PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

ATTACHMENT 3

ADAPTIVE MANAGEMENT PLAN

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Adaptive Management Plan
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PREFACE - Purpose and Scope of Adaptive Management in the Program

Adaptive management in the Program is a systematic process administered by the Governance Committee for continually improving management by: 1) designing certain Program management activities to test alternative hypotheses, and 2) applying information learned from research and monitoring to improve Program management. The process also includes the flexibility to use information and experience from all sources.

The Governance Committee intends this Adaptive Management Plan (AMP) to describe the processes and procedures for implementing adaptive management. Terms within the AMP including, for example, objective or performance measure, have definitions specific to the AMP (see Sections III and IV). The Governance Committee does not intend the AMP to be used to determine Endangered Species Act (ESA) compliance or to automatically or implicitly establish Program requirements (e.g., to create obligations to achieve specific results).[1]

The AMP will be implemented within the existing Program defined contributions of money, land, and water unless amended in accordance with Section III.B.1 of the Program Document. The AMP, which will be amended as learning proceeds, includes those Program management activities and criteria that are subject to systematic investigation.

The Governance Committee recognizes the importance of implementing the AMP in attempting to achieve the following overall management objectives for whooping cranes, least terns, piping plovers, and pallid sturgeon:

1) Improve production of least tern and piping plover from the central Platte River.
2) Improve survival of whooping cranes during migration.
3) Avoid adverse impacts from Program actions on pallid sturgeon populations.

The Governance Committee does not anticipate that these three overall management objectives will be modified, but the underlying management objectives related to the means of achieving these objectives, as described in Section IV.A and B. of this document, may be changed through the process described in 1), 2), and 3) below.

1) If information developed through the AMP, or other information, justifies changing a management objective, the Governance Committee may do so and will develop and implement new practices intended to achieve the changed management objective.
2) If information developed through the AMP, or other information, justifies abandoning a management objective the Governance Committee may do so.
3) If information developed through the AMP or other information, indicates a particular practice to achieve a management objective is not working and the management objective is neither modified nor abandoned, the Governance

[1] Adoption of the AMP does not constitute an admission by the states or water users of support or acceptance that any hypothesis or ecological model is valid, is based on the best science available or should be used as a measure of appropriate or reasonable accomplishments or success.

Committee will develop and implement alternative practices intended to achieve the same adaptive management objective.

For example, the AMP contains management objectives for creating channels with certain characteristics with specific practices. If it is determined that the these practices cannot achieve the desired channel characteristics then the practices may be modified, or abandoned for alternative practices for the purpose of achieving the same desired channel characteristics. Similarly, if it is determined that the desired outcome of management, in our example channel characteristics, should be modified, then these management objectives would be modified and management practices would be designed to meet the new management objectives. Likewise, if it is determined that the desired outcome of a particular channel characteristic be abandoned, the Governance Committee may do so. Throughout this, the overall management objectives of benefiting the target species would not change.

This plan is a strategic document that lays out the broad policies and guidelines for conducting adaptive management during the Program. More detail and specific operating plans will be prepared as additional information becomes available. These operating plans will identify specific management objectives for Program lands, specific management actions to be taken to achieve the management objectives, and specific monitoring and research activities that will be used in the evaluation of the management. The AMP is a flexible or "living" document and will be modified during the First Increment of the Program. At a minimum, the AMP will be revisited annually. Changes to the AMP may be recommended by the Executive Director or advisory committees, but the Governance Committee has the ultimate authority to make changes in the Plan. A process for modifying the AMP is described in more detail in Section I.G. below.

I. INTRODUCTION

Adaptive management as described in this Adaptive Management Plan (AMP) is a series of scientifically driven management actions (within policy and resource constraints) that use the monitoring and research results provided by the Integrated Monitoring and Research Plan (IMRP; Section V of this plan) to test priority hypotheses related to management decisions and actions, and apply the resulting information to improve management. Adaptive management works iteratively as illustrated in the "six steps" of adaptive management illustrated in Figure 1a (Nyberg 1999).

Science based adaptive management operates on the premise that:

1) Uncertainty exists in a managed system, and reduction of uncertainty can improve management;
2) Uncertainty can be reduced through adaptive management but can never be eliminated;
3) Management decisions must be made despite the uncertainty;
4) Monitoring and research programs are in place to evaluate management decisions and to continually improve the knowledge (e.g., underlying conceptual ecological models, computer models) on which these decisions should be based; and

5) Learning about the effects of management will hasten improvement of management decisions in the future resulting in more rapid and cost-effective attainment of management objectives.

Adaptive management experiments can be categorized into two types: “passive” and “active” (Walters and Holling 1990, Murray and Marmorek 2003). In passive adaptive management, alternatives are assessed in step 1 of Figure 1a, and the management action deemed *best* is designed and implemented in steps 2 and 3. Monitoring and evaluation (steps 4 and 5) then lead to appropriate adjustments (step 6). In active adaptive management, managers explicitly recognize in step 1 that they do not know which activities are best, and then select several alternative activities to design and implement in steps 2 and 3. Monitoring and evaluation of each alternative helps in deciding which was more effective in meeting objectives, and adjustments to the next round of management decisions can be made based on those lessons.

Passive adaptive management may initially be less expensive and require fewer people, because only one alternative management technique or strategy is implemented. However, if managers are incorrect in their assumptions, it can take longer to learn which activities are indeed most effective. The absence of a formal comparison of alternatives may mask weaknesses in the approach assumed to be best. As a result, it may prove necessary to go through several iterations of passive adaptive management experiments. Passive adaptive management is also more likely to confound natural environmental change and management effects, hampering managers’ ability to draw confident conclusions.

Active adaptive management may require a larger initial investment of time, labor, and funds, but since several alternatives are tested (usually including a no-action control), learning happens faster and fewer iterations may be needed to find the best alternative. In the Platte River, active adaptive management can only happen at the System and Program Scale through contrasts in actions over time (e.g. different flows in different years), as there are no control systems (see Section I.E. below, for definition of the various scales). At the System Scale, however, actions in one year may have a continuing effect in subsequent years for some ecosystem components, so the intended contrast is blurred. However, sharp spatial contrasts in actions can be created at the Project Scale (see Section V.B), which will likely provide the most promising opportunity for active adaptive management.

A major implication of adaptive management is that learning becomes one of the goals of management; therefore, the collection of useful data through monitoring and research should be an integral part of management decisions and actions. Monitoring and research should be designed to reduce management uncertainty. Typical sources of uncertainty include:

- Ecological (structural) uncertainty: population, community, or landscape dynamics are not completely known; important biological processes are at work; and, there are competing lines of thought as to how they work.
- Environmental variation: uncontrollable natural and anthropogenic changes that increase randomness in system dynamics.
- Partial controllability: management decisions are applied to the system in an unpredictable way and/or by parties not involved in the adaptive management

process, and are influenced by overriding forces (e.g., laws, regulations, and agreements).
- Partial observability: uncertainty about resource status, inability to see the system.

Program monitoring and research need to consider these sources of uncertainty and attempt to reduce, eliminate, or account for them in analyses and management decisions. However, the expected likelihood and costs of reducing uncertainty, and the expected benefit in terms of improved management decisions, will also be considerations when prioritizing monitoring and research projects. Of these major sources of uncertainty, partial controllability or implementation uncertainty is perhaps the largest issue in the Program (i.e. the land and water 'treatments' are uncertain at the Program and System scales). The AMP recognizes the contingent nature of various hypothesis tests and the importance of prioritizing monitoring and research activities based on these contingencies.

The following is the AMP for the Platte River Recovery Implementation Program (Program) and is a product of the Adaptive Management Working Group (AM Working Group) described in Section I.A. of this plan. This AMP is a strategic document that provides a framework for plans that will describe the adaptive management activities to occur. This AMP is dynamic and will change throughout the First Increment of the Program. The process for changing the AMP is also described in Section I.G. of this plan.

I.A. Program Goals and Program Objectives

The Program's long-term goals and First Increment goals and objectives are stated in the Program Document Section II and Section III.A.3.a.and b. The First Increment objectives include the protection, and where appropriate, restoration of 10,000 acres of habitat for the three avian target species and provide water capable of reducing shortages of U.S. Fish and Wildlife Service (FWS) target flows by an annual average of 130,000 to 150,000 acre-feet. The 10,000 acres of habitat identified as one of the First Increment objectives will initially include 9,200 acres that approximate or have the potential to approximate through restoration, habitat complex characteristics described in Table 1 of the Land Plan; and, up to 800 acres of habitat that have or have the potential to have the characteristics of non-complex habitat described in Table 2 of the Land Plan (Program Attachment 4).

Program goals and objectives will be achieved as a combination of individual land and water actions (e.g., individual water projects, individual land acquisitions) implemented over the First Increment. These actions are considered treatments applied to the associated habitats resulting in some desired response by target species and/or their habitats (Figure 2). The Program's approach to reducing shortages to target flow and the protection and restoration of land are described in the Water Plan (Attachment 5 of the Program) and Land Plan (Attachment 4 of the Program), respectively. These plans are subject to change by the Governance Committee based on learning through adaptive management.

I.B. General Concept of the Program's Adaptive Management

The Program objectives (see Section I.A. above) can only be modified through formal amendment of the Program and not as a part of the AMP. Individual land and water management actions (or treatments), where possible, will be developed and designed to gain the greatest feasible understanding of the response to management actions of the target species and components of their habitat through monitoring and research (Sit and Taylor 1998, Walters 1986). Program water will generally be managed to try to achieve flows as described in "Water Plan Reference Material" (Water Plan, Attachment 5, Section 11) and to produce effective adaptive management experiments. The guidelines for land acquisition, both complex and non-complex, are described in the Program's Land Plan (Program Attachment 4, Tables 1 and 2). The Governance Committee may use analysis of information provided by the AMP during the First Increment to change these characteristics and/or guidelines contained in the Land and Water Plans.

I.C. Organizational Structure to Implement Platte River Adaptive Management

The Signatories (Colorado, Nebraska, Wyoming and the Department of the Interior (DOI)) have agreed to carry out financial and contracting responsibilities in coordination with the Governance Committee as described in the Organizational Structures Document (Program Attachment 6). Otherwise, Program decision-making lies with the Governance Committee, which is made up of Signatory and non-Signatory members. The organizational structure for making decisions and carrying out activities related to the Program is illustrated in the Organizational Structures Document (Attachment 6) and reproduced as Figure 3 in this plan. The following is a general description of the responsibilities and relationship of each component related to this plan.

I.C.1. Policy Functions

The Governance Committee will annually (or more often at their discretion) 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 Program Document and its attachments (e.g., Milestones Document, Land Plan, and Water Plan). The Governance Committee evaluations will:

1) Assess whether the Program activities and criteria being examined are working as originally envisioned;
2) Except as noted in Section III.B.1 of the Program Document, modify the Program based on new information;
3) Determine whether there are other or better uses for the resources committed to the activity and criteria;
4) Considering available information including any reviews from advisory groups, 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 adaptive management.

As part of the evaluation process, the Governance Committee will review information including, but not limited to, experimental results, costs, progress reports, and other AMP products. Opinions of an Independent Scientific Advisory Committee (ISAC), and peer reviewers if any, should be compiled and summarized as part of the evaluation process. The Governance Committee may approve changes to planned management activities and criteria and/or have its changes and implementation schedule peer reviewed under the Peer Review Guidelines (Appendix A) prior to implementation.

I.C.2. Roles and Responsibilities

I.C.2.a. Governance Committee

The Governance Committee makes policy decisions to implement the Program, and will make all decisions related to adaptive management, unless expressly delegated to the Program's Executive Director (ED), including changes to budgets and Program activities and criteria. As a part of its annual review of Program implementation and accomplishments, the Governance Committee will approve budgets and work schedules for staff necessary for implementation of the plan for the subsequent year or other defined budgetary cycles.

I.C.2.b. Executive Director

The ED carries out Program activities at the direction of the Governance Committee. The ED will provide staff support, coordinate activities with the Governance Committee's advisory committees, make recommendations on budget and schedule necessary to implement activities under this Plan, and provide a review of the implementation of the Plan. The ED will direct and supervise a staff capable of implementing the Program. The ED will also coordinate adaptive management activities with cooperators and provide oversight of contracts and contractors. The ED will provide the Governance Committee with a review and status of Program tasks and will make recommendations to the Governance Committee on adaptive management decisions.

The ED will be expected to work in close cooperation with the advisory committees and the Environmental Account (EA) Manager so that any recommendations being brought forward to the Governance Committee reflect the views of all those involved in the adaptive management program and that majority and all views are presented clearly and fairly. If necessary, and with Governance Committee approval, the ED may establish an ad hoc committee, including the ED, to work through Program activities that overlap between the advisory committees and the EA Manager.

To ensure that the scientific component of the AMP is effectively implemented, the ED's responsibilities include but are not limited to:

1) Synthesizing the scientific aspects of Program management through consultation and cooperation with the advisory committees, the EA Manager, and contractors,
2) Providing recommendations to the Governance Committee in consultation and cooperation with the ISAC, other advisory committees, and the EA Manager on matters including:
    a. Schedules and priorities for implementing projects to test existing and new hypotheses,
    b. Scopes of work for management, research and monitoring activities, including a recommendation on whether the work is done by staff, cooperators, and/or contractors,
    c. Technical review of proposals to do contract research and monitoring, and
    d. Modifying existing and developing new management plans for Program land and water necessary to implement the AMP.

3) Reporting on all land acquisition and management decisions with regard to how they relate to costs, the relative benefit to the target species, and contribution toward fulfilling the Program's objectives, including recommendations, if any, from the Land Advisory Committee (LAC), and
4) Conducting meetings and workshops with the advisory committees and the Governance Committee periodically to provide opportunities for detailed review of the implementation of the AMP.

The ED and staff will conduct a minimum of one workshop per year with the Governance Committee and advisory committees.

I.C.3. Advisory Functions
The ED will be providing information related to the AMP to, and assist in, communication between the Governance Committee, Land, Water, Technical Advisory Committees (LAC, WAC, and TAC, respectively) and the ISAC. The advisory committees will perform the duties described in committee charters contained in the Organizational Structures Document (Program Attachment 6).

The advisory committees will be formed by the Governance Committee in accordance with the processes included in their respective charters. The committees will provide advice on implementation of the Land Plan (LAC), Water Plan (WAC), and scientific aspects of the Program, including implementation of the AMP (TAC, WAC, LAC and ISAC).

I.C.3.a. Stakeholder Advisory Committees
The Land, Water, and Technical Advisory Committees are generally made up of representatives of stakeholder groups participating in the Program. These committees are expected to participate with the ED in the synthesis of the information and recommendations to be presented to the Governance Committee and ISAC.

I.C.3.b. Independent Scientific Advisory Committee
The purpose of the ISAC is to insure scientific integrity and quality in the Program by providing the Governance Committee with independent reviews of the Program's processes and products. The ISAC will provide independent scientific advice to the Governance Committee through the ED on scientific issues, including adaptive management, during the First Increment of the Program, according to their charter in Program Attachment 6, Appendix I. The ISAC will be composed of approximately five independent scientists knowledgeable in technical areas critical to the implementation of the AMP. The tasks to be completed by ISAC will be defined in a scope of work.

I.C.3.c. Environmental Account Manager
The FWS has been charged with the management of the Nebraska EA through an employee, the EA Manager. Each year an EA Annual Operating Plan (AOP) will be developed as described in the Water Plan (Attachment 5; Section 1). Most management actions and adaptive management experiments to test hypotheses will depend on the EA Manager being an integral part of the advisory process. Generally, water release decisions will be made within the overall management framework established by the AMP. Managers of other Program water will

coordinate their water projects through the ED and EA Manager, as appropriate, to facilitate monitoring and research.

I.D. National Academies of Science Review

At the request of the Cooperative Agreement Governance Committee, the DOI funded an 18-month review by the National Academies of Sciences (NAS) National Research Council (NRC) of the science related to the target species use of the Platte River, the FWS criteria for suitable habitat and target river flows, and the science related to the geomorphology of the river. The findings and recommendations of the NRC independent peer review (NRC 2005) were considered in the development of this plan and will be one of many sources of information considered in the implementation of adaptive management.

Overall, most recommendations related to monitoring and research contained in the NRC review were already in, or have been, incorporated into the Program's monitoring and research. For example, the NRC recommended that issues regarding other species of concern be considered in the Platte River area. The monitoring and research effort was modified to include additional effort for monitoring other species (i.e., species in addition to the target species). Additional funds and efforts have also been added to the monitoring and research budget to monitor water quality on Program lands.

While most items identified by the NRC are addressed, there remain a few items that the NRC identified as important considerations that have not been incorporated directly in to the AMP. These issues include:

1) Monitoring throughout geographic area of the target species' range using radio telemetry or banding,
2) Contribution of contaminants to current rate of least tern and piping plover mortality,
3) Monitoring of direct human influence (e.g., harvest of wild fish) for pallid sturgeon,
4) Determine the role of the Platte River in recovery of the pallid sturgeon, and
5) Impacts of long-term climatic influences.

While the Governance Committee and others may agree that these items are important aspects related to the target species, they have not been included in the Program because they were outside the scope of the Program, budgetary priorities, policy decisions, addressed by other groups, and other reasons. The Governance Committee may choose to participate with other groups on these issues in the future. Although, with respect to item 5, the Program will monitor year to year changes in weather, as these are important covariates in determining year-to-year fluctuations in monitoring and research results.

I.E. Scale of Platte River Adaptive Management

While the Program is designed to provide ESA compliance for existing and certain new water related activities throughout the Platte River basin upstream of the Loup River confluence, the land acquisition and management for the target bird species will occur in the central Platte River region (Lexington to Chapman, Nebraska), and Program water activities would be designed to provide benefits for the target bird species in the central Platte River region with subsequent benefits to the pallid sturgeon in the lower Platte River region (below the confluence with the

Elkhorn River). These areas are generally known as the "associated habitats" and comprise the study area for the AMP.

Adaptive management may occur at multiple scales during the Program:

- System Scale: System scale adaptive management evaluates the effects of Program management actions on the target species and associated habitats (as defined in the Program Document) throughout the entire study area. For example, the management of Program land may impact the way whooping cranes use both Program and non-Program lands.
- Program Lands: Program lands (or simply Program) scale adaptive management evaluates the effects of Program management actions on lands acquired by the Program (i.e., the entire parcel in which several management actions may be occurring), and management of non-Program lands as appropriate and when permitted by the landowner. For example, multiple management practices will occur on some Program lands designed to achieve a specific outcome for the entire parcel (e.g. the development of a habitat complex).
- Project Scale: Project scale adaptive management evaluates the effects of individual Program land management activities and water management projects. For example, the effect of a specific land management activity such as forest removal will be evaluated.

These scales will often be "nested" such that several individual project scale evaluations may be needed or combined into Program lands or System Scale evaluations, as appropriate. Additional detail will be provided for each of the scales through the development of management hypotheses.

I.F. Process for Modifying the Adaptive Management Plan

I.F.1 Process for Developing Work Plans

Annual and 5-year work plans will be developed for implementing the AMP. For Program Year 1, the following table identifies the road map to be followed in developing the first work plans.

Tasks	Responsible Party	Timeline	Comments
2007 Annual Work Plan - AMWG meeting to identify the components, identify scope of the annual work plan, define the products, better define what the work plan and experimental design will entail	AMWG	Nov-06	This will guide the 2007 work plan development
AMWG meeting to integrate the baseline monitoring with the IMRP	AMWG	Dec-06	This would guide interim baseline monitoring needs for early in the Program
Identify basic baseline monitoring needs for 2007	AMWG	2007	Examples of baseline monitoring needs include: Lidar, species use, and vegetation/geomorphology.

Tasks	Responsible Party	Timeline	Comments
Develop broad experimental design recommendations to GC from AMWG (what management actions are recommended to test priority hypotheses, what is timeline, where to implement management actions?)	AMWG, TAC, LAC, WAC, ED	Through December 2007	This will be one voice among many influencing which management actions the GC decides to implement
In parallel, work on 5-year workplan	AMWG	Through December 2008	Work plan tiers from the AMP
In parallel, conduct analysis and get outside expertise to help address work plan and experimental design feasibility issues	AMWG guides, others participate	Through December 2008	Potential need for outside expert assistance

I.F.2 Process for modifying the AMP during the First Increment of the Program

The AMP will be changed through a collaborative process led by the ED using an ad hoc committee of representatives of the LAC, WAC, and TAC. The process will also include review input from the ISAC and other peer reviewers as appropriate. The process will be based on the products resulting from the implementation of the Program's operating and implementation plans. The work plans will be developed by the ED, using the AMP as a strategic planning template. Budgets will be updated annually, reflecting the accumulating evidence for priority hypotheses, and making or modifying the plans for the subsequent year or years.

The steps involved in changing the AMP will likely include:

1. The ED will compile reports summarizing the previous field seasons of management, monitoring and research. This process will be completed on a different schedule for each project; although, it will typically occur in the fall and early winter of each year.
2. The ED will provide the AMP and reports summarizing the previous field seasons of management, monitoring and research to the LAC, WAC, TAC, and the ISAC for review in preparation of a workshop to be held annually. The workshop will typically be held mid-winter.
3. The ED will convene the workshop to facilitate changes in the AMP. The ad hoc committee attending the workshop will include representatives of the LAC, WAC, TAC, and the ISAC. The purposes of the workshops include:
   a. Developing modifications to CEMs based on new knowledge.
   b. Any member of the ad hoc committee or advisory committees may add to or modify the list of hypotheses expressing his or her scientific view.
   c. Reevaluate the remaining and new hypotheses to determine the priority hypotheses that will be recommended to the Governance Committee to be carried forward in the revised AMP.
   d. Reevaluate management objectives, management actions, indicators to address hypotheses related to management, and identify modifications that will be recommended to the Governance Committee.

   e. Reevaluate the monitoring and research identified in the IMRP portion of the AMP to determine if the proposed new or modified priority hypotheses are addressed by the existing protocols (Table 1).
   f. Reevaluate the sequencing of implementing tests of priority hypotheses.
   g. Develop recommended modifications of the list of protocols to insure that all priority hypotheses (including proposed changes) are addressed and eliminate unnecessary protocols and reallocate budgets.
4. Incorporate workshop products into the revised draft AMP and circulate to the Governance Committee at least two weeks in advance of an annual workshop to be held with the Governance Committee and advisory committees.
5. Based on the outcome of the workshop with the Governance Committee, the ED's office will revise and finalize the AMP for approval by the Governance Committee. Such approval would include budgets necessary to implement the AMP for the following 12 month period.
6. The ED will modify the Program AOP to reflect changes in the AMP
7. The Governance Committee will review the proposed AMP and AOP and will direct the ED to implement the work plans as approved for the upcoming field season. This approval will occur at the first regularly scheduled Governance Committee Meeting following the completion of the AMP and AOP.

II. POLICIES AND PRACTICAL CONSIDERATIONS

Adaptive management in the Program will be conducted within the limitations and constraints presented by policy, budget, federal and state laws and regulations, including state water law and interstate compacts and decrees, and the necessary elements of a scientific program.

II.A. Policy Considerations

In investigating any approach to maintaining and improving habitat for the target species, proposed actions must be feasible within the limitations of the resources available to the Program in the First Increment. This includes the quantity of water provided by the Environmental Account and other sources of Program water, 10,000 acres of habitat from those available under the willing seller/buyer concept, and budgets established for habitat restoration and monitoring, research and adaptive management activities. Thus, any decisions regarding tests of management activities must be conducted within the Program resources. In addition to these fundamental constraints on the Program, the following additional constraints have been identified from the Program Document, Program Attachments, and Governance Committee direction.

1. Care should be taken in considering management actions that preclude all other future management options.
2. All actions should be consistent with the Program's "Good Neighbor Policy".
3. All lands and water will be acquired from willing sellers or lessors.
4. Each approach will acknowledge system constraints, including storage capacity and water rights.

5. All land acquisition and management decisions will take into account the costs, the relative benefit to the target species, and contribution toward fulfilling the Program's objectives.
6. Program lands include Nebraska Public Power District's (NPPD) Cottonwood Ranch (2,650 acres), lands acquired by the State of Wyoming (470 acres), any lands acquired in the associated habitats by the National Fish and Wildlife Foundation using funds contributed prior to the Program as a result of ESA consultations, and other lands available to the Program as determined by the Governance Committee.
7. Management of Program water will not cause flows above the flood stage as defined by the National Weather Service.
8. The AMP does not preclude management or regulatory responsibilities of individual parties involved in the Program.

II.B. Considerations for and Elements of a Comprehensive Scientific Program

Successful application of adaptive management requires the best scientific foundation possible. Experiences from other restoration programs provide good lessons that can be applied in the context of the Program. A solid scientific foundation typically consists of a blend of monitoring (e.g., baseline data and long-term trend detection), experimental research (e.g., to determine cause-and-effect relationships), simulation modeling (e.g., to provide a tool to design experiments and test scientific understanding), and independent peer review.

With respect to monitoring and research, it is important to note that good experimental design generally includes 1) random allocation of treatments (including controls) to experimental units, and 2) replication of treatments across multiple experimental units. Ideally, all potential confounding variables are controlled directly through the design (e.g., held constant except the one under investigation), adjusted for in the statistical analysis, or removed through randomization. In general, scientific experiments can be conducted in the field, at a small scale in a model of field conditions (mesocosm), and in the laboratory (microcosm). All three approaches have inherent strengths and weaknesses which can be summarized as follows: field – most realism, but least experimental control; microcosm – least realism, but most experimental control; and mesocosm – intermediate to the other two. All three approaches may be used to test hypotheses during the Program as dictated by hypotheses and best available science.

The following should be considered when developing and implementing adaptive management actions and investigations:

1. Program treatments (land acquisitions and water deliveries) will not be applied in a random manner or with replication, so an experimental approach at the System and Program scale utilizing controls and replications will not be possible. Manipulative experiments at the project level (e.g., mesocosm and microcosm) that take advantage of experimental design features, such as randomization and controls within specific project areas, will be possible.
2. Because of the difficulties in applying an experimental approach at the system and Program scale, observational data collection for monitoring purposes may be the predominantly "field-scale" approach. However, opportunities will be sought to implement manipulative studies particularly with the management of Program lands

to test hypotheses. In addition, certain approaches to observational studies (e.g., use versus availability analysis of species habitat preference) may increase the utility of these observational data.

3. Relatively modest management treatments (water during certain periods) will reduce the power of field-scale experiments to detect an effect of the Program over the entire area of interest. Nevertheless, manipulative experiments at the field, meso, and microcosm scale may allow relatively powerful experiments that can detect treatment effects and patterns, and aid in the overall assessment of the Program's effects during and at the end of the First Increment. Also, the design of Program monitoring will take advantage of likely natural events such as large natural pulse flows and similar management of non-Program lands.
4. Large portions of the study area are currently under various types of physical management (e.g., tree clearing, disking, etc.). At the system level, this may provide more opportunity to learn species response and response of habitat features to different management measures, but it will also reduce the Program's ability to separate Program effects from other activities. At the project scale this form of system noise can be minimized and accounted for in the research design.
5. Study designs should allow a before/after analysis to determine biological response to Program management, yet limited quantitative pre-Program data exist. While there is a paucity of pre-Program data, there may be opportunity to develop pre-project data for small scale project studies. In addition, the combination of these smaller scale studies using optimum designs with the Program level correlation and trend analysis will allow a more powerful approach to determine the effect of the Program on target species and their habitat.
6. Because the river is a continuum, flows and management actions can not be confined to certain sections and management actions in one section may have effects on other sections. Such lack of independence between sites will need to be considered in experimental design and analysis.

These considerations and others (e.g., time lag) will be integrated as much as practical into experimental designs for testing hypotheses at various spatial scales, drawing together three elements: the CEMs and hypotheses in Section III below; the management objectives, indicators, and management actions in Section IV below; and the monitoring, research, analytical methods in the IMRP (Section V below).

III. CONCEPTUAL ECOLOGICAL MODELS AND HYPOTHESES

This section focuses on Conceptual Ecological Models (CEM) and hypotheses. These CEMs are broad general conjectures about how the Platte River system functions and are to be distinguished from the numerous other "models" associated with the Platte River, including computer models, statistical models, biological models, physical models, etc., which may be used as tools in evaluations under this plan and/or means to develop management predictions. These models will be tested and likely revised using information developed under this Plan. Brief descriptions of these other models are found in Appendix B. Hypotheses are outgrowths of the CEMs and are more specific and quantifiable conjectures about how the Platte River system functions and how the system may respond to Program management actions. A hypothesis may be tested by making predictions based on the hypothesis, designing a study, conducting the study and comparing the predictions against the resulting data and conclusions.

III.A. Conceptual Ecological Models

CEMs provide a visual framework or graphical representation for the current or hypothesized understanding of the central and lower Platte River associated habitats relative to target species, including the underlying hypotheses on how the driving forces, relationships, and processes impact the valued ecosystem components. CEMs are also used to identify competing hypotheses and research questions to be addressed by management, monitoring and research. During the First Increment, CEMs will be reviewed and evaluated, as information becomes available, and new questions, models and hypotheses will be formulated that may be used to modify management actions and monitoring and research.

By the very nature of adaptive management, CEMs will be reviewed on a regular basis and modified as warranted based upon findings within the adaptive management implementation. The Governance Committee will have final approval of the AMP, and thus the CEMs.

III.B. Hypotheses

For the Program, hypotheses deal with system processes (e.g., the role of sediment in channel morphology), system ecology (e.g., the way target species use the central Platte), and the response of target species and their habitat to Program management. CEMs were used by the AM Working Group to develop hypotheses and to identify areas of uncertainty and disagreement (i.e., competing hypotheses). The competing hypotheses regarding how the system "works" and what functions or effects various management practices are proposed to achieve are illustrated in the CEMs or they are easily derived from the CEMs as the alternate to the stated hypothesis.

During the July 1997 Cooperative Agreement, summary hypotheses were developed by the AM Working Group and are included in the tables below. Besides these hypotheses, the AM Working Group, Governance Committee, and other individuals have identified many other hypotheses that have not been prioritized or completely drafted and reviewed. This larger list of hypotheses is contained in Appendix C.

III.C. Conceptual Ecological Models and Broad Hypotheses

The AM Working Group created an overall conceptual model of the Platte River system (Figure 4). In developing the current system CEM, broad hypotheses were also developed and are included in the following table.

System Hypotheses
S-1: A combination of flow management, sediment management, and land management (i.e., Clear/Level/Pulse) will/will not generate detectable changes in the channel morphology of the Platte River on Program lands, and/or habitats for whooping crane, least tern, piping plover, pallid sturgeon and other species of concern.
S-2: A combination of non-managed flows, sediment management and land management (i.e., Clear/Level/Mechanical Maintenance) will/will not generate detectable changes in the channel morphology of the Platte River, and/or habitats for whooping crane, least tern, piping plover, pallid sturgeon and other species of concern.

System Hypotheses
S-3: Program management actions will/will not have a detectable effect on target species use of the associated habitats.
S-4: Program management actions will/will not be of sufficient scale and magnitude to cause detectable system wide changes in channel morphology and/or habitats for the target species.

The AM Working Group also developed CEM's for each of the target species (whooping crane, least tern and piping plover, and pallid sturgeon) and for the physical processes and wet meadows in the central Platte River. The following sections include each of the CEM's as well as the hypotheses, as developed at AM Working Group meetings, associated with various linkages in the CEM's as denoted by a numbered arrow.

III.C.1. Whooping Crane (WC) CEM

The draft CEM for whooping cranes (Figure 5) was developed using the process generally described above in Section III.A. Hypothesis corresponding to linkages in the CEM are found in the table below.

Whooping Crane Hypotheses
WC-1: Whooping cranes that use the central Platte River study area during migration seasons prefer habitat complexes and use will increase proportionately to an increase in habitat complexes. Characteristics of a Program habitat complex are defined in the Land Plan Table 1.
WC-2: Whooping cranes prefer palustrine wetlands to river channel, based on known migratory stopover habitats. Whooping crane use of the central Platte River study area during migration seasons will increase proportionately to an increase in palustine wetlands.
WC-3: Whooping cranes do forage in wet meadows and agriculture fields proportionate to their availability.
WC-4: In the central Platte River study area, whooping cranes prefer conditions created by species target flows and annual pulse flows.

III.C.2. Least Tern and Piping Plover (TP) CEM

The draft CEM for least terns and piping plovers (Figure 6) was developed using the process generally described above in Section III.A. Hypotheses corresponding to linkages in the CEM are found in the table below.

Least Tern and Piping Plover Hypotheses
TP-1: In the central Platte River study area, terns and plovers prefer/do not prefer riverine habitats as described in Land Plan Table 1 and use will/will not increase proportionately to an increase in habitat complexes.
TP-2: The maintenance of tern and plover populations in the central Platte requires/does not require that sandpits and river continue to function together to provide nesting and foraging habitat.
TP-3: Ephemeral nesting areas in the river are/are not needed for long-term nesting success of tern and plover.

Least Tern and Piping Plover Hypotheses
TP-4: Existing river flows influenced by drought, floods, hydrocycling, etc., do/do not provide a sufficient forage base (invertebrate/fish recruitment, survival, and correct composition) throughout the central Platte River study reach for populations of terns and plovers during the nesting season.

III.C.3. Pallid Sturgeon (PS) CEM

The draft CEM for pallid sturgeon (Figure 7) was developed using the process generally described above in Section III.A. Hypothesis corresponding to linkages in the CEM are found in the table below.

Pallid Sturgeon Hypotheses
PS-1: Current habitat in the lower Platte River is/is not suitable for adult and juvenile pallid sturgeon.
PS-2: Water related activities above the Loup River do/do not impact pallid sturgeon habitat.
PS-3: Non-Program actions (e.g., harvest, stocking, Missouri River conditions) determine the occurrence of pallid sturgeon the lower Platte River

III.C.4. Physical Process (PP) CEM

Draft CEMs and corresponding hypotheses regarding the overall physical processes of the Platte River, including wet meadows, are discussed in the following table and illustrated in Figures 8, 9, and 10. The CEMs were developed using the technical subgroup as described above in Section III.A.

Physical Processes Hypotheses Flow-Sediment-Mechanical Approach
PP-1: Flows of varying magnitude, duration, frequency and rate of change affect the morphology and habitat quality of the river, including: • Flows of 5,000 to 8,000 cfs magnitude in the habitat reach for a duration of three days at Overton on an annual or near-annual basis will build sand bars to an elevation suitable for least tern and piping plover habitat; • Flows of 5,000 to 8,000 cfs magnitude in the habitat reach for a duration of three days at Overston on an annual or near-annual basis will increase the average width of the vegetation-free channel; • Variations in flows of lesser magnitude will positively or negatively affect the sand bar habitat benefits for least terns and piping plovers.

Physical Processes Hypotheses Flow-Sediment-Mechanical Approach
PP-2: Between Lexington and Chapman, eliminating the sediment imbalance of approximately 400,000 tons annually in eroding reaches will: • Reduce net erosion of the river bed; • Increase the sustainability of a braided river; • Contribute to channel widening; • Shift the river over time to a relatively stable condition, in contrast to present conditions where reaches vary longitudinally between degrading, aggrading, and stable conditions; and • Reduce the potential for degradation in the north channel of Jeffrey Island resulting from headcuts.
PP-3: Designed mechanical alterations of the channel at select locations can accelerate changes towards braided channel conditions and desired river habitat using techniques including: • Mechanically cutting the banks and islands to widen the channel to a width sustainable by program flows at that site, and distributing the material in the channel; • At specific locations, narrowing the river corridor and increasing stream power by consolidating over 90 percent of river flow into one channel will accelerate the plan form change from anastomosed to braided, promoting wider channels and more sand bars. • Clearing vegetation from banks and islands will help to increase the width-to-depth ration of the river
PP-4: Higher water surface elevations resulting from raised river bed elevations can generate measurable increases in the elevation, extent, frequency and/or duration of growing-season high water tables in wet meadows within 3,000 feet of the river.

III.C.5. Priority Hypotheses and Looking Outward Matrix

An initial list of priority hypotheses to be tested was developed by the AM Working. Also, as the Program progresses, additional hypotheses are likely to be added or modifications made to the existing hypotheses using the process described in I.F.2 above.

Hypotheses are numerous and diverse and it is understood and agreed that not all hypotheses can or will be addressed or investigated due to time constraints (certain responses to management actions will take longer than the First Increment), physical limitations (only have so much water and land), cost constraints beyond the scope and/or available resources of the Program, or because they conflict with agreed upon policies. Therefore, hypotheses will be evaluated and prioritized with the following guidelines (the numbering system used in the guidelines does not reflect level of importance between different criteria).

Technical Guidelines (applied by ED, ISAC, and advisory committees):

1. Is there a scientific basis for the hypothesis based on existing data, information, and reviews?
2. Is there a critical interdependency with a high priority hypothesis?
3. Will testing the hypothesis limit the opportunities to test other high priority hypotheses?
4. Is the hypothesis on a critical path to achieve Program goals and objectives – nice to know versus need to know?

5. Is testing the hypothesis cost effective (dollars, other resources) and/or technically feasible?
6. Is the hypothesis on a critical path to assist in developing future Program goals and objectives?
7. Is the hypothesis critical to testing one of the two primary Strategies?
8. If the hypothesis is addressed, will it influence Program management?
9. Can Program actions be used to test the hypothesis or can research be conducted (can it be measured) to investigate the issue/action/hypothesis?
10. Does the hypothesis address areas of disagreement?

Policy Guidelines (applied by the Governance Committee):

1. Is the proposed hypothesis testing within Program constraints (Program goals and objectives, legal, compact, decrees, etc.)?
2. Is funding available and appropriate?
3. Are there other factors influencing hypothesis testing?

The AM Working Group initially discussed prioritizing all current hypotheses using the guidelines above and relating them to the CEMs, but decided that time constraints did not allow for this. Therefore, the group drafted broad hypotheses for the CEM's and included current links on the CEMs. As currently stated, many of the hypotheses are not testable, but they convey the general concepts and ideas regarding the topic(s). Further development, refinement, and prioritization will be needed for hypotheses and relationship clearly identified in the CEMs. This work will continue into the First Increment.

The AM Working Group took the initial step in the development of priority hypotheses by describing broad relationships among functional components of each CEM. These broad hypotheses were further refined by the development of specific hypotheses based on the relationship among functional components of the system as illustrated in x-y graphs (Appendix D). The x-y graphs illustrate the key relationships upon which hypotheses are based. For example, graphs S1 in Appendix D illustrates the three different hypothesized relationships between habitat for target bird species and competing approaches to channel management. In this example it is hypothesized that mechanical/sediment/flow management (i.e. clear/level/pulse) will result in improved habitat for the target bird species, that mechanical means combined with non-Program managed flows will have an equivalent habitat response, and that neither approach will have a measurable impact on habitat (the null hypothesis). The hypotheses illustrated in the x-y graphs were then placed into a matrix that illustrates the interaction of the major components of the physical environment, system inputs and valued ecosystem components. Hypotheses were placed into eight categories including system, pallid sturgeon, tern and plover, whooping crane, pallid sturgeon, flow, sediment, mechanical, and wet meadow (Appendix E). Each matrix contains detailed information the AM Working Group considered important for evaluating the relative need for testing of each hypothesis and the Working Group's recommended priority for each hypothesis. The rational for the recommended priority is also included. The high priority hypotheses identified through this effort are included in Table 2. It is notable that an important hypothesis may receive a lower priority because other hypotheses must be completed before a test is possible.

IV. MANAGEMENT OBJECTIVES, INDICATORS, AND PROPOSED MANAGEMENT ACTIONS FOR PROGRAM LANDS

This section provides initial management objectives, indicators (performance measures), and initially proposed management actions to be evaluated through adaptive management during the First Increment, which were derived from the priority hypotheses (Table 2). The AM Working Group recommends that the priority hypotheses, initial management objectives, and management actions be the basis for an initial work plan for the Program. These will be further developed and additional management objectives, indicators (performance measures), and proposed management actions will be added as necessary during the First Increment to test refined hypotheses and hypotheses yet to be proposed. Management actions will be implemented within the framework of the IMRP such that adequate study design and analysis methods (e.g. baseline) are incorporated. During Program First Increment, additional management objectives, indicators, and proposed management actions will likely be developed through the process of refining CEMs and identifying priority hypotheses.

The Program will initially attempt to achieve the following management strategies with the Governance Committee making a decision at the end of each step (Figure 11):

1. Begin with efforts at a sufficient scale to test concepts, to generate anticipated effects large enough to measure, but at a scale unlikely to cause undesirable impacts to third parties.

2. Monitor the effects of actions on key indicators of resource management objectives, and on indicators of undesirable consequences.

3. Determine if the same management action should be scaled up, or if the management action should be modified or abandoned.

4. Assuming management actions are resulting in desired outcomes, and as safety and efficacy of actions are established, increase scale to accomplish key management objectives (e.g., objectives included in Section IV.A.) by the end of the Program First Increment.

The following sections provide descriptions of initial proposed management objectives, indicators, and management actions, as proposed by one or more parties. Management objectives are broad descriptions of what the Program is trying to achieve. Additional site specific management actions, indicators and objectives will be created and refined through the CEM development process and included as a part of management plans for individual project or Program land parcels prior to the initiation of management on Program lands.

In this plan there are instances where management objectives, action, indicators, and hypotheses are implicitly accepted or explicitly stated as “true” or “false”. For example, some descriptions make use of terms or phrases that imply knowledge of changed conditions (e.g., such as rehabilitate or restore), knowledge of current conditions (e.g., sediment imbalance of a stated amount), or use of particular terminology. It is understood that the use of such terms or phrases does not imply acceptance by all parties of the underlying hypotheses or agreement on definitions of all technical terminology.

