterflows for uses within a defined stream channel (e.g., flows designed for fish and wildlife).

Integrated Monitoring and Research Plan (IMRP). The Program's plan for biological response (habitat and species) monitoring and research to provide: (1) integrated monitoring and research data to evaluate the effectiveness of the Program in providing habitat for target species, (2) data supporting Program Adaptive Management decisions regarding management activities during the Program's First Increment, and (3) scientifically defensible data that allow the determination of future milestones for the Program.

invertebrates. All animals without a vertebral column (e.g. spiders, crabs, or worms).

Land Committee or Land Advisory Committee. A standing subcommittee of the Governance Committee, chaired by local landowners, to provide advice on land-related Program activities, including development of guidelines for land habitat management, leasing, and acquisition. The committee works closely with local communities and landowners to determine the most appropriate ways to cooperatively achieve the habitat goals.

land component. The portion of the Program that relates to the acquisition and management of land as habitat for the target species.

land interest holding entity. A nongovernment entity that holds title to Program lands or enters into leases, easements, and other contractual arrangements for Program lands, is retained through contracts with the signatories, and works at the direction of the Governance Committee.

land maintenance. The physical effort made throughout the term of the Program to sustain vegetation or topography of a parcel of Program land in the condition described in the Program's management plan for that parcel of land, after any initial restoration has taken place. Examples include burning vegetation, repairing fences, and reshaping bank areas.

land management. Management of a parcel of Program land that includes all Program activities related to that parcel. Examples include restoration, maintenance, research and monitoring, controlling access, and coordination with neighbors.

land management plan. A parcel-specific plan for all Program activities on or related to that parcel of Program land.

land or habitat protection. The Program will acquire, restore, and manage land and interests in land to provide the greatest biological benefit for the target species. Land and interest in land will be acquired from willing landowners only.

latilong. Encompasses a rectangle covering 1 degree of latitude by 1 degree of longitude.

lease, lessee, and lessor. A lease is a short- or long-term rental of land for specific purposes. A lease gives the lessee use or access rights to a property for a set period of time. A lessee is the holder of the lease and the lessor is the one who lets property under a lease.

lipid. Any of a group of organic compounds, including the fats, oils, waxes, sterols, and triglycerides, that are insoluble in water but soluble in common organic solvents, is oily to the touch, and together with carbohydrates and proteins constitute the principal structural material of living cells.

littoral. The region along the shore of a nonflowing body of water. Littoral habitat is to a lake what riparian habitat is to a river.

littoral habitat. Habitat where light reaches the reservoir bottom.

Lower Platte Habitat Area. The Lower Platte River below the confluence with the Elkhorn River used by the pallid sturgeon.

lowland grasslands or bottomland grasslands. Grasslands with emergents of open water within the flood plain.

macroinvertebrate. Insects and other biota without a vertebral column.

median. Middle value in a distribution, above and below which lie an equal number of values.

megawatthour. Energy equivalent to using 1,000,000 watts for 1 hour, which is usually the unit by which wholesale rates are measured.

mesic. Environmental conditions that have medium moisture supplies as compared to wet conditions (hydric) or dry conditions (xeric).

Milestones. The Department of the Interior and states intend that during the Program's First Increment, Endangered Species Act compliance will be measured through the achievement of First Increment Milestones that include steps to be taken with associated schedules.

mitigation. Methods or plans to reduce or eliminate adverse project impacts. Mitigation includes avoiding, minimizing, rectifying, reducing, or compensating impacts.

modeling. Use of mathematical equations to simulate and predict physical events and processes.

monitoring. Data collection according to protocols in the Integrated Monitoring and Research Plan that takes place on Program lands and non-Program lands.

morphoedaphic index (MEI). The MEI is a formula for calculating potential fish yields from lakes. Higher MEI levels indicate higher projected fish standing crops.

National Environmental Policy Act (NEPA). Act requiring Federal agencies to analyze and disclose in advance the effects of Federal actions.

National Register of Historic Places, The. A federally maintained register of districts, sites, buildings, structures, architecture, archeology, and culture.

net economic benefits. Economic benefits less economic costs.

new depletions. Depletions to streamflow in the Platte River caused by water-related activities initiated since the signing of the Cooperative Agreement on July 1, 1997.

No Action Alternative. Typically, the no action alternative is the description and analysis of the most likely future that could be expected in the absence of a project, and it serves as the reference point against which the alternatives are compared in an EIS. Early in the Program planning process, however, it became clear that it would not be possible to estimate, with any degree of certainty or accuracy, what the conditions throughout the Basin would be without the proposed action. Changes in water conditions if each Federal-nexus water project in the Basin underwent individual ESA Section 7 consultations could not effectively be predicted; therefore, the present conditions that exist in the Basin as of 1997 are used in most cases as the quantitative baseline for comparing alternatives.

noncomplex habitat. Lands that, while not meeting the definition of a habitat complex, provide demonstrable benefits to the target species, such as sandpits and existing or restorable nonriparian wetlands and wet meadows within 3.5 miles of the centerline of the main channel area, or 2 miles of the banks of a side channel, in the area from Lexington to Chapman, Nebraska.

non-Project lands. Lands irrigated from the North Platte River but that do not have a contract for storage with Reclamation.

noxious weed control. The measures necessary to contain and/or eradicate plants identified as noxious weeds by the State of Nebraska, consistent with Nebraska law.

ogee. (Architecture) 1. A double curve with the shape of an elongated S. 2. A molding having the profile of an S-shaped curve. 3. An arch formed by two S-shaped curves meeting at a point. Also called “ogee arch."

operation and maintenance costs. The ongoing, repetitive costs of operating a water system; for example, employee wages and costs for treatment chemicals and periodic equipment repairs.

other species of concern. Federal- or state-listed endangered, rare, or declining species other than the four targeted species.

PHABSIM (Physical Habitat Simulation Methodology). A computer model used to simulate relationships between streamflow and physical habitat conditions for river-dependent species, particularly fish.

pallid sturgeon habitat. The lower Central Platte River from Lexington to the mouth of the Missouri River.

parts per million (PPM). A measurement of concentration on a weight or volume basis. This term is equivalent to milligrams per liter (mg/L), which is the preferred term.

peak flow. In the context of the Program, the highest flows maintained for 1 to 5 consecutive days in any given year.

peak load plant. Powerplant that normally is operated to provide power during maximum load periods.

percolation. (1) The slow seepage of water into and through the ground; (2) The slow passage of water through a filter medium.

permeability. Generally used to refer to the ability of rock or soil to transmit water.

plan form (river). The channel pattern of a reach of river as observed from the air (or from an airplane), including relatively straight, meandering, braided, or anastomosed channels.

plastron. The ventral part of the shell of a turtle or tortoise.

point bar. Sediment deposit formed at the inside of a bend or meander in a stream.

power interference. A temporary, intentional reduction or interruption in power generation at a hydroelectric facility for the purpose of retaining the stored water for release at a later and more desirable time.

powerplant. Structure that houses turbines, generators, and associated control equipment.

power pool. Two or more interconnected electric systems which operate as a single system to supply power to meet combined load requirements.

Proposed Program (or Program). The proposed Platte River Recovery Implementation Program.

protocol. The plan for a scientific experiment or treatment; in the case of the Program, there are specific protocols for the monitoring of each species during the Program's First Increment. Such monitoring is needed for adaptive management.

pulse flow. Streamflow that for a limited period of time (e.g., a few to 30 days) is significantly higher than the antecedent and/or typical rates of flow in the river.

raptor. Any predatory bird.

reach. A portion of a stream or a river.

Reasonable and Prudent Alternative (RPA). Actions, or the modification of actions, necessary under the ESA to offset the adverse effects of a proposed Federal action found likely to cause jeopardy to one or more threatened and endangered species or to adversely modify critical habitat before the Program was in place.

recharge area. Generally, an area that is connected with underground aquifer(s) by a highly porous soil or rock layer. Water entering a recharge area may travel for miles underground.