IV.A. Management Objectives and Indicators

Management objectives are a means to evaluate effectiveness of different Program actions within an adaptive management framework. Management objectives represent the desired outcome of one or a combination of management actions expressed in quantitative and measurable terms. Management objectives are not synonymous with Program Objectives (see Section I.B above). Management objectives relate to management actions and provide the linkage between the purpose of management and the Program Goals and Objectives. Indicators are measurable parameters within the objectives that will be used to gauge the ability of the management actions to meet the management objectives, and ultimately the Program Goals and Objectives. More work is required on the specific management objectives and indicators in Section IV, which will be accomplished through the process described in Section I.F. above.

The following is a preliminary list of overall management objectives for the First Increment of the Program. These objectives were develoloped by the AM Work Group.

1) Improve production of Least Tern and Piping Plover from the central Platte River

- a) Increase number of fledged tern and plover chicks
  - i) Increase nesting pairs (indicator is nesting pairs)
  - ii) Increase fledge ratios (indicator is chicks successfully produced per unit adult, nest or pair) and reduce chick mortality from causes such as flooding, predation, weather, inadequate forage.
- b) Reduce adult mortality
  - i) Reduce predation (indicator is nesting pairs)

2) Improve survival of Whooping Cranes during migration

- a) Increase availability of whooping crane migration habitat along the central Platte River (indicators are the area of suitable roosting habitat, area of suitable foraging habitat, proportion of population, crane use days, etc.).

3) Avoid adverse impacts from Program actions on Pallid Sturgeon populations

- a) Indicators have not been identified as more research is needed to determine what potential indicators the Program may affect.

4) Within overall objectives 1-3, provide benefits to non-target listed species and non-listed species of concern and reduce the likelihood of future listing

- a) Increase availability of habitats for these species (Land Plan "other species of concern") along the central Platte River. Indicators are species occurrence, Land Plan Table 1 and 2 characteristics).

IV.B. Proposed Management Actions

The purpose of management actions is to achieve management objectives. There are two different "strategies" (a logical package of management actions) proposed to achieve management objectives. One strategy attempts to rehabilitate the Platte River towards a braided channel morphology as the underpinnings of restoring habitat for key management species (commonly referred to as "Clear/Level/Pulse"). The other strategy attempts to achieve similar management objectives by mechanical creation and maintenance of habitat for target species, which may or may not depend on the Platte River (although all actions will occur within the Platte River associated habitats). This strategy has commonly been referred to as the "clear/level/mechanical maintenance" or "clear/level/plow", although a better term may simply be "mechanical creation and maintenance" such that the clear/level portion is not hard-wired into the strategy. The Governance Committee has also committed to implementing management actions that are part of this strategy, and other groups outside of the Program will also be implementing management actions that could be considered part of this approach.

It is the intent of the Governance Committee to implement and test the management actions of these two strategies in parallel using the "stair-step" approach described in Figure 11. This parallel implementation is also consistent with the preferred means of implementing adaptive management experiments (i.e., active adaptive management).

The Governance Committee and others recognize the difficulties and potentially confounding responses from implementing both of these strategies simultaneously and the needed time to recognize changes on the various scales. Careful thought and planning in the management implementation and measurements for monitoring and research will be needed to eliminate these problems as much as possible and/or account for them in monitoring and research. The hypotheses referenced in this section are the CEM hypotheses included in the tables above.

IV.B.1. Flow-Sediment-Mechanical Approach

The Governance Committee agrees to pursue and test the concept of "clear-level-pulse" (Flow-Sediment-Mechanical Approach), with additional details related to the specific hypotheses to be tested and field tests to be developed. The following describes the objectives of the flow-sediment-mechanical pulse approach:

1. Create and maintain where possible a wide braided channel with a high width/depth ratio. The main channel width would be sized for sustainability, based on available bankfull flows (as augmented by the Program), and considering habitat and landscape characteristics. The desired braided plan form may require consolidation of the flow and river channels to maximize stream power and aided by removal of wooded banks and islands and addition of sediment.

2. Offset the existing sediment imbalance by increasing sediment inputs to the habitat area from one or more of the following sources:
    a. sand augmentation through mechanical actions- island and bank clearing and leveling,

b. sand augmentation from bank and island actions not directly related to bank cutting and island leveling (an example could be excavation associated with wetland development), or

c. reducing the imbalance through channel plan form changes, tributary delivery improvements, or flow routing changes.

3. Use the EA and other Program water to create annual peaks as large as can be sustained over many years, likely through the creation of annual, short-duration high flows within existing banks. Try to ensure that the spring peak flow is higher than any subsequent summer flow.

The focus of this concept is on several overall management objectives for Program lands including: 1) improvement of river channel areas on Program lands toward habitat complex characteristics described in Table 1 of the Land Plan (increased availability of areas of wide, shallow channel with unobstructed view and sandbars suitable for roosting and nesting); 2) maintain those improvements; and, 3) minimize or offset current river processes that tend to diminish channel areas on Program lands approximating Land Plan Table 1 characteristics. This approach would prioritize Program land acquisition upstream of Minden, Nebraska, with an objective of acquiring roughly 6,400 acres upstream of this location, and the remaining 2,800 acres downstream. By prioritizing upstream sites, overall Program habitat benefits could be maximized.

The over-arching hypothesis associated with the Flow-Sediment-Mechanical approach, as indicated by the physical processes CEMs in Section III, is that a combination of flow management, sediment management, and land management implemented concurrently will generate detectable changes in the channel morphology of the Platte River, and habitats for whooping crane, least tern, piping plover, pallid sturgeon and other species of concern. In turn, creating the habitat conditions described in Land Plan Table 1 will increase least tern and piping plover production from riverine habitats, and increase survival of migrating whooping cranes.

Species benefits may be gained by implementing one or two of the individual management actions of the Flow-Sediment-Mechanical approach, however more substantial benefits can be realized by applying these actions in tandem (e.g., when sediment is added to the river without mechanical actions, the habitat benefits may not be detectible within the First Increment of the Program; flow increases without sediment augmentation could result in negative effects). Meaningful tests of the Flow-Sediment-Mechanical approach will be compromised without implementing all three actions in concert. Following is a discussion of each of the three actions.

IV.B.1.a. Mechanical

Management Action: To increase the acreage of channel area greater than 750 feet wide by 30 percent over the 1998 baseline conditions for the study area, and restore channel habitat toward Land Plan Table 1 characteristics. The following methods and others where appropriate and effective will be used:

i. consolidate the flow and river channels to maximize stream power and help induce braided channel characteristics;

ii. mechanically cut banks and lower islands to a level that will be inundated by anticipated annual peak flows; and

iii. mechanically clear vegetation from islands and banks in the single channel as needed to aid the widening process and make sediment available for recruitment to the river.

Consolidating flows and widening the river at select locations by cutting banks and leveling islands can begin in Year 1 of the Program prior to increases in annual high flow, provided acceptable Program lands or Cooperator lands are available. Clearing vegetation and widening the river independent of consolidating flow should be concurrent with implementation of increases in annual high flows. Mechanical flow consolidating and river widening actions can occur independent of sediment augmentation, but greater increases in river width are expected at sites downstream of sand augmentation. The design and location of mechanical actions should be guided by available data, science, numerical modeling, and the availability of Program lands or cooperator lands. Where favorable conditions exist, mechanical actions may also be used to modify the topography, soils, and/or connectivity with the Platte channel on Program lands to support wet meadow conditions at these sites.

Potential Effects: The mechanical action of consolidating flows will help shift the river to a braided condition, which widens the river and creates more sand bars (CEM Physical Processes (PP) Hypothesis 3). Cutting banks and leveling islands in conjunction with pulse flows will widen the river (PP-3). Pulse flows are needed with both mechanical actions of consolidating flow and river widening to raise sand bars to an elevation suitable for least tern and piping plover nesting habitat (PP-1). Sediment augmentation is required in conjunction with increases in flows and contributes to wider sustainable channels, contributes to increases in occurrence of sand bars, restores stream bed elevation, and over time will promote the occurrence of a braided plan form in currently anastomosed reaches of the river (PP-2).

Creation of ephemeral sand bars (braided condition) with Land Plan Table 1 characteristics will increase least tern and piping plover production on riverine habitats and will reduce predation by shifting nesting locations from one year to the next and/or maintaining separation between nests and river banks (CEM Tern and Plover (TP) Hypotheses 1 and 3). Creating a wider, braided channel will reduce channel depths, and increase forage opportunities for least tern and piping plover chicks (TP-4) leading to improved growth and survival (TP-1). Increasing channel width, sand bars, and shallow water depths (braided condition) will increase roosting habitat for whooping cranes (CEM Whooping Crane (WC) Hypothesis 1), thereby increasing migration survival of whooping cranes.

Restoring stream bed elevation will increase water stage for a given flow, which will increase growing-season groundwater elevations in adjacent meadows, increasing the area/extent of wet meadow habitat. Increasing wet meadows during migrational times will increase migration survival of whooping crane.

IV.B.1.b. Sediment augmentation

Management Action: Sediment is mechanically placed into the river from banks, islands and out-of-bank areas at a rate that will eliminate the sediment deficiency and restore a balanced sediment budget within the expected future flow regime. Starting in Year 1 of the Program, choose one location on Program lands, or Cooperator lands above Overton, as this would focus sand augmentation in upstream locations which may also provide benefits for later restoration efforts downstream. River sand will be moved from approximately 20 acres and be pushed to locations and elevations where it can be mobilized by the river flow. Leveled areas would need to be lowered to the elevation that can be overtopped and scoured by a flow to prevent seedling survival. At the time of or prior to full implementation of the annual high flows in the water plan, sediment augmentation at one or more additional sites would be implemented with volumes of sand augmentation based on the estimated sediment deficiency. The rate of augmentation at each site should be guided by sediment transport rates and flows, and by monitoring at, upstream and downstream of the augmentation site. The location for these sites should be guided by the location of sediment deficiencies as determined by available data, and numerical modeling, and guided by the availability of Program lands or Cooperator lands. In addition to sand augmentation, alternative methods above will be investigated, such as channel plan form changes, improvement to tributary delivery or flow routing changes and then develop a master plan for sustaining a sediment balance over the long-term.

Potential Effects: Sand augmentation, combined with flows and mechanical actions, will have the same effects as described in Section IV.B.1.a.

IV.B.1.c. Flows

Management Action: Using the Environmental Account in Lake McConaughy and the Program's ability to deliver 5,000 cfs of Program water at Overton, as well as the flexibility in the CNPPID and NPPD canal and reservoir system operations (assuming mutually acceptable arrangement can be made for the use of that flexibility), short-duration near-bankfull flows will be generated in the habitat reach in the springtime or at other times outside of the main irrigation season. The intent is to achieve these flows, if possible, on an annual or near-annual basis.

Testing will begin in the first year of the Program with a pulse flow target of up to 5,000 cfs for three days at Overton. An "operational plan" for achieving this objective will be developed by the EA Committee or other committee, with close coordination with the ED, and implemented within the first year of the Program. This pulse flow will be monitored to test the logistics of coordinating pulse flow creation, to evaluate the effects on infrastructure, and to assess the fate and effect of the pulse as it moves to and through the habitat reach. Biologic and geomorphic monitoring and research efforts will be developed through coordination with the TAC. As the Program develops an increased ability to safely deliver pulse flow water over time, including the recovery of some lost conveyance capacity in the North Platte River at North Platte, flows of larger magnitude and/or modified durations will be generated, with increasing emphasis on achieving measurable improvements in channel morphology and habitat conditions, including increased sand bar height and reduced vegetation in the active channel.

Potential Effects: Flow modification, combined with sediment augmentation and mechanical actions, will have the same effects as described in Section IV.B.1.a. In addition, increasing flows in the central Platte River during the February-July time frame may improve habitat conditions for forage fish used by least terns (TP-4) and improve habitat conditions and help provide spawning cues for the pallid sturgeon in the lower Platte River, increasing their survival and reproduction (PS-2).

IV.B.2. Mechanical Creation and Maintenance Approach
The Governance Committee agrees to pursue and test the concept of using mechanical creation and maintenance ("clear-level-plow"), with additional details related to the specific hypotheses to be tested and field tests to be developed

The objectives of the mechanical creation and maintenance approach are:

1) Improve least tern and piping plover production by management of sandpits and riverine islands developed and maintained by mechanical and other means (e.g., herbicides, grazing, burning) without the need for pulse flows described in IV.B.1.c (TP-2 and TP-4).

2) Improve survival of whooping cranes by providing non-riverine wetlands, upland habitats, and open channel habitats similar to those described in IV.A.1 maintained with mechanical and other means without the need for pulse flows described in IV.B.1.c (WC-2).

IV.B.2.a. Sandpit Management
Management Action: To increase the amount of nesting habitat available to least terns and piping plovers the Program will acquire 200 acres of sandpits that will include at least 40 acres of bare sand. Each individual pit will have a water to bare sand ratio of 1:1 to 3:1 and bare sand areas will be islands or peninsulas with a base with half or less of the maximum width. The areas with nesting birds at time of acquisition will receive predator management that includes fencing and predator removal. Areas within these sandpits that are not being utilized by birds will be returned to bare sand peninsulas or islands, shoreline length will be maximize and predator management techniques applied.

An additional 200 acres of abandoned sandpit or habitat created by the Program which is similar in nature to sandpits will be acquired that will include at least 40 acres of bare sand. Each individual pit will have a water to bare sand ratio of 1:1 to 3:1 and bare sand areas will be islands or peninsulas with a base with half or less of the maximum width. Areas will be returned to bare sand to maximum shoreline length and predator management techniques applied.

Potential Effects: Predator management will increase least tern and piping plover fledge ratios (fledglings per adult, nest or pair). Sandpit land management will increase barren sand at suitable slope, elevation, shape, etc. to increase usable nesting area. If numbers of nesting pairs is currently limited by nesting substrate this will increase nesting pairs. Maximizing wetted area will increase plover foraging area. Diversified water depths in ponds will allow for a diverse fish assemblage to provide tern forage. Both activities would increase the number of nesting pairs if foraging habitat is limiting nesting pairs.

IV.B.2.b. Restore, Create and Maintain Bare Sand Riverine Islands and Channel Width
Management Action: Islands will be created using the same methods as in "clear-level-pulse" except for the EA augment pulses described in IV.B.1. Maintenance will require a mechanical maintenance emphasis on nesting island and surrounding channel area during low flow years.

Channels of 750 feet wide will be created and maintained using mechanical means similar to methods in the "clear-level-pulse" except for released pulses.

Predator management at known least tern and piping plover nesting colonies at constructed riverine islands will begin Year 1 of the Program.

Potential Effects: These management actions will increase barren sand on riverine islands for nesting area. If numbers of nesting pairs are currently limited by nesting substrate this will increase nesting pairs. If least terns and piping plovers prefer riverine islands for nesting over sandpits, there should be a shift in nesting off of sandpits to islands. If least terns and piping plover are more successful at reproduction on river islands, there should be greater fledge ratios over sandpits.

These management actions will also increase whooping crane roost habitat. Therefore increasing survival, based on the assumption that habitat along the Platte River limits whooping cranes survival.

IV.B.2.c. Create and Maintain Inundated Wetlands and Upland Areas

Management Action: Each 0.5 miles of linear wetland (sloughs, backwater) constructed on Program lands will include at least one area that has a shallow water area with a minimum water surface area of 500 feet by 500 feet. These areas will be designed such that they can be drained for vegetation management purposes. Where possible these wetlands will be filled by surface flow or pumping during whooping crane migration periods. These will not be necessary within the high banks when channel width already exceeds 750 feet.

The Cooperative Agreement whooping crane monitoring has resulted in many more hours of whooping crane use in corn fields compared to grasslands. Therefore, Program acquired agricultural fields not previously wetlands should be planted to corn. In addition the Program will explore enhancing the foraging value of these fields by flooding them utilizing existing irrigation equipment. One area 10 to 20 acres at least 200 yards from a road will be flooded during a spring and fall migration period to determine feasibility and cost.

All acquired properties will be evaluated for the presence of non-riverine wetlands that have been altered or filled and they will be restored to their original size.

The Program will utilize the remaining 400 acres of non-complex land to create 300 acres of palustrine wetland. These should have at least 25% of the area with a shallow water depth (approximately less than 10 inches) during whooping crane migration periods. Any upland areas acquired in the process of acquiring the desired wetland areas should have an easement attached limiting access during whooping crane migration time and the construction of permanent dwellings and animal confinement facilities and be resold or leased for other purposes such as farming, hunting or grazing at a rate that will repay the Program by the end of the first increment.

Potential Effects: Restored or created and maintained wetland areas will provide roosting and foraging areas for whooping cranes increasing survival, if habitat along the Platte River limits whooping cranes survival.

V. INTEGRATED MONITORING AND RESEARCH PLAN (IMRP)

To implement the 6-step process described in Figure 1b, the hypotheses developed in the assessment stage must be harmonized with the design of actions and associated monitoring in the design stage. The CEMs and priority hypotheses determine what is accomplished in the IMRP.

Ultimately, for each priority hypothesis, the AMP will articulate in the work plan (developed according to Section I.F1):

- what monitoring protocols will be used (Table 1);
- what management actions will be applied where and when to create spatial and temporal contrasts;
- what measurement precision of key indicators is attainable with the proposed protocols;
- what specific methods of data analysis will be used, and
- based on all of the above, what size of effects are desirable and detectable over what time period, with what levels of Type 1 and Type 2 error (e.g. concluding that a habitat feature benefits a species when in fact it does not, or concluding that a habitat feature doesn't benefit a species when in fact it does).

V.A. Introduction

As discussed above, effective adaptive management requires a thorough monitoring and research effort to collect vital knowledge for decision making. This section, Integrated Monitoring and Research Plan (IMRP) is designed to determine the biological response of the target species and their habitats to the actions throughout the entire study area, on Program lands, and in specific project management areas, during the First Increment of the Program through scientifically designed monitoring and research. The monitoring and research measures for the First Increment of the Program are composed of compliance monitoring and biological response monitoring and research (Figure 12). This section of the AMP focuses on the biological response monitoring and research for the Program. Information derived using the IMRP along with information from the FWS, state agencies, and others regarding the species biology, status, and recovery in the region, will be used to evaluate the Program's First Increment and overall species recovery assuming comparable methods and metrics are used in all areas. The Governance Committee will also use this information in the adaptive management of Program lands, Program activities, and the overall Program when developing Second Increment milestones.

Monitoring and research will be used to determine impacts on valued ecosystem components. Adaptive management decisions will be improved if statistically valid and meaningful monitoring and research data are gathered at the System, Program lands, and Project Scales during the First Increment. Monitoring activities will document trends in changes of parameters of interest in relation to measured variables (covariates) that have the potential to impact those trends. Research will necessarily be more limited in scope and scale but will provide an estimate of cause and effect relationships between management actions and outcomes. Monitoring and research information will be integrated to provide a weight of evidence supporting changes in management. It will not only support changes, it will help identify what changes are needed and provide information on the best means of modifying management actions. Information will be gathered throughout the First Increment and will be used to improve management during the First Increment and in decisions made at the end of the First Increment (e.g., increase or decrease in land or water).

V.B. Monitoring Versus Research, and How They Must be Integrated

Following development of the CEM's and hypotheses, monitoring and research approaches may be refined and changes may be made to protocol descriptions. Monitoring and research will be linked to CEM's and hypotheses. The current list of hypotheses and protocols are cross referenced in Table 1.

V.B.1. Monitoring

Program monitoring is designed to provide unbiased estimates of population and habitat parameters over space and time with high precision. Monitoring data will be used to estimate status (e.g. mean, median, minimum, and maximum) and trend in the entire study area, and in specific areas of interest within the study area (e.g., Program lands). In addition, both individual (gross) and net trends are of interest. A statistical survey design has been employed to meet these objectives. The design includes the establishment of survey panels, the revisit design (plan for the timing of survey of panels), the membership design (rule for sample units' membership in a panel), the definition of sample unit, and the enumeration of the sampling frame.

All monitoring and research will be conducted by following detailed and scientifically accepted protocols. Program staff, or contractors under the supervision of Program staff, will develop additional monitoring and research protocols as needed. All protocols will be subject to review by the Program's Technical Advisory Committee and approval by the Governance Committee. Monitoring studies are designed to address hypotheses by documenting trends in selected performance measures related to biological response with statistical inference possible to the appropriate study areas.

Monitoring is defined as the collection and analysis of repeated observations or measurements over a long period of time to document the status or trend in the parameters of interest. These data will be used to test hypotheses by assessing such relationships as whether there is a non-zero trend through time, or assessing whether or not there are spatial differences in indicators along gradients of flow/habitat conditions. The Program's monitoring is focused on estimating trends in species and habitat and therefore measures factors that directly relate to the condition/status of the species or its habitat. The monitoring portion of the IMRP is designed to detect statistically significant changes in measured parameters over time and document correlations between management activities, other random variables, and those changes.

The IMRP is designed to provide monitoring data that are unbiased for the region of interest (system, Program lands, or project specific area). Each portion of the monitoring program (e.g., species use, channel dynamics) will involve protocols and Standard Operating Procedures (SOP) detailing the methods of data collection. Protocols and SOPs should not be changed during the monitoring period unless the new approach to monitoring is clearly superior, can overlap with existing monitoring for a period of time, and the two methods are highly correlated.

The development of monitoring protocols will consider existing (i.e., pre-treatment) data and data collection methods to evaluate the costs and benefits of collecting data with the same methods and in the same locations during the Program. Where appropriate, existing protocols will be used or modified for use in the Program. Quantitative data that have been collected with similar methods and in the same study area will be analyzed with data collected under the IMRP when appropriate. The combined data could be used to conduct before-after-control-impact (BACI) studies when controls are available, before-after comparison when control areas are unavailable, to calculate an estimate of trend, or conduct resource selection function (RSF) analyses (see Section V.I).

The methods used for Program monitoring have been chosen to provide status and trend estimates of indicators of biological response. The monitoring is designed to collect data quickly and in a repeatable fashion (i.e., two people taking the measurement should get the same value). Monitoring data for documenting trends will be most useful after many years of consistent data collection. At a minimum, the monitoring portion of the plan must continue for the entire First Increment. The value of continuous monitoring data will only be realized if the IMRP has sustained political and financial support.

V.B.2. Research

Program research is designed to evaluate the merit of specific hypothesized cause and effect relationships (i.e., as developed through CEMs) among species and habitat associations and species and habitat response to Program management. Each research project will be hypothesis driven and will follow a specific protocol with defined objectives, a statistical survey design, and anticipated analysis methods to meet the objectives. When appropriate, monitoring data and management models will be used to predict the outcome of a specific management measure and the observed response will be evaluated against the predicted species and habitat response.

Research will include detailed studies (short-term, 3-5 years) of specific management actions, studies taking advantage of the limited opportunity for manipulative experiments, and studies that utilize habitat and species response to natural events combined with Program activities. Research projects typically use the latest technology and methods and have specific study objectives. Examples of these objectives include the tests of hypotheses, tests of habitat suitability models, and modeling of physical processes. Research objectives will typically be designed to resolve issues related to the potential impact of Program management activities on the indicators of biological response, assist in the understanding of the biology of the target species, fill knowledge gaps required to induce measurable improvements to the recovery of the target species and their habitats, assist in the validation and improvement of management methods, and/or allow the testing and improvement of existing species habitat models.

Models will be used for both monitoring and research projects. Statistically based models will use monitoring data to estimate trends in the indicators of biological response and predict future direction of trends. Other statistical models may be used in the data analysis to estimate effect sizes and correlations. Research data will also be used in the development of process models (e.g., models describing the process of sediment transport, island building, vegetation encroachment, etc), and calibration and verification of these models will use both research and monitoring data.

It is important that linkages are established between the different models, research studies and monitoring components. The linkage between monitoring and research is to some extent established by the basic study design. For example, Figure 13 illustrates the Cottonwood Ranch research related to management of a portion of the channel conducted by NPPD. The figure illustrates the anchor points used to locate monitoring activities and how they were incorporated into the research protocol. This kind of co-location of monitoring and research data collection will be a primary means of linking monitoring and research activities on all Program lands.

A more theoretical linkage between different activities related to monitoring, research and model building will be illustrated through the development of a 'Looking Outward Matrix' (template provided in Figure 14). A Looking Outward Matrix shows the information to be passed from one model/sub model/monitoring/research activity to another (i.e. specific variables, units, spatial and temporal scales. This is a useful tool for improving the integration of both modeling and monitoring activities. The Looking Outward Matrix will be developed during the First Increment.

Monitoring and research conducted under the IMRP will be integrated such that they will collect similar data where possible (e.g., "channel width" for monitoring projects will be measures the same as "channel width" for research projects). The spatial scale for monitoring will generally be broader with effort spread throughout the study area as opposed to research in specific areas such as Program lands, although, monitoring intensity can be increased on any area of interest.

Conducting both monitoring and research will hasten management improvement opportunities. Conducting only monitoring would result in a long time period requirement to collect enough data to justify modification of management actions. Only conducting research could result in not knowing whether actions are having system-wide improvements on variables that have a long response time. Therefore, it is essential to conduct both monitoring and research efforts.

V.C. Discussion of Scale Issues Related to Monitoring and Research

The general study area for monitoring and research for the three bird species consists of an area 3.5-miles either side of the Platte River centerline beginning at the junction of U.S. Highway 283 and Interstate 80 near Lexington, Nebraska, and extending eastward to Chapman, Nebraska. When side channels of the Platte River extend beyond the 3.5-mile area, a 2-mile area is included around these channels. For pallid sturgeon, the study area consists of the lower Platte River between its confluence with the Elkhorn River and its confluence with the Missouri River. This geographic limitation was established for primary data collection by the Governance Committee and is thought to include the area most likely used by the three bird target species when they are also using the Platte River. The selection of the lower Platte River for the pallid sturgeon is based on historical data contained in the Baseline Document. Obviously all four species occur outside this geographic area and the Program will incorporate information from other contemporary studies of these species from areas outside the general study area.

The design of the monitoring and research includes three spatial scales: System, Program Lands, and Project Scale (see also Section I.E.).

- System scale monitoring investigates the entire study area. The objective of this level of monitoring is to evaluate the effects of the Program on the target species' and their habitats throughout the associated habitats (see Program Document, Section I.A, for description). This will be done through analysis of correlations of species use, species abundance, use site characteristics and other variables (e.g., resource availability, changes in land use, river stage, etc.). Examples of system level monitoring include tracking trends in sediment budget, the abundance of sand bars and islands, the abundance of wet meadows, the abundance of whooping crane roosting sites and their physical and biotic characteristics throughout the study area, whooping crane monitoring, and least tern and piping plover monitoring. System scale monitoring allows the estimation of habitat selection (Manley et al. 2002) by target species, which is useful in the evaluating the effectiveness of the First Increment of the Program in meeting goals and objectives in the Program and evaluation of hypotheses related to species habitat needs. Little or no research can effectively be conducted at the system scale due to long time-lags, diversity of the overall system, etc. However, multiple smaller scale research experiments (Program lands scale or project scale) could be nested to research issues on the system scale.

- Program lands scale monitoring and research will investigate specific actions taken to implement the Land and Water Plans. The objective of Program lands scale research and monitoring is to evaluate the effectiveness of the entire suite of management practices implemented on each parcel of Program land, including documenting beginning conditions prior to Program management. Coordination will be needed between those implementing the IMRP and those implementing the Land and Water Plans to insure that proper data are collected before management begins and to learn the nature and extent of the proposed management actions. Examples of Program lands scale monitoring and research include determining plant species composition and abundance and more detailed measurements of sediment budget, channel widths, and abundance of sandbars and islands on parcels of Program lands.

- The objective of project scale monitoring and research is to evaluate processes (e.g., the relation of flow to channel maintenance) and management methods (e.g., a specific timber clearing activity, wet meadow development, island creation). Several research areas and topics for the evaluation of processes and methods are identified in Table 1. For example, the IMRP contains research items related to channel geomorphic processes (e.g., sediment transport, island building, flows) and management methods to influence channel geomorphology (e.g., sediment augmentation, island lowering) (see Tasks 1-4 in Table 1). Specific monitoring and research studies will be adopted for each type of project. However, it is important that research be conducted as soon as practical for use in adaptive management. This research will 1) provide knowledge related to processes to be used in other projects, 2) identify successful methods that can be implemented in other areas, as they are deemed appropriate, and 3) identify needed time to allow meaningful research data to be collected during the First Increment. It is also important to consider monitoring and research needs when evaluating land protection options through the Land Plan (Attachment 4).

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 and population response of the 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 First Increment of the Program, and 4) provide scientifically defensible data to facilitate development of milestones for future Program increments. Analysis of information from all three levels of monitoring and research will be used to learn which management actions are most likely to achieve stated goals and objectives and to make adaptive management decisions during the First Increment. Near the end of the First Increment this information will be used to evaluate the Program and develop Second Increment milestones.

V.D. Timing and Schedule

System scale monitoring will begin as soon as a Program is implemented and continue with the same protocols through the First Increment. In doing so, it will be possible to view the system as various flows occur, both natural and Environmental Account induced, and as new Program lands are protected and managed. Program lands scale monitoring should begin as each parcel of land is protected. Necessary baseline data should be collected through Program lands level monitoring prior to land management activities. This will allow each parcel to be evaluated as a unit through implementation of various restoration and management activities.

Research protocols will be implemented as topics arise and lands become available. Several specific research areas are currently identified and timelines established. These include research related to pallid sturgeon and research related to geomorphic process and restoration methods. For pallid sturgeon, several research items are included in Table 1. Implementation of some of these items (as described in Section V.K.) will begin after work is completed by the University of Nebraska-Lincoln, and summary of existing pallid sturgeon information. The Program anticipates regular review of all monitoring and research, but the Governance Committee has agreed that specific attention will be paid to review of pallid sturgeon research activities at the end of Year 4 and Year 7. During these reviews the Governance Committee will determine how the Program will proceed with future pallid sturgeon research.

In-channel geomorphic process and restoration activities are identified as Tasks 1-4 in Table 1. Most of these activities are planned for implementation over the first three years of the Program, with some work continuing throughout the Program. Actual implementation will be contingent on availability of appropriate Program lands or other lands available to the Program (e.g., The Nature Conservancy, Audubon, Platte River Trust, etc.) and personnel to conduct the research. These research activities were developed through a joint effort of the EIS Team and Parsons Engineering (Parsons 2002).

V.E. Experimental Design Strategy Across Multiple Scales

The study design for each monitoring and research component of the IMRP has been integrated into one overarching statistical survey design. Through the use of a common design, the monitoring and research activities will collectively determine the biological response to Program management actions. This integrated survey design is intended to maximize the use of monitoring and research resources by enabling the shared use of data for multiple studies, and ensure unbiased estimates with inference to the intended resource.

The cornerstone of the IMRP is a systematic sample of survey units throughout the length of the Platte River reach. This systematic sample will allow unbiased estimation of monitoring and research parameters at the system, Program, or project level scale. Utilizing an equal probability based sample of units will enable post-stratification and will provide pre-treatment data for all areas in the system (specifically useful for Program land purchases at locations unknown at the start of the Program). For any given stratification scheme, the sample for each stratum will contain population units in proportion to their presence in the landscape. Monitoring activities are intended for trend estimation and the examination of the influence of other variables on the estimated trend. Hypotheses developed from monitoring (i.e. factor A was the cause of a trend) will be evaluated with experimental research. Research will investigate the hypothesized cause and effect relationship and may involve the application of treatments such as habitat manipulation.

V.E.1. Monitoring Design

Monitoring revisit design - Survey designs for environmental monitoring are greatly enhanced by the use of panels to identify which sample units are surveyed on each visit through time. A panel is a collection of sample units that are always sampled at the same time (Fuller 1999). The frequency and pattern at which panels are visited through time is the revisit design (McDonald 2003).

The revisit design of a monitoring program reflects the relative importance of each monitoring objective. Visiting a set of sample units every year (pure panel) ensures low variance for trend estimates but the sites tend to wear out and obtain biases through conditioning, particularly when destructive sampling is used (Fuller 1999, McDonald 2003). Visiting a set of sites in alternating years (rotating panel) allows for the inclusion of more sites in the sample (increasing the chance of observing rare elements) and results in low variance for the estimation of mean levels (status) within a year (Fuller 1999, McDonald 2003). Urquhart and Kincaid (1999) found the pure panel to be the best for detecting linear trends through time and revisiting new sample units each time to be the best for estimating status. The revisit design for biological monitoring under the IMRP will balance the objectives for status and trend estimation equally as suggested by McDonald (2003), Fuller (1999), Breidt and Fuller (1999), and Urquhart et al. (1998).

The IMRP revisit design involves a split panel; a panel (group of sample units) that is visited every year and several panels that are visited in rotating years. Using the notation specified by McDonald (2003), the revisit design for biological monitoring will be [1-0, 1-3]; one panel will be surveyed each visit (the 1 pure panel visited each time is indicated by the 1-0) and four panels will be surveyed once every fourth visit (the 4 rotating panels each surveyed 1 time and then not surveyed 3 times are indicated by the 1-3). This split panel design has been shown to provide the most power for estimating status and trend (Urquhart and Kincaid 1999, Breidt and Fuller 1999). The total number of panels is 5, the sum of the numbers in the string of the McDonald (2003) notation. Since most biological monitoring is conducted on an annual basis, this translates to one pure panel visited every year and four rotating panels each visited once every four years. The revisit design of the rotating panel was planned so that every panel will be visited three times during the First Increment of the Program.

Monitoring membership design - The membership design specifies the selection of sample units for each panel (McDonald 2003). The terminology commonly associated with probability-based statistical sampling is appropriate at this level of the design. Common probability-based membership designs include simple random sampling, stratified sampling, and systematic sampling. The importance of using probability-based sampling in a long term monitoring study can not be overemphasized (Edwards 1998). The probability-based sample will enable unbiased estimation of ecological parameters and variances with well defined inferences (Thompson 1992, Peterson et al. 1992).

A probability-based sample can include units in the sample with equal or unequal probability. The use of an equal probability sample for collecting natural resource monitoring data will give the widest range of statistical analysis options (McDonald 2003). The sample of units to be included in a panel for the biological response monitoring under the IMRP will be based on a systematic sample in space. Systematic placement of sample units within the study area will ensure that the estimates will be representative of the entire study area (Thompson 1992, Peterson et al. 1992).

This survey design has defined a sample unit to be any point along the centerline of the widest channel of the central Platte River as it traverses through the study area (see anchor points as shown in Figure 13). The river can be viewed as a one-dimensional feature in two-dimensional space. The number of points in the population of points along the centerline of the river is infinite. An equal probability sample of points from this infinite population will provide "anchors" for data collection. These anchor points will serve as the sample units for a broad range of sampling activities. For example, some studies may sample along a transect crossing through the anchor point and perpendicular to the flow of the river while another study may sample a plot of land adjacent to the river on the nearest exposed land north of the anchor point. This sample unit was selected to encompass all surveys for a river-focused Program into one survey design.

One sample of anchor points will be used to co-locate all research and monitoring studies. This systematically placed set of anchor points will facilitate correlations between the monitoring components. The spatial intensity of sampling for each study can be increased or decreased within the framework of the sample points (e.g. 1 point every ¼ mile, 1 point every 8 miles). Any point along the centerline had an equal probability of inclusion in the sample of population units.

A set of anchor points was systematically placed (i.e. equally spaced based on a random starting point) along a defined centerline of the river during the July 1997 Cooperative Agreement. The U.S. Army Corps of Engineers (COE) navigational maps and 1998 color infrared photographs were used to determine the widest channel. The centerline was documented in a line theme called (baseline.shp). Anchor points were established every 400 meters along the centerline and documented in a point theme called (400m_pts.shp). This file was updated with the river miles

(400ma_pts.shp) using the "River Miles for the Central Platte River" dataset published by the U.S. Bureau of Reclamation, Great Plains Region, Platte River EIS Office.

For First Increment data to be most useful, monitoring activities will need to survey the exact same sites. For this reason, the centerline will not be changed if the river thalweg moves during the First Increment. For example, there will be geomorphic monitoring designed to evaluate cross sections of the river at an anchor point. The cross sections will be oriented perpendicular to flow and the endpoints will be marked on the banks. Throughout the First Increment, the direction of flow of the river may shift at an anchor point, but for comparison purposes, the orientation of the cross section should not be shifted. Keeping the centerline and the sample activities in the same location will increase precision for trend detection.

The monitoring design has intentionally avoided stratification in the membership design. Since attributes of long term monitoring locations evolve through time, a stratified design will tend to lose efficiency as monitoring data accumulate. For example, it is common for a sample unit that has been assigned to one stratum at the beginning of the study to be more similar to another stratum after a number of years (e.g., grassland in Year 1 has developed into a shrubland by Year 10). In this case the stratum of the sample unit at analysis time is unclear. The sample unit could be analyzed with the initial stratum (grassland) resulting in high within strata variance since the units attributes have changed. Alternatively, the sample unit could be moved to the ecologically appropriate stratum (shrubland) for the analysis, though the probability of inclusion of this sample unit in the new stratum is un-defined. A systematic placement of points throughout the study area will ensure coverage of each stratum in proportion to the relative abundance of the stratum each year.

Monitoring data analysis - Analyses conducted with monitoring data will include the estimation of linear trend and status (mean levels). Trends can be estimated at one individual sample unit (gross trend) and across all sample units (net trend; Duncan and Kalton 1987). The average of gross trends across each sample unit will be used to estimate net trend (Urquhart et al. 1998). Ecologically structured variance components (identifiable by the revisit design) of net trend can be incorporated into a standard linear statistical model resulting in powerful estimates of the trend of interest (Urquhart et al. 1998).

Statistical analysis methods such as post-stratification (Thompson 1992) will be used to estimate the status and trend of certain groups of monitoring locations. Locations can be grouped into geomorphological or bridge segments for analyses that are consistent with historic analyses. Alternatively, locations can be grouped into areas with significant influence by human structures (bridges, diversions, etc.) and locations not directly influenced by human structures. Sampling units will be classified into strata before each analysis so that the within strata variance is minimized.

In concert with systematic sampling of habitat parameters over the entire study area, systematic monitoring of species use will also occur throughout the entire study area. The monitoring protocols pertaining to species use do not involve definitions of habitat types ("suitable habitat") within which sampling is concentrated or restricted. Protocols for monitoring use locations of the target species are designed to allocate known search effort throughout a defined study area, regardless of habitat suitability. Thus, habitat characteristics at use locations documented by the monitoring will be contrasted to habitat characteristics throughout the study area. In some protocols, the study area has been defined through the use of habitat (fish monitoring will only occur in water) but this has only occurred when the habitat can be defined by the Program. It is recognized that the species monitoring protocols collect data only on individuals using the central Platte River (the lower Platte River for pallid sturgeon), not on the entire whooping crane, least tern, and piping plover populations. Therefore, these results are only applicable to the populations' use of this area and are biased for inference to the entire population.

V.E.2. Research Design

The hypothesized relationships among species and habitat associations and species and habitat response to Program land and water management (treatments) will be evaluated with research. Proper research designs will produce accurate and precise results with an efficient use of resources. Research designs will include both experimental and observational studies. Inferences to the cause and effect relationship will be possible with experimental research while inferences with observational studies will be limited to associations (Keuhl 1994).

There are many components of the statistical design of experimental research. Each IMRP research project will be designed for a specific research question and will ideally contain the following components: controls, randomization, and replication. The use of control areas will enable efficient estimation of treatment effects (Keuhl 1994). Without controls, there will be no benchmark estimate of changes that would have occurred in the treatment areas regardless of the treatment (Keuhl 1994). Randomization is a critical component of experimental design. Randomization applies to the selection of experimental units from the population and forms the basis of the applicability of research results to the population. Randomization also applies to the application of the treatments to experimental units enabling the experiment to account for confounding factors (Neter et al. 1996). Replication refers to the duplication of the study design to multiple experimental units. Replication provides an estimate of experimental error and increases the precision for tests of treatment effects (Neter et al. 1996). Analyses of experimental research with controls, randomization, and replication are described in many statistical texts (Box et al. 1978, Keuhl 1992, Neter et al. 1996).

In the cases where IMRP research project designs are not able to incorporate controls, randomization, and replication, constrained study designs will be developed (Skalski and Robson 1992). It is anticipated that system wide Program effectiveness research will not always be able to incorporate each of the statistical design components because of the lack of replication at the treatment level (the Platte River) and lack of control areas (water treatments effecting the entire reach). Instead, small scale manipulative studies will be conducted on Program lands and inferences will be restricted to the project area with system wide conclusions left to professional judgment.

Smaller scale studies at the project level will use the optimum design available. Experimental design features such as control areas, randomization, and replication, will be possible within specific project areas. Several analysis techniques have been designed for use with this type of data (e.g., before-after control-impact designs, control-impact designs, before-after designs, and gradient response analyses; Skalski and Robson 1992). Final judgments about management effectiveness will be based on independent manipulative research studies supported by correlations observed among sites and with the monitoring data.

An example of IMRP experimental research could be the study designed to evaluate the effectiveness of clear, level, and pulse activities. Models (see Appendix B) could be used to predict the channel topography expected to result from the management implementation. Study reaches will be randomly selected and the 3 treatments (uncleared and unleveled, cleared and unleveled, cleared and leveled) will be randomly assigned to reaches. Channel and sandbar topography, grain size distribution, and vegetation characteristics will be measured in and downstream of each reach, both before and after the pulse flows are implemented. Parameter values derived from the post-treatment topography will be compared to predicted values to judge the management effectiveness. These conclusions combined with system wide trends of topographical parameters, slope, sediment supply, etc. will provide the information necessary to determine if further implementation of the management activity is warranted.