Record of Decision. Under NEPA, a Record of Decision (ROD) is a document which states the decision made, describes the environmental factors considered, the preferred plan, and the alternatives considered in an EIS.

regime of the river. Expected long-term flow characteristics of a river associated with particular conditions of basin development and river management.

restoration. The initial effort after acquisition to alter vegetation or topography of a parcel of Program land to the condition described in the Program's management plan for that parcel of land. The term "restoration" is used whether or not the land was previously in that condition.

return flow. Drainage water from irrigated farmlands or other water users that re-enters the water system to be used further downstream.

riparian. Of, on, or pertaining to the bank of a river, pond, or lake.

river geomorphology. Study of the configuration and evolution of rivers.

riverine. Of or pertaining to a river.

river stage. River surface elevation at a specified flow.

roosting. The act of birds or bats resting during the day or night, usually protected from weather and predators.

sandbar. An off-bank mass of sand built up by the action of river currents.

scour. Removing debris and sediments from a channel by the force of water.

screening report. Under the National Environmental Policy Act, a report documenting how alternatives and elements of alternatives not covered in the environmental impact statement were screened out of the process.

Section 7. The section of the Endangered Species Act that requires Federal agencies to consult with the Fish and Wildlife Service regarding effects of their activities on endangered species and critical habitat for those species.

sediment. Unconsolidated solid material that comes from weathering of rock and is carried by, suspended in, or deposited by water or wind.

sediment load. Mass of sediment passing through a stream cross-section in a given period of time, expressed in millions of tons.

selenosis. Effects of selenium toxicity.

short ton. A unit of mass equal to 2,000 pounds.

sight distance. Area of clear view preferred by some of the target species to detect the approach of predators. Ensuring an appropriate sight distance improves habitat for these species.

signatories. The three States — Colorado, Nebraska, and Wyoming — and the Department of the Interior, all of which signed the Cooperative Agreement in1997, promising to pursue a Basinwide, cooperative effort to improve and maintain habitat for endangered species in the Platte River Basin.

slough. A backwater area, swamp, or marsh.

sponsors (Program lands). Entities or individuals who dedicate the use of lands to the Program but retain ownership of all property rights. Sponsored lands must be protected by other federal, state, or local programs; managed under regulatory oversight as habitat; or protected by nonprofit conservation groups or government agencies.

species of concern. Species identified by the Fish and Wildlife Service for which further biological research and field study are needed to resolve these species' conservation status.

study area. The Program study area, or area of potential impact, includes the North Platte River Basin, South Platte River Basin, and the Central Platte River Basin.

subirrigated. Irrigation below the surface (as by periodic rise of the water table or by a system of underground porous pipes). Irrigation of crops from water table(s) that are, in turn, supplied by seepage from above-lying canals, laterals, reservoirs, or irrigated fields.

suspended sediment (or suspended load). A quantification of the amount of sediment transported in or by the river.

swale. A long, narrow, shallow channel.

tailwater. Water immediately downstream of a dam.

target flows. Flows of certain volumes and at certain times of the year identified by Fish and Wildlife Service personnel to improve habitat conditions for the target species in the Central Platte. Details are provided in the attachment, "Draft Instream Flow Recommendations."

target species. The four species—whooping crane, interior least tern, piping plover, and pallid sturgeon—that depend on habitat in the Central Platte River Basin and that the Cooperative Agreement was developed to protect.

Technical Committee. The Technical Committee, a subcommittee of the Governance Committee, is charged with developing the framework for habitat and species monitoring and research, as well as a peer review process for scientific studies.

terrestrial. Growing or living on land.

thermocline. A transition layer between deep and surface water. The thermocline is not simply the middle layer of the reservoir, it is a specific temperature layer, which forms at variable depth depending on climatic conditions (e.g., if the thermocline is at 65 feet, and depth in an area ranges from 0-100 feet, then that area where the **water** depth is less than 65 feet, but where light reaches the bottom, is littoral habitat as per this definition).

third-party impacts. Impacts to landowners, residents, and other nonsignatory entities who are not party to formal agreements with the Program.

threatened species. Any species which has potential of becoming endangered in the near future. [See P.L. 93-205 for legal definition, Endangered Species Act, sec. 3 (20).]

transport capacity. The capacity of a river to carry sediment in suspension or to move sediment along the riverbed. Usually expressed as mass per unit of time.

travel cost method. Method of estimating the value of recreation based upon observed market behavior of a cross-section of visitors in response to direct out-of-pocket and time costs of travel.

trophy concept. Fishery managed for the opportunity to catch larger than average fish.

turbidity. Cloudiness of water, measured by how deeply light can penetrate into the water from the surface.

under-runs. Water use that is less than the baseline.

unvegetated channel width. A measurement of the portion of the channel that is unvegetated.

vegetated channel width. A measurement of the portion of the channel that is vegetated.

Water Action Plan. The Water Action Plan, along with the three State projects (Pathfinder Modification - Wyoming, Tamarack Plan - Colorado, and Lake McConaughy Environmental Account - Nebraska), will serve as the water component of the Governance Committee's Alternative.

Water Action Plan Committee. The Water Action Plan Committee has developed a Water Action Plan, which has been reviewed and approved by the Governance Committee.

water conservation/supply project. The water components of the Water Action Plan. A portion of the instream flow objectives will be met through a program of incentive-based water conservation and water supply activities. During the Program’s First Increment, the goal is to provide at least 50,000 acre-feet per year on average of net hydrologic benefit through water conservation/supply projects.

Water Management Committee. Subcommittee of the Governance Committee responsible for coordinating each state's development of a means to track new water depletions or accretions to ensure mitigation of impacts from new water diversions and proper crediting for water conservation.

water-related activities. Activities and aspects of activities which (1) are subject to section 7(a)(2) of the ESA; (2) occur in the Platte River Basin upstream of the confluence of the Loup River with the Platte River; and (3) may affect Platte River flow quantity or timing, including, but not limited to, water diversion, storage, and use activities.

water re-regulation project. A project that temporarily diverts and/or stores water so that it will be returned to the river at a later and, ideally, more desirable time.

water-surface elevation. The elevation of a water surface above or below an established reference level, such as sea level.

water table. The level of groundwater. The upper surface of the zone of saturation of groundwater above an impermeable layer of soil or rock. This level can be very near the surface of the ground or far below it.

well field. Area containing one or more wells that produces usable amount of water.

well monitoring. The measurement, by onsite instruments or laboratory methods, of the quality of water in a well.

wetlands. Lands including swamps, marshes, bogs, and similar areas such as wet meadows, river overflows, mud flats, and natural ponds consisting of permanent or seasonal shallow bodies of water.

wet meadow. Areas generally with a low-lying, undulating surface consisting of a mosaic of swales with wetland soils and vegetation and ridges with upland native or restored grasslands.

wetted perimeter. The distance along the bottom and sides of a stream, creek, or channel in contact with the water.

wetted width. The width measurement of water only (i.e., excludes islands, sand bars, etc.) in the river channel.

wild concept. Fishery totally supported by natural reproduction.

yield. The quantity of water (expressed as a rate of flow) that can be collected for a given use from surface or groundwater sources. The yield may vary with the use proposed, with the plan of development, and also with economic considerations.