An example of IMRP observational research could be the study designed to evaluate the effectiveness of whooping crane habitat restoration activities. Aerial and ground surveys will be implemented; ideally radio telemetry would be used, to document areas used by whooping crane individuals. The relative use of the restoration areas by whooping crane will be used to judge the management effectiveness. Characteristics of used areas will also be contrasted to characteristics of available areas (from monitoring data or collected simultaneously) in resource selection function analyses (Manly et al. 2002).

V.H. Monitoring and Research Protocols

Specific and detailed protocols will be written for each study related to management designed to achieve habitat characteristics listed in Land Plan Tables 1 and 2 and for other research and monitoring projects developed during the Program. Research into cause and effect processes will usually take place on Program lands. The research site may receive intensive study over a few years with data collection methods designed for analysis through process models. Research and monitoring will be most complementary if the research methods are the same as monitoring methods, but they may require some differences.

Peer review of monitoring and research protocols is an important component of IMRP protocol development. Peer review will be conducted following the Scientific Peer Review Guidelines (Appendix A). Peer review was conducted for the whooping crane monitoring protocol developed during the July 1997 Cooperative Agreement and the comments were considered by the TAC. Other monitoring protocols will be subject to peer review before full implementation. Peer reviewed monitoring protocols will be accepted as final and contractors implementing a protocol will be expected to follow the protocol methods as closely as possible. Research protocols developed during the Program will also be subject to peer review before implementation. Research protocols will detail the research objectives and expected research plan without full details of the specific study methods. Contractors hired to implement a research protocol will have flexibility in the study methods but will be expected to employ the most scientifically acceptable methods to accomplish the research objectives.

V.I. Monitoring and Research Data Analysis

The Governance Committee, with recommendations and analysis from the advisory committees, ISAC, and ED, will consider and evaluate the information collected from the monitoring and research studies. This evaluation may involve scientific advisors, peer review of data and reports, and statistical and trend analysis of data collected over the length of the Program. The evaluation will also involve a comparison with data contained in the Baseline Document when appropriate (see "Use of Baseline" below). In addition, existing models, updated models, and new models will be available for use in analyzing data. For example, the response of Program lands to management will initially be evaluated against predicted habitat needs defined by the FWS whooping crane model. As new data on whooping crane habitat use is acquired the model will be evaluated and modified as appropriate or a new model developed. The model was recently reviewed and updated once by the USGS, but further updates may be warranted after further data collection (Farmer et al. 2005). Thus, management for whooping cranes may initially be evaluated based on the existing whooping crane model while future predictions and evaluations would be made using an updated or new model.

In the scientific method for determining the effect of a management action, traditionally a null hypothesis will be adopted as the model that must be rejected in order to infer that an indicator has changed or that a cause-and-effect relationship exists. Normally, the null hypothesis would be the hypothesis that there is no difference in the value of an indicator between reference areas and assessment areas or that there is a zero correlation between two indicators along their gradients. Scientists often are concerned with the statistical power of an experiment, that is, the probability of rejecting a null hypothesis when it is false. In the case of Program monitoring, the null hypothesis will usually be that there is no impact to parameters such as sandbar elevation, channel width, or species use. Accepting a "no impact" results when an experiment has low statistical power may give Program administrators and the public a false sense of concern that the Program is ineffective. The power of the test to detect an effect is a function of the sample size, the chosen α value, estimates of variance, and the magnitude of the effect. The α level of the experiment is usually set by convention, if not by regulation, and the magnitude of the effect in an observational study is certainly not controllable. Thus, sample size and estimates of variance usually determine the power of observational studies and give weight to the evidence of an effect.

Observational studies in natural ecosystems typically have low statistical power to detect impacts of a treatment. When observational studies are designed properly, the ultimate determination of statistical power is sample size. The lack of sufficient sample size necessary to have reasonable power to detect significant differences and the large and uncontrollable environmental variation are common problems in field studies, such as those discussed in this document. Estimates of habitat availability or use can be made in a given year through sample surveys, but tests of other parameters for any given year (e.g., reproductive success, species abundance) may have relatively little power to detect an effect of flow or habitat on the species of concern. The anticipated lack of power is a concern and should be addressed by increasing sample size when practical, through the use of efficient study design, and by minimizing measurement error (e.g., the use of the proper study methods, properly trained personnel, etc.). However, most field studies in natural ecosystems will result in data that must be analyzed with an emphasis on detection of biological significance when statistical significance is marginal.

Trends detected during the First Increment for several important variables may suggest effects, even when tests of statistical significance on individual variables have marginal confidence. This deductive, model-based approach is illustrated by the following discussion. The evaluation of Program management actions might include an assessment of the effects from flow modifications on individual birds (e.g., size of use area) and population effects such as reproduction (e.g., fledged young). Several outcomes are possible from the bird studies. For example, an increase in apparent habitat in the assessment area implies a benefit to birds. An increase in bird use in the assessment area without an increase on similar "reference area(s)" may be interpreted as evidence of an effect of flows on individual birds. The presence of a greater number of nests in the assessment area as compared to reference areas increases the weight of evidence that an effect can be attributed to the flow modifications. However, an increase in use of both the reference and assessment area may be interpreted as a response unrelated to the Program. It is important to consider survey effort and methods in all areas when comparing these types of data. For example, more birds may be found in the assessment area simply because a vigorous survey protocol is being implemented to look for them there and not in other areas. Data on covariates (e.g., prey, weather) for the assessment and reference area(s) could be used to further clarify this interpretation.

Integration of monitoring and research is essential in understanding the effects of management actions in a long-term adaptive management program. Monitoring data may suggest correlations between trends in the variable of interest with management actions. For example, the amount of in channel reproductive habitat for least terns and piping plovers may appear correlated to river stage. However, the connection between river stage and management activities may be unclear. Manipulative studies of the effect of Water Plan activities may provide information that assists in the subjective assessment of the relative importance of Program management actions to species and habitat trends. Multiple indicators of correlation among target species and their habitat and Program actions, combined with research indicating cause and effect relationships between management actions and habitat or species responses will result in a subjective "weight of evidence" determination of impact of management actions on species and their habitat.

The biologically significant level of changes in variables associated with the target species is subjective and will depend on the species involved. Thus, the Program will need to consider this point and the weight of evidence when evaluating the monitoring and research data. Adaptive management decisions could be applied to management actions (land and water allocations/plans), indicators of biological response, and/or monitoring and research activities to better serve the needs of the Program. During the annual evaluation, the Governance Committee, based on recommendations from the ISAC, ED, and advisory committees, will decide if any adaptive management changes will be made (Figures 1 and 2). Changes to monitoring and research objectives, protocols, and budgets as a result of the annual reviews should only be implemented when sufficient data warrant such a change to avoid reducing the value of the monitoring and research data.

Analysis of research and monitoring data will be conducted in accordance with the analysis procedures outlined in each protocol. Analysis methods will necessarily vary and no attempt is made here to prescribe specific methods. It is assumed that both statistical and theoretical models will be used in these analyses. However, it is the philosophy of this plan that analyses will be conducted using generally accepted statistical procedures that allow a straightforward interpretation of the results.

Use of the Baseline - A Baseline Document was developed for completion of Milestone R1-1 of the July 1997 Cooperative Agreement. The Baseline Document reviews the existing information related to the target species in the associated habitats (e.g., species occurrence, habitat use) as well as landscape/physical habitat data collected in the central Platte River (e.g., GIS information, sediment transport information). The document also identifies which data may be used in an analysis of Program effectiveness (e.g., before-after analysis). In general, there are very limited amounts of quantitative data that were collected according to a written or reproducible protocol.

Trend Analysis Methods - There are many statistical analysis methods used to evaluate the significance of a trend in data, including parametric and nonparametric techniques. Certain techniques have been favored and used more often in certain disciplines. A description of four techniques expected to be used with the Program monitoring data follows. Use of one technique over another will depend on the distribution and independence properties of the data. Additional data analysis techniques may become available as result of current research into statistics and computer intensive methods (e.g., Manly et al. 2002).

Simple linear regression (Sokal and Rohlf 1995) will often be used to estimate the linear relationship between the response variable and the time variable. The regression model provides an estimate of slope while incorporating the effects of covariates. The null hypothesis will be that the slope is not different from zero. This analysis technique assumes the response variable is normally distributed.

Mixed models for longitudinal data (Verbeke and Molenberghs 2000) may be more appropriate in many situations, particularly since computer programming has improved the estimation procedures. The model provides an estimate of slope while incorporating the effects of covariates and multiple sources of random variability (individual, spatial correlation, measurement). Null hypothesis will be that the slope of the trend coefficient is not different from zero.

Non-parametric methods (e.g., Mann-Kendall Test described in Helsel and Hirsch 1992) will be used when the lack of distributional assumptions about the response variable is necessary (e.g., not normally distributed). The model provides a nonparametric estimation of trend. The null hypothesis will be that the response does not tend to increase or decrease over time.

Difference metrics will be calculated as basic summary measures for changes in a response variable at a site. These metrics will normally be calculated in a pairwise manner and will not incorporate multiple years. The differences will be used in univariate analysis procedures to estimate overall changes in the study area.

Habitat Selection Analysis - Scientists identify resources used by animals (e.g. vegetation type, food, etc.) and document their availability (usually expressed as abundance or presence/absence).

These studies are carried out to identify the long-term requirements for the management or conservation of an animal population. In the case of the Program, habitat selection by target species is of interest for the evaluation of biological response to management activities and existing models and hypothesis regarding habitat suitability. Manly et al. (2002) provide a unified statistical theory for the analysis of selection studies. In habitat selection studies, the availability of a habitat resource is the quantity accessible to the animal (or population of animals) and the use of a habitat resource is that quantity utilized during the time period of interest (Manly et al. 2002). When use of a habitat resource is disproportionate to availability then the use is considered selective (i.e. the animal is showing a preference for the habitat resource).

Habitat selection studies can be used with marked or unmarked individuals. In most of the observational studies conducted by the Program, it will be impossible to identify unique animals. It is expected that the data will contain more than one habitat selection made by the same individual. Pseudoreplication occurs when an analysis of this type of data does not reflect the number of individuals sampled and does not account for the influence of individuals that are present in the data multiple times (Hurlbert 1994). These individuals can overly influence the analysis and the results are not applicable to the population. However, in the absence of a marked population of animals, we can use observations of animals seen from randomly or systematically based surveys in time and space to reduce field observation biases.

When conducting resource selection analyses the issue of scale is very important as it relates to the definition of available habitat. For example, when determining the scale of the "available" dataset in analysis of whooping crane habitat use, the results may vary if the available set of data is based on the entire study area, within bridge segments, or within 1-mile of use locations. To deal with this issue data analysis will likely be conducted at multiple scales.

Meta-analysis - Meta-analysis is useful in the analysis of ecological field studies. This analysis involves the combination of statistical results from several independent studies that all deal with the same issue (Hedges and Olkin 1985). It may be extremely important for use when historical and baseline data exist on species and habitat response. The simplest form of meta-analysis is illustrated by the following discussion. If several independent statistical comparisons are made on the same response indicator but with relatively low sampling intensity, then it is possible that none are significant at the traditional level of $P < 0.05$. However, all or most significance levels may be "small" (e.g., all Ps are < 0.15) and suggestive of the same type of response. The probability that, for example, three or more independent tests would, by chance, indicate the same response direction suggesting a positive or negative response from the management action, is itself an unlikely event. The combined results may establish response due to the management action with overall significance level $P < 0.05$. This type of analysis may also be useful in interpreting the results of several separate cause-effect research project as to how the entire system works.

V.J. Reporting

Generally, all Program research and monitoring will be coordinated by the ED and staff, reviewed by the appropriate advisory committee(s) and ISAC, and approved by the Governance

Committee. These reports will be used to produce annual/biannual work plans or operating plans by taking a retrospective look at each of following questions:

1) Have the intended actions been implemented?
2) Have the intended processes occurred?
3) Has the intended amount of habitat been created?
4) Have the intended species responses occurred?

These questions are listed in cause-effect and sequential order. Early in the Program, the focus at the System and Program Scales will be primarily on implementation of actions, with baseline measurements of processes, habitat and responses. However, project level monitoring and research may be able to tackle hypothesis tests early in the period of the First Increment. These work plans would then plan out the steps for the next year (or two) given what has occurred to date.

All contractors and participants in Program monitoring and research will prepare annual reports and a final report. Besides the traditional introduction, methods, results, and discussion/ summary sections found in scientific reports, monitoring and research reports for the Program will included, at a minimum:

1) Summary of management actions taken at the site(s) to help ensure that unexpected treatments can be accurately considered in the evaluation of results,
2) Elaboration on any unexpected treatments or management and the impacts that they had or may have had on the results,
3) A link back to how the results address or answer questions and priority hypotheses from the CEMs.

These reports will be compiled by the ED and staff, then supplied to the Governance Committee and the proper advisory committee(s) (e.g., TAC and LAC for island clearing activities, WAC for tracking/accounting activities, ISAC) for review. The advisory committees will annually review these reports and provide advice and recommendations regarding the activity, the report, and adaptive management to the Governance Committee through the process described in I.F.2. The Governance Committee will make final adaptive management decisions. The Governance Committee, and ED, with advice from the committees will ensure that management decisions are properly implemented. Investigators will be encouraged to publish the results of their final approved research and monitoring projects in appropriate peer-reviewed journals.

V.K. Species Specific Monitoring and Research Protocols

Using a collaborative process to develop CEMs and hypotheses, and knowledge of each species and their habitats, a list of proposed monitoring and research activities was developed (Table 1). These monitoring and research activities will be cross referenced to hypotheses presented in Section III of this plan and in Table 1.

The monitoring and research activities were designed to address specific questions regarding hypotheses and models regarding the relationship of target species to their habitat. The identified monitoring and research activities were used during the July 1997 Cooperative Agreement period to begin developing monitoring protocols and will be used in the future to identify new hypotheses, models, and protocols that are needed for their evaluation by the Program. Most monitoring protocols were developed during the July 1997 Cooperative Agreement related to species use of the area and habitat variables associated with use locations. However, very few research protocols were developed, as these will be site specific. Monitoring and research protocols developed to date are attached in Appendix F and are on file with the Program's ED. Additional protocols will be identified and developed as needed during the Program.

As described above, the general philosophy of the IMRP is that monitoring will provide an estimate of trend in habitat conditions and habitat use by target species with statistical inference possible to the entire area of interest, or to specific subdivisions of the entire area. Analysis of trend data will also allow an evaluation of the relative selection for habitats by target species, and the effect of various environmental variables to that selection. Research will provide an estimate of cause and effect among variables of interest, which will be used to interpret apparent trends of habitat conditions and use. These data will be used to make adaptive management decisions regarding which habitats to protect, which methods to use to enhance or restore protected habitats, and how best to achieve species benefits desired by the Program. The following is a general discussion of the monitoring and research planned for the First Increment. More detailed information will be contained in the work plans.

V.K.1. Whooping Crane

Monitoring of whooping cranes is designed to annually gather information on whooping crane stopovers and habitat use in the central Platte River valley. Monitoring will be conducted using systematic aerial and ground sample surveys that will result in an annual index of crane use. The objectives for whooping crane monitoring include:

1) Detect whooping crane stopovers in the study area;
2) Identify the locations of use and crane group movements in the study area;
3) Document crane group activities at use sites;
4) Document the physical and/or biological characteristics of use sites; and,
5) Collect landscape data associated with use sites.

The monitoring is designed to allow evaluation of changes in the frequency and the distribution of stopovers within the study area over time. Opportunistic locates will also be used to detect whooping crane stopovers in the study area. Crane group movements will be documented to identify use sites and to describe the patterns of movement of each crane group. Observers will also document each activity displayed by the crane groups. Habitat parameters will be described and measured for the purpose of comparative habitat analyses (e.g., habitat suitability or preference analyses). Habitat parameters will be measured at transects established at use sites and at random sites throughout the study area. Random sites for transects will occur on Program and non-Program lands (where access is available) so that habitat availability can be estimated system wide and for specific Program lands. These landscape data will be used in use/availability analyses using aerial photography and GIS information. The Program has available a complete land use/cover GIS layer based on 1998 color infrared photography. The Program will continue regular collection of landscape data for the study area through other protocols, such as the "Protocol for Aerial Photography in the Central Platte River Valley". Information will also be collected from the FWS and state agencies throughout the whooping crane's migrational corridor. Monitoring whooping crane use of the study area following this protocol began in 2001.

Research related to the whooping crane will primarily occur through the detailed analysis of monitoring data to evaluate the relative importance of different feeding habitats (e.g., wet meadow and cropland) and roosting sites (e.g., various channel widths) and to determine the relative importance of environmental factors (e.g., roads) in influencing selection of roosting, loafing and feeding sites. These data will ultimately be used for adaptive management decisions related to the whooping crane and to evaluate hypotheses and models that initially are guiding habitat protection activities for the whooping crane. Research activities indirectly related to the whooping crane and its habitat are described in more detail under in-channel habitat investigations.

V.K.2. Interior Least Tern and Piping Plover

The monitoring protocol for least terns and piping plovers has three main objectives:

1. Determination of nest site characteristics by locating tern and plover nests within the study area,
2. Determine the relationship of environmental parameters to nesting colonies of least terns and plovers by documenting reproductive habitat parameters at least tern and piping plover nesting colonies in the study area, and
3. Document numbers of least tern and piping plover adults in the study are through a simple count during each survey period.

Monitoring will consist of two components: 1) effort-based census of the Platte River between Lexington and Chapman, Nebraska, and 2) census of sandpits and historic (pre-Program) constructed nesting areas. Habitat parameters will be measured at all located colonies. Surveys for use will be conducted at least three times during each year by airboat within the river and by foot at sandpits. Pre-Program data exist for some of the study area and data resulting from surveys of these areas during the First Increment of the Program will allow a “before-after” analysis of use. However, most of the analysis will look for trends in habitat and use during the Program. The timing of Program habitat protection and management activities will provide some opportunity for a “before-after” analysis of the effect of Program activities. For example, least tern and piping plover surveys began during the July 1997 Cooperative Agreement; this information will provide use data from the river and on other accessible areas from before Program implementation. If the Program acquires in-channel or sandpit habitats managed for terns and plovers where pre-Program data exist, then direct comparisons of the protected lands before and after protection and comparisons between in-channel and sandpit habitats will be possible. Information from all components will be used to make informed judgments regarding the changes in least tern and piping plover reproductive parameters associated with Program activities. Monitoring of least tern and piping plover reproduction following this protocol began in 2001.

A detailed analysis of monitoring data will be used to evaluate the relative importance of different nesting habitats (e.g., sandbars and sandpits) and to determine the relative importance of environmental factors (e.g., human activity) in influencing selection of nesting sites and their success. Research into the effectiveness of surveying for least terns and piping plovers using the monitoring protocol is also planned. This will entail a double-sampling, current airboat and intensive ground survey, when terns and plovers are found nesting within the river channel. Research and monitoring related to prey for terns (fish) and plovers (invertebrates) are also planned. If a prey base is found to be inadequate, in quality and quantity, to support nesting and rearing terns or plovers, further research and monitoring will be added to identify potential means for alleviating factors limiting prey populations, considering factors such as temperature, drought, flow variations, hydrocycling and others. All data will ultimately be used for adaptive management decisions related to the least terns and piping plovers and to evaluate hypotheses and models that initially are guiding habitat protection activities for the terns and plovers. Research activities indirectly related to least terns and piping plovers and their habitat are described in more detail under in-channel habitat investigations.

V.K.3. Pallid Sturgeon

Pallid sturgeon monitoring and research will initially focus on the following five protocols/ activities. Under each activity are the objectives, generally stated.

1. A summary of existing information on the pallid sturgeon;
    - Objective is to understand the existing knowledge on pallid sturgeon biology range wide, but with particular emphasis on the Platte River.
2. Micro- and macro-habitat use/selection by adult and juvenile sturgeon, relative to conditions;
    - Objectives are to 1) determine what habitats pallid sturgeon use (and select for) in the Platte River, and what are the similarities and differences with habitat use and selection in other parts of the species range, 2) Does use and selection change with changes in river conditions, and if so how?
3. Identify the physical effects of subtly different rates of flow (stage and associated elements) over time on connection, construction, maintenance, and evolution of pallid sturgeon habitat components. Data need is pursuant to developing appropriate offsets for flow reductions stemming from implementation of the Program and New Depletions Plans;
    - Objective is to quantify and identify how the distribution of existing macro and meso habitats change over time and flow conditions.
4. Characterization of selected water quality parameters in the lower Platte and tributary contributions;
    - Objective is to determine what the range and variation, both spatially and temporally, of selected water quality parameters (particularly temperature, turbidity, dissolved oxygen, and specific conductivity) are in the lower Platte River under a range of flow conditions, as well as the relative contributions of the individual sub-basins.
5. Periodic evaluation and peer review of information.

Additional monitoring and research will be conducted if warranted. A decision to conduct additional monitoring and research will be made during the First Increment of the Program based on the evaluation of data from the above tasks. The first decision node for identification of monitoring and research items will occur upon completion of the research and finalization of the report conducted by the University of Nebraska-Lincoln. The University of Nebraska-Lincoln study conducted research on the pallid sturgeon in the lower Platte River. When the report is completed, the results of this work and the products of the existing information review will be evaluated. Similar reevaluations will occur throughout the Program. The Governance

Committee, after receiving advice from the TAC will reconsider the entire research and monitoring package for the pallid sturgeon after each review. Monitoring and research will be based on the existence of important data gaps and a determination by the Governance Committee that additional research and/or monitoring activities related to the pallid sturgeon are needed during the Program's First Increment. The monitoring and research tasks may include tasks as outlined in Table 1 (additional description of these tasks can be found in the FWS's Pallid Sturgeon Monitoring and Research Plan, February 10, 2005) some other mix of tasks, or new tasks that are defined based on the available information at that time. It is anticipated that the initial review and revision of the pallid sturgeon portion of the Integrated Monitoring and Research Plan will occur during the First Year of the Program. All work done on the pallid sturgeon during the Program's First Increment will be coordinated with contemporary work being conducted on the species by others in the Missouri River and its tributaries.

If species specific habitat management is conducted by the Program, the existing monitoring and research protocols will be reviewed to make sure they are adequate to evaluate the management activities. If needed, additional monitoring and research protocols will be developed to evaluate the specific management actions.

V.K.4. Other Listed and Non-Listed Species of Concern
The Program will monitor for selected other species of concern on Program lands. For example, sandhill crane use will be documented on Program lands during whooping crane monitoring, or the Program may monitor neotropical migrants on Program lands to evaluate the impacts of forest clearing. Specific protocols will be written prior to Program implementation.

The Program will also monitor and evaluate the status of other listed and non-listed species and other habitats using existing information. While the Program will not actively collect field data on all species throughout the central Platte region, it will consider the information collected by others (e.g., FWS, States) as part of the overall Program monitoring effort. The list of species that the Program will monitor and evaluate is found in the Baseline Document (Section V.I., Use of the Baseline). This list contains the species identified in the Land Plan (Attachment 4), as well as other listed and non-listed species. The "species of concern" identified in the Land Plan are those species that the Program will consider, where practical, when developing land management plans and is a significantly smaller list than the other listed and non-listed species that will be monitored using existing information as part of the IMRP.

V.K.5. In-channel Characteristics
In-channel characteristics (e.g., sandbars, vegetation encroachment, etc.) were identified during the July 1997 Cooperative Agreement as a high priority for monitoring and research. Monitoring of in-channel characteristics will be conducted through implementation of the protocols "Monitoring the vegetation of the central Platte River valley" and "Monitoring the channel geomorphology of the central Platte River valley". These protocols include monitoring of vegetation and geomorphology, respectively, along transects systematically placed throughout the study area (system level) and more intensively on Program lands (Program level). Vegetation monitoring will provide estimates of species composition, diversity, and density in all habitats according to their availability. Geomorphology monitoring will provide channel width, depth profiles, and sediment grain size information.

Significant and detailed research into channel geomorphology and processes was identified through a joint effort between the EIS Team and Parsons Engineering, working for the Governance Committee, during the July 1997 Cooperative Agreement period. The general objectives (focus) of the research identified are:

1) Investigate the erosion, transport, and deposition processes in the central Platte River including as feasible and appropriate, factors including flow variability, drought, high flow events and hydrocycling.
2) Investigate the in-channel vegetation dynamics in the central Platte River, including investigating the processes of vegetation removal and how to prevent vegetation establishment.
3) Conduct a comprehensive geomorphic assessment of the central Platte River from Lexington to Chapman, Nebraska; including distribution/number/size and persistence of sandbars, how management impacts the river, and what width can be supported with various flows.
4) Investigate proposed in-channel restoration activities; including island lowering, sand augmentation, and pulse flows.

The Parsons-EIS Team group developed a detailed list of reconnaissance-level descriptions of investigations that will be implemented to resolve questions identified by numerous interests regarding Platte River channel trends, processes, and restoration treatments. Research is to begin year one of the Program, and most work would be conducted within the first three years of the First Increment, however, actual implementation will depend on availability of lands, development of management plans, and personnel. These items are described in detail in the final report and tables provided by Parsons Engineering on January 16, 2001 (Parsons 2002) and generally described in the first four tasks of Table 1. Research protocols to investigate Platte River channel trends, processes, and restoration activities will be developed during the Program.

V.K.6. Habitat Comparisons

The overall monitoring and research design and protocols/activities planned for implementation during the Program, will allow the Governance Committee, with recommendations from the TAC and LAC, to make comparisons of species use of different areas with differing habitat characteristics. Examples of comparisons that might be of interest to the Governance Committee include complex and non-complex areas, areas managed using different techniques, and areas managed for different physical parameters, such as 1,000-foot channel widths and 700-foot channel widths.

The objectives for habitat comparisons are 1) a determination of the extent and characteristics of habitats preferred by the target bird species, and 2) the degree to which various environmental variables influence this preference.

Following is an illustration of how data collected at whooping crane use sites, Program lands, and system wide will allow these comparisons. The whooping crane monitoring protocol directs measurements of three transects at all river use sites. These transects are measured perpendicular to the general flow of the channel using survey equipment and will provide a description of habitat used by whooping cranes. The geomorphology protocol directs in-channel measurement of transects, perpendicular to the general flow of the channel, systematically throughout the study area and more intensively at Program lands using survey equipment. Using the description of whooping crane use sites, the Governance Committee can evaluate whether or not habitat complexes as currently described (Program Attachment 4, Table 1), complex habitat areas under varying management, non-complex habitat areas, or non-Program lands provide these same characteristics using direct comparisons and whether whooping cranes show differential preference for one more of these habitat areas through resource selection function analysis. The number of whooping cranes detected through this monitoring plan may be insufficient to allow population or species level determinations. However, the Program has not identified surrogate measurements in the case that this concern is realized.

V.K.7. Channel Capacity

The Water Plan (Attachment 5, Section 2) contains a discussion of management action anticipated to address channel capacity issues along the North Platte River below Lake McConaughy. Once management actions are decided upon, appropriate monitoring and research will be designed and conducted to evaluate the management actions.

VI. MONITORING AND RESEARCH DATA STORAGE

This section describes the conceptual design and implementation methods for a database management system for all administrative information and data and reports created under the biological monitoring and research component of the Program.

VI.A. Design Considerations and Specifications

VI.A.1. Area of Interest

A large number of biological monitoring and research activities described under the Program. The collection of such large amounts of data during the Program's first thirteen year increment by potentially numerous contractors, cooperators, agencies, and staff necessitates a centralized database management system that will permanently store, organize, and distribute Program data and information. A database management system (DBMS) is a collection of computer programs that enables users to store, modify, and extract information from a database. This information can be in the form of raw or summary data, metadata, and texts such as reports, protocols and address lists. Central storage of data and text allow all users to access the data quickly, ensures that all users are looking at the same and most up-to-date information that has been subjected to rigorous QA/QC procedures, and forces standardized data collection and reporting over the life of the Program. These characteristics of a DBMS have many implications for data analysis and interpretation.

A database management system will provide a safe, long-term storage warehouse of data and reports which will be less volatile and more accessible than information stored on individual computers or in filing cabinets distributed across different locations. Warehousing all data in one database will facilitate consistency in data collection and reporting over time and within individual projects and will ensure that data from different projects will be linked by date and location, allowing investigators to search for relationships between events in time and space. Consistent and efficient data collection requires creating standardized raw data collection forms that ensure the necessary information is recorded in the proper format. If study results will be compared between years or the data will be analyzed for trend to determine if resource parameters are changing over time, then it is critical that the format for the collected data remain constant across years and principal investigators.

Secondary to standardized data collection and reporting, and data storage and retrieval is the use of a DBMS to keep the public notified of current events within the Program and provide an avenue of contact for public questions and input. A DBMS with a web-based component will allow easy access for all Program participants and provide a venue for public outreach and participation.

VI.A.2. Database Design

The database management system will be a web-based system supported by common and tested database management software such Oracle™ or IBM's DB2™. Data will be viewed using Microsoft Access™ and texts will be 'pdf' documents that can be viewed with Adobe Acrobat Reader™. Different levels of security will ensure that only principal investigators can submit data and reports, only the DBMS manager can alter data and reports, and that all other users have read-only access to data and text. A third level of security will allow the public and non-Program groups to view Program news, reports and data that are reported in a format appropriate for public viewing.

A web-based DBMS will allow real-time updates to the database and ensure that all Program participants have access to the database (at their assigned level of security) from any location through the Internet. Another benefit of the web-based system is the accessibility of the Program information. The only hardware and software that will be necessary to submit, access, and retrieve information from the database is a computer with an internet connection and the correct version of web-browser, which historically can be downloaded free of charge (e.g., Netscape Navigator 4.0).

The database management system will be developed and managed by an independent contractor (private or government) for the Program. The contractor will work with the Governance Committee, ED and Program staff and proper advisory committees to develop the DBMS. The Program staff will periodically evaluate the system to ensure it is performing to expectations and operating within budget. Periodic evaluations will also allow the contractor to further develop and enhance the system to keep the DBMS efficient, "user-friendly" and up-to-date with the current technology (i.e. software enhancements).

The database will be created and managed using database management software such as Oracle™ or IBM's DB2™. The database software will be chosen based on cost, flexibility and the perceived life of the software. The design of the database management system is described below, with examples of how each component will be used by Program participants or the general public.

***Web Page* -** The database point of entry (i.e. access for all users other than the database manager) will be the Program's home page on the world-wide-web. This web page will feature a description of the Program, contact names and addresses of primary participants, links to web pages that contain hydrologic information for the Platte River, weather information and web-pages of Program participants. There could also be links to other relevant sources of information such as web pages for the Nebraska Geospatial Data Clearinghouse and cooperators like the Nebraska Department of Natural Resources. The web page will be the portal for the database and a database directory will direct users to information and applications available inside the DBMS.

Access to information inside the database will depend on the type of user, and participants with security clearance will use login names and passwords to access Program participant-only information. For example, the general public could enter the database through the web page, requiring no login name or password, but access will be limited to completed work products ready for distribution to the public. A program participant could enter any portion of the database (i.e. protocols, raw data, administrative information, etc.) with read-only access. This type of security would permit users to view text and data and query and retrieve data for analysis while preventing anyone from purposefully or accidentally altering the content or format of data tables and texts. The third level of security would be assigned to primary investigators. These users would have the same level of access as regular Program participants but they would also have the ability to submit data and text to be entered into the database. Only the database manager will have the ability to alter existing data tables and texts by adding or deleting information or changing formats. Alteration of data tables will follow a very specific protocol and all record changes will be documented in a log within the DBMS.

An important component of the database management system is the ability to track and record uses of the database at all security levels. Software will be used to calculate and record the number of visits, the average time for each visit, types of data queries submitted and information relative to the submission of data and text to the database.

***Directory* -** The directory found on the Program's web page will direct users to information and applications within the database management system. For illustration, the web page could categorize components of the DBMS as "Information" or "Applications" and further categorize information as "Administrative" or "Project-Based". Administrative information contained in the DBMS will consist of information such as directories of projects and participants, permit application forms, committee meeting minutes and budgets. Project-based information contained in the DBMS will consist of information such as individual project descriptions, protocols, raw data, metadata and reports. Applications available within the DBMS will consist of (1) viewing aerial photos and GIS thematic layers or maps, (2) data query and retrieval and (3) data/text submission.

***Administrative Information* -** The database management system will contain administrative information for the Program. A portion of this information will only be available to Program participants and access will be gained by use of a login name and password. A complete list of all Program participants will be stored in the database along with telephone numbers, email addresses and street addresses. Currently, the ED has a database of over 550 individuals interested in receiving news and information on the July 1997 Cooperative Agreement, with a majority of the list being private individuals who reside in the central Platte River valley, and the names and addresses of Program participants. Users can use this list for contacting other Program members and for in-house mailings and memos, as well as public mailings.

Other information that will be stored in the Administrative Information component of the database will be minutes from committee meetings, scheduled agendas, budget information and template forms for required permits and Program paper work. Budget information and template forms will likely only be used by Program staff however, minutes and agendas are of interest to a wider audience and thus would be accessible at all security levels. Examples of forms that would be accessible in the database are ESA permit applications, expense forms and memos. Completed forms will also be stored in the database so that users can reference past material to complete or update necessary permit applications, memos, and other various administrative documentation. For example, if an ESA permit needs to be renewed, the principal investigator can download the appropriate form from the database and view completed ESA permit applications for the same or other projects that were successful in the past.

***Project-Based Information* -** Within the database will be a directory list of current and past Program research and monitoring projects. Most of this information will be available to all users, including the general public. The directory for Project-based information will contain project names, current and past principal investigators along with contact phone numbers and addresses. From the directory users can choose to view the project's description (duration, goals, personnel, etc.), protocol(s) for data collection, metadata, raw data and reports. Investigators or Program participants can view past protocols, data and reports to become more informed about project goals and results.

Users can access data from other projects to include information and covariates in their analyses and reports. Metadata and project protocols will explain the data and allow others to perform their own statistical analyses or link information collected from other projects to their own data. Storing project information and data in electronic form in the database will not only provide safeguards for keeping information that the Program has invested many resources into collecting, but it fosters sharing of information and promotes users to become well informed of other projects. Sharing data also promotes investigations into relationships between projects and project data that were not initially targeted. The Program's philosophy of employing an adaptive management strategy to the Platte River basin relies on the ability to easily access past and current information to compare results between years and among projects.

***Land and Water Management Plan Implementation Information* -** The database management system will contain information about the Program land and water management actions. Information such as actual EA releases, land purchases, and all land management activities will be documented in the database. Storing information about management actions will facilitate the use of the information in the analysis of Program monitoring and research data.

***Applications* -** The database management system will not only store data and information but it will house applications that allow users to perform tasks relating to database use and management. The first and probably most important task a user will perform is submitting data or text to be included in the database management system. All submitted data will be in the form of a comma delimited text file. This will allow participants to make their own choices as to what software they use to house the data on their personal computer, and it will remove the requirement that all users purchase necessary software updates and use the identical versions of the same software. Once the data is submitted to the database, the database manager will run a Quality Assurance/Quality Control (QA/QC) (refer to Section VI.C. below) routine to make sure that the submitted file contains the correct data fields and all data follow the required formats (e.g. correct units of measurement, missing values correctly indicated), and that data is not replacing existing data within the database. It will still be the responsibility of the principal investigator to perform rigorous QA/QC on their data and text prior to submission. Once the data has been added to the database the database manager will notify the submitter via email when the data has been appended to the database and can be viewed on the web page.

All text will be submitted in the form of a Microsoft Word ™ document. Users will not be required to use a specific version of Microsoft Word ™. The database manager will convert the Word documents to 'pdf' format so that all users can access and view the document from the database. The database manager will notify the submitter once the document(s) have been added to the database and are viewable on the web page. Text documents will be easily downloaded to a local computer in 'pdf' format with the click of a button.

Another important application of the database system is the data query and filter application. If called by the user, a window will appear that allows the user to define data that he/she would like to view. Data can be called to the screen by project name, season and year or data queries can be more complex, calling data by location and or time of observation as well as by any other available field. An investigator may want to extract and view all observations from all projects linked to three specific anchor points along the river corridor or the investigator may want to view all data collected during a specific hydrologic flow event, say flow of the main river channel greater than 5000 cfs. This easy to use and built-in application with capabilities to query, filter and display data will prove to be a valuable asset to the Program.

Data will be downloaded in a comma delimited text format with the click of a button, which will allow the user to view and analyze filtered data on a local computer using their available software. Information regarding all data submissions, extractions, and query events will be recorded and stored by the database manager to accompany other database administration records and documents. These records will be viewed during periodic evaluations of the DBMS.

A GIS and aerial photograph interface will be integrated into this DBMS. This interface will contain a link to the catalog of aerial photographs and videographs that are available from the FWS, U.S. Geological Survey, Bureau of Reclamation, Program, and other sources as available. Depending on propriety concerns, the photographs could be stored in the Program's database or the Program's web page could contain a link to another web site containing the photographs. The GIS and aerial photograph interface will include orthophotos, digital elevation models and GIS thematic layers and maps created by individual projects.

The GIS and aerial photograph interface will contain links to Project data and metadata. This will allow users to retrieve information relative to specific regions or sample points visible in a thematic layer with a point and click of the mouse. For instance, when viewing a thematic layer illustrating the locations of least tern and piping plover islands the user could point and click on an island or group of islands to view all least tern and piping plover data associated with those locations. Anchor points along the main river channel will also be geo-referenced, allowing users to view data associated with each anchor point or sets of points when viewing their locations through the GIS Interface. This application is similar to the data query and filter application only the user can call data linked to locations in space while viewing the locations on a mapped section of the Platte River corridor.

VI.B. Timing

The development of the DBMS will be implemented through three phases, as described below.

- **Phase I.** The first step in developing the DBMS will involve taking a look at current data, developing a list of possible data sources, and prioritizing the incoming data according to levels of importance. The characteristics of the most important data sources will be used to design the technical specifications of the data storage components of the database. The list of future data sources will allow some flexibility to be built into the system from the beginning.

  The contractor responsible for building the database will work with principal investigators, ED and staff, advisory committees, and the Governance Committee to standardize raw data entry forms, spreadsheet formats, and reporting forms that will be mandatory throughout the life of the individual monitoring or research project. This will ensure that collected data will stay consistent in format and quality across years and principal investigators. It will also ensure that the data can be accurately and efficiently uploaded into the database.

  Phase I will involve developing the web-based component of the system. Phase I will be completed early in the Program, and the resulting DBMS will be called the "pilot system". This pilot DBMS will be ready to store project data in Year 2 and the web page that allows access to the system will also be functional by this time. Applications and administrative information may not yet be available on the database.

- **Phase II.** Following Phase I there will be a period of ongoing evaluation of the DBMS by Program participants and the database manager. This period will allow users to provide input and suggestions for further development of the system. Until data is actually uploaded to the database and users get a chance to access the data through the "pilot system" the full potential for the DBMS will not be realized. Principle investigators and Program participants will be able to use the pilot system during this time and provide input and comments into the DBMS structure. During Phase II, links between different data sources and levels of information will be made. This will allow the applications of the DBMS to become operational. Thus, Phase II will involve creating the aerial photograph and GIS interface and the data query and filter applications.

  Phase II can be considered the period in which the DBMS grows in sophistication, not only improving efficiency and ease of use, but linking data and texts and allowing users to connect and query multiple layers of data. Phase II will last for a period of 2 to 3 years.

- **Phase III.** Phase III will begin once the Program has decided that the DBMS satisfies all reasonable objectives set by the Program and the database manager, and the DBMS is at a stage where no major improvements or modifications need to be made to the system. This phase will consist primarily of updating the system with current data and information as it is collected and reported by the users, tracking uses and changes made to the database by users, and monitoring of the system's performance and integrity. Phase III will begin at the end of Phase II and last through the duration of the First Increment of the Program. As new projects develop, the database contractor will work with principal investigators and Program staff during the creation of the study's protocol to develop the necessary forms and spreadsheets for data collection. This will ensure that the information collected from the project has a proper place in the database and can be linked to data collected by other projects according to a location in space and time.

VI.C. Database Quality Assurance/Quality Control (QA/QC)

QA/QC measures will be implemented for all database system components by the ED and staff. Observers will be responsible for inspecting his or her data forms for completeness, accuracy, and legibility. The study team leader will review data forms to insure completeness and legibility, and any problems detected will be corrected. Once the data has been submitted to the database manager for inclusion in the database, the manager will review the submitted data for general quality, ensuring the proper fields have been included, units of measure are consistent with past data and missing values are appropriately labeled. Once data have been appended to the database, the manager will check the updated database for completeness and accuracy.

The database manager will check applications for data querying and retrieval periodically, ensuring that all components are functioning properly.

VI.D. Report Format

The DMBS manager will annually prepare a draft and final report describing the current state of the database management system including additions or modifications, troubles encountered, a record of uses in the past year, and suggestions for improvement of the database. The report will contain a summary table that displays the number of data/document submissions, average time from submission until the information is viewable on the web, number of users (i.e. general public, program participants), number of data queries and number of data downloads.

VI.E. Administration

Administration of DBMS will be delegated to the ED by the Governance Committee. Administration of the DBMS may or may not be further delegated to a contract manager depending on decisions to be made after initiation of the Program.