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INDEX

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ABBREVIATIONS AND ACRONYMS

area:perimeter	area to perimeter
Basin	Platte River Basin
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
°C	degree Celsius
CCC	Civilian Conservation Corps
CD	compact disk
CDC	Centers for Disease Control
CDOW	Colorado Division of Wildlife
Census	Bureau of the Census
CFR	Code of Federal Regulations
cfs	cubic feet per second
CNPPID	Central Nebraska Public Power and Irrigation District
Cooperative Agreement	*Cooperative Agreement for Platte River Research and Other Efforts Relating to Endangered Species Habitats Along the Central Platte River, Nebraska*
Corps	U.S. Army Corps of Engineers
CPI	Consumer Price Index
CPR model	Central Platte River OPSTUDY Model
CPRV	Central Platte River valley
CWCB	Colorado Water Conservation Board
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DEIS	Draft Environmental Impact Statement
DEQ	Department of Environmental Quality
DO	dissolved oxygen
DW	dry weight
e-mail	electronic mail
EA	Environmental Account
EAC	Environmental Account Committee
EC	electrical conductance
EIS	Environmental Impact Statement
EO	Executive Order
EOM	end of month
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act

°F	degree Fahrenheit
FEIS	Final Environmental Impact Statement
FR	*Federal Register*
FERC	Federal Energy Regulatory Commission
FWCA	Fish and Wildlife Coordination Act
GAMS	Generalized Algebraic Modeling System
GIS	Geographic Information System
Glendo Stipulation	Amendment of 1953 Order to Provide for Use of Glendo storage water
Governance Committee Program Document	Governance Committee's Platte River Recovery Implementation Program Document, 2005
Groundwater Mound	high groundwater area south of the Central Platte River
HECRAS	Hydrologic Engineering Centers River Analysis System
IFIM	Instream Flow Incremental Methodology
IHA	Index of Hydrologic Alteration
IMPLAN	Impact Analysis for Planning Model
IMRP	Integrated Monitoring and Research Plan
Interior	U.S. Department of the Interior
I-O	input-output
ITA	Indian trust assets
JTU	Jackson turbidity unit
kaf	thousand acre-feet
LB962	Legislative Bill 962
LC	Land Subcommittee
maf	million acre-feet
MCP	mid-continent population
mg/L	milligrams per liter
M&I	municipal and industrial
MEI	Morphoedaphic Index
MOA	Memorandum of Agreement
MRO	Midwest Reliability Organization
msl	mean sea level
NAS	National Audubon Society
NDEQ	Nebraska Department of Environmental Quality
NDNR	Nebraska Department of Natural Resources
NEPA	National Environmental Policy Act

NHPA	National Historic Preservation Act
NGPC	Nebraska Game and Parks Commission
NPPD	Nebraska Public Power District
NPRWUMEIS	North Platte River Environmental Impact Statement Model
NPS	National Park Service
NRC	National Research Council
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places
NWI	National Wetland Inventory
NWR	National Wildlife Refuge
NWS	National Weather Service
Order, 1953	1953 Order Modifying and Supplementing the North Platte Decree
PCB	polychlorinated biphenyls
PDSI	Palmer Drought Severity Indices
PHABSIM	Physical Habitat Simulation Methodology
P.L.	Public Law
ppb	parts per billion
ppm	parts per million
PRAM	Platte River Agricultural Model
Present Condition	present conditions existing in the Platte River Basin
Program	Platte River Recovery Implementation Program
Program's First Increment	first 13 years of implementation of the proposed Platte River Recovery Implementation Program
PRESP	Platte River Endangered Species Partnership
PRT	Platte River Whooping Crane Habitat Maintenance Trust
RA	Re-Regulating Account
Reclamation	Bureau of Reclamation
RCC	Reservoir Coordinating Committee
RM	river mile
RPA	Reasonable and Prudent Alternative
SEDVEG Gen3	Sediment Transport and Vegetation Model
SDF	stream depletion factors
SDFView	Stream Depletion Factors View Model
Secretary	Secretary of the Interior
Service	U.S. Fish and Wildlife Service
SHPO	State Historic Preservation Officer
SPREISM	South Platte River Environmental Impact Statement Model
SWA	State Wildlife Area

TC	Technical Subcommittee
TDS	total dissolved solids
TMDL	total maximum daily load
TNC	The Nature Conservancy
TSS	total suspended solids
UET	upper effects threshold
µg/L	micrograms per liter
µS/centimeter	microsiemens per centimeter
U.S.	United States
U.S.C.	United States Code
USGS	United States Geological Survey
WECC	Western Electricity Coordinating Council
Western	Western Area Power Administration
WG&F	Wyoming Game and Fish Department
WMC	Water Management Subcommittee
WNV	West Nile Virus
WSE	water surface elevation
WSPHS	Wyoming Division of State Parks and Historic Sites
WWDC	Wyoming Water Development Commission

LIST OF PREPARERS AND DISTRIBUTION LIST

LIST OF PREPARERS FOR THE DRAFT AND FINAL ENVIRONMENTAL IMPACT STATEMENT

Donald Anderson, B.S. Geology, B.S. Soil Science, M.S. Watershed Science. Twenty years experience in hydrologic modeling, water resource management, land use management and environmental planning in the private sector and in local and Federal government.

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Mark Butler, Platte River Liaison, U.S. Fish and Wildlife Service, B.S. Watershed Sciences (Hydrology concentration). Twenty-six years' experience in water resource issues and analysis.

David Carlson, B.S. Wildlife Biology. Twenty-eight years as a biologist for local, state, and Federal agencies, and twenty-four years in river system ecology.

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Gary Davis, B.A. Environmental Conservation. Twenty years in environmental compliance including NEPA, Endangered Species Act, and Clean Water Act.

Lisa M. Fotherby, BSCE Civil Engineering, MSCE Ph.D. Hydraulic Engineering. Twenty years in river engineering and river restoration projects nationwide.

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Janice McKee, B.S. Botany, M.S. Plant Ecology. Seventeen years as a plant ecologist and wetland specialist with the U.S. Fish and Wildlife Service, Reclamation, and in the private sector.

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Mark Rodney, B.S. Physical Sciences, M.S. Meteorology, M.S. Civil Engineering. Twenty-four years professional experience in river systems modeling and operations with the U.S. Army Corps of Engineers and the Service.

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Mohammed A. Samad, B.S. in Civil Engineering, M.S. in Civil Engineering, Ph.D. in Civil Engineering. Dr. Samad worked for 3 years for the East Pakistan Water and Power Development Authority, twenty years for private consulting firms, and the last fifteen years for the Reclamation's Sedimentation and River Hydraulics Group. Dr. Samad's work experience has been related to the hydrologic, hydraulic, and sediment transport aspects of river studies in Indonesia, Thailand, South America, Bangladesh, and the United States.

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Don Treasure, B.S. Wildlife Management. Twenty-two years with Reclamation in NEPA and Endangered Species Act compliance issues.

Erika Wilson, B.S. Wildlife Management, M.S. Zoology and Physiology. Fourteen years as a fish and wildlife biologist with the Service, Grand Island, Nebraska.

Sharon Whitmore, B.S. Fish and Wildlife Biology. Twenty-two years experience in large river native and endangered species management and coordination of studies with the Forest Service and the U.S. Fish and Wildlife Service, primarily on the Missouri River and the Platte Rivers. Pallid sturgeon.

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Bureau of Indian Affairs, Washington, DC
Bureau of Land Management, Colorado State Office, Lakewood, CO
Bureau of Land Management, White River Field Office, Meeker, CO
Bureau of Land Management, Wyoming State Office, Cheyenne, WY
Bureau of Reclamation, Denver, CO
Bureau of Reclamation, Eastern Colorado Area Office, Loveland, CO
Bureau of Reclamation, Great Plains Region, Billings, MT
Bureau of Reclamation, Nebraska-Kansas Area Office, Grand Island, NE
Bureau of Reclamation, Wyoming Area Office, Mills, WY
National Marine Fisheries Service, Portland, OR
National Park Service, Denver, CO
National Park Service, Fort Collins, CO
National Park Service, Midwest Region, Omaha, NE
National Park Service, Washington, DC
Natural Resources Conservation Service, State Office, Lakewood, CO
Natural Resources Conservation Service, Service Center Office, Lincoln, NE
Natural Resources Conservation Service, Wyoming State Office, Casper, WY
Office of Surface Mining, Washington, DC
U.S. Army Corps of Engineers, Cheyenne, WY
U.S. Army Corps of Engineers, Kearney, NE