VI.F. Existing Data Evaluation

The database management system manager will review existing data for all projects to evaluate consistency and become familiar with current data collection protocol and recording formats. The developer will work with principal investigators to develop standardized raw data collection forms and formats for storing data electronically. Current protocol and raw data entry forms may not need revisions.

VI.G. Data Sheets

Principal investigators of existing projects will meet with the database manager to confirm that existing raw data entry sheets provide the necessary framework for good, consistent data collection. Data sheets will be developed for future projects after the project's goals and data collection protocol have been defined.

VII. ESTIMATED BUDGET

The current estimated budget for monitoring and research activities is contained in Table 1 and totals $30,006,275. Budget for implementing other aspects of the AMP, such as paid experts to serve on the ISAC, management actions, etc. are included in the overall Program budget (Program Attachment 1)

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Table 1. Identified protocols/activities and draft estimated budget for monitoring and research

Ref. No.	Protocol/Activity	Description, Responsible Party, and Schedule	13 year Budget	CEM Hypotheses
Geomorphology and Vegetation				
1	Monitoring the **channel geomorphology** of the Central Platte River valley	**Description:** Annual geomorpholocal (including flows) monitoring throughout the study area (system level monitoring) and more intensely on Program lands (Program level monitoring). **Responsible Party**: Program. **Schedule:** Monitoring will be conducted annual once the Program begins.	$877,500	PP-1, PP-2, PP-3
2	Monitoring the **vegetation** of the central Platte River Valley	**Description:** Annual vegetation monitoring throughout the study area (system level monitoring) and more intensely on Program lands (Program level monitoring), focusing on out-of channel areas. **Responsible Party:** Program. **Schedule:** Monitoring will be conducted annual once the Program begins.	$877,500	PP-1, PP-2, PP-3
3	Evaluate sediment erosion, transport, and deposition processes	**Description:** This study will obtain data on the hydraulic and sediment transport processes, especially the deposition and erosion along the river bed and banks, and the formation of bedforms, bars, and islands within the overall channel. The data will be analyzed using physical principals to develop an understanding of the sediment deposition and erosion processes acting on the river, with special emphasis on the habitat characteristics of open-view width and sandbar dimensions. **Responsible Party:** Program. **Schedule:** Research will begin once necessary lands are available and specific protocols can be written.	$2,302,344	PP-1, PP-2, PP-3

Ref. No.	Protocol/Activity	Description, Responsible Party, and Schedule	13 year Budget	CEM Hypotheses
4	Evaluate in-channel vegetation dynamics	**Description:** The vegetation dynamics study focuses primarily on developing an understanding of the processes of interaction between flow, sediment transport, and vegetation. To develop this understanding, an extension of existing vegetation demography investigation is included, along with investigations of the specific interaction between flow, sediment transport, and vegetation at locations where vegetation plots on the river would be established. Because of the inherent uncertainties and non-idealized conditions that exist when collecting data in the field, a laboratory component of data collection has been included. Further description provided in the Parsons/EIS Team report. **Responsible Party:** Program. **Schedule:** Research will begin once necessary lands are available and specific protocols are written.	$2,235,600	PP-1, PP-2, PP-3
5	Comprehensive geomorphic assessment from Lexington to Chapman, Nebraska	**Description:** This investigation will provide a qualitative and quantitative geomorphic assessment of the Platte River. Existing data will be compiled and a substantial amount of new data on the current and historical form of the river will be collected, focusing primarily on the reach from Lexington to Chapman with possible extensions upstream and downstream. Development of a comprehensive assessment of the river's form and processes controlling the form are necessary precursors to implementation of any treatments intended to modify the river's form. The comprehensive geomorphologic assessment will also provide a forum for interaction among the various investigation components to allow development of an appropriate interpretation of the results of the various investigations regarding meeting of habitat objectives from a sediment, vegetation, and geomorphic perspective. Further description provided in the Parsons/EIS Team report. **Responsible Party:** Program. **Schedule:** Research will begin once necessary lands are available and specific protocols are written.	$3,570,905	PP-1, PP-2, PP-3

Ref. No.	Protocol/Activity	Description, Responsible Party, and Schedule	13 year Budget	CEM Hypotheses
6	Investigation of river restoration activities	**Description:** This study will test the performance and effects of pulse flows, measures to remove vegetated islands, and measures to create sand bars. The pulse flow would be tested in three phases: The first, initial phase would be to gather information on discharge wave travel times and wave attenuation and on river stage at locations where there is concern about potential flooding problems. Selected vegetated river islands would be cleared and lowered from each of four study reaches prior to the second pulse flow test. The second and third pulse flow tests would be conducted to study the removal of new vegetation on the river bed and sandbars, the building of new sandbars (with and without woody debris), and other sediment transport processes. Further description provided in the Parsons/EIS Team report. **Responsible Party**: Program. **Schedule:** Research will begin once necessary lands are available and specific protocols are written.	$1,607,526	PP-1, PP-2, PP-3
		Aerial Photography and GIS		
7	Protocol for Aerial Photography in the Central Platte Valley	**Description:** Provide aerial photographs at regular intervals throughout the Program for analysis in other protocols. Black and white photographs will be taken in even years and cover the 1 mile area on either side of the centerline of the river. CIR photographs will be taken in odd years and cover the 3.5 mile area on either side of the centerline of the river. **Responsible Party:** Program. **Schedule:** Aerial photography began in 2000 and will continue annually as described in the Protocol	$378,000	PP-1
8	Protocol for GIS Analysis of Ortho-rectified CIR Photography - with minimum land cover types as those included in 1998 analysis	**Description:** Create a land use/cover GIS layer with CIR photos taken at the end of the first increment. This protocol will use the CIR photos from reference no. 3 and includes ground truthing of cover and use types. This study will replicate the 1998 land use/cover procedure to facilitate a before-after study of land use. **Responsible Party:** Program. **Schedule:** GIS Analysis will occur near the end of the first increment using ortho-rectified photos.	$270,000	PP-1

Ref. No.	Protocol/Activity	Description, Responsible Party, and Schedule	13 year Budget	CEM Hypotheses
Least Terns and Piping Plovers				
9	Monitor potential and known nesting habitat, distribution and number of breeding pairs, and reproductive success of **least terns and piping plovers** in the central Platte valley	**Description:** Monitor annual presence of least terns and piping plovers in the study area (in-channel and pits), nesting attempts/success, fledge success, and habitat parameters at reproductive sites. **Responsible Party:** Program. **Schedule:** Monitoring using this protocol began in 2001 and will continue annually as described in the protocol.	$1,053,000	TP-1, TP-2, TP-3
10	Protocol for measuring channel habitat characteristics at **least tern and piping plover** nest/colony locations	**Description:** Monitoring colony characteristics to complement reference no. #9. The geomorphology monitoring transect methods (ref no. 1) will be used at each in-channel colony site. **Responsible Party:** Program. **Schedule:** Monitoring will begin when least terns and/or piping plovers are found nesting on natural islands within the river channel.	$202,500	TP-1, TP-2, TP-3
11	Monitor riverine prey base (fish) for **least terns**	**Description:** Collection of prey base information (e.g. species composition, distribution, habitat utilization). Data will be used in other protocol to determine relationship of flows on hab, pred, etc of prey base for tern and plover. **Responsible Party:** Program. **Schedule:** Monitoring to begin with Program implementation.	$526,500	TP-4
12	Determine relationship of flows on creation/maintenance of habitat, predation, nest inundation, and distribution, abundance and composition of prey base for **least terns and piping plovers.**	**Description:** Analysis of information from ref no. 1-6 on creation and maintenance of sandbar habitat; ref. no. 9 on predation, nest inundation; and from ref. no. 11 and 20 on abundance and composition of prey base to determine relationship with flow data from USGS/NEDNR. **Responsible Party:** Program. **Schedule:** Analysis will occur near the end of the first increment when sufficient information has been collected through implementation of above referenced protocols.	$540,000	PP-1, PP-2, PP-3, TP-1, TP-2, TP-3, TP-4

Ref. No.	Protocol/Activity	Description, Responsible Party, and Schedule	13 year Budget	CEM Hypotheses
13	Determine reproductive habitat requirements for **least terns and piping plovers** and if reproductive habitat is limiting in the central Platte valley (Considered very important, likely to be done later in Program)	**Description:** Reproductive habitat parameters will be collected as part of reference nos. 9 and 10 and can be used to define tern and plover habitat requirements. GIS could be used to determine the amount of this type of habitat to evaluate if it is limiting. **Responsible party:** Program. **Schedule:** analysis will occur near the end of the first increment when sufficient information has been collected through implementation of above referenced protocols.	$67,500	TP-1, TP-2, TP-3
14	Determine impacts limiting reproductive success of **least terns and piping plovers** in central Platte (Determined through analysis of monitoring data)	**Description:** Analysis of reproductive data and habitat data collected as part of reference numbers 9 and 10. **Responsible Party:** Program. **Schedule:** analysis will occur near the end of the first increment when sufficient information has been collected through implementation of above referenced protocols.	$81,000	TP-1, TP-2, TP-3
15	Determine the importance of riverine and non-riverine habitat to **piping plovers and least terns** (Determined through analysis of monitoring data)	**Description:** An analysis of nest numbers, fledge success, etc collected as part of ref. no. 9 and 10 to the amount of riverine and non-riverine habitat available. Amounts of habitat from aerial photos (GIS) and/or airboat surveys to be conducted as part of reference no. 3-6. **Responsible Party:** Program. **Schedule:** analysis will occur near the end of the first increment when sufficient information has been collected through implementation of above referenced protocols.	$105,300	TP-1, TP-2
16	Identify limiting factors to prey bases for **least terns and piping plovers**	**Description:** Analysis of data collected through ref. No. 11, 17, 18, 19, 20 and protocols collecting physical habitat data within the channel. **Responsible Party:** Program. **Schedule:** analysis will occur near the end of the first increment when sufficient information has been collected through implementation of above referenced protocols.	$175,500	TP-4
17	Determine effects of temperature on **least tern** prey base (fish) (Secondary consideration to The Effect of Flow on Temp which is covered by another protocol)	**Description:** Research study will be a combined field and laboratory (if published information not available for correct species) exercise. Will need to follow studies to determine prey species, abundance, composition, and effects of flow on temperature. **Responsible Party:** Program. **Schedule:** analysis will occur near the end of the first increment when sufficient information has been collected through implementation of above referenced protocols.	$405,000	TP-4

Ref. No.	Protocol/Activity	Description, Responsible Party, and Schedule	13 year Budget	CEM Hypotheses
18	Determine effects of temperature on **piping plover** prey base (insects)	**Description:** Research study will be a combined field and laboratory (if published information not available for correct species) exercise. Will need to follow studies to determine prey species, abundance, composition, etc. **Responsible Party:** Program. **Schedule:** analysis will occur near the end of the first increment when sufficient information has been collected through implementation of above referenced protocols.	$405,000	TP-4
19	Determine availability of prey base in non-riverine reproductive habitats for **least terns**	**Description:** Study will research the abundance and composition of fish found in sandpits and other non-riverine areas available to terns. Study should include correct sampling methods to look at availability in the water column. **Responsible Party:** Program. **Schedule:** Protocol will be developed and implemented after necessary sandpits are selected and access gained.	$236,250	TP-4
20	Determine availability of prey base in non-riverine reproductive habitats for **piping plovers**	**Description:** Study will research the abundance and composition of prey (insects) for piping plovers found in sandpits and other non-riverine areas available to plovers. **Responsible Party:** Program. **Schedule:** Protocol will be developed and implemented after necessary sandpits are selected and access gained.	$236,250	TP-4
21	Determine if prey base availability limit **least tern and piping plover** populations	**Description:** Analysis of field information gathered under reference no. 11, 17, 18, 19, 20 and flow information. Also includes a study to watch foraging terns and plovers to determine foraging rates/distances. **Responsible Party:** Program. **Schedule:** analysis will occur near the end of the first increment when sufficient information has been collected through implementation of above referenced protocols and a protocol has been written to collect data on foraging terns and plovers.	$175,500	TP-4
		Whooping Cranes		
22	Monitor changes in quantity, quality, and distribution of **whooping crane** migrational habitat over time. Parameters will be defined using GIS protocols (covered by GIS)	**Description:** Analysis of information from whooping crane habitat use (ref no. 23) and the post-first increment land cover/use GIS layers (ref no. 8) to determine the spatial distribution of migrational habitat. **Responsible Party.** Program. **Schedule:** GIS Analysis will occur near the end of the first increment using ortho-rectified photos.	$0	WC-1, WC-2, WC-3, PP-1, WC-4

Ref. No.	Protocol/Activity	Description, Responsible Party, and Schedule	13 year Budget	CEM Hypotheses
23	Monitor **whooping crane migrational habitat use.**	**Description:** Document characteristics of use habitat, monitor activity at use sites and estimate an index of the amount of use. **Responsible Party:** Program. **Schedule:** Monitoring using this protocol begin in 2001. Monitoring will continue annual during the Program.	$2,632,500	WC-1, WC-2, WC-3, PP-1, WC-4
24	Monitor physical and structural characteristics of loafing, foraging, and roosting **whooping crane** migrational habitat (Covered by habitat use protocol)	**Description:** All whooping crane use areas are covered as part of Whooping Crane Use Monitoring Protocol, ref. No. 23. **Responsible Party:** Program. **Schedule:** Monitoring using this protocol begin in 2001. Monitoring will continue annual during the Program.	$0	WC-1, WC-2, WC-3,
25	Conduct thorough analyses of existing databases to update current understanding of **whooping crane** habitat use and behavior during migration (Currently being conducted by NGPC)	**Description:** Review of existing data related to whooping crane habitat used during migration. **Responsible Party:** NGPC **Schedule:** Complete. Report done by Jane Austin and Amy Richert (2001).	$0	WC-1, WC-2, WC-3, WC-4
26	Determine **whooping crane/tern/plover** habitat response to site-specific restoration activities. Species will be targeted by specific protocols.	**Description:** This study will analyze data collected from species use protocols to determine the relationship between the use of restored/managed areas (including management and restoration techniques) with flow data, land use/cover data (program land use), population data, and other data. **Responsible Party:** Program. **Schedule:** Monitoring and research activities will begin after Program restoration activities have been implemented.	$405,000	WC-1, WC-2, WC-3, WC-4, TP-1, TP-2, TP-3

Ref. No.	Protocol/Activity	Description, Responsible Party, and Schedule	13 year Budget	CEM Hypotheses
27	Determine factors affecting **whooping crane** distribution and habitat use in the central Platte River valley (Determined using monitoring data)	**Description:** This study will analyze data collected from whooping crane migrational use protocol (ref. no. 23) and other whooping crane use information to determine the relationship in spatial use patterns with flow data, Land use/cover data (program land use), and population data. **Responsible Party:** Program. **Schedule:** Analysis will occur near the end of the first increment after sufficient data have been collected through whooping crane use monitoring protocol, other studies, and as part of the GIS analysis.	$0	WC-1, WC-2, WC-3, WC-4
28	Determine relationships between river stage and wet meadow hydrology for **whooping crane** habitat	**Description:** This will be a more refined and site specific investigation on wet meadow hydrology based on information from the COHYST/other studies of wet meadows at various distances from the river. **Responsible Party:** Program. **Schedule:** Research will be conducted when suitable wet meadow sites are protected or restored on Program lands.	$135,000	WC-1, WC-2, WC-3, PP-4
29	Determine relationships between wet meadow hydrology and the physical, biological, and chemical composition of wet meadows for **whooping crane** habitat (i.e., wet meadow quality)	**Description:** Research was conducted on existing wet meadows within the central Platte region by the USGS. This research will augment the existing information on wet meadow quality issues in the Platte River associated habitat in combination with protocol 28. **Responsible Party.** Program **Schedule:** Research will be conducted when suitable wet meadow sites are protected or restored on Program lands	$1,000,000	PP-4, WC-1, WC-4
30	Determine relative importance, quality, quantity, and distribution of wet meadows and other semi-aquatic habitats to migrating **whooping cranes** in the central Platte valley.	**Description:** This study will analyze data collected from whooping crane migrational use protocol (ref. No. 23) to look at use (i.e., importance) of all habitat types. **Responsible Party.** Program. **Schedule:** Analysis will be conducted during the Program (e.g., near the end of the first increment) when sufficient data have been collected on whooping crane use.	$0	WC-1, WC-3
31	Determine the importance of **whooping crane** habitat along the central Platte River to the recovery of the species	**Description:** Program needs feedback on the relative importance of the Platte River when considered with all sites along the migrational corridor. **Responsible Party:** USFWS **Schedule:** On-going. Part of NAS review.	$0	WC-1, WC-4

Ref. No.	Protocol/Activity	Description, Responsible Party, and Schedule	13 year Budget	CEM Hypotheses
Pallid Sturgeon				
32	Quantification of **pallid sturgeon** habitats available in the lower Platte	**Description:** Identify the physical effects of subtly different rates of flow (stage and associated elements) over time on connection, construction, maintenance, and evolution of pallid sturgeon habitat components. Data need is pursuant to developing appropriate offsets for flow reductions stemming from implementation of the Program and New Depletion Plans. **Responsible Party:** Program. **Schedule:** Mapping will begin within the first few years of the Program.	$810,000	PS-1
33	Characterization of selected water quality parameters in the **lower Platte** and tributary contributions	**Description:** This study builds on current monitoring. Monitor the variation, both spatially and temporally of selected water quality parameters (e.g. temperature, turbidity, dissolved oxygen, and specific conductivity) in the lower Platte River as well as the relative contributions of the individual sub-basins to lower Platte water quality parameters using established methodologies. **Responsible Party:** Program. **Schedule:** Annual Monitoring beginning with Program implementation.	$491,400	PS-1, PS-2
34*	Quantification/modeling of **pallid sturgeon** habitats available in the lower Platte	**Description:** Identify and quantify the distribution of micro-habitat types available in the lower Platte River. **Responsible Party:** Program. **Schedule:** This effort is expected to be based on information gained in item 36 and review of other information.	$337,500	PS-1, PS-2
35	**Pallid sturgeon** existing information summary	**Description:** Assemble and summarize, where appropriate, the existing information on pallid sturgeon biology. This effort should encompass information gathered throughout the specie's range, but particular emphasis should be placed on information from the Platte River. **Responsible Party:** Program. **Schedule:** Review will be conducted within the first year of the Program.	$32,400	PS-1, PS-2, PS-3

Ref. No.	Protocol/Activity	Description, Responsible Party, and Schedule	13 year Budget	CEM Hypotheses
36	Micro- and macro-habitat use/selection by adult and juvenile **pallid sturgeon**, relative to conditions	**Description:** This study builds on current research to capture wild pallid sturgeon, implant transmitters, and track their movements upon release. This will allow the identification of micro- and macro-habitats, and habitat setting (e.g. position in relation to other channel features) used by wild pallid sturgeon in the lower Platte River and confluence area, as well as identify changes in habitat use relative to conditions. Established protocols may be incorporated and data transfer/sharing with Missouri River research will be facilitated. **Responsible Party:** Program. **Schedule:** Research will begin in first year of Program.	$2,623,050	PS-1
37*	**Pallid sturgeon** food habits	**Description:** This study builds on current research. Analyze stomach contents using non-lethal techniques. **Responsible Party:** Program. **Schedule:** This effort is expected to be based on information gained in item 36 and review of other information.	$24,300	PS-1
38*	Characterize the relationship of flow regime and sediment transport to habitat creation/ maintenance in the **lower Platte River**	**Description:** Investigate the relationship between flow regime and sediment transport to creation and maintenance of habitat in the lower Platte River. This effort should adapt and build on methodologies used by USGS and NGPC for efforts in the Platte River. **Responsible Party:** Program. **Schedule:** This effort is expected to be based on information gained in item 36 and review of other information.	$432,000	PS-1, PS-2
39*	**Pallid sturgeon** larval collection & identification of spawning habitat	**Description:** This study builds on current research. Larval pallid sturgeon should be collected using established protocols. Sampling will be targeted in areas of pallid sturgeon use as identified in item 36. Samples should be preserved in ethanol or other fixative that does not preclude DNA analysis, and sturgeon will be separated for DNA analysis. **Responsible Party:** Program. **Schedule:** This effort is expected to be based on information gained in item 36 and review of other information.	$1,048,950	PS-1

Ref. No.	Protocol/Activity	Description, Responsible Party, and Schedule	13 year Budget	CEM Hypotheses
40*	Characterize relationship between **central Platte and lower Platte** flows	**Description:** This item is listed here because it is part of the broader pallid sturgeon research plan, but the associated tasks will be addressed by the Water Management Committee. This is a refinement of the "Testing the Assumption" analysis. Refine the current analysis to be usable in real time and improve accuracy for use with refined habitat use knowledge gained through items 36, 37, 38 and 42. Refinements are expected within the first increment. **Responsible party:** Program. **Schedule:** This effort is expected to be based on information gained protocols idenified above and review of other information.	$0	PS-2
		Other Species of Concern		
41	Monitor and evaluate the status of **other listed and non-listed species and other habitats** using existing information for throughout the region and through measurement on Program lands	**Description:** Protocol for proceedure to contact various agencies/groups and reporting on information on "other species of concern" in the study area to evaluate Program management and other activities. For Program lands protocols will be written to monitor the impact of Program management on other species of concern (e.g., neotropical migrants) **Responsible party:** Program. **Schedule:** Annual during the Program	$1,475,500	Other Species CEM's and Hypotheses not drafted
		Database		
42	Design, implement, and maintain a **database** for long-term storage and retrieval of data and reports generated through monitoring and research activities	**Description:** Database design, requirements for implementation, and maintenance needs for a spatially referenced, internet accessable, quality assured and quality controled warehouse for datas collected during research and monitoring. **Responsible Party:** Program. **Schedule:** Ongoing during the Program.	$1,755,000	All

Ref. No.	Protocol/Activity	Description, Responsible Party, and Schedule	13 year Budget	CEM Hypotheses
Water Quality				
43	Design and implement a water quality monitoring program	**Description:** Design and implement a water quality monitoring program to augment existing local, State, and Federal water quality monitoring efforts in the region. Focus will be related to Program lands **Responsible Party:** Program. **Schedule:** Ongoing during the Program.	$475,000	All
	Grand Total		$30,006,275	

Table 2. List of Priority Hypotheses.

X-Y Graph number	Link to CEM Hypotheses	Description of hypothesis	Description of alternative/competing hypotheses	Rationale based on Prioritization Criteria
System				
S1	S-1, S-2	The Platte River form can be modified by either mechanical/sediment/flow management (i.e., clear/level/ pulse) or mechanical means along with non-Program managed flows (i.e., clear/level/mechanical).		Influence Program management, goals, and objectives
S1a	S-1, S-2, S-4	Program channel habitat restoration actions will result in detectable change to Platte River form and function	Can not detect a significant effect on indicators	Influence Program management, goals, and objectives
S1b	S-3	Program land management actions (i.e., restoration into habitat complexes) will have a detectable effect on target birds species use of the associated habitats	Can not detect a significant effect on indicators	Influence Program management, goals, and objectives
S1c	S-1, S-2	Program actions will increase functional wet meadows in habitat complexes during the first increment		Influence Program management, goals, and objectives
S2	S-1, S-2	Implementing Program land and water management actions (i.e., habitat complexes and clear/level/pulse) will have a detectable effect on other species use of the associated habitats	Within the overall management objectives for whooping crane, terns and plovers, and pallid sturgeon, benefits can be provided to non-target listed species and non-listed species of concern thereby reducing the likelihood of future listing and improve overall ecosystem diversity.	Influence Program management, goals, and objectives

X-Y Graph number	Link to CEM Hypotheses	Description of hypothesis	Description of alternative/competing hypotheses	Rationale based on Prioritization Criteria
Terns and Plover				
T1	TP-1, TP-2, TP-3	Additional bare sand habitat will increase the number of adult least terns.	bare sand is not currently limiting number of adults	Critical path for Program goals and objectives
T2	TP-4	Tern productivity is related to the number of prey fish (<3 inches) and fish numbers limit tern production below 800 cfs from May-Sept.	prey fish do not limit tern production at 799 cfs or tern production is limited by summer flows of < 50 cfs	On critical path for Program, will influence future water management
T2a	TP-4	Flow rates influence the number and species diversity in tern prey base (fish).	tern productivity not affected by fish community species diversity	On critical path for Program, will influence future water management
P1	TP-1, TP-2, TP-3	Additional bare sand habitat will increase the number of adult piping plover.	bare sand is not currently limiting number of adults	Critical path for Program goals and objectives
P2	TP-4	Plover productivity is related to the number of suitable macroinverts and macroinverts limit plover production below 800 cfs from May-Sept.	macroinverts do not limit plover production at 799 cfs or plover production is limited by summer flows of < 50 cfs	On critical path for Program, will influence future water management
TP 1	TP-2	Interaction of river and sandpit habitat.	LT and PP show no preference for the river over sandpits	Address areas of disagreement
TP 2	TP-1, TP-2, TP-3	The central Platte River may act as a source or sink for terns and plovers.	currently not a sink	Will be addressed through current monitoring effort
TP 4d	TP-1, TP-2	Correlation between river island habitat and flow.		Address areas of disagreement, potential impacts to Program management
TP 5	TP-1	Use of riverine islands by least terns and piping plovers will increase with active channel width.	use will not increase with channel width	Will influence Program management
Whooping Cranes				
WC 1	WC-1, WC-2, WC-3	Whooping Crane use will increase as function of Program land and water management activities.	Whooping Crane use will not increase as function of Program land and management activities.	Influences Program management

X-Y Graph number	Link to CEM Hypotheses	Description of hypothesis	Description of alternative/competing hypotheses	Rationale based on Prioritization Criteria
WC 3	WC-1, WC-2, WC-3	Whooping crane use is related to habitat suitability.The prediction of habitat suitability for whooping crane in channel habitat as a function of water depth (preferred depth?) and channel width (define as wetted width, open width other?)	WC use of areas is not directly linked to FWS habitat suitability values	Influences Program management and Program goals and objectives
WC 4	WC-3	Whooping crane use of the central Platte River study area will increase proportionally to an increase in wet meadows	WC do not use wet meadows currently and are unlikely to respond to increases in wet meadow area	Influence Program goals and objectives
WC 5	WC 4	Whooping cranes are adversely affected by nocturnal disturbances that lead to flushing (walking or flying) which could lead to potential mortality.	WC are not negatively impacted by nocturnal disturbances	High degree of disagreement
Pallid Sturgeon				
PS-1	PS-1, PS-2	Program flow/sediment management will result in a positive species response by the pallid sturgeon in the lower Platte River.	Program flow/sediment management will result in no increase in species use/occurrence by the pallid sturgeon in the lower Platte River.	Influences Program management and Program goals and objectives
PS-2	PS-2	Program water management will result in measurable changes on flow in the lower Platte River.	Program water management will result in statistically insignificant changes on flow in the lower Platte River	Influences Program management and Program goals and objectives
PS-4	PS-1, PS-2	Flows in the lower Platte will affect pallid sturgeon habitat suitability.	Flows in the lower Platte River will have no effect on pallid sturgeon habitat suitability	Influences Program management and Program goals and objectives
PS-5	PS-1	Pallid sturgeon habitat suitability is maximized between water temperatures of X and Y in the lower Platte River.	pallid sturgeon use is independent of river water temperature	Influences Program management and Program goals and objectives

X-Y Graph number	Link to CEM Hypotheses	Description of hypothesis	Description of alternative/competing hypotheses	Rationale based on Prioritization Criteria
PS-6	PS-1, PS-2	Increasing flow in the lower Platte will affect pallid sturgeon habitat availability.	increasing flow in the lower Platte River will have no effect on pallid sturgeon habitat availability	Influences Program management and Program goals and objectives
PS-7	PS-1	Increasing habitat availability in the lower Platte will increase pallid sturgeon use.	pallid sturgeon use is independent of lower Platte River habitat availability	Influences Program management and Program goals and objectives
PS-9	PS-2	Increasing Program flow releases will decrease water temperatures in the lower Platte River.	River water temperature is independent of flow rate in the lower Platte River Increases in program flow releases will increase water temperatures on the lower Platte River	Influences Program management and Program goals and objectives
PS-11	PS-3	Non-Program actions (e.g., harvest, stocking, Missouri River conditions) determine the occurrence of pallid sturgeon in the lower Platte River	Program actions will affect the rate of occurrence of pallid sturgeon in the lower Platte River such that use is disproportionate to external factors (e.g., stocking, harvest, local conditions) relative to local population.	Influences Program management and Program goals and objectives
Physical Processes - Flow				
Flow #1	PP-1	Increasing the variation between river stage at peak (indexed by Q1.5 flow at Overton) and average flows (1,200 cfs index flow), by increasing the stage of the peak (1.5-yr) flow through Program flows, will increase the height of sand bars between Overton and Chapman by 30% to 50% from existing conditions.	Flow magnitudes and channel compilations are insufficient to generate bars high enough to provide habitat for LT and PP. Bars may quickly vegetate making them poor habitat for target species. Bars can be created/maintained by mechanical/other means.	Fundamental to testing the Flow, sediment, mechanical strategy

X-Y Graph number	Link to CEM Hypotheses	Description of hypothesis	Description of alternative/competing hypotheses	Rationale based on Prioritization Criteria
Flow #3	PP-1	Increasing 1.5-yr Q with Program flows will increase local boundary shear stress and frequency of inundation at existing green line (elevation at which riparian vegetation can establish). These changes will increase riparian plant mortality along margins of channel, raising elevation of green line. Raised green line = more exposed sandbar area and wider unvegetated main channel.	Insufficient Program flows to adequately increase shear stress on banks. Plant mortality can be achieved by other means.	Fundamental to testing the Flow, sediment, mechanical strategy
Flow #4	PP-1	Annual riparian seedling mortality greater than 90% is required to prevent riparian encroachment on exposed bars, thereby increasing (maintaining at least 10 acres/mile) exposed bars between Overton and Grand Island that are usable as LT and PP habitat.	Riparian seedling mortality greater than 90% is needed to increase exposed bar area. Other factors drive exposed bar area instead of seedling mortality. Plant mortality can be achieved by other means.	Fundamental to testing the Flow, sediment, mechanical strategy
Flow #5	PP-1	Increasing magnitude and duration of a 1.5-yr flow will increase riparian plant mortality along the margins of the river. There will be different relations (graphs) for different species.	Insufficient Program flows to maintain required flow durations. Plant mortality can be achieved by other means.	Fundamental to testing the Flow, sediment, mechanical strategy

X-Y Graph number	Link to CEM Hypotheses	Description of hypothesis	Description of alternative/competing hypotheses	Rationale based on Prioritization Criteria
Physical Processes - Sediment				
Sediment #1	PP-2	Average sediment augmentation nr Overton of 185,000 tons/yr under existing flow regime and 225,000 tons/yr under Governance Committee proposed flow regime achieves a sediment balance to Kearney.	Augmentation greater than or less than 225,000 tons/year is needed to balance the sediment budget and increase exposed bar area. There is no sediment imbalance. Exposed bar area or occurrence of braiding will not be affected by increased sediment. Sediment balance is insignificant except in local instances. Satisfactory bar areas can be created and maintained through strictly mechanical actions.	Fundamental to testing the Flow, sediment, mechanical strategy
Sediment #2	PP-2	A balanced sediment budget (sediment augmentation of 225,000 tons/year near Overton under proposed Governance Committee flows) when implemented with mechanical actions (channel consolidation & widening) in anastomosed reaches will promote braided channel morphology with an average braiding index in the main channel of greater than 3.	Flows and sediment augmentation are insufficient to achieve desired braiding index.	Fundamental to testing the Flow, sediment, mechanical strategy
Sediment #3	PP-2	Increasing the average braiding index of the main channel by achieving a balanced sediment budget, increases the active unvegetated width of the main channel at an index flow of 2,000 cfs(at Overton).	Width will not change with increasing braiding index	Fundamental to testing the Flow, sediment, mechanical strategy

X-Y Graph number	Link to CEM Hypotheses	Description of hypothesis	Description of alternative/competing hypotheses	Rationale based on Prioritization Criteria
Sediment #4	PP-2	Increasing the average braiding index to greater than 3 for the main channel in the sediment deficient reach near Overton will increase and maintain exposed bar area greater than 1.5 acres in the reach between Overton and Kearney at an index flow of 1,200 cfs (at Overton).	There is no relationship between braiding index and area of exposed bars. Exposed bars may be created (maintained) through mechanical means without need to change braiding index.	Fundamental to testing the Flow, sediment, mechanical strategy
Physical Processes - Mechanical				
Mechanical #2	PP-3	Increasing the Q1.5 in the main channel by consolidating 85% of the flow, and aided by Program flow and a sediment balance, flows will exceed stream power thresholds that will convert main channel from meander morphology in anastomosed reaches, to braided morphology with an average braiding index > 3.	Higher stream power (higher 1.5 yr Q and/or more consolidation of side channels) needed to convert channel to braided morphology. Lower stream power will convert channel to braided morphology	Fundamental to testing the Flow, sediment, mechanical strategy
Mechanical #3	PP-3	Reducing the number of channels in a transect to 3 or less under balanced sediment budget will convert anastomosed reaches of the Platte River between Overton and Chapman to a braided channel morphology. With proposed flow regime, should occur with greater number of channels	Reducing the number of channels in a transect to 1 or 2 is necessary to achieve an average braiding index in the main channel of greater than 3.	Fundamental to testing the Flow, sediment, mechanical strategy

X-Y Graph number	Link to CEM Hypotheses	Description of hypothesis	Description of alternative/competing hypotheses	Rationale based on Prioritization Criteria
Mechanical #4	PP-3	Increasing the average braiding index to greater than 3 in the main channel by channel manipulation will promote in the Platte River at the mechanically changed sites a total main channel wetted width exceeding 500 to 750 ft at an index flow of 1,700 cfs (at Overton).	A braiding index greater then 4 is needed to achieve a width greater than 500 ft There is no relation between braiding index and channel width	Fundamental to testing the Flow, sediment, mechanical strategy
Mechanical #5	PP-3	Increasing the average braiding index to greater than 3 for the main channel by mechanical channel manipulation, will increase and maintain exposed bar area greater than 1.5 acres at mechanical changed sites at an index flow of 1,200 cfs (at Overton).	Mechanically consolidating flows will have no effect on areal extent of bars.	Fundamental to testing the Flow, sediment, mechanical strategy
Wet Meadows				
WM-2	PP-4	Wet meadows producing the optimum productivity and diversity of macro-invertebrates potentially consumed by WC exhibit certain characteristic combinations of soils, hydrology, size and location. Mormon Island and adjacent to Rowe Sanctuary have some of best existing combinations	There are too many possible combinations of site characteristics to allow for a meaningful characterization of “desirable” conditions.	Basic information need to evaluate what conditions in wet meadows are important for productivity that is meaningful to WC use, Help inform what sites to acquire and/or protect/restore.
WM-3	PP-4	Shallow surface water and groundwater in March and April support high productivity and diversity of macroinvertebrates as potential food sources to WC in wet meadows.		Basic information need to evaluate what conditions in wet meadows are important for productivity that is meaningful to WC use, Help inform what sites to aquire and/or protect/restore.

X-Y Graph number	Link to CEM Hypotheses	Description of hypothesis	Description of alternative/competing hypotheses	Rationale based on Prioritization Criteria
WM-4	PP-4	A predominance of organic-rich soils supports the productivity and diversity of macro-invertebrates as potential WC food sources in bottomland grasslands.	Wet meadows and their soils are too complex and variable to allow this individual factor to be effectively assessed.	Basic information need to evaluate what conditions in wet meadows are important for productivity that is meaningful to WC use, Help inform what sites to acquire and/or protect/restore.
WM-8a	PP-4	As the spring depth to groundwater increases, surface soils stay frozen longer. Where groundwater is closer to the surface soils thaw sooner.		Each site will respond to river channel stage uniquely, this hypothesis is a prerequisite to many of the other hypotheses (if there is no response from program actions, it becomes less important)

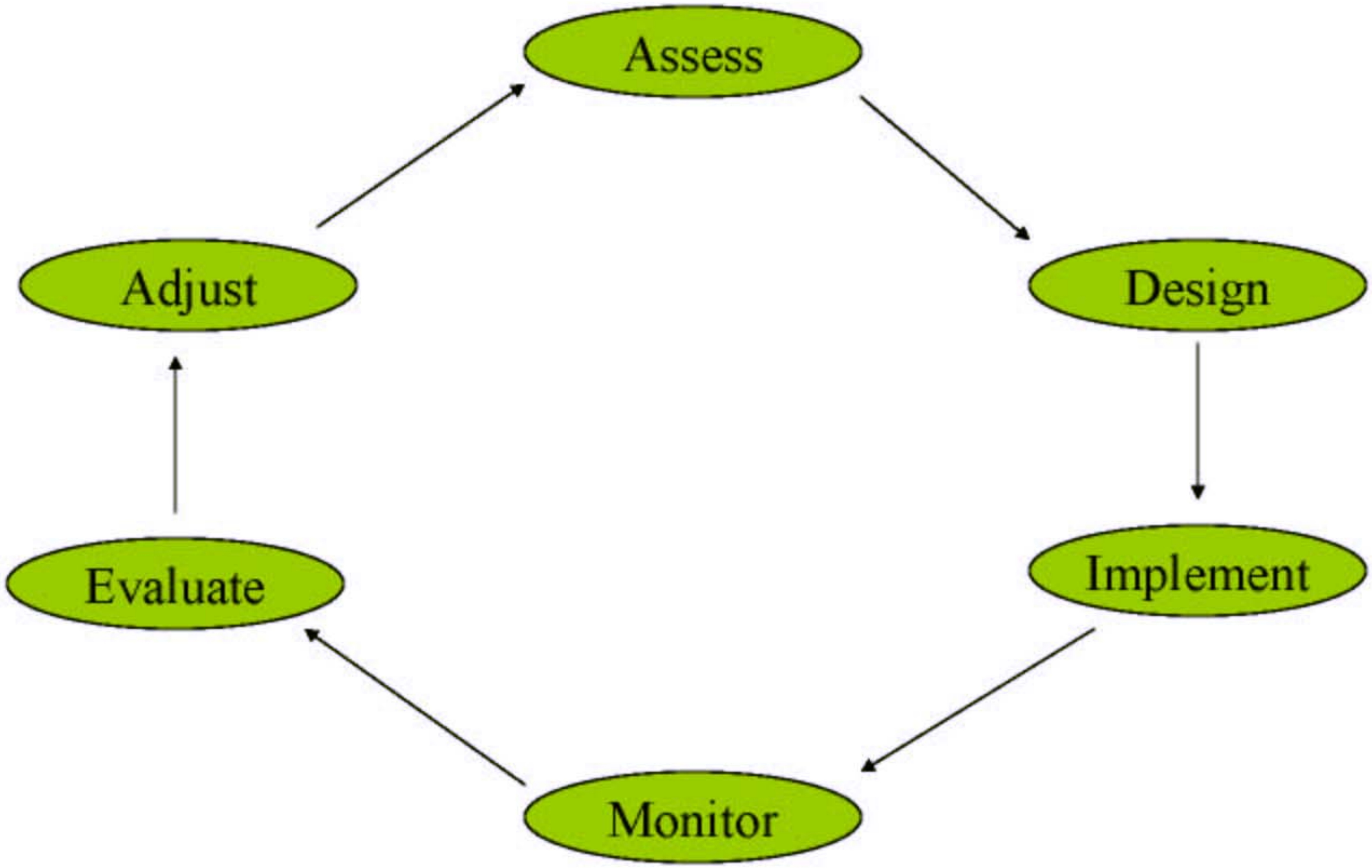


Figure 1a. Six steps of adaptive management (Nyberg 1999).

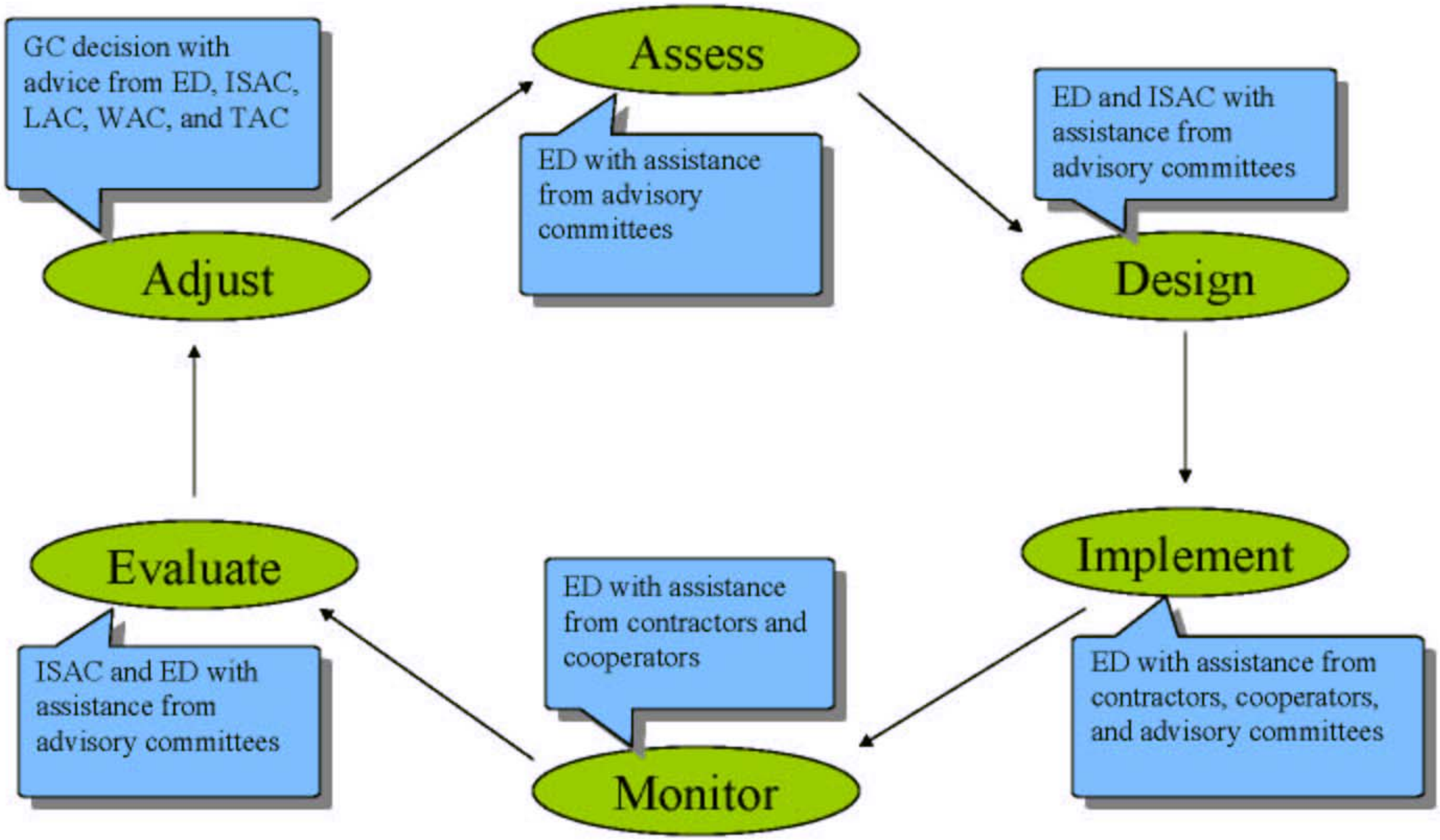


Figure 1b. Six steps of adaptive management and task assignments for the Program (modified from Nyberg 1999)

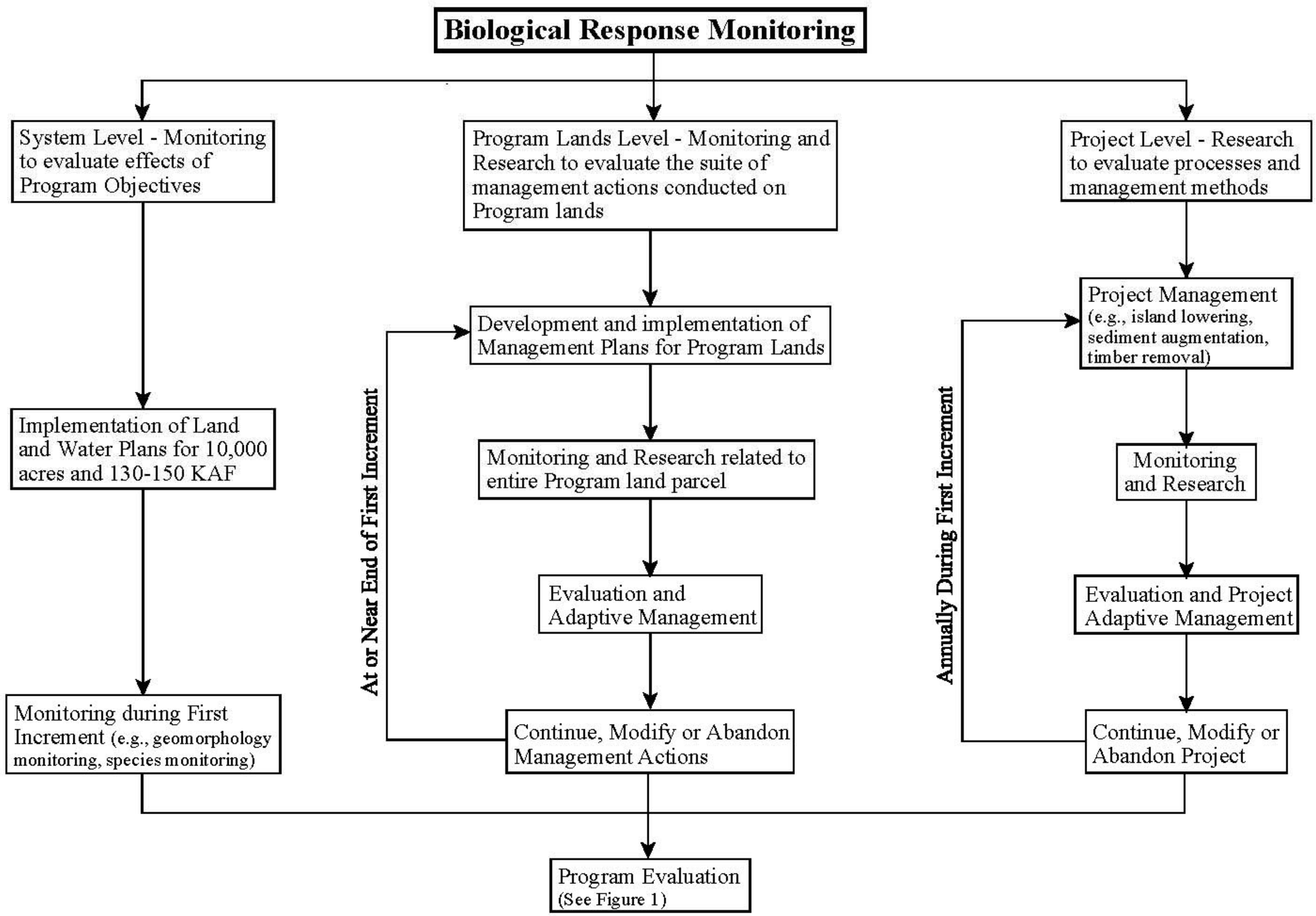


Figure 2. Biological response monitoring and adaptive management during Program

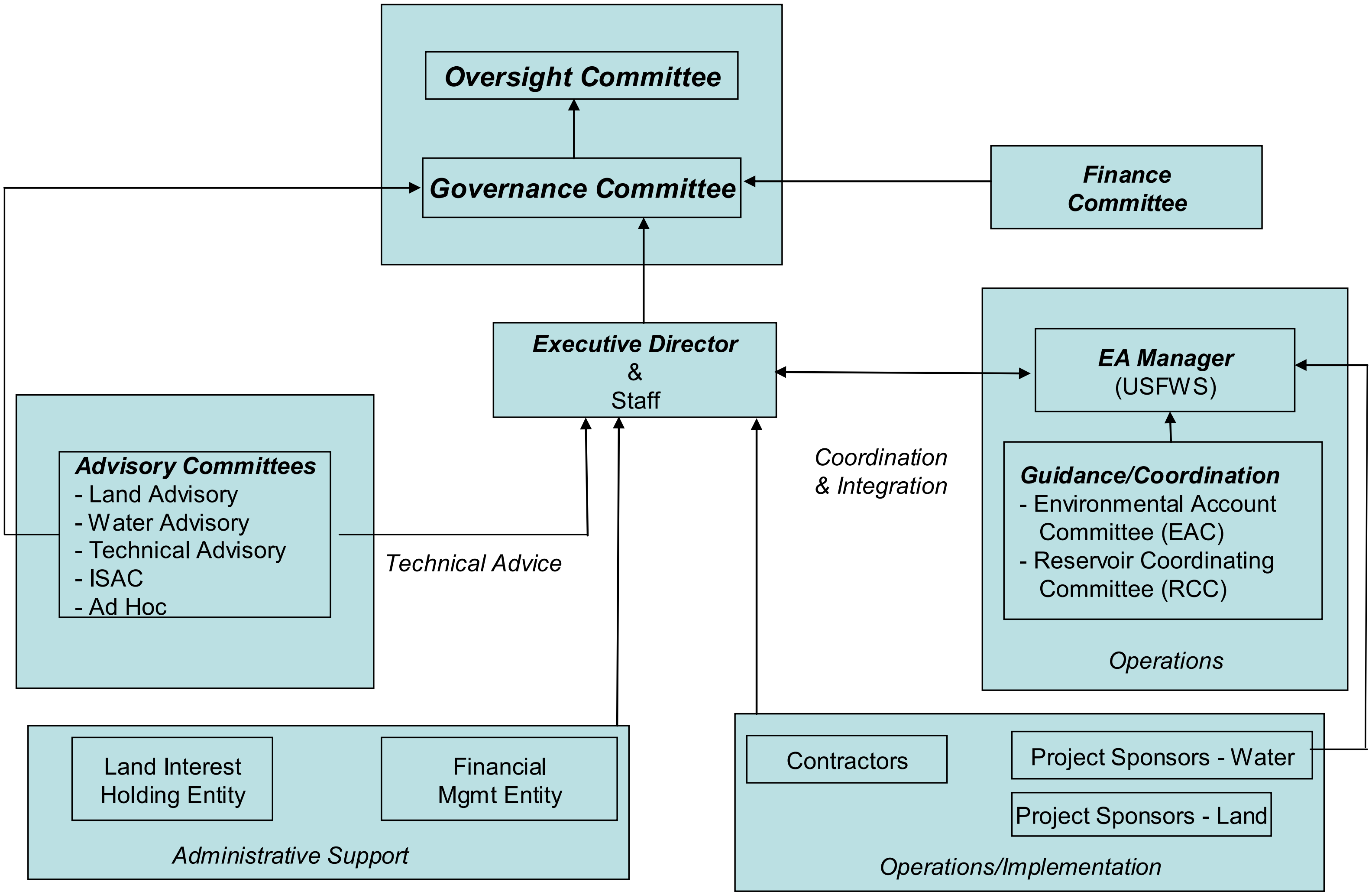


Figure 3. Figure from Organizational Structure Document.

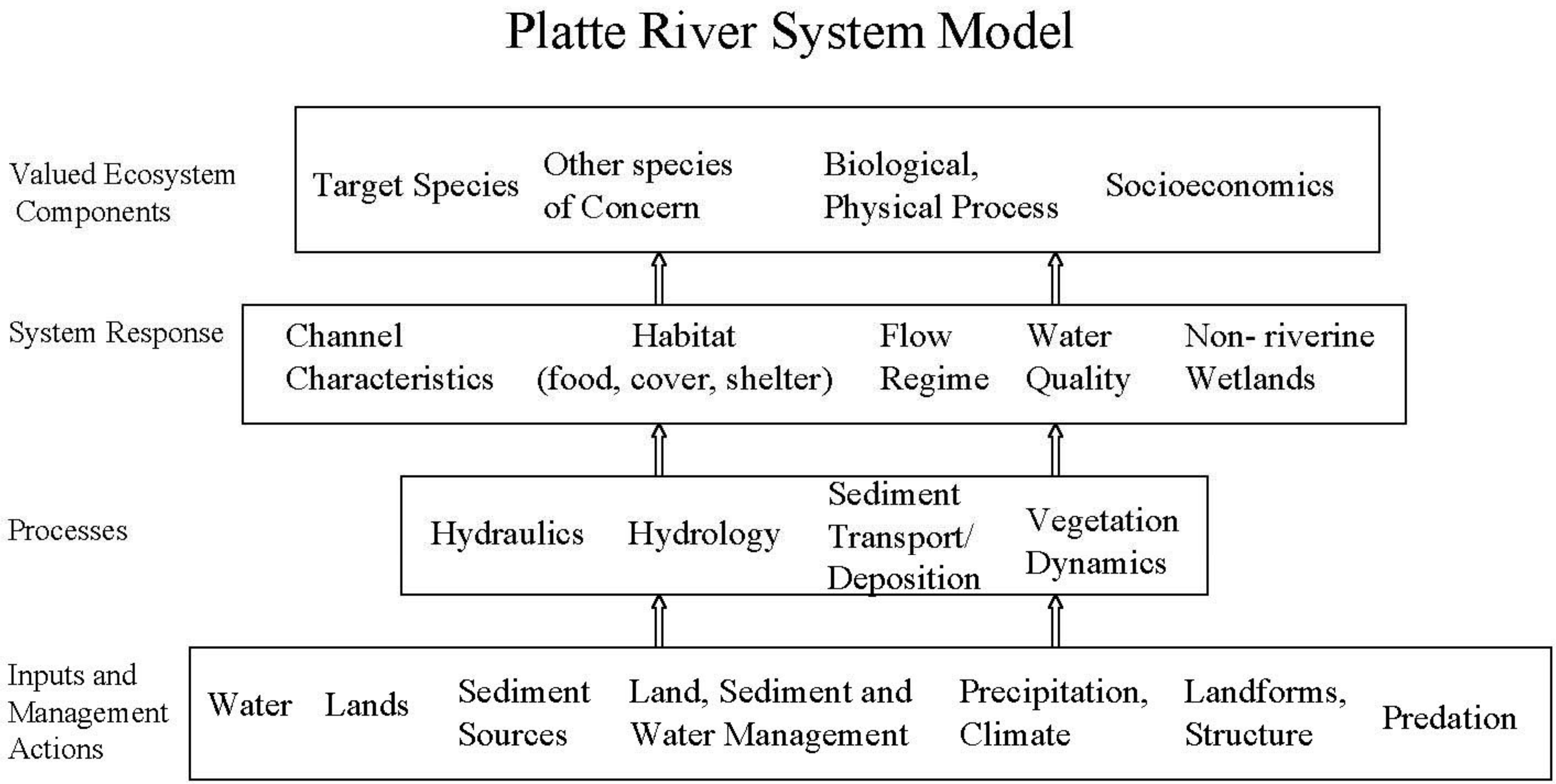


Figure 4. Platte River system conceptual ecological model.

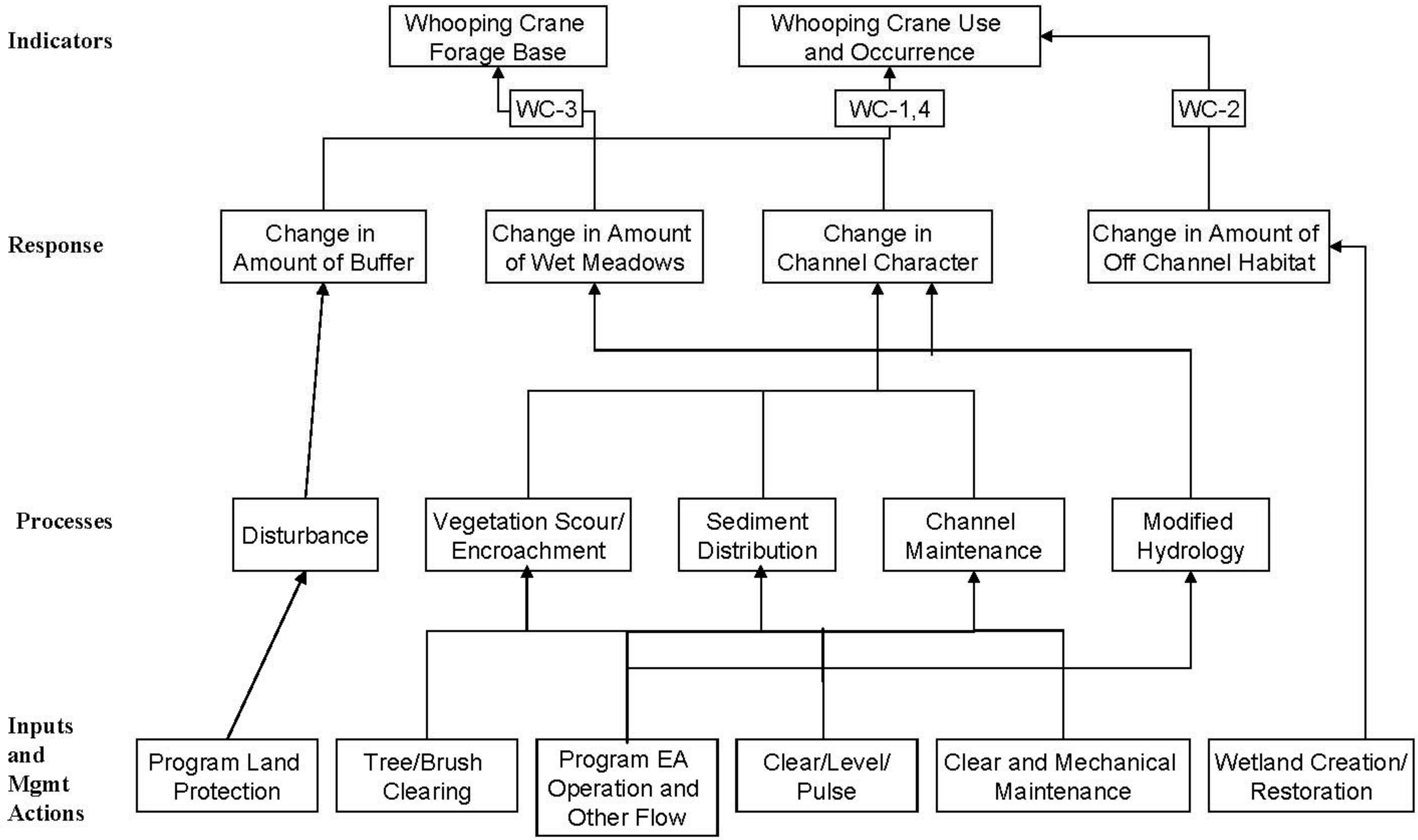


Figure 5. Whooping crane conceptual ecological model (including example locations for current hypotheses).

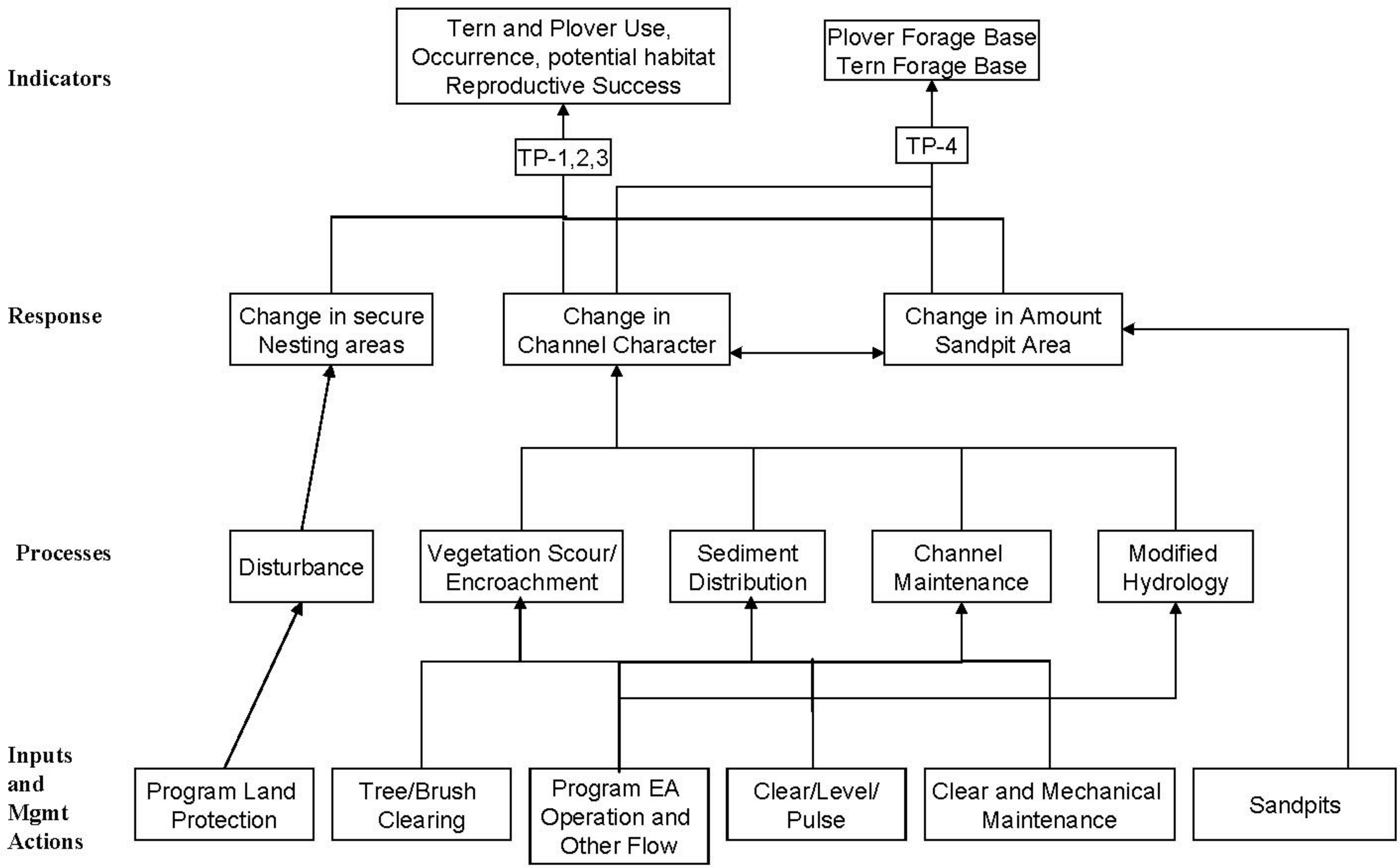


Figure 6. Least tern and piping plover conceptual ecological model (including example locations for current hypotheses).

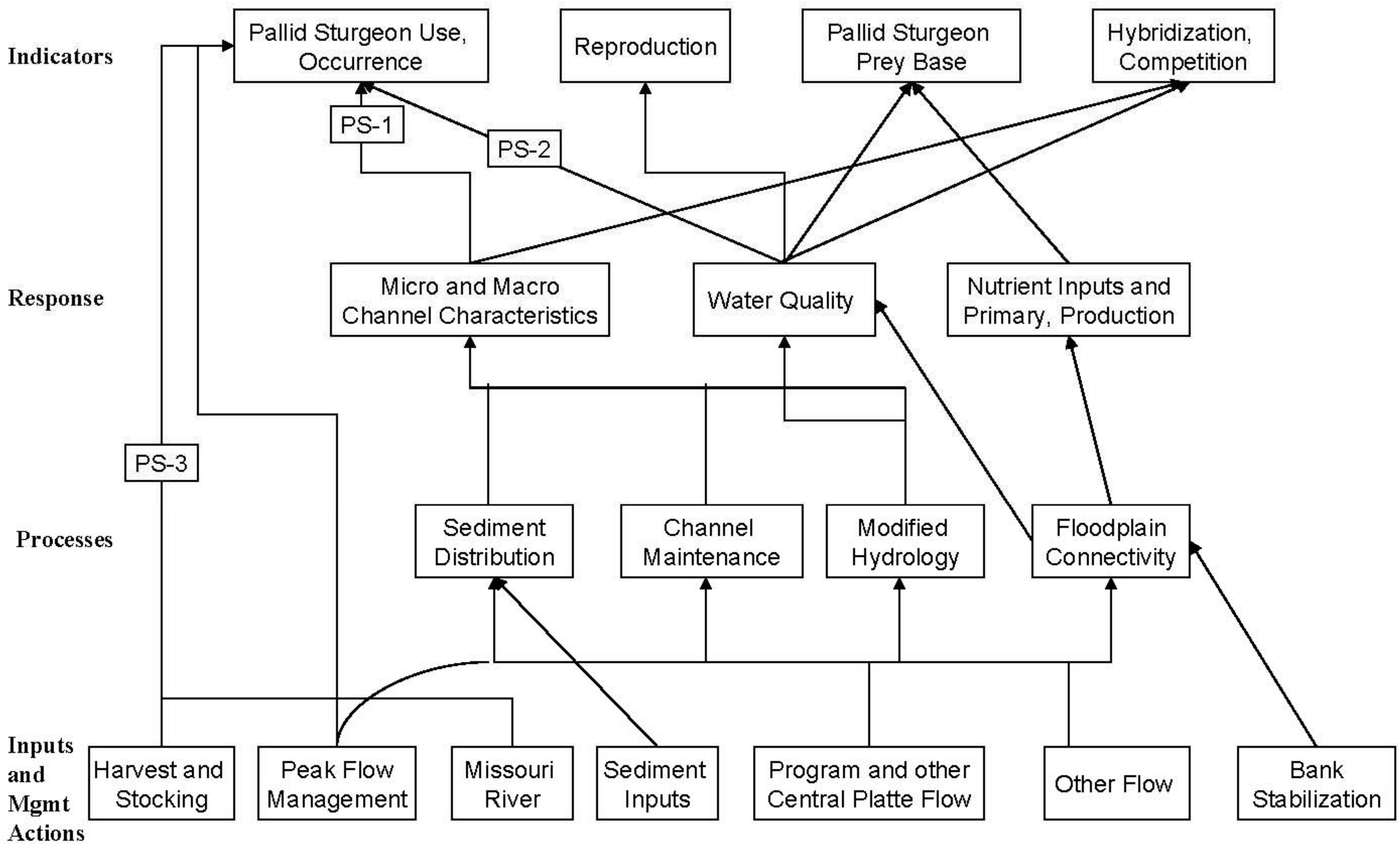
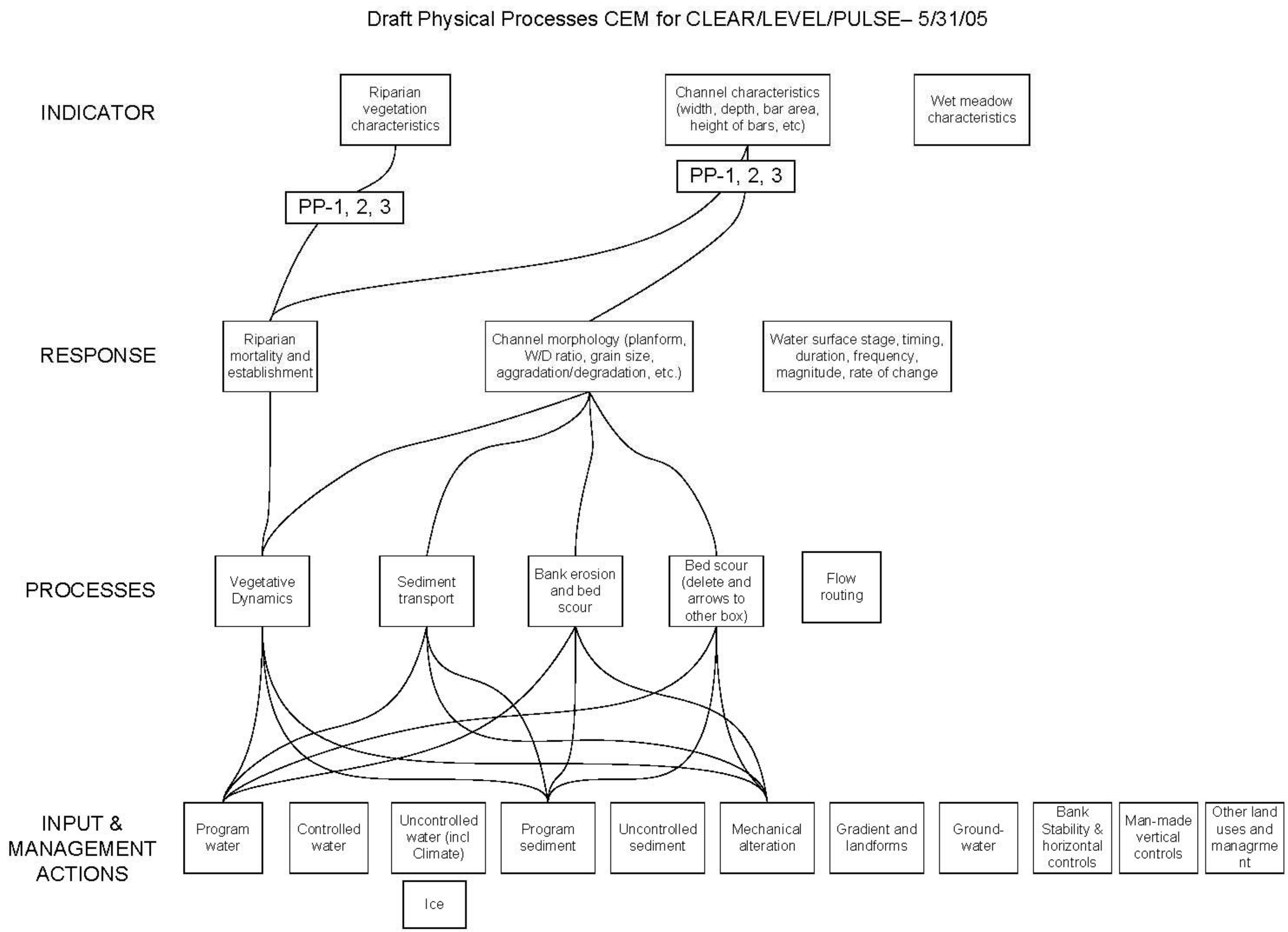


Figure 7. Pallid sturgeon conceptual ecological model (including example locations for current hypotheses).



NOTE: The lines illustrate priority hypothesized linkages; however, a complete set of hypothesized interactions is too complex to illustrate here.

Figure 8. Flow-sediment-mechanical CEM

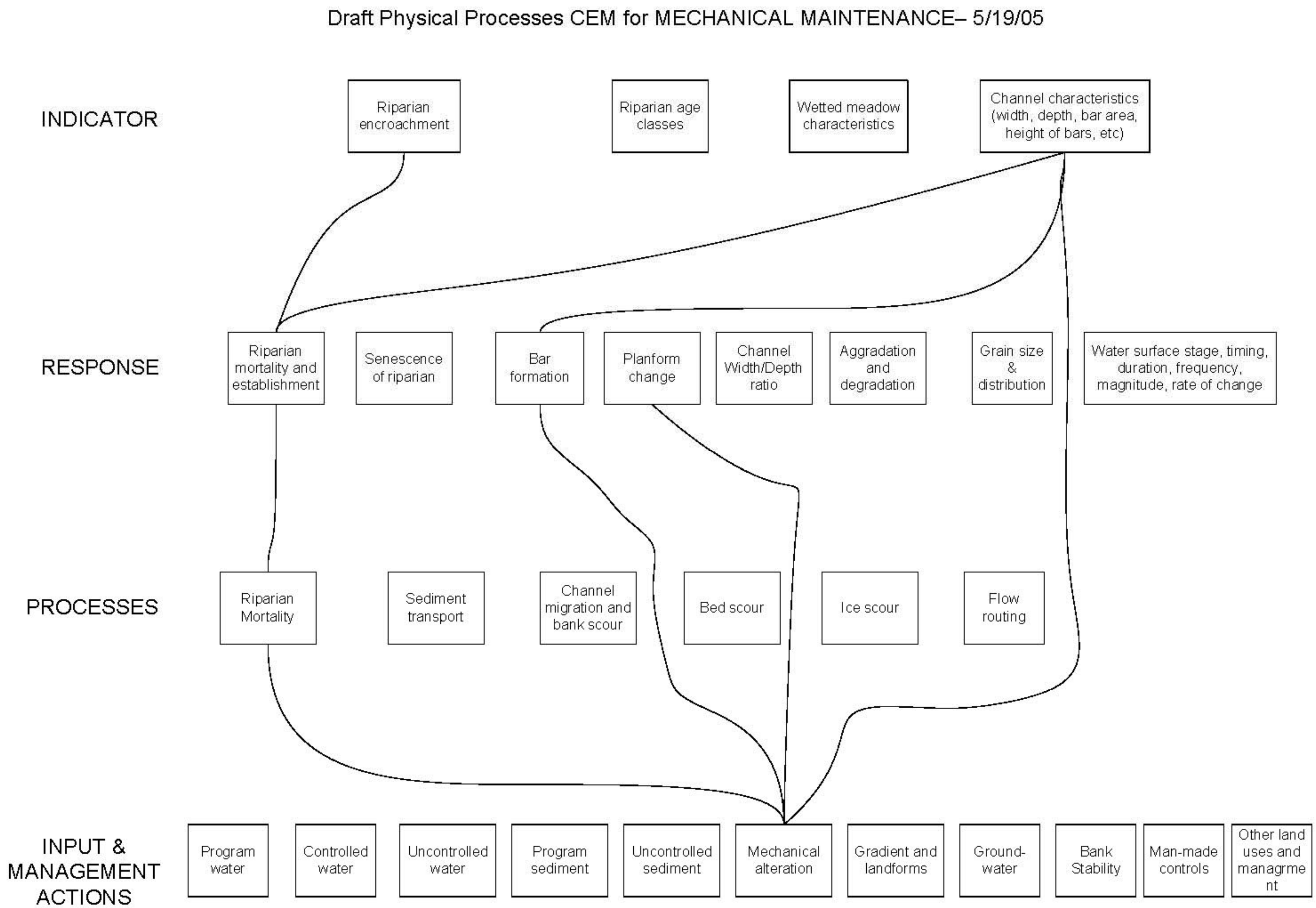


Figure 9. Mechanical creation and maintenance CEM

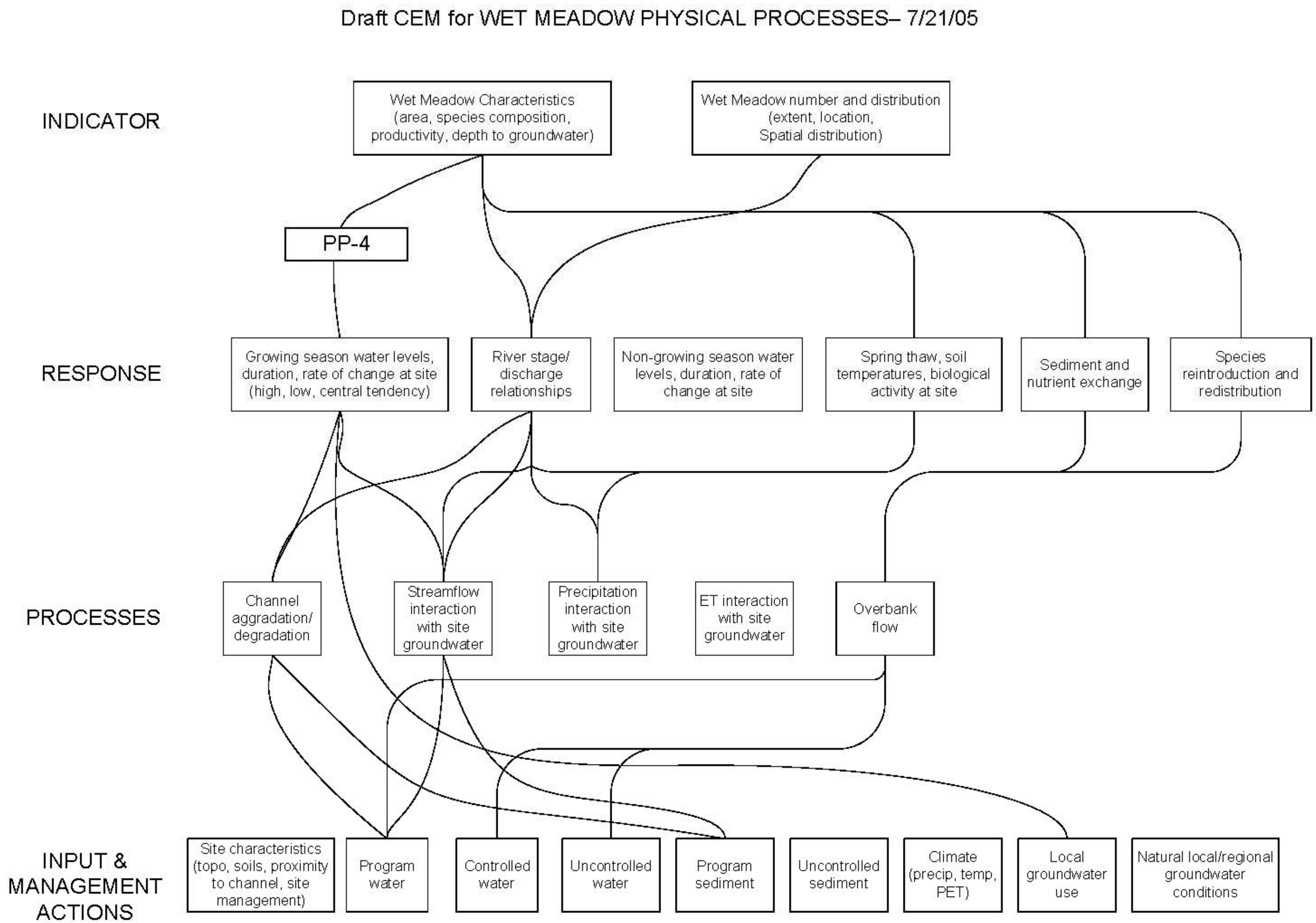


Figure 10. Wet meadow CEM

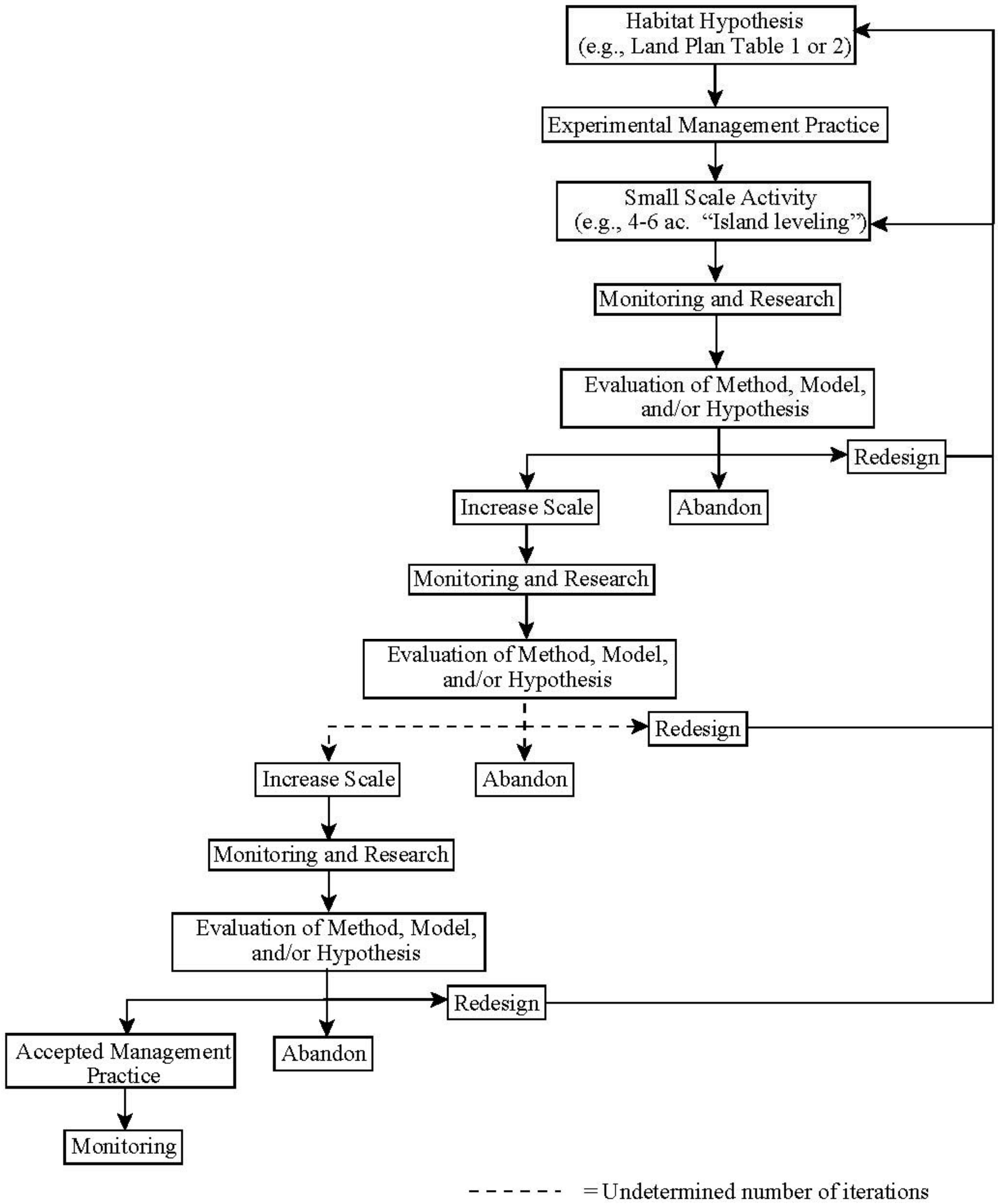


Figure 11. Example adaptive management process with stair step approach

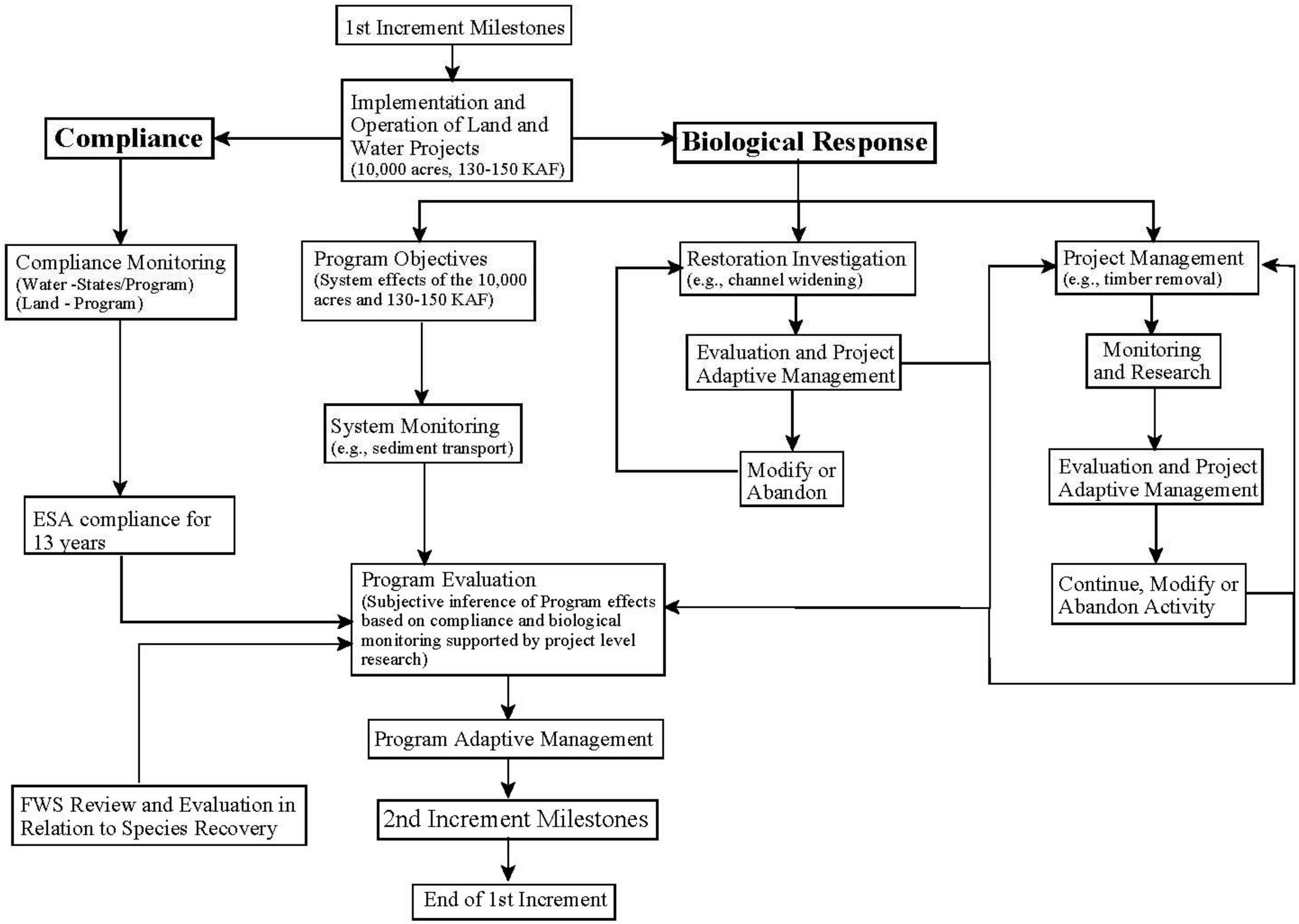


Figure 12. Compliance monitoring and biological response monitoring for the Program