U.S. Army Corps of Engineers, Omaha District, Omaha, NE
U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Grand Junction, CO
U.S. Department of Energy, Argonne National Laboratory, Lakewood, CO
U.S. Department of Justice, Denver, CO
U.S. Department of the Interior, Denver, CO
U.S. Department of the Interior, Office of the Solicitor, Lakewood, CO
U.S. Department of the Interior, Office of Environmental Policy and Compliance, Washington, DC
U.S. Department of the Interior, Office of the Solicitor, Washington, DC
U.S. Environmental Protection Agency, Denver, CO
U.S. Environmental Protection Agency, Kansas City, KS
U.S. Federal Energy Regulatory Commission, Chicago, IL
U.S. Federal Energy Regulatory Commission, Washington, DC
U.S. Fish and Wildlife Service, Cheyenne, WY
U.S. Fish and Wildlife Service, Denver, CO
U.S. Fish and Wildlife Service, Grand Island, NE
U.S. Fish and Wildlife Service, Lakewood, CO
U.S. Fish and Wildlife Service, Washington, DC
U.S. Fish and Wildlife Service, Aransas National Wildlife Refuge, Austwell, TX
U.S. Fish and Wildlife Service, Rocky Mountain Arsenal NWR, Commerce City, CO
U.S. Forest Service, Chadron, NE
U.S. Forest Service, Fort Collins, CO
U.S. Forest Service, Golden, CO
U.S. Forest Service, Lakewood, CO
U.S. Forest Service, Laramie, WY
U.S. Forest Service, Monte Vista, CO
U.S. Geological Survey, Denver, CO
U.S. Geological Survey, Fort Collins, CO
U.S. Geological Survey, Lakewood, CO
U.S. Geological Survey, Lincoln, NE
U.S. Geological Survey, Rapid City, SD
U.S. Geological Survey, Reston, VA
U.S. Geological Survey, Rolla, MO
U.S. Minerals Management Service, Herndon, VA
U.S. Western Area Power Administration, Loveland, CO

State Governors

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Nebraska Governor Dave Heineman, Lincoln
Wyoming Governor Dave Freudenthal, Cheyenne

State Agencies, Colorado

Colorado Department of Natural Resources, Denver
Colorado Department of Transportation, Aurora
Colorado Division of Water Resources, Denver
Colorado Division of Wildlife, Denver
Colorado Division of Wildlife, Fort Collins
Colorado Historical Society, Denver
Colorado Legislative Council of the General Assembly, Denver
Colorado State Engineer's Office, Denver

Colorado State Forest Service, Fort Collins, CO
Colorado Water Conservation Board, Denver
State of Colorado, Commissioner of Agriculture, Lakewood
Office of Attorney General, Denver

State Agencies, Nebraska

Federal Highway Administration, Nebraska Division, Lincoln
Nebraska Game and Parks Commission, Lincoln
Nebraska Department of Agriculture, Lincoln
Nebraska Department of Environmental Quality, Lincoln
Nebraska Department of Natural Resources, Lincoln
Nebraska Department of Roads, Lincoln
Nebraska Department of Water Resources, Lincoln
Nebraska Farm Bureau Federation, McCook
Nebraska Game and Parks Commission, Kearney
Nebraska Game and Parks Commission, Lincoln
Nebraska Game and Parks Commission, Alliance

State Agencies, Wyoming

Environmental Quality Council, Cheyenne
Office of State Lands and Investments, Cheyenne
Wyoming Department of Agriculture, Cheyenne
Wyoming Department of Environmental Quality, Cheyenne
Wyoming Farm Bureau Federation, Laramie
Wyoming Game and Fish Department, Cheyenne
Wyoming Game and Fish Department, Casper
Wyoming Municipal Power Agency, Lusk
Wyoming State Engineer's Office, Cheyenne
Wyoming State Engineer's Office, Torrington
Wyoming State Geological Survey, Laramie
Wyoming Water Development Commission, Cheyenne

Tribes

Apache Tribe of Oklahoma, Anadarko, OK
Assiniboine and Sioux Tribes of Fort Peck, Poplar, MT
Blackfeet Nation, Browning, MT
Cheyenne River Sioux Tribe, Eagle Butte, SD
Cheyenne-Arapaho Tribes of Oklahoma, Concho, OK
Comanche Nation, Lawton, OK
Crow Creek Sioux Tribe, Fort Thompson, SD
Crow Tribe of Indians, Crow Agency, MT
Eastern Shoshone Tribe, Fort Washakie, WY
Flandreau Santee Sioux Tribe, Flandreau, SD
Fort Peck Assiniboine and Sioux Tribe, Poplar, MT
Fort Sill Apache Tribe, Apache, OK
Jicarilla Apache Nation, Dulce, NM
Kiowa Tribe of Oklahoma, Carnegie, OK
Lower Brule Sioux Tribe, Lower Brule, SD
Mandan, Hidatsa and Arikara Nation, New Town, ND
Mescalero Apache Tribe, Mescalero, NM

Minnesota Mdewakanton Sioux, Morton, MN
Northern Arapaho Tribe, Fort Washakie, WY
Northern Cheyenne Tribe, Lame Deer, MT
Northwestern Band of Shoshoni Nation, Bringham City, UT
Oglala Sioux Tribe, Pine Ridge, SD
Omaha Tribe of Nebraska, Macy, NE
Otoe-Missouria Tribe of Oklahoma, Red Rock, OK
Pawnee Nation of Oklahoma, Pawnee, OK
Ponca Tribe of Nebraska, Niobara, NE
Ponca Tribe of Oklahoma, Ponca City, OK
Prairie Island Dakota Community of Minnesota, Welch, MN
Rosebud Sioux Tribe, Rosebud, SD
Santee Sioux Tribe of Nebraska, Niobrara, NE
Shakopee Mdewakanton Dakota Comm., Prior Lake, MN
Shoshone-Bannock Tribes, Fort Hall, ID
Shoshone-Paiute Tribes of the Duck Valley, Owyhee, NV
Sisseton Wahpeton Sioux Tribe, Agency Village, SD
Southern Ute Indian Tribe, Ignacio, CO
Spirit Lake Sioux Tribe, Fort Totten, ND
Standing Rock Sioux Tribe, Fort Yates, ND
Upper Sioux Community of Minnesota, Granite Falls, MN
Ute Mountain Ute Tribe, Towaoc, CO
Wichita and Affiliated Tribes, Anadarko, OK
Winnebago Tribe, Winnebago, NE
Yankton Sioux Tribe, Marty, SD

City and County Agencies, Colorado

City of Boulder
City of Fort Collins
City of Fort Lupton
City of Greeley
City of Loveland
City of Northglenn
City of Thornton
City of Westminister
Denver Regional Council of Government, Denver
Denver Water Board, Denver
Denver Water Department, Denver
Grand County Court House, Hot Sulphur Springs
Greeley Water Board, Greeley
Jackson County Commissioners, Walden
Larimer County Health Department, Fort Collins
Larimer County Planning Department, Fort Collins
Mesa County, Board of Directors, Grand Junction
Petros and White, LLC for Summit County, Denver
Town of Estes Park
Town of Frederick
Town of Julesburg

City and County Agencies, Nebraska

Adams County, Hastings
Buffalo County, Kearney
City of Gothenburg
City of Kearney
City of Scottsbluff
Gosper County, Smithfield
Grand Island Utilities Department, Grand Island
Hall County, Grand Island
Kearney County, Minden
Lincoln County, North Platte
Lincoln Lancaster County Department of Health, Lincoln
Phelps County, Holdrege
Platte County, Columbus
Scottsbluff County, Gering

City and County Agencies, Wyoming

Carbon County, Rawlins
City of Buffalo
City of Casper
City of Douglas
Town of Fort Laramie
Town of Glendo
Town of Lingle
Town of Riverside
Town of Torrington

Irrigation, Power, Natural Resources, and Conservation Districts

Bijou Irrigation District, Fort Morgan, CO
Browns Creek Irrigation District, Bridgeport, NE
Casper-Alcova Irrigation District, Mills, WY
Central Nebraska Public Power and Irrigation District, Holdrege, NE
Central Platte Natural Resources District, Grand Island, NE
Colorado River Water Conservation District, Glenwood Springs, CO
Colorado Water Conservation District, Denver, CO
Converse County Conservation District, Douglas, WY
Gering-Fort Laramie Irrigation District, Gering, NE
Goshen Irrigation District, Lyman, NE
Jackson County Water Conservancy District, Walden, CO
LaPrele Irrigation District, Douglas, WY
Laramie Rivers Conservation District, Laramie, WY
Little Snake River Conservation District, Baggs, WY
Lower Big Blue Natural Resources District, Beatrice, NE
Lower Loup Natural Resources District, Ord, NE
Lower Platte North Natural Resources District, Wahoo, NE
Lower Platte South Natural Resources District, Lincoln, NE
Lower South Platte Water Conservancy District, Sterling, CO
Medicine Bow Conservation District, Medicine Bow, WY
Middle Niobrara Natural Resources District, Valentine, NE
Middle Park Water Conservancy District, Granby, CO

Middle Republican Natural Resources District, Curtis, NE
Mitchell Irrigation District, Mitchell, NE
Nebraska Public Power District, Columbus, NE
Niobrara Conservation District, Lusk, WY
North Loup River Irrigation District, Ord, NE
North Platte Natural Resources District, Gering, NE
Northern Colorado Water Conservancy District, Berthoud, CO
Omaha Public Power District, Omaha, NE
Paisley Irrigation District, Lewellen, NE
Papio-Missouri River Natural Resources District, Omaha, NE
Pathfinder Irrigation District, Mitchell, NE
Pioneer Irrigation District, Haigler, NE
Riverside Irrigation District, Fort Morgan, CO
Rock Ranch Irrigation District, Torrington, WY
Saratoga-Encampment-Rawlins Conservation District, Saratoga, WY
South Platte Irrigation District, Ogallala, NE
South Platte Natural Resources District, Sidney, NE
Southern Power District, Grand Island, NE
Southwestern Water Conservancy District, Durango, CO
St. Vrain and Left Hand Water Conservancy District, Longmont, CO
Tri-Basin Natural Resources District, Holdrege, NE
Twin Loup Reclamation District, Scotia, NE
Twin Platte Natural Resources District, North Platte, NE
Twin Platte Natural Resources District Board, Sutherland, NE
Upper Big Blue Natural Resources District, York, NE
Upper Elkhorn Natural Resources District, O'Neil, NE
Upper Niobara-White Natural Resources District, Chadron, NE
Wheatland Irrigation District, Wheatland, WY

Environmental and Conservation Groups

American Rivers, Washington, DC
American Rivers, Nebraska Field Office, Lincoln, NE
Audubon Colorado, Boulder, CO
Audubon Rowe Sanctuary, Gibbon, NE
Audubon Society Nebraska, Omaha, NE
Boulder Audubon Society, Boulder, CO
Ducks Unlimited, Bismarck, ND
Environmental Defense Fund, New York, NY
Fort Collins Audubon Society, Fort Collins, CO
Grazing Lands Conservation Initiative, Burke, VA
Kansas Wildlife Federation, Wichita, KS
National Wildlife Federation, Boulder, CO
Nature Conservancy of Colorado, Boulder, CO
Nature Conservancy, Nebraska Chapter, Aurora, NE
Nebraska Bird Observatory at Crane Meadows, Wood River, NE
Nebraska Wildlife Federation, Elmwood, NE
North Platte Walleyes Unlimited, Casper, WY
Platte River Basin Environments, Inc., Scottsbluff, NE
Platte River Whooping Crane Habitat Maintenance Trust, Wood River, NE
Sierra Club, Missouri Valley Group, Omaha, NE

Sierra Club, Sheridan, WY
The Nature Conservancy, Arlington, VA
The Nature Conservancy, Saratoga, WY
Trout Unlimited, Boulder, CO

Other Water Users Organizations

Colorado River Water Conservation District, Glenwood Springs, CO
Colorado River Water Users' Association, Rock Springs, WY
Lingle Water Users Association, Lingle, WY
Nebraska Water Users, Lexington, NE
Platte Canyon Water and Sanitation District, Littleton, CO
South Adams County Water and Sanitation District, Commerce City, CO
Upper North Platte Valley Water Users' Association, Saratoga, WY
Upper North Platte Water Users Board, Encampment, WY

Electric and/or Power Organizations

Intermountain Rural Electric Association, Sedalia, CO
Kansas Electric Power Cooperative, Inc., Topeka, KS
Loveland Water and Power, Loveland, CO
Mid-West Electric Consumers Association, Wheat Ridge, CO
Missouri Basin Power Project, Wheatland, WY
Municipal Energy Agency of Nebraska, Lincoln, NE
Pacificorp Power Supply, Glenrock, WY
Tri-State Generation and Transmission Association, Inc., Denver, CO

Miscellaneous Organizations

Arkansas River Power Authority, Lamar, CO
BBC Research and Consulting, Denver, CO
Beerline Canal Company, Broadwater, NE
Bernard, Lyons, Gaddis, and Kahn, Longmont, CO
Bishop Brogden Associates, Englewood, CO
Board of Educational Lands and Funds, Lincoln, NE
Central Wyoming Fairgrounds, Casper, WY
Colorado Citizens Campaign, Denver, CO
Colorado Farm Bureau, Centennial, CO
Colorado River Commission, Big Piney, WY
Colorado State University, Fort Collins, CO
Colorado Water Resources Research Institute, Fort Collins, CO
DBA Valley Pump and Supply, Torrington, WY
ERO Resources, Inc., Denver, CO
Fischer, Brown and Gunn, P.C., Fort Collins, CO
Glendo Marina, Glendo, WY
Great Plains Meter, Inc., Aurora, NE
Hageman and Brighton, P.C., Cheyenne, WY
Holland and Hart, LLP., Denver, CO
Holland and Hart, Cheyenne, WY
Hydrosphere Resource Consultants, Boulder, CO
Independent Consultants Network, Inc., Boulder, CO
Independent Petro Association Mountain States, Denver, CO
Izaak Walton League of America, Laramie, WY

Kaplan, Kirsch, and Rockwell, Denver, CO
Kleinshmidt Associates, New Castle, PA
Krassa and Miller, P.C., Boulder, CO
Land Stewardship Consulting, Boulder, CO
League of Women Voters, Lincoln, NE
Lefler and Franklin, Omaha, NE
McCarty Land Water Valuation, Loveland, CO
Medicine Bow Energy Inc., Medicine Bow, WY
Metropolitan Utilities District, Omaha, NE
Minnesota State University at Mankato, Mankato, MN
Moses, Wittemyer, Harrison and Woodruff, P.C., Boulder, CO
Mountain Mail, Salida, CO
Natural Resources Consulting Engineers, Inc., Fort Collins, CO
Nebraska Cattlemen, Lincoln, NE
Nebraska Farmers' Union, Lincoln, NE
Nebraska Farm Products Inc., Cozad, NE
Nebraska State Home Builders Association, Lincoln, NE
Nebraska State Irrigation Association, Lincoln, NE
Nebraska Water Resources Association, Lincoln, NE
Nebraskans First, Lincoln, NE
North Front Range Water Quality Planning, Loveland, CO
North Park Stock Growers, Walden, CO
Olsson Associates, Lincoln, NE
Pahlke, Smith, Snyder, Petitt and Eubanks, Scottsbluff, NE
Platte River Endangered Species Partnership, Cheyenne, WY
Platte River Flood Control Association, North Platte, NE
Platte River Hydrologic Research Center, Merino, CO
Playa Lakes Joint Venture, Lafayette, CO
Porzak, Browning & Bushong, LLP, Boulder, CO
Powder River Basin Resource Council, Sheridan, WY
Public Service Company of Colorado, Denver, CO
Resource Engineering, Inc., Glenwood Springs, CO
Riverside Technology, Inc., Fort Collins, CO
Rocky Mountain Farmers Union, Greenwood Village, CO
Rolf C Campbell & Associates, Lake Forest, IL
S.S. Papadopulos and Associates, Boulder, CO
School of Natural Resource Sciences, Lincoln, NE
Science Applications International Corporation, Lakewood, CO
Simons and Associates, Edwards, CO
Six Mile Ditch Co., Gothenberg, NE
South Dakota State University, Brookings, SD
Southwest Consolidated Sportsmen, Las Cruces, NM
Spronk Water Engineers Inc., Denver, CO
St. Catharine Motherhouse, St. Catharine, KY
States West Water Resources Corp., Cheyenne, WY
Stein and Brockmann, PA, Santa Fe, NM
Stream Systems Technology Center, Fort Collins, CO
Tetra Tech EC, Inc., Lakewood, CO
Tetsel Mutual Ditch Company, Merino, CO
The 1961 Partnership, Kearney, NE