Cottonwood Ranch Monitoring and Research Sections

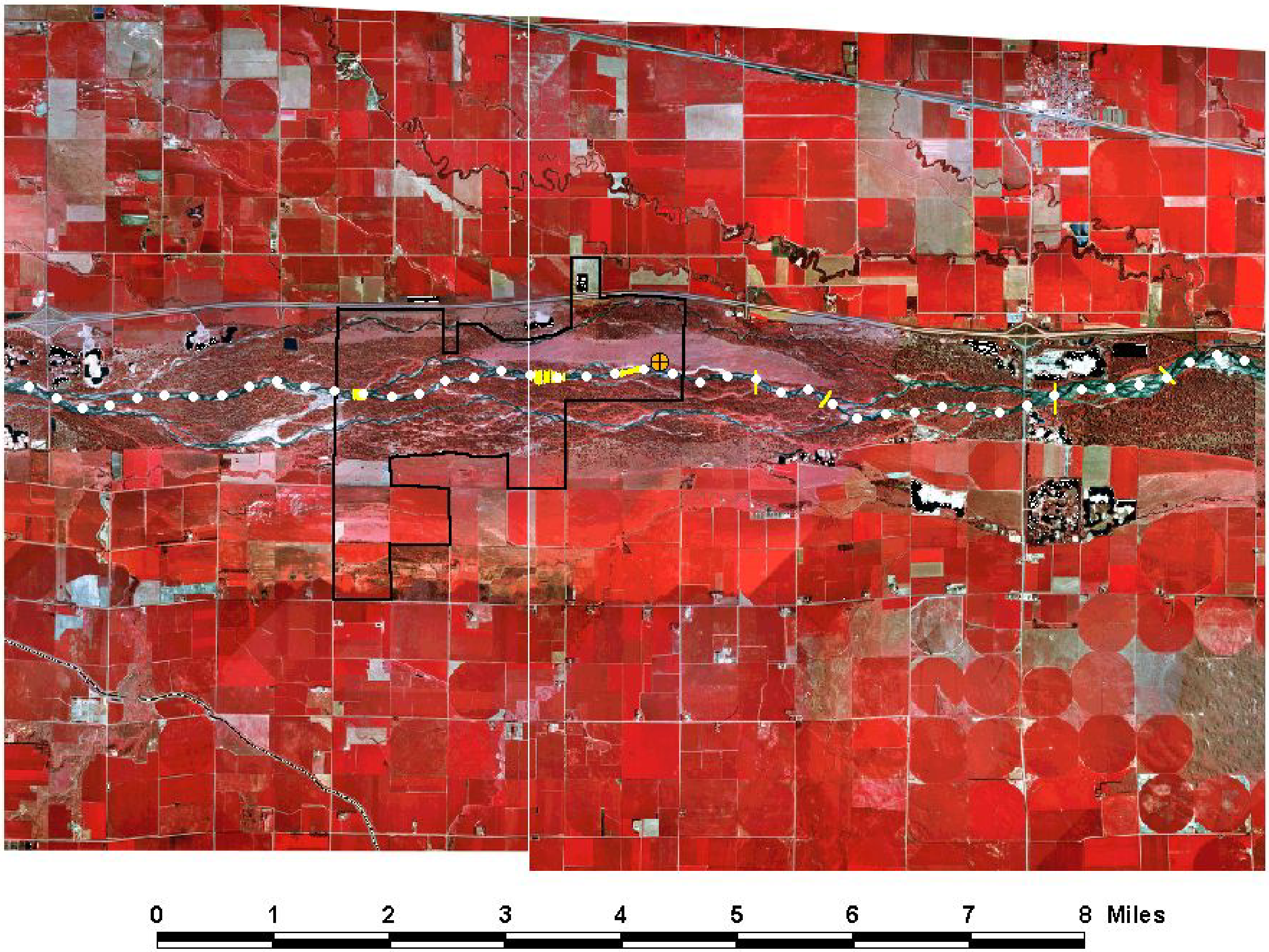


Figure 13. Monitoring and research transects (dashes) at Cottonwood Ranch and example of the series of anchor points (dots) to locate the monitoring transects.

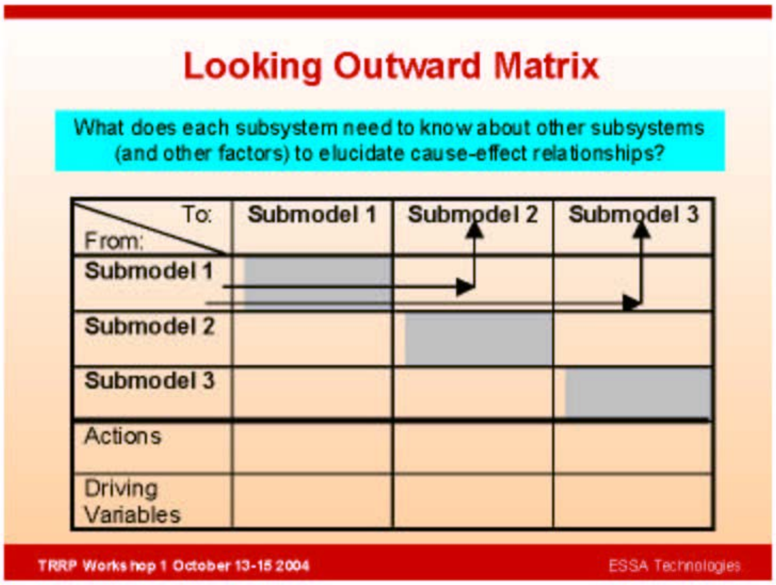


Figure 14. Looking outward matrix (example used from Dave Marmorek, ESSA Technologies)

Appendix A – Peer Review Guidelines

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

SCIENTIFIC PEER-REVIEW GUIDELINES

These guidelines have been developed to provide a general process for peer-review of scientific documents during the Platte River Recovery Implementation Program (Program). Peer-reviews conducted during the Program will be conducted in accordance with "INSTRUCTIONS TO PEER-REVIEWERS" (Attachment A).

WHAT IS PEER-REVIEW? Scientific peer-review is a process by which technical experts provide unbiased comments, suggestions, and evaluation of the science and technology of proposals, study plans, reports of data analyses, and other documents. Peer-review provides evaluation of the technical quality and relevancy of a document in meeting objectives or in addressing hypotheses. Peer-review usually involves obtaining comments from appropriate technical experts ("peers") who have no financial, supervisory, or familial relationship to the authors of the work. Peer-review is not an administrative review, nor does peer-review address political or other non-scientific features of a project or document.

Peer-review typically involves review by several technical experts in the appropriate subject area. By obtaining multiple, independent technical opinions, the peer-review process provides a means of evaluating the scientific soundness of a product, further minimizing introduction of bias or conflict of interest. The process of peer-review ultimately cannot insure that a document or product is without fault.

Peer-review should be an efficient process so that monitoring, research, publications, and other work can proceed in a timely manner. This process should be streamlined and not create a bottleneck of bureaucracy, delaying appropriate publications, fieldwork, data analyses, or modeling.

WHY IS PEER-REVIEW NECESSARY? Peer-review serves to strengthen a document, whether it is a study plan, proposal, or report, in several ways. A review can provide suggestions for improvements of the work. Experts typically suggest better approaches, more efficient methods, innovative approaches to analysis, and supporting data or literature. A document or plan that has been viewed as being sound, through peer-review, achieves improved credibility in the eyes of the scientific community. Peer-review enhances the reliability of a document, having been examined by peer-scientists. Where proposals or study plans are developed to address specific needs, peer-review can insure that the project serves the specific objectives of the program.

WHEN WILL PEER-REVIEW BE USED? The process described in this document may be used for products (proposals, plans, models, data, reports, protocols, etc.) funded by the Program or for other products essential to meeting Program milestones, but lacking adequate review. All products relied upon by the Program that influence management decision may be subjected to the following peer review process at the discretion of the Governance Committee with advice from the Technical Advisory Committee or other advisory committees. For some products, however, a high level of scientific quality may be maintained by existing quality control and administrative review procedures, and peer review will be unnecessary.

WHAT ARE THE PRIORITIES FOR PEER REVIEW? The first priority for peer review are items identified for peer review in the 1997 Cooperative Agreement Milestones, which include all water depletion/accretion impact analyses, and all habitat and species monitoring and research activities. Proposals and protocols for new research and monitoring activities necessary for meeting Program milestones will receive the second priority for peer review. Third priority will be given to recent reports of completed studies considered essential to meeting Program milestones. Already peer-reviewed products will receive the lowest priority for peer review. Priorities may change depending on issues.

PEER-REVIEW PROTOCOL

1. The Executive Director will administer the peer-review process for the Governance Committee. The duties of the Executive Director are as follows:

    a) Assemble Master List of potential reviewers with assistance from the standing advisory committees (Technical, Land, Water).
    b) Select reviewers for each work product to be reviewed, and obtain approval of selected reviewers by the Governance Committee.
    c) Handle all correspondence with reviewers.
    d) Compile and transmit all relevant materials from reviews to Panel members for decision-making.
    e) Coordinate revision of work product if needed.
    f) Prepare, obtain approval from the Governance Committee, and administer budget for reviews.
    g) Ensure the review process works in a timely and efficient manner.

2. The Governance Committee and its recognized advisory committees (Technical, Land, Water) identify the need for peer-review as requirements for proposals, studies, or reports arise. The requesting committee identifies each need for peer-review to the Executive Director (see figure below).

3. The Executive Director will determine priorities for peer review in keeping with the guidelines noted above, and develop budgets for peer review for approval by the Governance Committee. A Peer Review Working Group consisting of one member of the Governance Committee and one member from each of the Governance Committee's standing advisory committees (Technical, Land, Water) or other group as identified will assist the Executive Director in this effort. Budgets and priorities will be subject to the approval by the Governance Committee and may change as the Program evolves.

4. Reviewers meeting the standards outlined in these guidelines will conduct the peer-review.

5. When peer review is appropriate the Executive Director, in consultation with the Peer Review Working Group, will select three peer-reviewers from scientific areas appropriate to the subject or discipline of each request. The reviewers will conduct independent peer-reviews and send reviews to the Executive Director. According to the specific needs of each peer-review task, the reviewers could complete review of a single or group of related proposals, plans, or reports. A statistician will participate as a fourth reviewer when the subject or discipline includes experimental design and/or statistical analyses.

6. A list of qualified and willing experts will be assembled in a number of technical topic areas; reviewers will be carefully selected from this list to ensure reviewers are the most appropriate based on the subject matter being reviewed. The Executive Director will maintain a file with the resume and credentials of each peer-reviewer.

7. Criteria for peer-reviewers include:

    a) No conflict of interest for or against the project document or its authors based on financial interest in the product or author(s), familial relationship with the author(s), personal bias for or against the institution or author(s), professional connection to the institution or author(s), organizational affiliation, or potential to be influenced by lobbying or other political pressure to produce a certain result or more work in the area of this product.

    b) Expertise appropriate for the theme of the project or document(s).

    c) The ability to complete a technical review in a reasonable time, as determined by the requesting committee.

    d) Individuals will be selected from a diversity of institutions, including state, federal, local government, and non-governmental organizations for each project, while avoiding members from the same institution or agency as the author(s).

8. The committee requesting review, in conjunction with the Peer Review Working Group, will approve the Peer-review Panel. Objections regarding individuals must relate to the criteria outlined in number 7. The Governance Committee will resolve all conflicts.

9. An attempt will be made to obtain voluntary participation on Peer-review Panels without cost to the Governance Committee. A stipend or honorarium will be offered for review when necessary. The Governance Committee will approve an annual budget for peer-reviews.

10. The requesting advisory committee will prepare specific guidance for each review task. Suggested guidance includes an outline of the specific need for peer-review, the milestones or objectives to be addressed by the work, and other specific criteria for the document.

11. Reviewers shall provide written comment on the document(s) under review. Reviews will be conducted similar to the system and methods used by the National Science Foundation and major scientific journals and in accordance with the Proposal, Protocol and Study Plan Review Guidelines and Report Review Guidelines (see Attachment A).

12. Upon completion of the reviews, the Executive Director will:
    a) Prepare a package of material including all reviews and any relevant material,
    b) Distribute all material to requesting committee for a determination of action,
    c) If appropriate work with the requesting committee and author to make any needed revisions,
    d) Maintain a file of peer-reviews for each document, and
    e) Provide a summary of items a-c to the Governance Committee for approval.

13. The peer-review process does not determine the approval or disapproval of the activity associated with the request (funding a study, use of data or analytical results, publication of a report, etc.). Peer reviews may not be definitive (i.e., there may be disagreement among reviewers). The Committee seeking the review may or may not have the authority to approve the review; however, at a minimum, it is responsible for transferring the review summary and document(s) to the Governance Committee, who will have final authority to approve the review.

DOCUMENTATION OF PEER-REVIEW CONDUCTED OUTSIDE THE PROGRAM

There will likely be cases where the Program will benefit from models, data, analyses, or conclusions drawn by projects developed in the past or ongoing, but supported by institutions outside the oversight of the Program. The committee requiring the information will determine the need for peer-review of these products.

There is no intent to duplicate the peer-review conducted by others. Scientific journals typically conduct their own peer-review. Most major journals have high-quality peer-review that is universally accepted. Scientists are encouraged to publish their findings in the peer-reviewed scientific literature whenever possible and appropriate. In most instances this level of peer review is considered adequate for the purposes of the Program.

Institutions and agencies may administer their own peer-review process for study plans and reports. In using the models, data, or conclusions (reports) from studies not funded by the Program, the appropriate advisory committee is responsible for determining if additional peer-review is necessary. In making the decision regarding the need for peer-review it may be helpful to document an institution's peer-review process for the project or report. With the assistance of the appropriate advisory committee, it may be useful to consider the following information on alternative peer-review processes when available:

I. Title of Study / Project / Report:
II. Type of Work: __report __study plan/proposal __model __ other (specify)
III. Principal Investigators: name, address, phone number, and e-mail
IV. Source of financial support for project / report:

V. Peer-Review Documentation

A. Names / Institutions of peer-reviewers (may have been anonymous)

B. Brief Description of the peer-review process:

C. Were revisions made to the project/report in response to reviewers' comments?

ATTACHMENT A

PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

INSTRUCTIONS TO PEER-REVIEWERS

Thank you for agreeing to review this product. The following is a summary of expectations for peer-review and the topics that we wish each peer-reviewer to address.

A. INDEPENDENCE OF A PEER-REVIEW

Peer-review must provide an unbiased opinion of the scientific quality of a product (proposal, report, data, map, etc.) by individuals who are independent from the authors and external to them and their institution. A review must be independent of various types of conflicts of interest with the author(s) and with the product under review. The Platte River Recovery Implementation Program (Program) places considerable reliance on the objectivity, integrity, and professionalism of each peer-reviewer to provide technical opinion of each product without bias or conflict of interest.

Please review each question about your bias or independence. Your peer-review will be anonymous to the author unless you choose to share it. Your review will be held in the file for the Program as documentation of the peer-review process for this product.

YOUR CONSIDERATIONS SHOULD INCLUDE THE FOLLOWING FACTORS THAT COULD LEAD TO BIAS OR CONFLICT OF INTEREST:

- financial interest in the product or the author(s);
- familial relationship with the author(s);
- bias, for personal reasons, for or against the author(s) or institutions of this product;
- professional connection (current or former: student or advisor, supervisor or supervised, employer, etc.) to the author(s) or the institution of this product;
- organizational affiliation (same agency, department, organization, business, etc.);
- impacts of lobbying or political pressure exerted by persons looking for a particular result or more work in the area of this product;

IF YOU FEEL THAT YOU CANNOT PROVIDE AN UNBIASED REVIEW, PLEASE DO NOT REVIEW THIS PRODUCT AND IMMEDIATELY RETURN THE DOCUMENT TO THE PROGRAM'S EXECUTIVE DIRECTOR.

B. PROPOSAL, PROTOCOL, AND STUDY PLAN REVIEW GUIDELINES

CONFIDENTIALITY - The enclosed product is a privileged communication. Please do not show it to anyone or discuss it, except to solicit assistance with a technical point. Your review and your recommendation should also be considered confidential.

TIMELINESS - In fairness to the author(s) and the needs of the Program, please return your review within ___ days. If it seems likely that you will be unable to meet this deadline, please return the product immediately or contact the Executive Director.

CONFLICTS OF INTEREST - Please review the "Independence of a Peer-review". If you feel that you might have difficulty writing an objective review, please return this material immediately, without reviewing it. If your previous or present connection with the author(s) or their institution(s) might be construed as creating a conflict of interest, but no actual conflict exists, please discuss this issue in the cover letter that accompanies your review.

YOUR REVIEW SHOULD ADDRESS THE FOLLOWING:

Please provide comments on separate sheets of paper. Support your comments with specific evidence from the text.

Do the objectives/hypotheses appropriately address the needs that have been identified for the Program? Are they scientifically sound, testable, and appropriate given the type or precision of the data available?

Is the design of the study scientifically sound? Is it technically and statistically appropriate for addressing the goals and objectives of the project? Is the reasoning behind the design based on generally accepted scientific principles?

Are the methods and experimental design appropriate in scale, timing, geographic scope, and precision for addressing the objectives? Are the measurements appropriate for addressing objectives?

Are plans for data analysis sound and likely to address the objectives?

Are the authors and their institutions well qualified, with appropriate facilities, to conduct the work?

Are the proposed time frame, personnel, and budget appropriate for conducting the work?

Will the products meet the needs identified?

C. REPORT REVIEW GUIDELINES

CONFIDENTIALITY - The enclosed manuscript is a privileged communication. Please do not show it to anyone or discuss it, except to solicit assistance with a technical point. Your review and your recommendation should also be considered confidential.

TIMELINESS - In fairness to the author(s) and to the needs of the Program, please return your review within __ days. If it seems likely that you will be unable to meet this deadline, please return the manuscript immediately or contact the Executive Director.

CONFLICTS OF INTEREST - Please review the "Independence of a Peer-Review" above. If you feel you might have any difficulty writing an objective review, please return the manuscript immediately, un-reviewed. If your previous or present connection with the author(s) or an author's institution might be construed as creating a conflict of interest, but no actual conflict exists, please discuss this issue in the cover letter that accompanies your review.

YOUR REVIEW SHOULD ADDRESS THE FOLLOWING:
What is the major contribution of this document? What are its major strengths and weaknesses, and its suitability for publication and/or use by the Program? Are conclusions based on sound scientific methods and reasoning? Please include both general and specific comments bearing on these questions and emphasize your most significant points.

General Comments:
1. Scientific soundness
2. Organization and clarity
3. Conciseness
4. Degree to which conclusions are supported by the data
5. Cohesiveness of conclusions

Specific Comments:
Please support your general comments with specific evidence and literature. You may write directly on the manuscript, but please summarize your handwritten remarks separately. Comment on any of the following matters that significantly affected your opinion of the manuscript:

1. Presentation: Is a tightly reasoned argument evident throughout? Does the manuscript wander from the central purpose?

2. Methods: Are they appropriate? Current? Described clearly and with sufficient detail so that someone else could repeat the work?

3. Data presentation: When results are stated in the text of the manuscript, can you easily verify them by examining tables and figures? Are any of the results counterintuitive? Are all tables and figures clearly labeled? Well planned? Too complex? Necessary?

4. Statistical design and analyses: Are they appropriate and correct? Can the reader readily discern which measurements or observations are independent of which other measurements or observations? Are replicates correctly identified? Are significance statements justified?

5. Conclusions: Has the author(s) drawn conclusions from insufficient evidence? Are the interpretations of the data logical, reasonable, and based on the application of relevant and generally accepted scientific principles? Has the author(s) overlooked alternative hypotheses?

6. Errors: Point out any errors in technique, fact, calculation, interpretation, or style.

7. Citations: Are all (and only) pertinent references cited? Are they provided for all assertions of fact not supported by the data in the manuscript?

D. FAIRNESS AND OBJECTIVITY

If the research reported in this paper is flawed, criticize the science, not the scientist. Harsh words in a review will cause the reader to doubt your objectivity; as a result, your criticisms will be rejected, even if they are correct!

Comments should show that:
1. You have read the entire manuscript carefully,
2. Your criticisms are objective and correct, and are not merely differences of opinion, and are intended to assist the author in improving the manuscript, and
3. You are qualified to provide an expert opinion about the research reported in this manuscript.

E. ANONYMITY

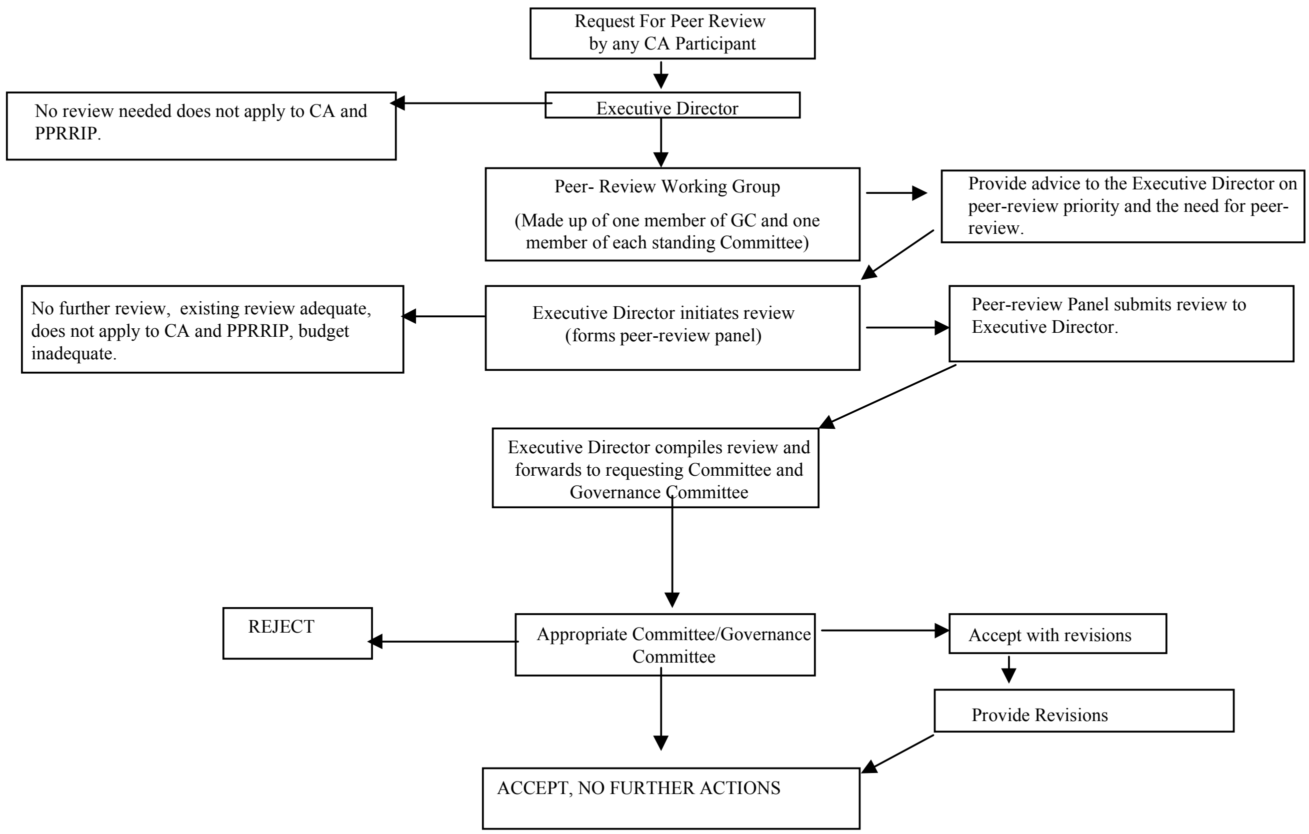
You may sign your review if you wish. If you choose to remain anonymous, avoid comments to the authors that may serve as clues to your identity, and do not use paper that bears the watermark of your institution.

RATING:
Please score each aspect of this manuscript using the following rating system: 1=excellent, 2=very good, 3=good, 4=fair, 5=poor.

	Rating
Scientific soundness	___
Degree to which conclusions are supported by the data	___
Organization and clarity	___
Cohesiveness of conclusions	___
Conciseness	___
Importance to objectives of the Program (For use by internal review panel only)	___

RECOMMENDATION	(check one)
Accept	___
Accept after revision	___
Unacceptable	___

Peer-Review Sequence Platte River Cooperative Agreement (CA) and Proposed Platte River Recovery Implementation Program (PPRRIP)



Appendix B - Models

Analytical and Computer Models
There has been considerable disagreement over the assumptions, data used, accuracy and appropriateness of almost all these models and they are not necessarily viewed as acceptable analytical tools by all parties during the adaptive management process. However, some or all of these models may be used to make predictions in regards to certain management actions or to analyze data collected through the monitoring and research efforts. Results of adaptive management may be used to update models as applicable.

Integrated Models

1. **Habitat Complexes** – Habitat complexes are assemblages of relevant habitat types important to the target species, and consist of channel areas, wet meadows, and buffers (see Land Plan Table 1).

2. **Non-Complex Habitat** – The states and water users suggested habitat criteria that included ranges for certain variables contained within a "Habitat Complex" and additional land cover types that are used by the target species. Through the process of negotiation the ranges were dropped and the non-riverine land cover types have become the "Non-Complex Habitat" (see Land Plan Table 2).

Physical Models

1. **Sediment/Vegetation Model** – The Sed/Veg Model predicts how changes in river flow and sediment transport into the central Platte River will affect the geometry of the river channel, channel vegetation, and important habitat characteristics for the target species.

2. **FWS Mountain Prairie Region Instream Flow Recommendations and Proposed Usage for the Platte River Recovery Implementation Program** – The FWS has developed Instream Flow Recommendations for the central Platte River (Platte River Recovery Implementation Program, Attachment 5, Section 11), which they believe are necessary to "achieve the flow-dependent goal of 'rehabilitation and maintaining the structure and function, patterns and processes, and habitat of the central Platte River Valley ecosystem'" for the purpose of creating and maintaining habitat for the three target avian species. The instream flow recommendations include species and annual pulse flows, and periodic annual peak flows.

3. **Central Platte River OPSTUDY Model** – "The Central Platte River OPSTUDY Model" (CPR Model) was developed by the U.S. Bureau of Reclamation and the FWS as a tool for evaluating management alternatives affecting flows in the central Platte River in Nebraska (Attachment-91 (F) of the DEIS). The CPR Model is a water accounting model for tracking gains, losses, diversions from and accretions to the central Platte River system.

4. Cooperative Hydrologic Study (COHYST) - The COHYST is a study designed to improve the understanding of hydrologic and geologic conditions in the Platte River Basin above Columbus, Nebraska. COHYST was developed by several Nebraska entities including natural resources districts, public power districts, state agencies, water user organizations, and environmental and agricultural organizations. When completed, COHYST will assist with understanding the interrelationship and interaction between surface water and groundwater and provide a tool in evaluating management and regulation options relating to groundwater and surface water.

Biological Models

1. Instream Flow Models – Two physical habitat simulation models developed for the Platte River have been used by the FWS to develop two biological models, one for whooping crane roosting habitat and one for forage fish habitat. These two models are based on applications of Physical Habitat Simulations Methodology (PHABSIM). Each model has two primary components: habitat suitability index models for the species (described below); and channel hydraulics models of the study area.

a. **Whooping Crane Model** – The Whooping Crane Model was developed by the Platte River Management Joint Study (PRMJS) Biology Workgroup (with a recent review and modification by the USGS (Farmer et al. 2005)). The purpose of the Whooping Crane Model is to predict the quality and spatial distribution of whooping crane roosting habitat.
b. **Forage Fish Model** – Several entities have contributed to the development of habitat suitability index models for Platte River forage fish. Suitability indices for microhabitat variables (i.e., depth, velocity, substrate, and cover) have been developed for 24 species or species life stages.

2. Tern and Plover Nesting Model – The U.S. Fish and Wildlife Service developed a Tern and Plover Nesting Model for use in the analysis of the Program for the Biological Opinion (B.O.). The purpose of the model is to predict the relative impacts of the annual and seasonal hydrology cycle on the formation of sandbars hypothesized to be suitable as nesting sites. This is not a computer simulation model, but a set of analytic procedures.

Appendix C. Additional Hypotheses Identified

Whooping Crane

Hypothesis
Whooping cranes prefer wetlands during migration that are at least 1 acre in size, have at least 400 feet of unobstructed visibility from an open water area with depths less than 0.7 feet are with in 0.5 miles of a feeding area (cropland during migration) and are at least 1,600 feet from the nearest disturbance (such as road or house).
Whooping cranes select for flows of 2,400 cfs at Grand Island
Probability of whooping crane use increases as channel widths increase
Whooping crane use is related to amount of channel inundation.
Whooping crane use will increase with an increase in suitable wet meadows near the channel.
Whooping crane use will increase with more wet meadow acreage.
Whooping crane use of wet meadows will increase with increased biomoass of macroinvertebrates
Repeated stage changes on a daily or sub-daily basis adversely impact whooping crane use of the Platte River for roosting
WC will remain on the roost if water depths do not fluctuate outside of 7-30 cm depth.
Species target flows and annual pulse flows are needed to create and maintain suitable habitat characteristics for whooping cranes in the following ways: -**<u>Provide roosting habitat</u>** (prevent a major break in wetted width in whooping crane roosting habitat; provide roosting habitat; provide migration habitat) -**<u>Sustain wet meadows and backwaters</u>** (sustain hydrologic and biologic processes which sustain wet meadows; inundate wet meadows; inundate backwaters; drive ecosystem processes in backwaters and wet meadows such as thawing and stimulation of biological activity that ultimately produces food for animals and favorable habitat for both animals and plants; feeding sites in wet meadows; influence groundwater levels, and composition and structure of biological communities in grasslands; maintain and enhance the occurrence of soil moisture and pooled water for the lower trophic levels of the food chain in low grasslands; bring the groundwater levels in grasslands up near to soil surface in areas of grassland and above soil surface in some lowest areas of grasslands) -**<u>Maintain channel characteristics and riverine community</u>** (form sandbars, trigger the response of the aquatic community; restore certain annual effects characteristic of the historic natural hydrograph; sediment transport; for redistribution and deposition of sediment; shaping channel morphology into wide, shallow channels; form and move ice, which scours vegetation and shapes the channel; maintain and enhance the physical structure of wide, open unvegetated and braided channel characteristics for resting, feeding and roosting; redistribute sediment in the active channel and maintain the geomorphology of the channel; in years with little or no ice formation, saturate soil in meadows) -**<u>Scour vegetation</u>** (scour seedlings off sandbars and prevent seed germination; scour vegetation of different size and age classes and prevent reestablishment of

vegetation; management of the recruitment of cottonwoods; seedling removal; cause and/or contribute to break up of ice and move ice for the effect of scouring vegetation off sandbars in the active channel) -**<u>Maintain predator barrier</u>** -**<u>Maintain nutritional and physiologic conditions</u>** (contribute important nutritional and physiological conditions for birds preparing to breed; support primary production of invertebrates which are needed by cranes for protein) -**<u>Help disperse birds</u>** (helps disperse birds and reduce losses due to disease [avian cholera, botulism, etc.])

Least tern and Piping Plover

Hypothesis
Sandpits do provide sufficient foraging habitat for terns and plovers.
Platte River is needed to provide sufficient foraging habitat for terns and plovers.
The tern and plover populations in the central Platte can be provided by the river only.
Predators learn where maintained nesting locations are and reduce the nesting success.
Minimal secure areas are needed for success nesting a. 0.25 mile not needed for buffer
For piping plovers and least terns to successfully nest and rear chicks in and along the central Platte River, a certain quantity and quality of forage items are required throughout the nesting season. River flow variability at different time scales (e.g., sub-daily, seasonal, annual) due to controlled (e.g., hydrocycling) and uncontrolled (e.g., floods) factors impact the ability of the central Platte River to produce and sustain the necessary forage base.
Repeated stage changes on a daily or sub-daily basis (e.g., caused by hydrocycling) adversely impacts the availability, abundance, and diversity of the aquatic invertebrate communities that forms the food base for piping plovers.
Repeated stage changes on a daily or sub-daily basis (e.g., caused by hydrocycling) adversely impact the distribution, abundance and composition of the aquatic fish community that forms the food base for the least tern by: a. Forcing daily lateral shifts in microhabitat availability, reducing the suitability of the central Plate River to support fish species. b. Decreasing recruitment of many central Platte River fish species that form the food base for the least tern due to desiccation of eggs. c. Increasing the frequency, magnitude and duration of localized high water temperature events.
A fledge ratio of 1.13 or 1.17 fledging/pair is needed to prevent the central Platte River from being a population sink for piping plover.
A fledge ratio of 0.7 fledging/pair is needed to prevent the central Platte River from being a population sink for least terns.
Tern and plover will select for specific elevations above current water levels compared to available elevations for nest initiation
Increased vegetation cover decreases tern and plover use.
Bare sand suitability increases with size
Least tern and piping plover use will be maximized at 50-65% water to sand combination.

Increased flow rates increase the amount of water area compared to sand area
Daily stage change impacts on tern and plover prey base
Target flows influence least terns and piping plovers in the following ways: -**Sustain backwaters and side channels** (inundate backwaters; drive ecosystem processes in backwaters that ultimately produce food for animals and favorable habitat; influence fish reproductive behavior and the availability and quality of spawning, nursery, and rearing habitat, including backwater habitat of fishes; maintain and rehabilitate backwaters and side channels as spawning and nursery habitats) -**Maintain channel characteristics and riverine community** (form sandbars, trigger the response of the aquatic community; restore certain annual effects characteristic of the historic natural hydrograph; sediment transport; for redistribution and deposition of sediment; shaping channel morphology into wide, shallow channels; form and move ice, which scours vegetation and shapes the channel; maintain and enhance the physical structure of wide, open unvegetated and braided channel characteristics; redistribute sediment in the active channel and maintain the geomorphology of the channel in years with little or no ice formation; provide channel habitat for water-dependent organisms, including spawning fish, shorebirds) -**Maintain biological diversity** (Maintain the components of biological diversity, e.g., invertebrates, fishes) -**Scour vegetation** (scour seedlings off sandbars and prevent seed germination; scour vegetation of different size and age classes and prevent reestablishment of vegetation; management of the recruitment of cottonwoods; seedling removal; cause and/or contribute to break up of ice and move ice for the effect of scouring vegetation off sandbars in the active channel) -**Support fish/aquatic community** (prevent loss of richness of aquatic species, especially fish and mollusks; support biological processes, which sustain fish and aquatic organisms dependent on certain flows; support spawning fish and other responses of the aquatic community; influence fish reproductive behavior and the availability and quality of spawning, nursery, and rearing habitat, including backwater habitat of fishes; maintain and prevent loss of the native fish community and will promote survival of fish young-of-the-year; promote critical stages in the life cycles of fishes and other aquatic organisms) -**Fish distribution and movement** (promote movement and (re)distribution of fishes and other aquatic organisms) -**Prevent low elevation nesting** (prevent nesting by shore birds at low elevations on sandbars; prevent shore birds from nesting at such low elevations in the channel that their nests would be subject to flooding during subsequent intervals of higher flows caused by local rainfall and/or flow regulation practices) **-Control water temperature** (relationship between flow and water temperature is considered important; prevents losses from the native fish community by curtailing rises in water temperatures to levels that otherwise would be detrimental or lethal to a variety of

life history stages of aquatic organisms, including fishes; prevent or reduce future harmful episodes to the aquatic community) -**<u>Maintain predator barrier</u>** (Provides a degree of barrier to terrestrial predators, which would otherwise more easily prey on shore bird nests) -**<u>Maintain nutritional and physiologic conditions</u>** (contribute important nutritional and physiological conditions for birds preparing to breed; facilitate nutrient cycling in the floodplain)

Pallid Sturgeon

Hypothesis
Water quality changes as a result of Program water management result in a measurable change in pallid sturgeon reproduction in the lower Platte River.
The net result of retiming due to depletions plans in the upper basin will/will not result in measurable changes in the lower Platte River.
The net result of retiming due to depletions plans in the upper basin will/will not result in measurable changes in channel characteristics in the lower Platte River associated habitat.
The net result of retiming due to depletions plans in the upper basin will/will not result in measurable changes in floodplain connectivity in the lower Platte River associated habitat
The net result of retiming due to depletions plans in the upper basin will/will not result in measurable changes in spring (March-June) peak flows in the lower Platte River associated habitat.
Incidental harvest of pallid sturgeon negate recovery efforts and benefits gained in the lower Platte River.
Pallid stocking efforts will impact ability to investigate other hypotheses.
Competition with non-native species could affect the recovery of the pallid sturgeon.
Changes in flow rate and/or channel characteristics will/will not result in detectable change in patterns/levels of pallid sturgeon use in the lower Platte River.
Program water management and retiming due to depletions plans will/will not result in detectable change in water quality in the lower Platte River.
Pallid sturgeon occurrence in the Platte River is incidental and not because of selection.
Pallid sturgeon do/do not spawn in the Platte River.
Pallid sturgeon use on the lower Platte River is dependant on conditions in the middle Missouri River basin.
Changes in water quality (temp, turbidity, etc) will result in detectable change in patterns/levels of pallid sturgeon use in the lower Platte River.
Program water management and retiming due to depletions plans will/will not result in measurable changes in pallid sturgeon use of the lower Platte River.
The lower Platte River does not provide essential habitat for the pallid sturgeon; rather it receives incidental usage.
The hydrological changes caused by the Program and new depletions plans will not provide measurable changes in the lower Platte River hydrologically, and/or stage changes.
Program flows and sediment management will result in measurable changes on sediment load in the lower Platte River

Increasing pallid sturgeon use in the lower Platte River will increase pallid sturgeon populations.
Different rates of flow in the lower Platte affect pallid sturgeon prey base.
Non-Program actions (e.g., harvest, stocking, Missouri River conditions) determine the occurrence of pallid sturgeon in the lower Platte River

Physical Processes (including wet meadow)

Hypothesis
Reclamation's unsteady-flow model for the Kingsley-to-North Platte reach of the North Platte River can be used to predict the two-day peak pulse flow magnitude in the river at North Platte, Nebraska resulting from a specified Kingsley EA release pattern to within 20% of the actual magnitude and with 75% certainty (3 out of 4 cases).
Reclamation's unsteady-flow model for the Central Diversion-to-Overton reach of the Platte River can be used to predict the two-day peak pulse flow magnitude in the river near Overton, Nebraska resulting from a specified amount and timing of EA water passing Central's diversion to within 25% of the actual magnitude and with 75% certainty.
Higher-magnitude peak flows will result in higher sand bars and a wider channel, and will accomplish more geomorphic work per unit of water released.
A flow magnitude of 5,000-8,000 cfs for a duration of 18 hours at Grand Island is needed to build sand bars to an elevation suitable for Least Tern and Piping Plover habitat.
A flow magnitude of 5,000-8,000 cfs for a duration of 18 hours at Grand Island is needed in two out of three years to prevent riparian seedlings from encroaching, and to maintain the width-to-depth ratio of the channel.
Managed flow releases in September will be more effective at removing seedlings than managed flow releases in March to May time frame.
The increased occurrence of peak flow events between 5,000-8,000 cfs for a duration of 18 hours at Grand Island in two out of three years will increase the average width of the seedling-free channel over time.
Most vegetation on banks can be removed at a shear force exceeding 0.5 to 1 lbs/sqft with a flow duration of 18 hours at Grand Island.
A flow magnitude of 5,000-8,000 cfs for a duration 18 hours at Grand Island is needed to initiate bank erosion.
A flow of 5,000-8,000 cfs will not build a sand bar that will remain emerged at typical summer flow peaks due to local rainfall events (i.e. 2,740 cfs, the median summer peak at Kearney from 1985 to 2004) and thus is the bars formed will not be habitat suitable for long-term propagation of least terns and piping plovers.
Sand bars which are not inundated within the growing season of when they are formed will vegetate beyond the 25% suitable for least tern and piping plover nesting in one growing season and this vegetation will not be susceptible to erosion in subsequent years with flows of the same magnitude that created the initial sandbar.
It is not possible to deliver a flow of 5,000 to 8,000 cfs for a duration of 18 hours at Grand Island within the current channel and infrastructure conveyance capacity.
There is an existing sediment imbalance creating a net loss of approximately 400,000 tons annually in the Platte River between Lexington and Grand Island, NE.