The Groundwater Foundation, Lincoln, NE
Trout, Witwer, and Freeman, Steamboat Springs, CO
Urban Drainage and Flood Control District, Denver, CO
University of Colorado, Boulder, CO
University of Colorado School of Law, Boulder, CO
University of Nebraska, Scottsbluff, NE
University of Nebraska-Lincoln, Lincoln, NE
University of Nebraska-Kearney, Kearney, NE
University of Nebraska-Omaha, Omaha, NE
University of South Carolina, Columbia, SC
URS Corporation, Denver, CO
Van Ness and Feldman, PC, Washington, DC
Voices for the Platte, Newman Grove, NE
Vranesh and Raisch, LLC, Boulder, CO
WL&C Inc., Casper, WY
W.W. Wheeler and Associates, Inc., Englewood, CO
Water Consult, Loveland, CO
Water Resources and Environmental Consulting, Boulder, CO
Western Ecosystems Technology, Inc., Cheyenne, WY
Western Sugar Cooperative, Torrington, WY
White and Jankowski, Denver, CO
Wildlife Management Institute, Fort Collins, CO
Wyoming Farmers' Union, Pine Bluffs, WY
Wyoming Stock Growers' Association, Cheyenne, WY
Zebre Law Offices, PC, Rock Springs, WY

Libraries

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Colorado School of Mines Library, Golden, CO
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University of Northern Colorado, James A. Michener Library, Greeley, CO
University of Wyoming, George W. Hopper Law Library, Laramie, WY

Western Wyoming Community College Library, Rock Springs, WY
Wyoming State Library, Cheyenne, WY

Media

Banner Press, David City, NE
Boulder Daily Camera, Boulder, CO
Denver Post, Denver, CO
Casper Star Tribune, Encampment, WY
Grand Island Daily Independent, Grand Island, NE
Hastings Tribune, Hastings, NE
Imperial Republican, Imperial, NE
Independent Newspaper, Littleton, CO
Kearney Hub, Kearney, NE
KELN, North Platte, NE
KGFW, Kearney, NE
KGOS, Torrington, WY
KHAS Channel 5, Hastings, NE
KJSK, Columbus, NE
KMGH TV Channel 7, Denver, CO
KNEB, Scottsbluff, NE
KNLV, Ord, NE
KRVN, Lexington, NE
KTCH, Wayne, NE
Lincoln Journal-Star, Lincoln, NE
Nebraska Public Radio, Lincoln, NE
Omaha World Herald, Omaha, NE
Rawlins Daily Times, Rawlins, WY
Record, Chadron, NE
Rocky Mountain News, Denver, CO
Scottsbluff Star-Herald, Scottsbluff, NE
Standard Greybull, Greybull, WY

Private Citizens

Daniel Abeel, Ellicott City, MD
Ken Abrahamson, Georgetown, CO
Larry Accord, Torrington, WY
Margaret Adams, Sherman Oaks, CA
Matt Adelman, Douglas, WY
Ralph Adkins, Pueblo, CO
Dennis Ahearn, West Chester, PA
Susan Ahlschwede, Omaha, NE
Martin Albert, Charlottesville, VA
Therea Albrecht, Manhattan, KS
George & Frances Alderson, Baltimore, MD
Carla Alexander, Kearney, NE
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Heidi Allen, Saint Paul, MN
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Rick Allen, Lexington, NE
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Doug Anderson, Little Rock, AR
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Nancy Bain, El Paso, TX
Marilyn Bair, San Francisco, CA
Frances Baker, Jefferson, IA
John Bakker, Corsica, SD
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Lee Harris, Omaha, NE
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Steve Mossman, Lincoln, NE
Boyd Mudra, Cicero, IL
Juliana Mujica, New Orleans, LA
Dave Murphy, Evansville, WY
David Murphy, Lincoln, NE
Glen Murray, Grand Island, NE
Stephanie Nagel, Plantation, FL
Patricia Nagorka, Parker, CO
Jessica Nagtalon, Felton, CA
O. Ruth Najacht, Wheaton, IL
Chuck Neal, Cody, WY
Ellen Neary, Omaha, NE
Grace Neff, Albany, OR
Nancy Neilsen, Louisville, TN
Edith, Neimark, Princeton, NJ
Jeffrey Nelson, Cottage Grove, MN
Debbie Neumeyer, Wright, MN
Stephen Newberg, North Granby, CT
Helen Newman, Chattanooga, TN
Sondra Newman, Boca Raton, FL
Dirk Nickel, Kearney, NE
Loren Niemack, Shelton, NE
Marvin Niemack, Shelton, NE
Heidi Nitze, New York, NY
Sunny Nixon, Santa Fe, NM
Nick Nochols, Catonsville, MD
Mike Norby, Lyman, NE
Brian Nordstrom, Prescott, AZ
Mark Norem, Big Timber, MT
Karen Norteman, Alfred, ME
Suzanne Norton, Lake Panasoffkee, FL
Raymond Note, Milford, NJ
John Novak, Jr., Wheaton, IL
Elaine Nowick, Milford, NE
Carroll Oden, Scottsdale, AZ
James O'Donnell, Lexington, NE
Gregg Oelker, Altadena, CA
Owen Okie, Dellwood, MN
Avi Okin, Kamuela, HI
David Oldfather, Kearney, NE
Germaine Oldfather, Kearney, NE
Darvin Oliver, Grosebeck, TX
Leif Olsen, Spanish Fork, UT
Arthur Olson, Glenwood, MN
Emily Olson, Las Vegas, NM
Terence O'Malley, Highland, CA
Hope Organ, Mc Kinney, TX
Robert Ormond, State College, PA
Larry Orzechowski, Phoenix, AZ
Ourada Cattle Company, Lexington, NE
Thomas Overbye, Staten Island, NY
Hugh Overy, Sedalia, CO
Patty Packer, Scotia, NY
Ann Paff, Albuquerque, NM
Laura Palm, Mahopac, NY
J. Palmer, Miami, FL
Barb Palmquist, Kenyon, MN
John Pamperin, Phoenix, AZ
Bob Parker, Marietta, GA
Helen Parker, Urbana, IL
Morton Parker, Pittsburgh, PA
Teresa Parker, Marietta, GA
Andrea Parr, Onalaska, WI
Nathan Pate, Ellisville, MO
Roger Patterson, Phoenix, AZ
Robert Payne, Chicago, IL
Renate Pealer, Hamilton, OH
Richard Pearson, St. Augustine, FL
Jim Pedersen, Encampment, WY
Jeri Peirce, Grand Lake, CO
Judith Perkins, Wauconda, IL