After a bar has been created by whatever means, ongoing stage fluctuations will decrease the bar area that could potentially be used by terns and plovers. Erosion will be less with a balanced sediment budget. Rate, magnitude, and frequency of stage fluctuation needs to be considered
Under current conditions of no sediment augmentation, the major sources of sediment are: the bed and banks of the river between Lexington and Jeffrey Island (est. 45%); the bed and banks of the river between Jeffrey Island and Kearney (est. 35%); and the tributaries (est. 20%).
The sediment loss within the stretch identified is not as great as stated and not as extensive.
Clearing bank vegetation will reduce bank stability and make the cleared location more susceptible to erosion under peak flows, force less than $0.5 lb/ft^2$.
Reducing the stability of the river banks through removal of vegetation, will increase the width to depth ratio of the channel.
Mechanically cutting the banks to widen the channel to a width sustainable by program flows at that site and distributing the material in the channel, is a sustainable means of channel widening and provides a source of sediment augmentation.
Mechanically lowering the islands to elevations inundated by flows of 500 cfs, mechanically lowering islands and distributing the material in the channel is a sustainable means of channel widening and provides a source of sediment augmentation.
Indirectly narrowing the width of the hydraulic corridor (preferred width less than 3,000 ft) by consolidating channels under proposed flow regime and balanced sediment budget will convert anastomosed reaches of the Platte River between Overton and Grand Island to a braided channel morphology.
The consolidation of flow from multiple channels into a single channel will achieve an active channel width that provides more acres of Table 1 habitat than the sum of acres available from individual channel widths.
Channel bank erosion and widening will occur when there is at least a 50% increase in flow when consolidating flow to a single channel.
10,000 acres of land can be developed into habitat as defined by current usage data for whooping cranes, least terns, and piping plovers. Lands with a wide range of physical characteristics including channels of various widths, palustrine wetlands sandpits, cropland and grasslands that contain a wetland component for roosting, foraging sites for least terns and piping plovers.
Suitable habitat for least terns and piping plovers include sandpits and riverine channels with shoreline habitats that can be developed and maintained by mechanical and other means in combination with existing river flows that will provide benefits to the species.
Suitable habitat for whooping cranes can be developed and maintained with mechanical and other means to provide channel habitat and palustrine wetlands in addition to the existing river flows that will provide benefits to the species.
Management of lands below the J-2 return provides sufficient habitat to offset any hypothesized channel degradation. The sediment transport measurements and questions addressed in the EIS/Parsons report need to be completed to determine a management plan, if any, for this reach.
Suitable habitat for whooping cranes can be developed and maintained with mechanical and other means to provide channel habitat and palustrine wetlands in addition to the existing river flows that will provide benefits to the species.

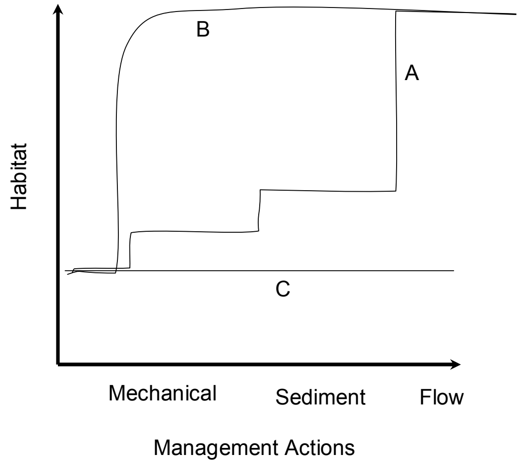
Management of lands below the J-2 return provides sufficient habitat to offset any hypothesized channel degradation. The sediment transport measurements and questions addressed in the EIS/Parsons report need to be completed to determine a management plan, if any, for this reach.
Throughout a majority of the central Platte River the unvegetated active channel is in dynamic equilibrium. Temporary narrowing occurs only during severe drought and can be corrected by mechanical means.
Flow regimes significantly less than USFWS target flows will provide adequate flows to support least tern and piping plover foraging habitat as well as whooping crane roosting habitat. The USFWS target flows are not biologically or hydrologically necessary to benefit or recover species.
Use of EA water for wetlands, and habitat enhancements other than target and pulse flows will provide benefits to the species.
The FWS recommendations related to habitat complexes and habitat characteristics are too narrow and exclude a broader range of habitat characteristics that are and can be successfully used by the species.
Channel incision due to clean water returns is limited to the upper most sections of the habitat along the south channel.
Currently Platte River characteristics including associated sandpit habitats are not limiting the recovery of whooping cranes, least terns or piping plovers.
The Clear-level-pulse concept must be tested in a stepwise manner, collecting appropriate data to answer the questions and hypothesis questions included in the EIS/Parson team report.
The EIS/Parsons Joint River Process Investigations Analysis list a number of questions associated with Tasks 1-4. It is assumed that all the questions are based on hypotheses that need to be investigated during the Clear/Level/Pulse investigations.
The Parson report sets forth alternative views related to incisive channel degradation and sediment transport. It is assumed that these views will be integrated into the sub-hypotheses and alternative sub-hypotheses being tested as part of the Clear/Level/Pulse investigations. The DWU note that the current placeholder statement needs some work if it stays to integrate testing these alternative scientific views
The Clear-level-pulse concept will not create or provide safe tern and plover nesting habitat.
The highest sandbars created with pulse flow attempts will be vegetated by the end of the first growing season and will not erode in subsequent pulses.
Fluctuations in river stage alter the cross-sectional profiles and dimensions of channel sand bars and islands. The specific effect of stage change on the morphology of these features is determined by the frequency, rate, direction and magnitude of the change, and by sediment supply conditions (balanced or not balanced relative to river transport capacity).
Repeated stage changes in excess of 1.0 feet on a daily or sub-daily basis (e.g., as caused by hydrocycling) will measurably reduce the dimensions of and/or greatly steepen the beach profile associated with channel sand bars and islands when compared to similar sites where such daily or sub-daily stage changes are not occurring.
Over the long term, uncontrolled variability in river stage (e.g., as caused by annual peaks and floods) has a substantially greater measurable effect on the profiles and dimensions of channel sand bars and islands in any given river reach than do more frequent but smaller-magnitude stage variations at sub-daily time scales (e.g., as caused by hydrocycling).

On average in any given year, Program-implemented pulse flows will have a substantially greater measurable effect on the profiles and dimensions of sand bars and islands in any given river reach than will more frequent but smaller-magnitude stage variations at sub-daily time scales.
The effect of sub-daily variations in stage on the profiles and dimensions of channel islands and sand bars is determined more by the available sediment supply in that reach of the river (sediment balance and sediment size distribution) than by the frequency, rate, or magnitude of stage changes.
Wet meadows
Water levels for wet meadows are primarily a function of regional groundwater levels and/or climatic events.
Regional groundwater levels and/or climatic events are more dominant than streamflow in influencing wet meadows.
When wet meadow water levels and streamflow show correlation, that is because they are both influenced by a third factor (i.e. regional groundwater table or climatic conditions), not because one is caused by the other.
Water levels in wet meadows can not be significantly influenced by a managed release of water down the river.
River stage is an important influence on the hydrology (water tables and soil moisture) of wet meadows adjacent to the river channel through its effect on groundwater gradients. The two preferred metrics for assessing wet meadow hydrologic conditions in terms of their potential to support habitat conditions described in Table 1 of the Land Action Plan are (a) the 10% cumulative frequency growing-season water levels, and (b) the 7-day moving average growing-season high water levels (see Henzey et al., 2004).
River stage does not have a significant influence on groundwater more than 3,000 feet from a flowing channel (BOR May 2001).
Releases of project water to elevate river stage concurrent with local precipitation and/or snowmelt events will generate more measurable improvements to wet meadow hydrology than will equivalent releases made at other times, as measured by one or both of the above metrics.
A water table rise during the early stages of spring thaw hastens soil thaw and promotes biological activity and/or productivity in wet meadow areas by bringing warmer water closer to the soil surface.
Platte River flows overtopping areas cleared of trees and brush deposit silt. Silt deposition from overtopping flows helps create organic surface soils capable of retaining more moisture and nutrients, and thereby helps develop desirable wet meadow conditions.
Establishment of a self-sustaining grassland component of a wet meadow can not be established on the bare mineral soils of areas cleared of trees and brush.
Overbank flooding from the river to wet meadow areas on at least rare occasions (*e.g.*, once every 5 to 20 years) improves the connectivity between wet meadows and river, repopulates wet meadows with whooping crane prey/forage species, modifies wet meadow swales, and enhances nutrient conditions (These prey and forage need to be identified so that the hypotheses can address whether or not this actually happens and whether or not whooping cranes actually utilize any of the prey and forage identified).
A high productivity and diversity of macro-invertebrates in areas used by whooping cranes along the Platte River will improve WC conservation and recovery

High water tables in wet meadows provide greater benefits to WC if they occur in the Feb-Jun period versus other times of year
Periodic inundation of wet meadow areas due to overbank flow increases their suitability as WC habitat and reduces risk of new species listings
Areas where surface soils thaw earlier allow for increased macro
As depth to groundwater increases during the Mar15-Apr15 period, the number of macroinvertebrates available as WC prey decreases.

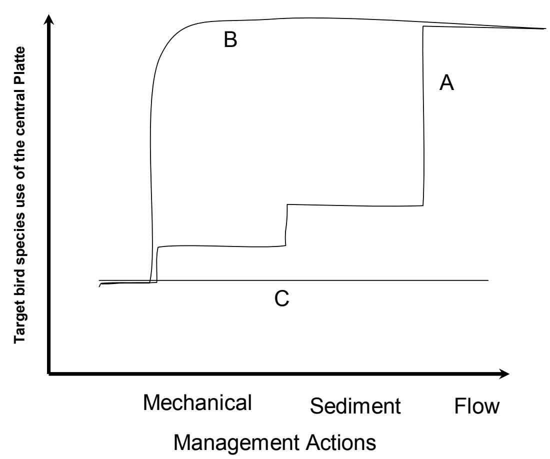
Appendix D. X-Y Graphs

S1. The Platte River form can be modified by either mechanical/sediment/flow management (i.e., clear/level/pulse) or mechanical means along with non-Program managed flows.



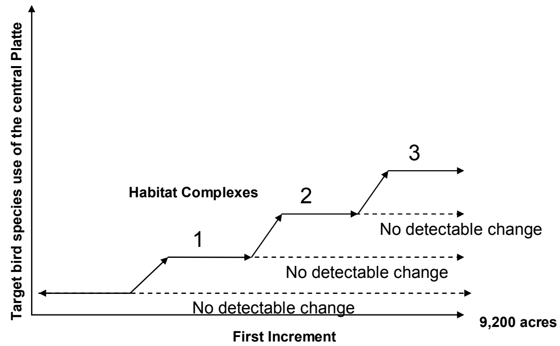
A) Mechanical modification of channel combined with sediment and flow management will affect channel morphology which will result in species use
B) Mechanical efforts alone can have the same affect as clear level pulse
C) Management actions will not be of sufficient scale and magnitude to cause detectable system wide changes

S1a. Program channel habitat restoration actions will result in detectable change to Platte River form and function.



a) Mechanical modification of channel combined with sediment and flow management will affect channel morphology which will result in species use (See figure S2),
B) Mechanical efforts alone can have the same affect as clear level pulse
C) It will not be possible to detect changes in channel form on a system wide level.

S1b Program land management actions (i.e., restoration into habitat complexes) will have a detectable effect on target birds species use of the associated habitats



Achieving habitat features on Program lands with characteristic approximating the guidelines in Table of the Land Plan (Habitat Complexes) and the Mgt. Joint Study will be an efficient and biologically effective long-term land conservation and management strategy on the Platte River for the target bird species. Overall habitat complex approach

Distribution – 3 complexes distributed throughout study reach

Location – 6,400 ac above Minden; 2,800 ac below Minden

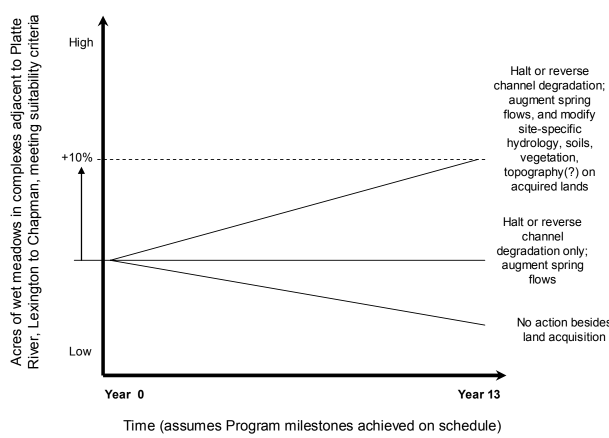
Channel – 2 miles long; 1,150 ft channels (overall 30% increase in channels >750 ft); maintained by clear/level/pulse approach

Wet Meadows – 640 ac per complex (10% increase in central Platte region)

Buffers – Up to 0.5 miles wide but may be variable

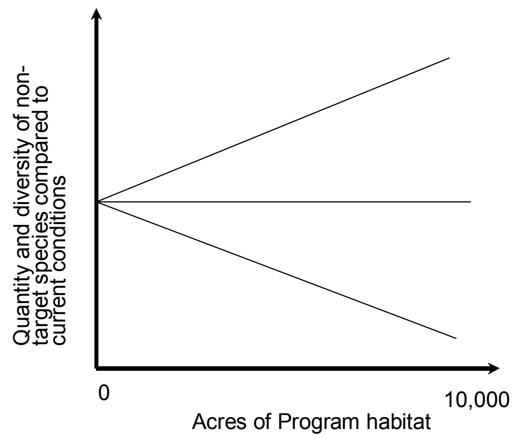
Restoration – At least 50% of land would undergo restoration

S1c: Program actions will increase functional wet meadows in habitat complexes during the first increment



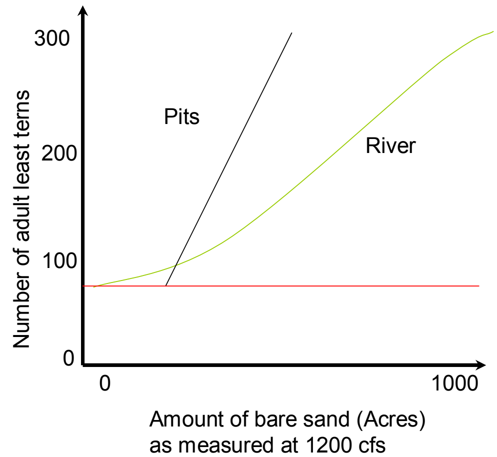
Proposed Program actions (land acquisition and management, halting or reversing channel degradation, augmenting spring flows, minimizing further reductions of peak flows) will increase the total acreage of wet meadows in habitat complexes by the end of the first increment. Absent these Program actions, total suitable wet meadow area is likely to decline.

S2 Implementing Program land and water management actions (i.e., habitat complexes and clear/level/pulse) will have a detectable effect on other species use of the associated habitats



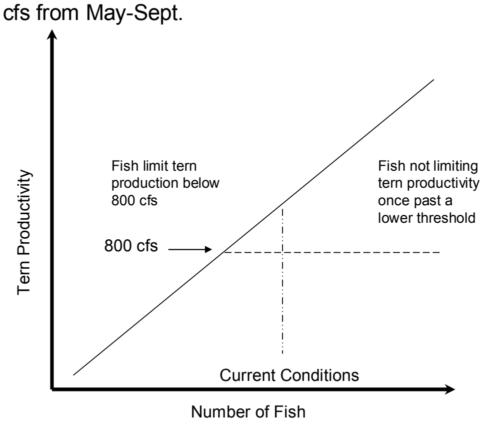
Management Objective #4 Within the overall management objectives for whooping crane, terns and plovers, and pallid sturgeon, benefits can be provided to non-target listed species and non-listed species of concern thereby reducing the likelihood of future listing and improve overall ecosystem diversity.

T1: Additional bare sand habitat will increase the number of adult least terns.



Green line is island densities from central Platte constructed islands using only years when birds were present on islands densities would be approximately half this if we use all years islands were present.
Black line using estimated acres and 96 bird average on 81 acres of sandpits last 4 years
Red line is bare sand not currently limiting so additional acres has no effect.

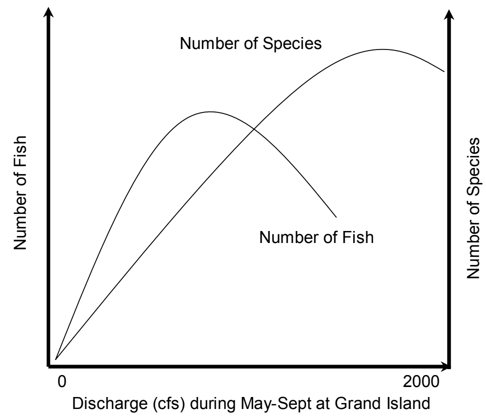
T2. Tern productivity is related to the number of prey fish (<3 inches) and fish numbers limit tern production below 800 cfs from May-Sept.



One of the USFWS target flows is related to fish populations for tern prey base. If the prey base is limiting terns, and flows are released to increase the prey base, tern numbers should increase. If fish numbers are not limiting the tern population, increased numbers of fish will not increase tern numbers.

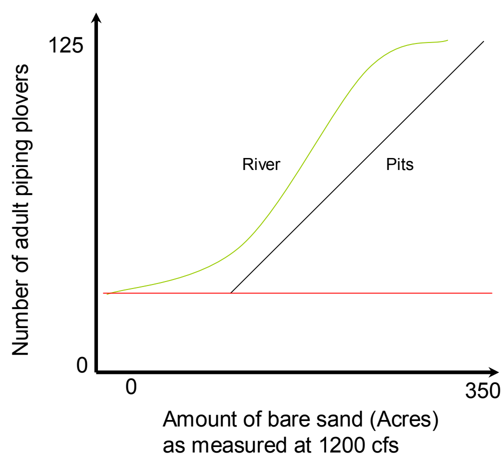
Factors that may limit fish populations include: temperature, nutrients, ambient air temperature, solar energy, fish movement, species composition, etc.

T2a. Flow rates influence the number and species diversity if tern prey base (fish).



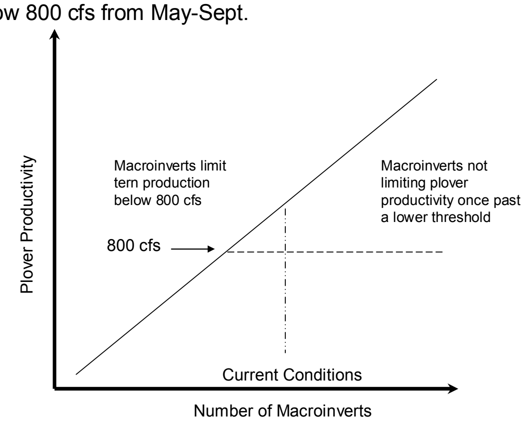
As flows increase there is a corresponding increase in both the number of species and number of individual fish. At some flow the numbers of fish decline due to the fact that some species with large numbers of individuals (e.g., killifish) due better at lower flows. The numbers of overall species increases because some of the individuals remain as well as other species "move in".

P1. Additional bare sand habitat will increase the number of adult piping plover.



Green line is island densities from central Platte constructed islands using only years when birds were present on islands densities are approximately half this is we use all years islands were present.
Black line using estimated acres and 30 bird average on 81 acres sandpits last 4 years
Red line bare sand not limiting so additional acres no effect

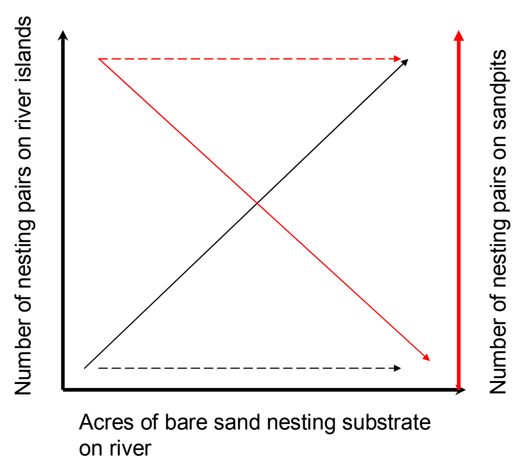
P2. Plover productivity is related to the number of suitable macroinverts and macroinverts limit plover production below 800 cfs from May-Sept.



If the prey base is limiting plovers, and flows are released to increase the prey base, plover numbers should increase. If macroinvert numbers are not limiting the plover population, increased numbers of macroinverts will not increase plover numbers.

Factors that may limit macroinvert populations include: temperature, nutrients, ambient air temperature, solar energy, species composition, etc.

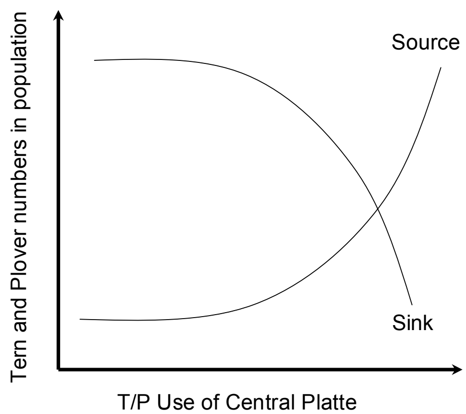
TP 1. There is an Interaction of river and sandpit habitat.



As river habitat increases, additional birds will 1) move into the region, and birds will continue to use the sandpits at current number or 2) move from sandpits to the river.

The relationship between use and location (river, sandpit) may indicate a relative preference for nesting location.

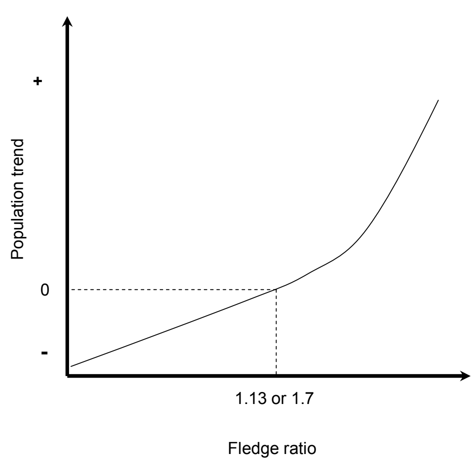
TP 2. The central Platte River may act as a source or sink for terns and plovers.



Unknown if birds that are fledge on the central Platte (pits or otherwise) breed elsewhere, die on winter grounds, other. Full investigation would require a banding study.

This is a good hypothesis, but it would be difficult to implement at a Program level because the scope of the test would be far outside of the Program scales. Production of a subpopulation is not always proportional to subpopulation trends because of interconnectedness to other subpopulations.

TP 2a. A fledge ratio of 1.13 or 1.17 fledging/pair is needed to prevent the central Platte River from being a population sink for piping plover.

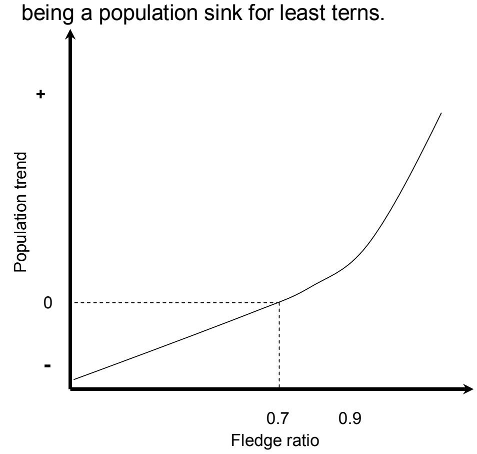


A long-term piping plover fledge ratio less than 1.13 or 1.7 will result in the area being a population “sink”.

Different areas (pits vs. river) and different nest management practices will influence the fledge ratio.

The fledge rates are based on studies of productivity for the entire metapopulation. Production of a subpopulation is not always proportional to subpopulation trends because of interconnectedness to other subpopulations (e.g., annual immigration/emigration and productivity of other subpopulations).

TP 2b. A fledge ratio of 0.7 fledging/pair is needed to prevent the central Platte River from being a population sink for least terns.

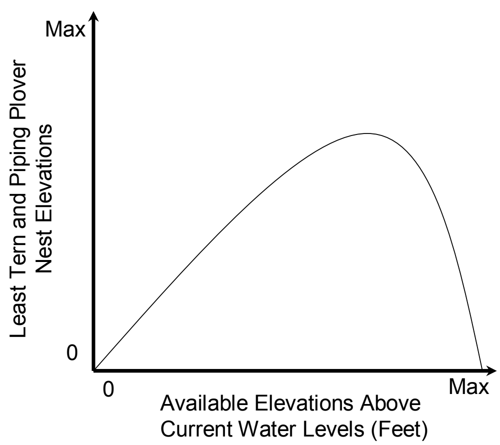


A long-term least tern fledge ratio less than 0.7 will result in the area being a population “sink”.

Different areas (pits vs. river) and different nest management practices will influence the fledge ratio.

The fledge rates are based on studies of productivity for the entire metapopulation. Production of a subpopulation is not always proportional to subpopulation trends because of interconnectedness to other subpopulations (e.g., annual immigration/emigration and productivity of other subpopulations).

TP 3. Tern and plover will select for specific elevations above current water levels compared to available elevations for nest initiation

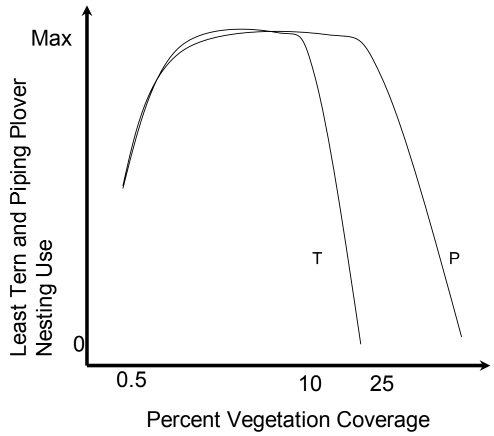


Hypothesis: Tern and Plovers select for specific elevations above current water levels compared to the available sandbar elevations for nest initiation

Alternate Hypothesis: Tern and Plovers randomly select sandbar elevations when initiating nests

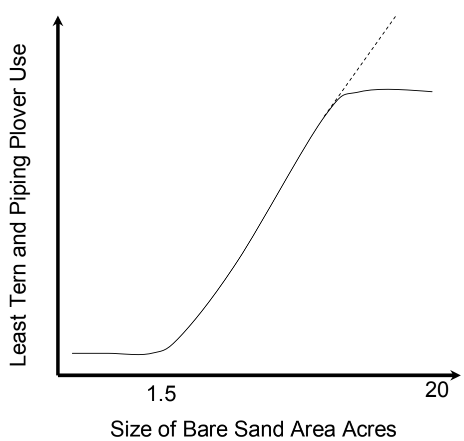
This hypothesis will evaluate elevations at 1,200 cfs as well as elevations associated with all other flows.

TP 4. Increased vegetation cover decreases tern and plover use.



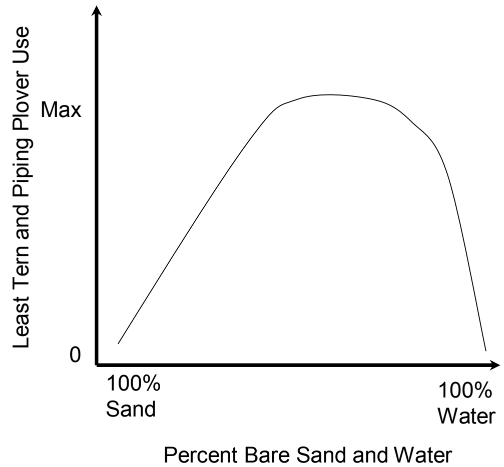
Least tern use within an area will decrease at 10% vegetative cover and piping plover use will decrease at 25% cover.

TP 4a. Bare sand suitability increases with size



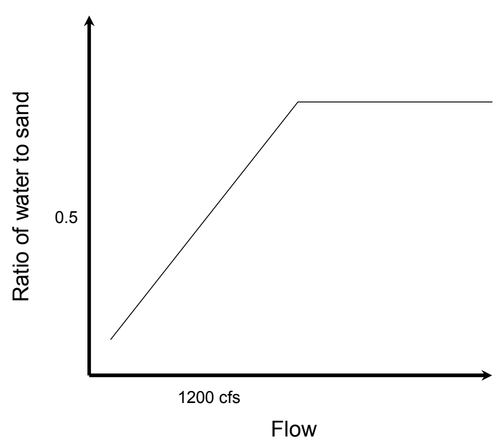
1.5 acres is the minimum size of bare sand area to be considered habitat by terns and plover. One hypothesis is that once a maximum bare sand area is reached additional area will not increase use. Other hypothesis is that more bare sand area will result in more use with no maximum.

TP 4b. Least tern and piping plover use will be maximized at 50-65% water to sand combination.



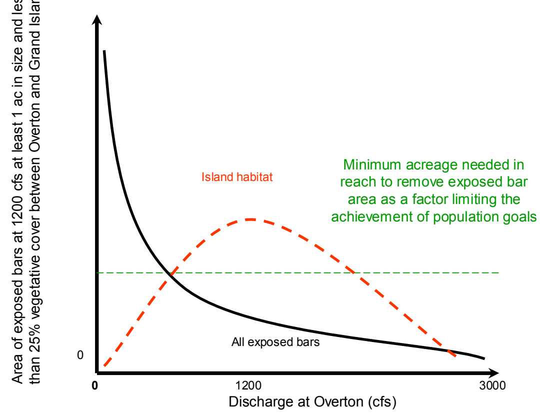
Tern and plover use of an area requires a combination of bare sand and water. If an area is comprised completed of either use will be zero. Optimal ratios may be different for the two species.

TP 4c. Increased flow rates increase the amount of water area compared to sand area



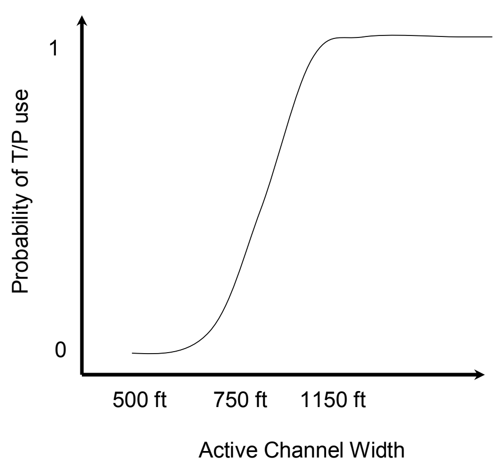
A flow rate of 1200 cfs results in the optimum water to sand ratio.

TP 4d. Correlation between river island habitat and flow.



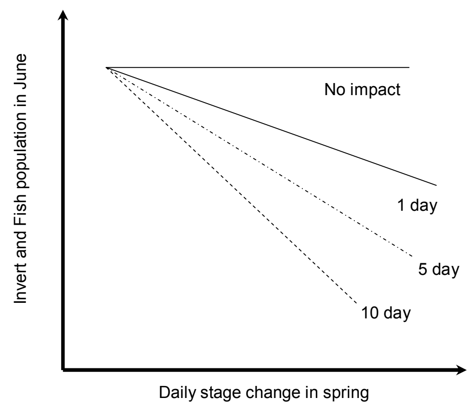
Once islands are created by peak flows or mechanical manipulation, flows at Overton of 1,200 cfs maximizes area of exposed island bars between Overton and Grand Island that is usable for LT and PP habitat. At lower flows, island areas are low due to connection with bank. At higher flows, island areas are low due to inundation.

TP 5: Use of riverine islands by least terns and piping plovers will increase with active channel width.



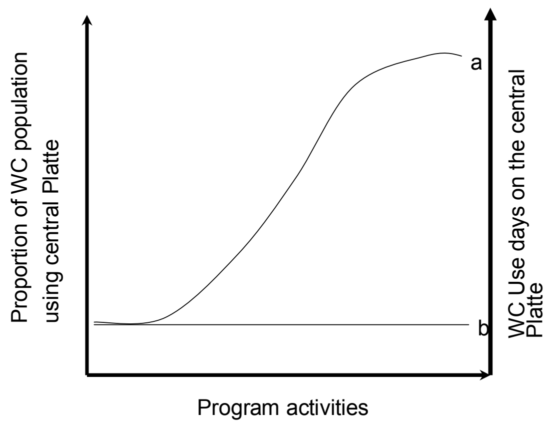
Tern and plover use of an area will be maximized when active channel widths are between 750 and 1150 feet wide.

TP 6. Daily stage change impacts on tern and plover prey base



Repeated stage changes on a daily or sub-daily basis adversely impacts the abundance and diversity of the aquatic invertebrate and fish communities that forms the food base for piping plovers and least terns, respectively. For plovers and terns to successfully nest and rear chicks in and along the central Platte River, a certain quantity and quality of prey items are required throughout the nesting season. Curves are likely different for different species of fish and invertebrates.

WC 1. Whooping Crane use will increase as function of Program land and management activities.

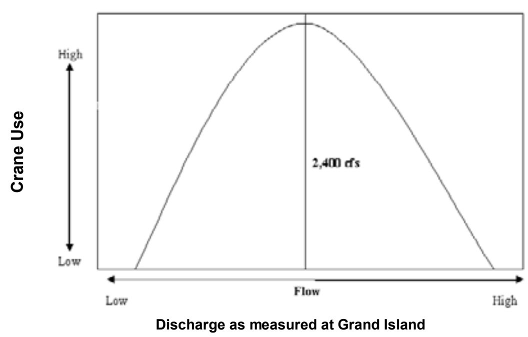


a. The amount of whooping crane use days will increase as Program activities increase.

b. Whooping crane use days will not increase with Program activities.

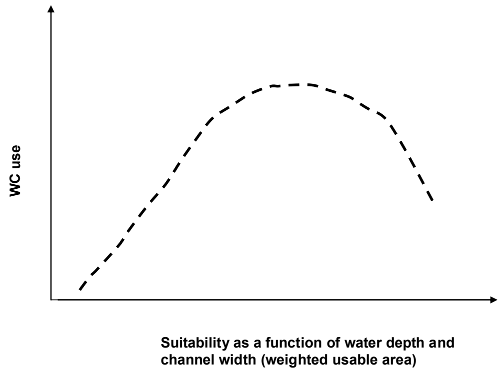
Analysis and consideration will be needed to investigate Program activities and non Program activities (e.g., Trust land management). Analysis could also be done on a bridge segment basis as well as a system basis.

WC 2. Whooping cranes select for flows of 2,400 cfs at Grand Island



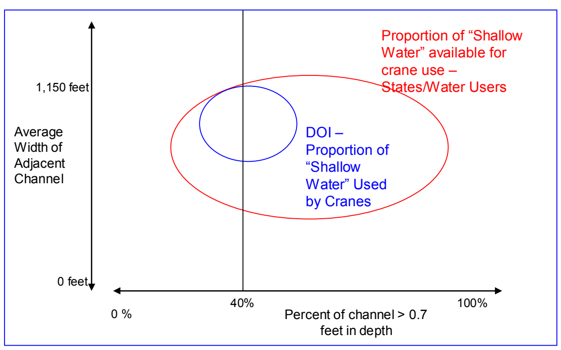
Whooping crane use is maximized at 2400 cfs

WC 3. Whooping crane use is related to habitat suitability

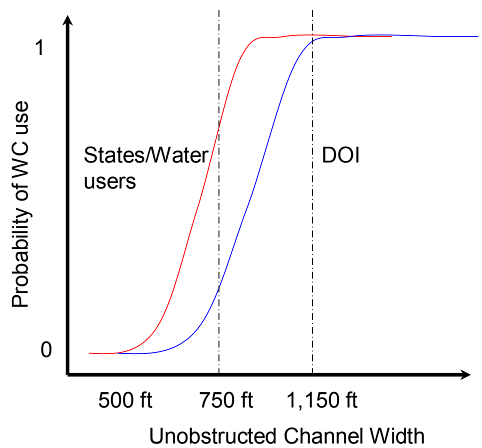


The prediction of habitat suitability for whooping crane in channel habitat as a function of water depth and unobstructed channel width. FWS Instream flow recommendation for fall and spring whooping crane migration season is 2,400 cfs. Farmer et al. estimates that peak suitability is achieved at 1700 cfs.

WC 3a. Whooping crane use is related to unobstructed channel width and channel depth



WC 3b: Probability of whooping crane use increases as channel widths increase



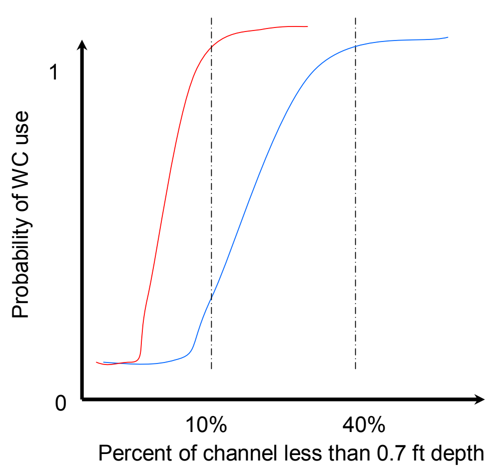
Whooping crane prefer wider, shallower channels w/open views; includes a. depth, b. width, c. distance to disturbance, d. proximity to wet meadow, e. size , f. length, g. water velocity, h. flight hazard, I. distribution.

a. Whooping crane use is proportional to unobstructed channel width.

b. Whooping crane use is not proportional to unobstructed channel width.

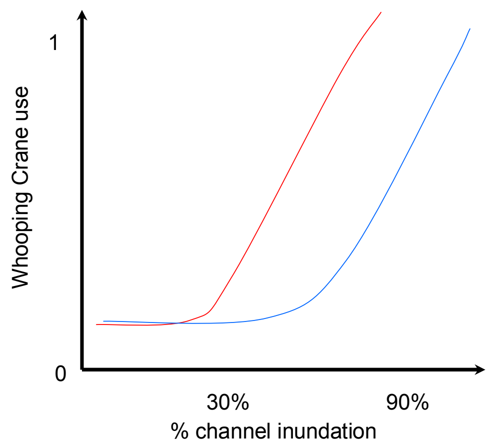
An evaluation should also be conducted that looks at probability of use in respect to varying, contiguous lengths of wide channel (e.g., 1.5 miles "wide" channel has greater frequency of use than 0.5 miles).

WC 3c. Whooping crane use is related to channel depth



For a given stretch of river 2-miles long and 1,150 feet wide, whooping crane use is proportional to percent of channel less than 0.7 ft.

WC 3d. Whooping crane use is related to amount of channel inundation.



For a given stretch of river 2-miles long and 1,150 feet wide, 90-100% of channel inundation during migration (wetted width) is needed to maximize whooping crane use.