K. Person, Holdrege, NE
Wayne Persons, Bradford, ME
Candice Peters, Long Island City, NY
Robert Peters, Estes Park, CO
Jean Peterson, Eugene, OR
Priscilla & Vernon Peterson, Leesburg, FL
Rose Pfaff, Highland Heights, KY
Connie Pherigo, Newton, IA
Walter Phillips, Neosho, MO
Donna Phipps, Lingle, WY
Jeff Pike, Cincinnati, OH
Karen Pike-Roberts, Holland Patnt, NY
Richard Pipes, Pleasanton, TX
Diane Pitochelli, Andover, MA
Pauline Plantz, Juniata, NE
Dana Podell, Greeley, CO
Barbara Poland, La Crescenta, CA
Linda Porter, Oswego, IL
Lisa Potter, Loveland, OH
James Powell, Golden, CO
William Powell, Hillsboro, IN
Amber Powers, Alborn, MN
John Powles, Columbus, OH
Prascher Farms, Inc., Kearney, NE
Maxine Priest, Estero, FL
Thomas Prince, Jacksonville, FL
Mary Pritchett, Orlando, FL
Lorraine Proulx, Melbourne, FL
Warren Pruess, Lake Jackson, TX
Maresa Pryor-Luzier, Bushnell, FL
Jess Putnam, Overton, NE
G. William Quarandillo, Grand Rapids, MI
Bernard Quetchenbach, Lakeland, FL
Bill Quint, Hillrose, CO
Vic Quint, Hillrose, CO
R&S Farms Inc., Lexington, NE
R.W. Olsen Farms Inc., Aurora, NE
Cynthia Radcliffe, Ann Arbor, MI
Joseph Radwan, Burbank, IL
David Raffety, Kearney, NE
Dan Rainforth, Doniphan, NE
Shirley Rand Kohan, Latrobe, PA
Philip Ratcliff, Cloverdale, CA
Edward Rate, Casper, WY
Richard Ray, Hastings, NE
Robert Ray, San Jose, CA
Edward Rayburn, Bruceton Mills, WV
Bob Read, Grand Junction, CO
David Reber, Allentown, PA
Denise Redvers-Higgins, San Juan Capistrano, CA
Michael Reeb, Belleville, IL
Pauline Reetz, Denver, CO
Julie Reich, Philadelphia, PA
Lawrence Reisinger, Colorado Springs, CO
Jim Rennau, Wood River, NE
Roy Repinski, Milwaukee, WI
Joe Restivo, Maypearl, TX
Keith Rexroth, Sidney, NE
Toni Rey, Riverwoods, IL
Larry Reynolds, Lexington, NE
Robert Rhodes, III, Mercersburg, PA
J.D. Rich, Austin, TX
Clyde Richards, Brookings, OR
Kathryn Richardson, Leawood, KS
Dianne Richmond, Lake Jackson, TX
Kelly Riedel, Chesterland, OH
Linda Ringle, Trenton, NJ
Ripp Farms Inc., Elm Creek, NE
Eugene Roark, Madison, WI
Harry Roberts, Atlanta, GA
Tyler Roberts, Upland, CA
Bina Robinson, Swain, NY
Gene Robinson, Casper, WY
Martha Robinson, Casper, WY
Anthony Robiolio, Secaucus, NJ
Christopher Rocca, Santa Fe, NM
Gloria Rodgers, Paradise, CA
Steve Roeder, Kearney, NE
Gene Rohrbeck, Casper, WY
Bruce Rolls, Scottsbluff, NE
Jill Ronning, Burnsville, Mn
Pat Rooney, Herndon, VA
Dollie & Greg Root, Casper, WY
Harold Roper, Davey, NE
John Rose, Riverside, RI
Keith Rosenberg, Santa Monica, CA
George Rosenberger, Loveland, CO
Jon Rosenblatt, Piscataway, NJ
Victoria Rosin, Philadelphia, PA
Jenny Ross, Truckee, CA
Keria Rossin, Deerfield, MI
Claudia Rousseau, Silver Spring, MD
Eileen Rowe, Afton, NY
David Ruch, St. Petersburg, FL
John Ruckman, Lakewood, CO
Lyndon Ruhnke, Portland, OR
Walter Rule, Ouray, CO
Ann Rumrill, Rochester, NY
Bernadine Runkel, Des Moines, IA
J. Blaine Runner, Ashby, NE
Michael Ryan, Heartwell, NE
Kaz Rybak, Wallingford, CT
Karen Sabala, Allen, TX
Nicholas Sabetto, Fort Loudon, PA

Barbara Sachau, Florham Park, NJ
Martin Sage, Syracuse, NY
Andrea Salvo, Broomfield, CO
Herbert Samenfeld, Aurora, CO
Gene Sands, Alton, IL
Gayle Sanfilippo, Lincoln City, OR
Basilio Santiago, San Juan, Puerto Rico
Patrick Santinello, Sonoita, AZ
Mervin Santos, Castro Valley, CA
Zalman Saperstein, Fish Creek, WI
Randy Sargent, Freeland, MI
Gale Sarowitz, Leavenworth, KS
Judy Saulcy, Encampment, WY
Ruth Sawyer, Beavercreek, OH
Carleton Schaller, Jr., Littleton, NH
William Schanf, Traverse City, MI
Mike Schaper, Conyers, GA
Lynn Scheirer, Reading, PA
Art Schick, West Union, SC
John Schick, Stockton, CA
Kenneth Schilz, Ogallala, NE
Maynard & Elsie Schimmer, Grand Island, NE
Carol Schlachter, Johnson City, TX
Edella Schlager, Tuscon, AZ
Gordon Schmid, Council Groves, KS
Helen Schmidt, Manchester, IA
Roger & Mabel Schmidt, Wood River, NE
Robbette Schmit, Coventy, CT
Schrock Farms, Elm Creek, NE
Linda Schrock, Lincoln, NE
Schroeder Corn & Cattle Company, Shelton, NE
Pete Schroeder, Steamboat Springs, CO
Donna Schubert, Taunton, MA
Miles Schumacher, Windsor Heights, IA
Carolyn Schwalbe, Columbia, MD
Sally Schwartz, Hyattsville, MD
Samuel Schwartz, Fort Wayne, IN
Martin Schwarz, Bertrand, NE
Tom Schwarz, Bertrand, NE
Robert Scott, Bedford, TX
Richard Seeley, La Crescenta, CA
Jacquelyn Seigal, Chesterfield, MO
Peggy Selk, Woodstock, IL
Kelly Sennhauser, Houston, TX
Alice Sevy, Keno, OR
Jerry Sewell, Sherman, TX
Voctor Shaffer, Brookville, PA
Kathy Shaffstall, St. Louis, MO
Jo Sharrai, Orofino, ID
Mary Shaw, Saint Cloud, FL
Carroll Sheldon, Kearney, NE
Doug Sheldon, Kearney, NE
Kathryn Sheppard, Lebanon, OH
Dennis Sherrerd, Keaney, NE
Mark Shirley, Encampment, WY
Barbara Shissler, Littleton, CO
Bill & Linda Shotkoski, Lexington, NE
Moras Shubert, Denver, CO
Rudolph Shupik, Bridgeport, CT
Walter Sidner, Marietta, GA
Robert Simister, Seminole, FL
Kenneth Simon, Anchorage, AK
Olin Sims, McFadden, WY
R.A. & Christine Sisco, Tulsa, OK
Phillip Sisler, Fossil, OR
Michael Skidmore, Chicago, IL
Donald S. Slaughter, Kearney, NE
Samuel Sledd, San Antonio, TX
Susan Sleight, Faber, VA
Rolf Smeby, Laporte, MN
Barbara Smith, San Diego, CA
Billie Smith, Dallas, TX
Brian Smith, Atlanta, GA
Darrell Smith, Milwaukee, WI
Iris Smith, Cedar Springs, MI
Keri Smith, Peoria, AZ
Nelson Smith, Allenspark, CO
Copley Smoak, Galveston, TX
Henry Smoke, Columbus, NC
Joe Snavely, Clearwater, FL
Carolyn Snegoski, Milwaukie, OR
Marilyn Snyder, Las Vegas, NV
Stanley Sobocinski, Milwaukee, WI
Virginia Soelberg, Johnston, IA
Michele Sohn, Port St. Lucie, FL
Merlyn Solt, Grand Island, NE
Robert & Geraldine Sorenseno, Shelton, NE
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David Spilver, Centennial, CO
Joyel Spoden, Janesville, WI
Richard Spotts, Saint George, UT
Kara Sprague, Pine Bush, NY
Kathleen Springsteen, Kalamazoo, MI
Keith Stafford, Kearney, NE
Moe Stavnezer, San Gabriel, CA
William Stebbins, Lake Zurich, IL
Ron Stear, Cozad, NE
Carol Steck, Nipomo, CA
Stephani Steckler, Indianapolis, IN
J.E. Steinmetz, Fontana, CA

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Karen Sterling, Cedar Creek, TX
Philip Stern, Allenspark, CO
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Judith Stetson, Falmouth, MA
Deborah Stevens, Westborough, MA
Rich Stevens, Pittsford, NY
Edward Stewart, Maryknoll, NY
Jon Stewart, Ipswich, MA
Leon Stigen, Grand Junction, CO
Randy Stinnette, Inland, NE
Mike Stoakes, Lee's Summit, MO
Henry Stokowski, Chicopee, MA
Gary Stone, Mitchell, NE
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Fred Stratton, Casper, WY
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William Strohl, Longmont, CO
James Stubbendieck, Lincoln, NE
Gary Suhr, Bertrand, NE
Shari Sujka, Winter Park, FL
Robert Sullivan, Fort Collins, CO
Don Sullwold, Elm Creek, NE
Hjalmar Sundin, Glenwood Springs, CO
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Nicole Swan, Corning, NY
Paul Sweeney, Barstow, LA
Sharon Sweeney, Winnemucca, NV
Tracy Swenson, Logan, UT
Richard Swift, Camarillo, CA
Arnie & Nancy Sybrant, Casper, WY
Charles & Roni Sylvester, La Salle, CO
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Marilynn Szydlowski, Albuquerque, NM
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Libby Tart, Denver, CO
Colin & Heather Taylor, North Platte, NE
Howard Taylor, Akron, OH
Randy Taylor, Elm Creek, NE
Richard Taylor, Tiverton, RI
Amanda Tep, Jonesboro, GA
Sharon Terleski, Twentynine Palms, CA
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Pat Thelen, Overland Park, KS
David Ther, Albuquerque, NM
Dave Thom, Juniata, NE
Antonia Thomas, Gata, OR
Garry & Beverly Thomas, Wood River, NE
Lydia Thompson, Laporte, CO
Roberta Thompson, Anaheim, CA
Gale Thomsen, Exeter, NE
Kenneth Thrasher, Greene, NY
Laverne Throop, Grand Island, NE
Jim Tierney, North Platte, NE
Doreen Tignanelli, Poughkeepsie, NY
Chris Timko, Roscoe, IL
Tama Tochihara, Eugene, OR
Kathleen Torres, Bellmore, NY
Paul Treadwell, Cortland, NY
Andrea Treanor, Irvine, CA
Carl Trick, Walden, CO
Rosemary Triplet, Grand Island, NE
Tom Troxel, Rapid City, SD
David True, Casper, WY
Diane Trullinger, Gothenburg, NE
Dave Tunink, Lincoln, NE
Virginia Tunks, Los Angeles, CA
Turkey Creek Farm Inc., Kearney, NE
Corinne Turner, Delton, MI
Earline Turner, Stone Mountain, GA
Michael Turner, Stonington, ME
Robert Turner, Boulder, CO
William Turner, Warren, OH
Anne Tyrrell, Norfolk, VA
Fred Uhe, Papillion, NE
Catherine Ullman, Novelty, OH
Gianna Vaccaro, Sagle, ID
Violette Van Belle, Reseda, CA
J. Van Deloo, Schenectady, NY
Charles Van Epps, Broomfield, CO
Art Van Rensselaer, Casper, WY
Tom Van Velson, Bellevue, CO
Ronald Vargason, Arlington Heights, IL
Alfred Verdini, Mahopac, NY
Cindy Vezinau, St. Clair Shores, MI
L. Vickrey, Steamboat Springs, CO
Mary Villaret, San Angelo, TX
Joseph Vincent, Harvey, LA
Vincent Vinciquerra, Port St. Lucie, FL
Carl Vinning, Pueblo West, CO
Paul Vohs, Forth Collins, CO
Chuck Volk, Cozad, NE
Francis Volpe, Mount Vernon, NY
Ted Von Hippel, Ph.D., Austin, TX
Jeanette Vrbas, Atwood, KS
Chris Waddell, North Miami Beach, FL
Nancy Wages, Gainesville, FL
Sidney Wagner, McCook Lake, SD
Darryl Wahler, Sterling, IL

Janet Walker, Jacksonville, FL
Heather Walker, Carlsbad, CA
Billy Wallace, Stillwater, OK
Martha Waltman, Newberry, FL
Glenn Wamble, Richardson, TX
Bob Wamsley, Coalmont, CO
Bertha Ward, Laramie, WY
Cynthia Wargo, Brunswick, OH
Robert Warrick, Oceanside, CA
Ted Watchorn, Dalton, NE
Nancy Wattenberg, Walden, CO
Clara Weaver, Inverness, FL
Sharon Webb, Collierville, TN
Robyn C. & Eric J. Weber, Denver, CO
Ruth Weber, Binhamton, NY
H. Dawson Weeks, Rio Rancho, NM
Carol Weenk, Sunrise, FL
Gene Weglinski, Denver, CO
Roger Weidelman, Loveland, CO
Paul Weidhaas, Leonardville, KS
Michael Weigert, Florence, SC
Melanie Weintraub, Magalia, CA
Dolores Weishaar, Algonquin, IL
Eleanor Weiss Zoub, Lincolnwood, IL
Bill & Connie Wells, Eldorado, TX
Joyce Wells, Madison, WI
Michael Wells, Clarkston, MI
Beth Welna, Collinsville, OK
Joyce Werner, Sterling, CO
M Werthman, Omaha, NE
Carl Weston, Durango, CO
Doug Wetlaufer, Waterloo, IA
Madelin Wexler, Chicago, IL
Matthew Whitcomb, Denver, CO
Gary White, Honolulu, HI
Paul White, Lafayette, IN
Karl Whitmore, Grand Island, NE
Claudia Whitnah, Martinez, CA
Charles Wickham, Topeka, KA
Elizabeth Widel, Omak, WA
David & Leslie Wildrick, Houston, TX
Jerome Wilensky, Golden, CO
Timothy Wiles, Lincoln, NE
Donald Zuck, Twin Falls, ID
Wilke Brothers Farm, Holdrege, NE
Merlin Wilke, Holdrege, NE
Lynn Willcockson, Denver, CO
George Williams, Saratoga, WY
James Williams, Nashville, TN
Stephen Williamson, Louisville, CO
Francille Willis, Lyndhurst, OH
Barbara Wilson, Seattle, WA
Jenny Wilson, Mesquite, TX
George Winard, Sherman Oaks, CA
Cecil Wingert, Kearney, NE
Farrell Winter, Santa Rosa, CA
Dean Wiseman, Shelton, NE
Kay Wiseman, Takoma Park, MD
Holly Wochos, West Bend, WI
Kenneth Woitaszewski, Wood River, NE
Martin Wolf, Colorado Springs, CO
Wayne Wolfram, Toledo, OH
Jean Woodman, Evanston, IL
David Wooledge, Erie, PA
Dawn Worster, Everett, MA
Dennis Wrage, Shelton, NE
Gregory Wright, Sherman Oaks, CA
James Wright, Casper, WY
Ross Wright, Sioux Falls, SD
Stuart Wright, Beaumont, TX
Emily Wrigley, Kansas City, MO
John Yockey, Phillips, NE
Matthew Yost, Boise, ID
David Young, Stow, OH
Janet Yurkanin, Lawrenceville, NJ
Ardis Zantek, Roseville, MN
David Zaparanick, Atlanta, GA
Douglas Zarek, Grand Island, NE
Ruth Zemek, Phoenix, AZ
Ralph Ziegler, San Antonio, TX
Stephen Zimic, Mineola, NY
David & Linda Zimmerman, Loveland, CO
Kathleen Zimmerman, Boulder, CO
Max Zischkale, Ruidoso, NM
Don Zobel, Miami, AZ
Loretta Zoldak, Dallas, TX