WC 4 Whooping crane use of the central Platte River study area will increase proportionally to an increase in wet meadows

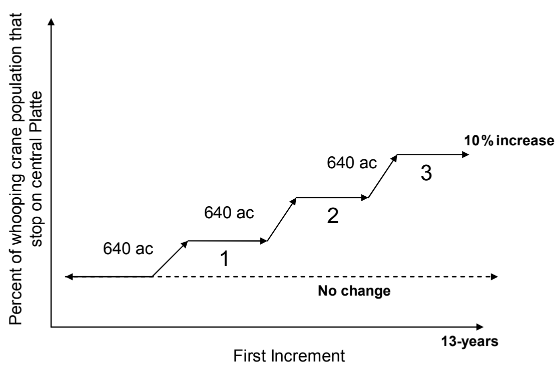
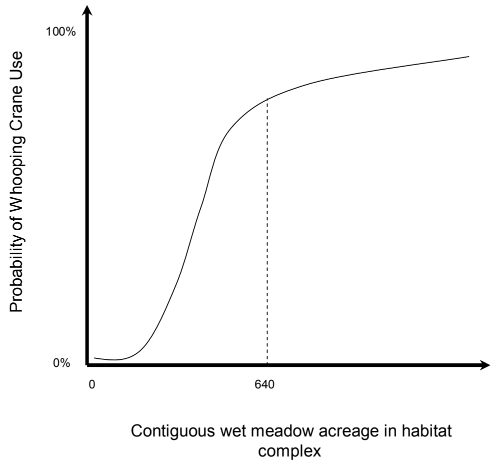


Table 1 wet meadow characteristics:

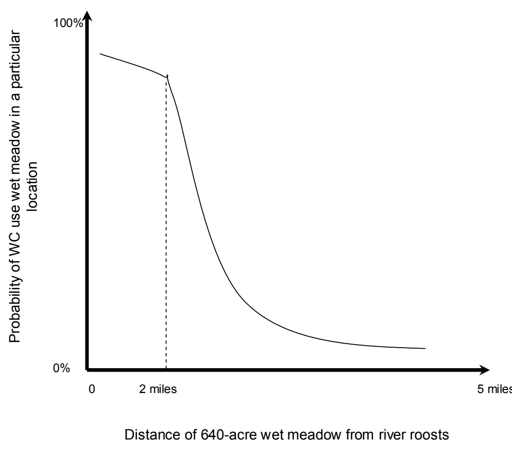
- Within of channel habitat whose length is two miles
- 640 contiguous acres
- Not less than 0.5-mile distant or appropriately screened from disturbance
- Appropriate mix of vegetation, hydrology, topography and soils, and food sources (see set meadow hypotheses

WC 4a: Whooping crane use will increase with suitable wet meadow size



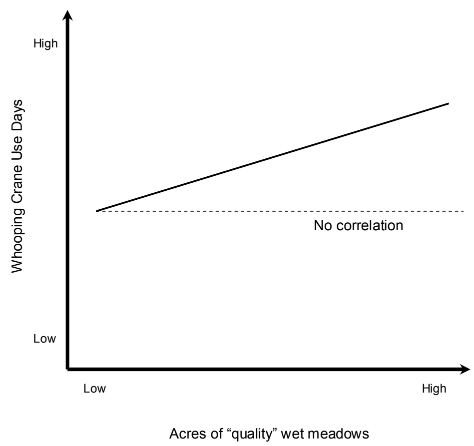
The probability that Whooping Cranes use wet meadow areas within a habitat complexes increases as the contiguous area of wet meadow in the complex increases. (This assumes these wet meadows have suitable hydrology and soils, and are within 2 miles of Platte channels with suitable roosting depths and unobstructed widths). A threshold of 640 acres per habitat complex is hypothesized to achieve desired Program benefits.

WC 4b. Whooping crane use will increase with an increase in suitable wet meadows near the channel.



The probability that Whooping Cranes use wet meadows in any particular location decreases as their distance from river roosts increases. (Assumes these wet meadows have suitable hydrology and soils). A distance of two miles for an individual complex is hypothesized to be the maximum acceptable to achieve desired Program benefits.

WC 4c. Whooping crane use will increase with more wet meadow acreage.

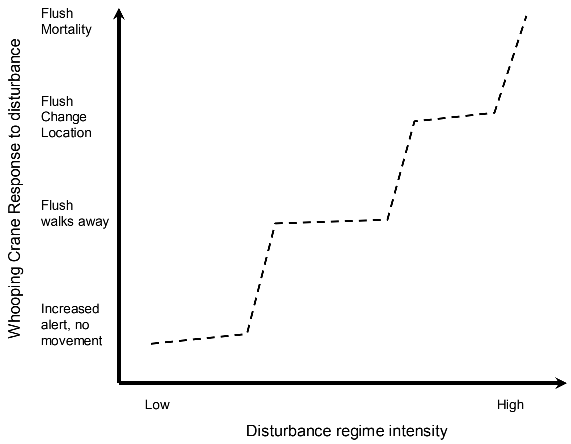


Increase in acres of quality wet meadows will increase use days of whooping cranes on the central Platte.

WC 4d: Whooping crane use of wet meadows will increase with increased biomoass of macroinvertebrates

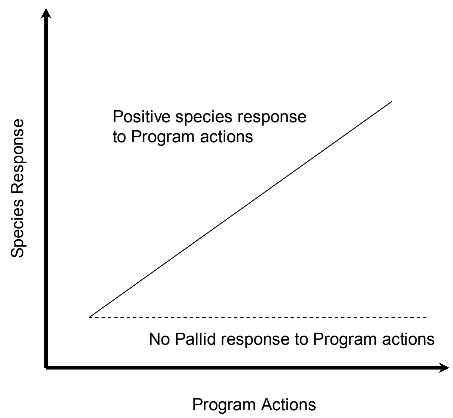
Increased macroinverts near soil surface or less than one-foot of water will increase whooping crane use days

WC 5 Whooping cranes are adversely affected by nocturnal disturbances that lead to flushing (walking or flying) which could potentially lead to mortality.



Roosting Whooping Cranes can be disturbed by many factors (animals, humans, vehicles, water flow and level changes). Level of disturbance can range from increased alert behavior through displacement from a roost, which can lead to increased probability of mortality. Mortality, if it occurs, is most likely a secondary effect of flying from a roost and colliding with power lines or other structures.

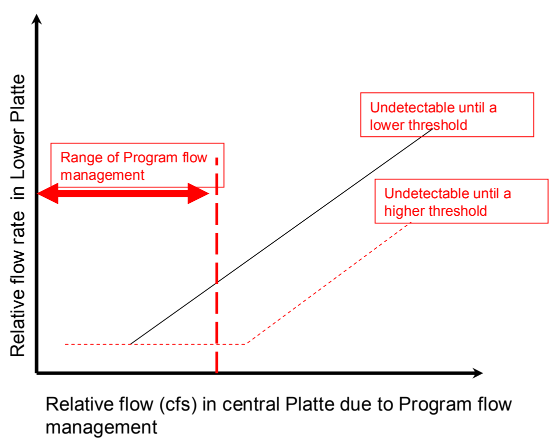
PS- 1: Program flow/sediment management will result in a positive species response by the pallid sturgeon in the lower Platte River.



Changes in flow rate and/or channel characteristics will not result in detectable change in patterns/levels of pallid sturgeon use in the lower Platte River.

Species use could be used as the indicator of species response?

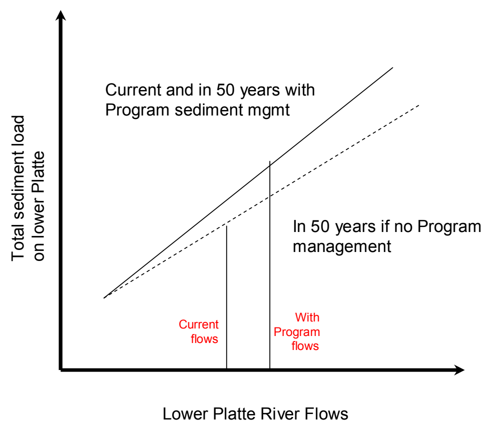
PS 2: Program water management will result in measurable changes on flow in the lower Platte River.



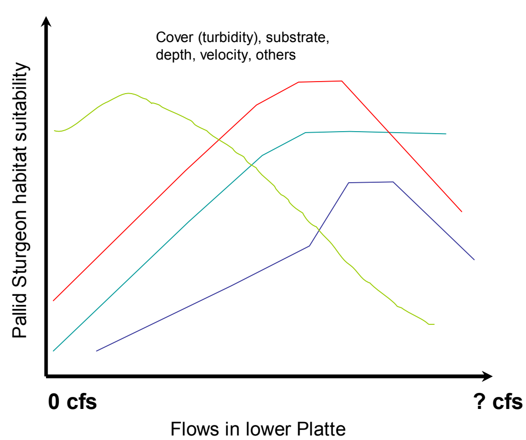
Program flow management results in measurable change in the lower Platte flows. The probability of detecting flow changes in the lower Platte as a result of Program water management activities (e.g., new depletions plans, summer flow augmentation) is improbable.

Program pulse flow management will have the greatest chance of resulting in measurable changes in the lower Platte.

PS 3: Program flows and sediment management will result in measurable changes on sediment load in the lower Platte River

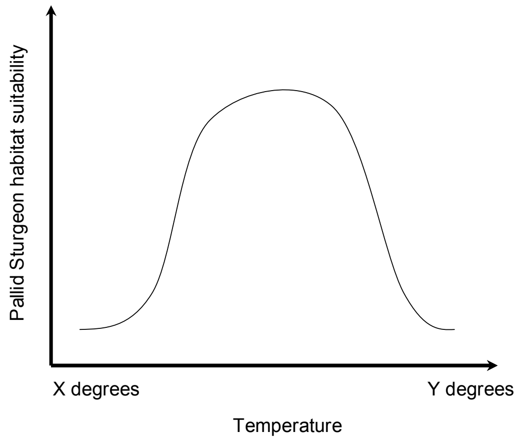


PS- 4: Flow in the lower Platte will affect pallid sturgeon habitat suitability.



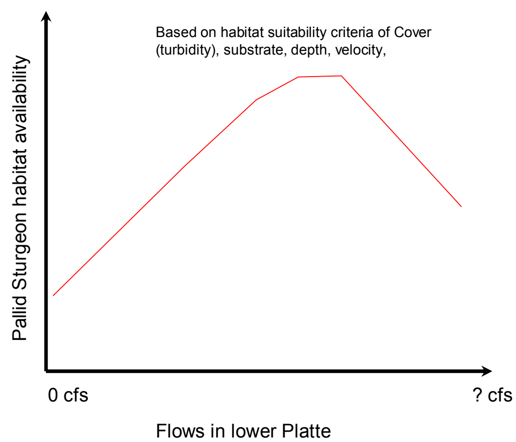
Flows on the lower Platte river affects habitat suitability for Pallid Sturgeon. Some habitat suitability is known, some requires more research.)

PS- 5: Pallid sturgeon habitat suitability is maximized between water temperatures of X and Y in the lower Platte River.



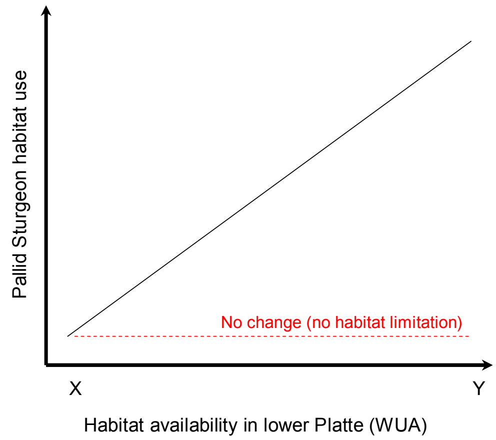
See text above

PS-6: Increasing flow in the lower Platte will affect pallid sturgeon habitat availability.



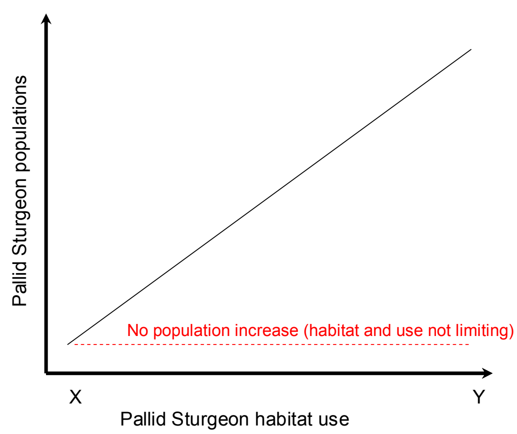
Increase flows on the lower Platte river will affect habitat availability for Pallid Sturgeon.

PS-7: Increasing habitat availability in the lower Platte will increase pallid sturgeon use.



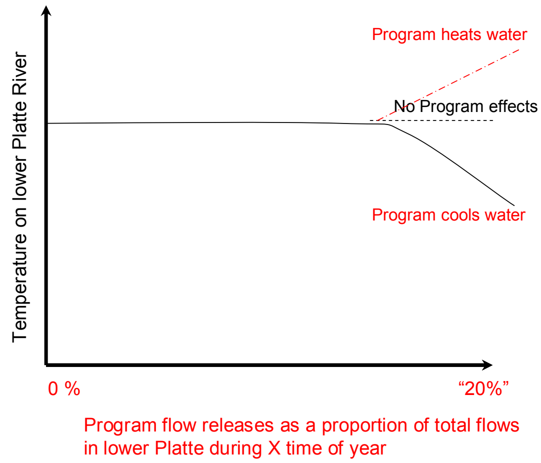
See text above

PS-8: Increasing Pallid sturgeon use in the lower Platte River will increase pallid sturgeon populations.



See text above

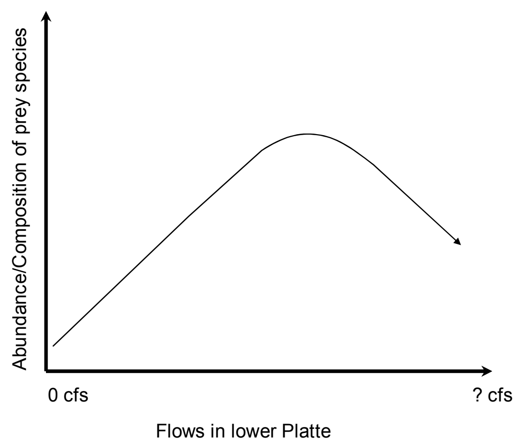
PS-9: Increasing Program flow releases will decrease water temperatures in the lower Platte River.



Increased program flow releases will decrease summer water temperatures on the lower Platte River

Increased program flow releases will have no effect on summer water temperatures on the lower Platte River (equilibrium conditions reached before the lower Platte River)

PS-10: Different rates of flow in the lower Platte affect pallid sturgeon prey base.

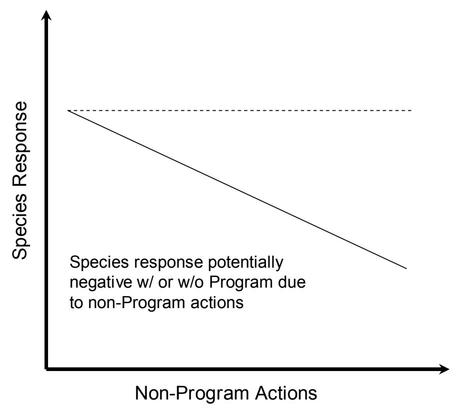


Numerous other parameters should be hypothesized including:

PS1b: Changes water quality (temp, turbidity, etc) will result in detectable change in patterns/levels of pallid sturgeon use in the lower Platte River.

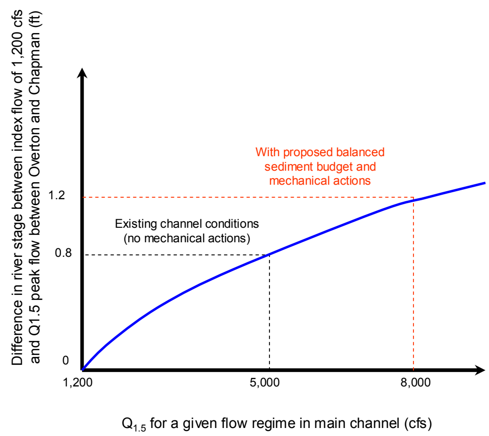
PS1c: Floodplain connectivity

PS-11: Non-Program actions (e.g., harvest, stocking, Missouri River conditions) determine the occurrence of pallid sturgeon the lower Platte River



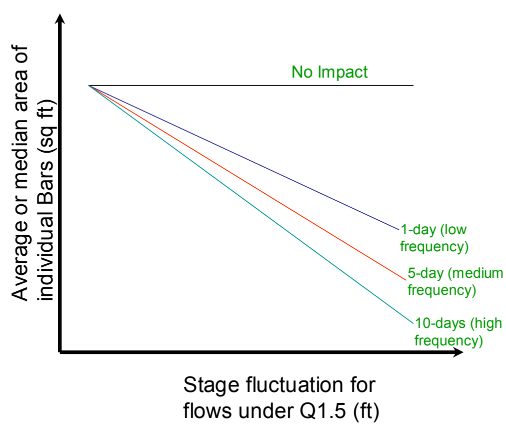
Non-Program actions: Incidental harvest, stocking, Missouri River conditions, Competition with non-native species, local water quality, disease, hybridization.

Flow 1: Increasing river stage variation will increase sand bar height



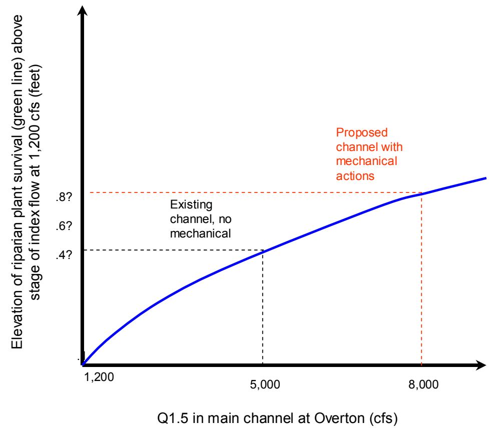
Increasing the variation between river stage at peak flow (indexed by $Q_{1.5}$ flow at Overton) and average flows (1,200 cfs index flow), by increasing the stage of the peak (1.5-yr) flow through Program flows, will increase the height of sand bars between Overton and Chapman by 30% to 50% from existing conditions, assuming balanced sediment budget.

Flow 2. Stage fluctuation will decrease bar area



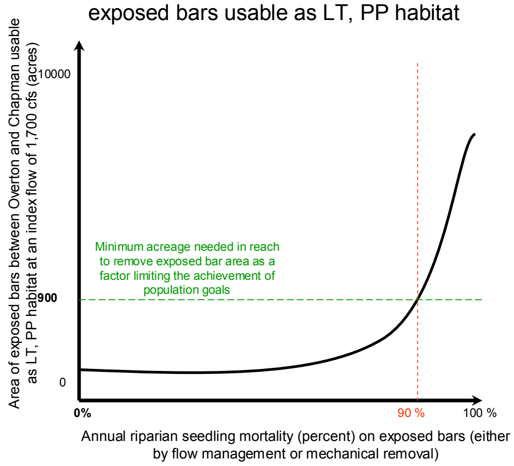
After a bar has been created by whatever means, ongoing stage fluctuations will decrease the bar area that could potentially be used by terns and plovers. Erosion will be less with a balanced sediment budget. Rate, magnitude, and frequency of stage fluctuation needs to be considered

Flow 3: Increased peak (1.5 yr) flow = raised green line (the lowest elevation at which vegetation can establish on river banks and sand bars) = more exposed sand bar area and wider unvegetated main channel.



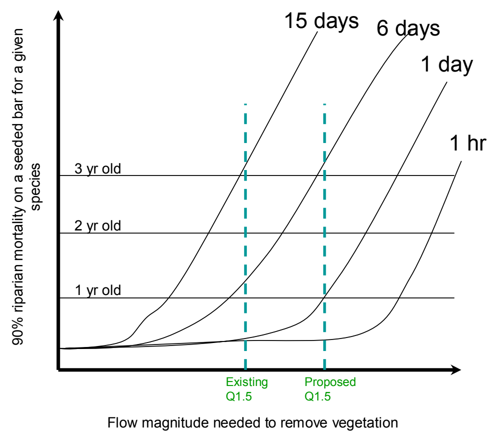
Increasing the 1.5-yr peak flow regime (indexed by $Q_{1.5}$ flow at Overton) with Program flows will increase the local boundary shear stress and frequency of inundation at the existing green line (elevation at which riparian vegetation can establish). These changes will increase plant mortality along the margins of the channel, raising the elevation of the green line. A raised green line results in more exposed sand bar area and wider unvegetated main channel.

Flow 4: Increased riparian plant mortality = more exposed bars usable as LT, PP habitat



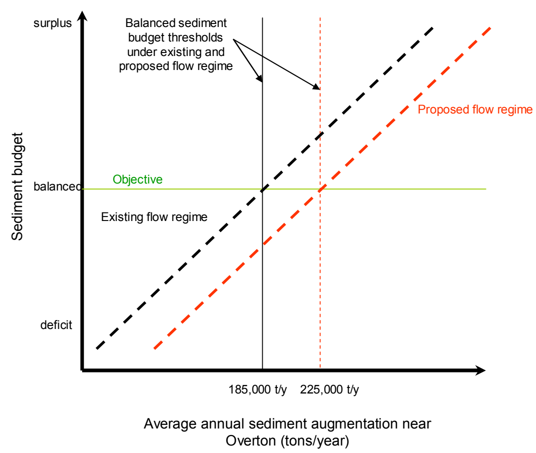
Annual riparian seedling mortality greater than 90% is required to prevent riparian encroachment on exposed bars, thereby maintaining at least 900 acres of exposed bars between Overton and Chapman that are usable as LT and PP habitat.

Flow #5: Increased magnitude and duration of flow increases riparian plant mortality



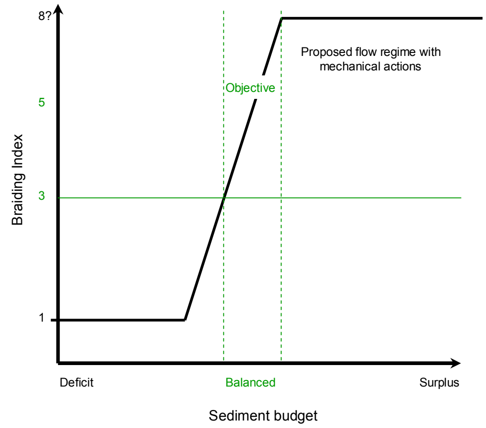
Increasing magnitude and duration will increase riparian plant mortality along the margins of the river. There will be different relations (graphs) for different species.

Sediment 1: Sediment augmentation balances the sediment budget.



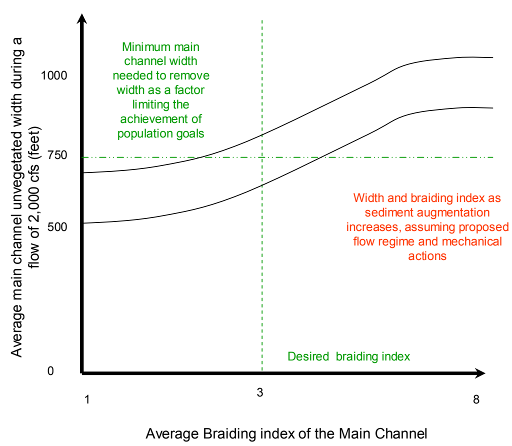
Sediment augmentation near Overton to 185,000 tons/yr under existing flow regime and 225,000 tons/year under the Governance Committee proposed flow regime achieves a sediment balance to Kearney.

Sediment 2: Balanced sediment budget promotes braiding and an increased braiding index



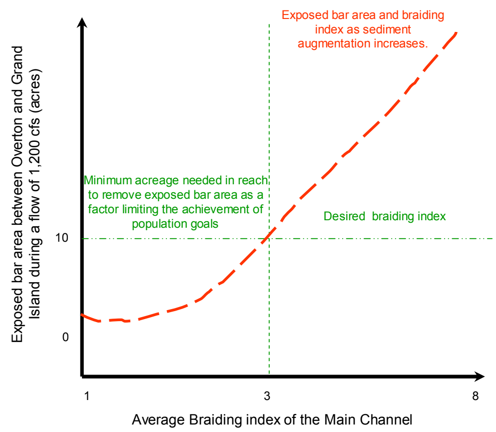
A balanced sediment budget (sediment augmentation of 225,000 tons/yr near Overton under proposed Governance Committee flows) when implemented with mechanical actions (channel consolidation & widening) in anastomosed reaches will promote braided channel morphology with an average braiding index in the main channel of greater than 3.

Sediment 3: Increasing the braiding index by achieving a sediment balance increases main channel width



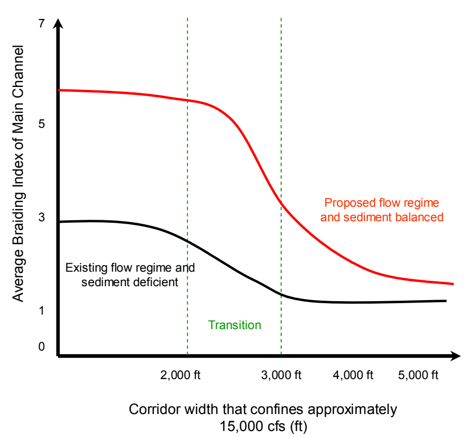
Increasing the average braiding index of the main channel by achieving a balanced sediment budget, increases the active width of the main channel at an index flow of 2,000 cfs (at Overton).

Sediment 4: Increasing the braiding index by achieving a sediment balance increases bar area



Increasing the average braiding index to greater than 3 for the main channel by achieving a sediment balance, will increase and maintain exposed bar area greater than 1.5 acres in the reach between Overton and Kearney at an index flow of 1,200 cfs (at Overton).

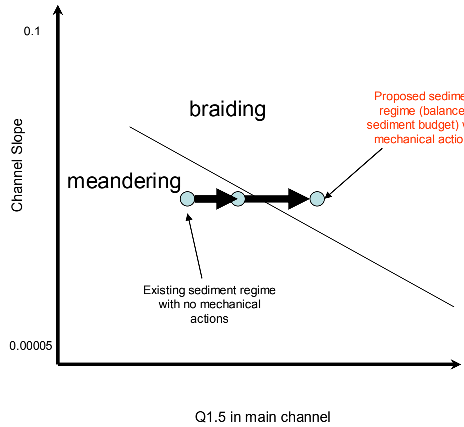
Mechanical (Channel manipulation) 1: Decreased "hydraulic corridor width" encourages braiding



Indirectly narrowing the width of the hydraulic corridor (preferred width less than 3,000 ft) by cosolidating channels under proposed flow regime and balanced sediment budget will convert anastomosed reaches of the Platte River between Overton and Chapman to a braided channel morphology.

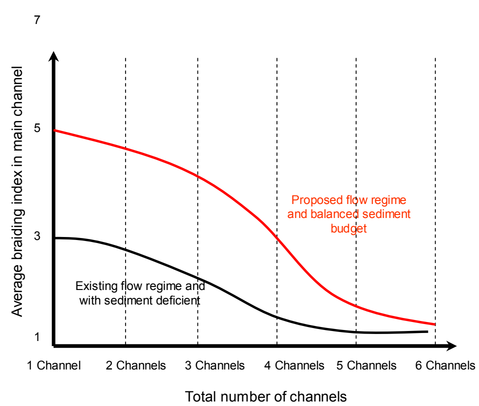
"Hydraulic corridor width" is defined as the width from furthest wetted left bank to furthest wetted right bank, as measured at an index flow of 15,000 cfs.

Mechanical (channel manipulation) 2: Stream power determines braided channel morphology (this focuses on channel consolidation rather than increased releases)



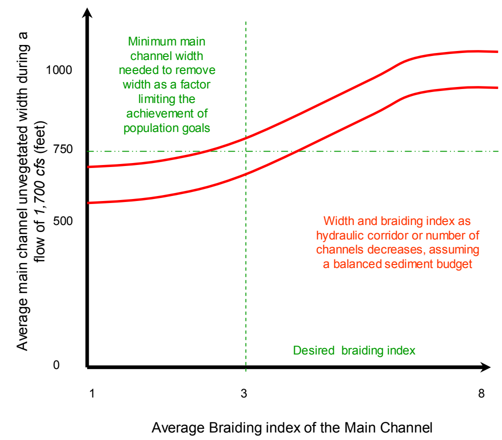
Increasing the Q1.5 in the main channel by consolidating 85% of the flow, and aided by Program flow and a sediment balance, flows will exceed stream power thresholds that will convert the main channel from a meander morphology in anastomosed reaches to a braided morphology with an average braiding index greater than 3.

Mechanical (Channel manipulation) 3: Reducing number of channels increases unit stream power, which encourages braiding



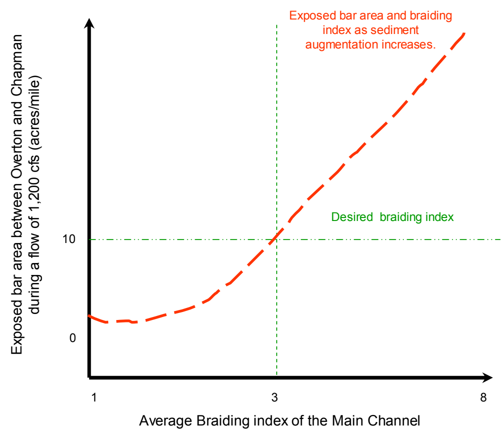
Reducing the number of channels in a reach of river to 3 or less under proposed flow regime and balanced sediment budget will convert anastomosed reaches of the Platte River between Overton and Chapman to braided channel morphology.

Mechanical (Channel Manipulation) 4: Increasing braiding by channel manipulation, increases main channel width



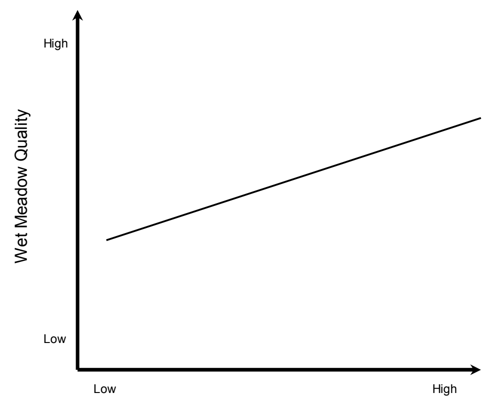
Increasing the average braiding index to greater than 3 in the main channel by channel manipulation will promote in the Platte River at the mechanically changed sites a total main channel wetted width exceeding 500 to 750 feet at an index flow of 1,700 cfs (at Overton).

Mechanical (Channel Manipulation) 5: Increasing the braiding index by channel manipulation increases bar area



Increasing the average braiding index to greater than 3 for the main channel by mechanical channel manipulation, will increase and maintain exposed bar area at 10 acres per mile at an index flow of 1,200 cfs (at Overton).

Wet Meadow 1: An increase in macroinvertebrate diversity and productivity increases the quality of a wet meadow as whooping crane foraging habitat.

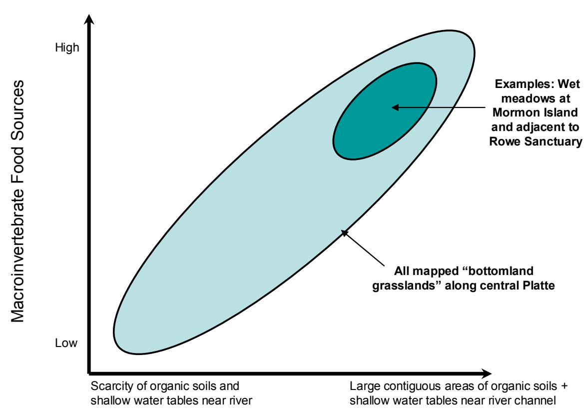


Productivity and diversity of macroinvertebrates in wet meadows

A high productivity and diversity of macro- invertebrates* in areas used by whooping cranes along the Platte River corridor will improve WC conservation and recovery.

(*Note: FWS posits similar relationships to other food sources: e.g., amphibians, reptiles, fish, freshwater shellfish)

Wet Meadow 2: Quality wet meadows provide potential macroinvertebrate food sources for WC

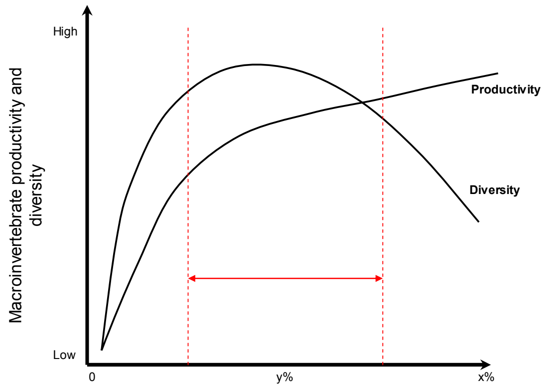


Combinations of site soils + hydrology + location + size * (quality)

Wet meadows producing the optimum productivity (biomass) and diversity of macroinvertebrates potentially consumed by whooping cranes exhibit certain characteristic combinations of soils, hydrology, size, and location. The ideal combinations are not yet fully understood, however along the central Platte habitat reach good existing examples are believed to be found at wet meadows at Mormon Island and adjacent to Rowe Sanctuary.

*NOTE: It is hypothesized that vegatation can be a good indicator of desired wet meadow conditions, but is not generally a primary determinant of those conditions

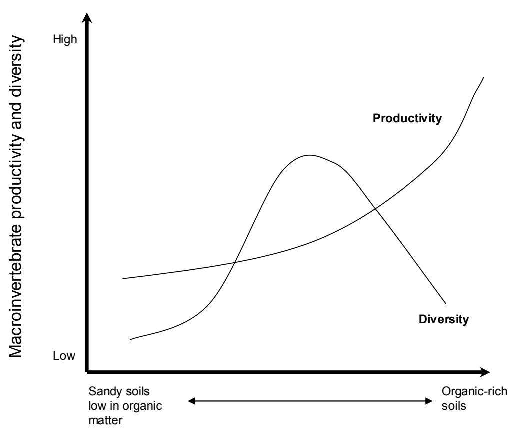
Wet Meadow 3: Suitable wet meadow hydrology (March-April)



Percent of area with water table surface +0.5 feet above to -0.5 feet below ground surface in March and April

Shallow surface water and groundwater less than 0.5 feet deep in March and April support high productivity and diversity of macroinvertebrates as potential food sources to Whooping Cranes in wet meadows, provided site soils are satisfactory.

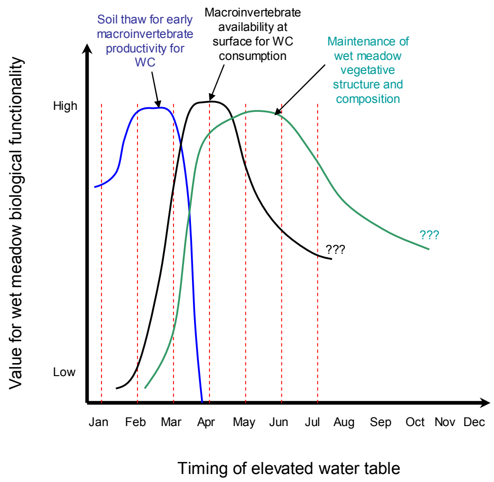
Wet Meadow 4: Suitable wet meadow soil conditions



Dominant soil type

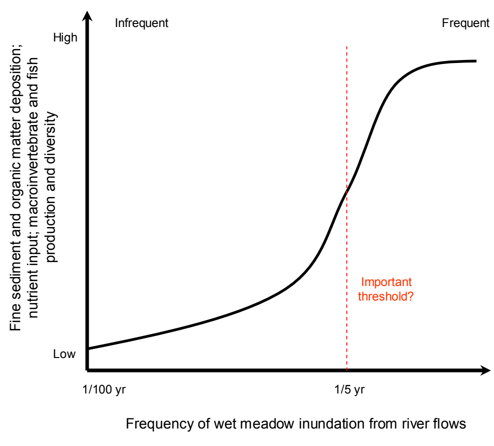
A predominance of organic-rich soils supports the productivity and diversity of macroinvertebrates as potential Whooping Crane food sources in wet meadows, provided site hydrology is satisfactory.

Wet Meadow 5: The timing of elevated water tables in wet meadows influences benefits for WC



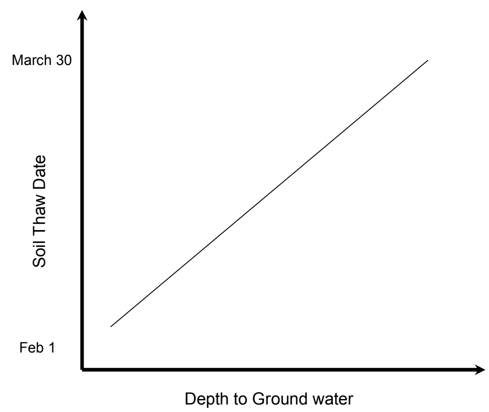
High water tables in wet meadows provide greater benefits to whooping cranes if they occur in the Feb-Jun period versus other times of the year, for multiple reasons. (See related charts 8a-d)

Wet Meadow 6: Periodic inundation of wet meadow areas increases their suitability as WC habitat



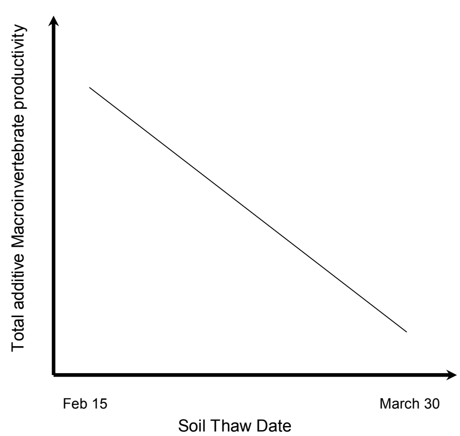
Periodic inundation of wet meadows between Overton and Grand Island increases fine-sediment and organic matter deposition, increases nutrient input, and increases the production and diversity of macroinvertebrates and fish available for Whooping Cranes. *[NOTE: Program actions are not expected to increase the frequency of wet meadow inundation by peak flows, however one intent of the Program is to minimize future reductions in the frequency of these events].*

Wet Meadow 6a: Soil thaw dates are related to ground water elevation.



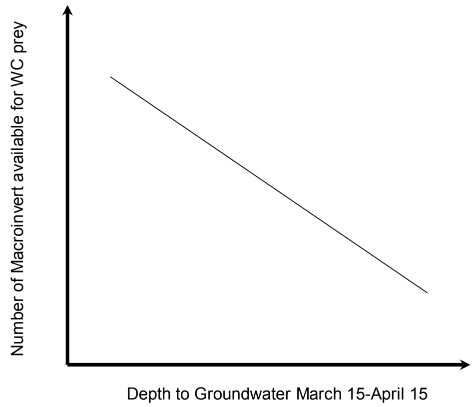
As the depth to ground water increases (i.e., higher elevation) the ground will stay frozen longer. Those areas where ground water is closer to the surface thaw sooner.

Wet Meadow 6b: Marcroinvertebrate production is higher in wet meadows where the soil thaws earlier.



Areas where the soils thaw earlier allow for increased macroinvert productivity.

Wet Meadow 6c: The availability of macroinverts for whooping crane prey decreases with greater depths to ground water.



As distance to ground water increases the number of macroinverts available as whooping crane prey decreases.

Appendix E. Matrices

System Matrix

Graph number	Description of hypothesis	Link to CEM Hypotheses	Source of information, if any	Detectability/ sensitivity (feasibility)	Time needed for measuring a response	Dependent Variable (Indicator)	Corresponding quantitative management objective	Description of alternative/competing hypotheses	Priority Hypotheses?	Rationale based on Prioritization Criteria
S1	The Platte River form can be modified by either mechanical/sediment/flow management (i.e., clear/level/ pulse) or mechanical means along with non-Program managed flows.	S-1, S-2	SedVeg Gen3	High	First Increment	Braiding index, channel width, sandbar area			Yes	Influence Program management, goals, and objectives
S1a	Program channel habitat restoration actions will result in detectable change to Platte River form and function	S-1, S-2, S-4	Joint Study	High.	1-10 years	Species use	Channel width increase, decreased depths with improve river habitat for species	Can not detect a significant effect on indicators	Yes	Influence Program management, goals, and objectives
S1b	Program land management actions (i.e., restoration into habitat complexes) will have a detectable effect on target birds species use of the associated habitats	S-3	Joint Study	Low	First Increment	Whooping crane use days/proportion of population, Least tern piping plover number of adults/nests/fecundity	Improve Production LT & PP, Impove Survival Whooping	Can not detect a significant effect on indicators	Yes	Influence Program management, goals, and objectives
S1c	Program actions will increase functional wet meadows in habitat complexes during the first increment	S-1, S-2		High. Requires good sampling/mapping of wet meadow areas at being and end of Program	First Increment	Wet meadows along habitat reach incomlexes at beginning and end of Program	10% increase in wet meadow acreage over the 1998 baseline trhough habitat acquisition and restoration (Note: meadow quality, not just quantity, will also be an important metric)		Yes	Influence Program management, goals, and objectives
S2	Implementing Program land and water management actions (i.e., habitat complexes and clear/level/pulse) will have a detectable effect on other species use of the associated habitats	S-1, S-2	Joint Study	Medium-High	1-5 years	Species occurrence; Land Plan Table 1 and 2 characteristics	Use by other species of concern. Prevent need to list additional species	Within the overall management objectives for whooping crane, terns and plovers, and pallid sturgeon, benefits can be provided to non-target listed species and non-listed species of concern thereby reducing the likelihood of future listing and improve overall ecosystem diversity.	Yes	Influence Program management, goals, and objectives

Tern and Plover Matrix

Graph number	Description of hypothesis	Link to CEM Hypothesis	Source of information, if any	Detectability/ sensitivity (feasibility)	Time needed for measuring a response	Dependent Variable (Indicator)	Corresponding quantitative management objective	Description of alternative/competing hypotheses	Priority Hypotheses?	Rationale based on Prioritization Criteria
T1	Additional bare sand habitat will increase the number of adult least terns.	TP-1, TP-2, TP-3		high	1-3 years after sand created	number of nesting adult lt	75 nesting pairs lt	bare sand is not currently limiting number of adults	Yes	Critical path for Program goals and objectives
T2	Tern productivity is related to the number of prey fish (<3 inches) and fish numbers limit tern production below 800 cfs from May-Sept.	TP-4	FWS Target flows	medium	x years above 800 cfs and x years below 800 cfs	number of fish between 0.5 and 3 inches long	x fish per meter of water, least tern fledglings per adult?	prey fish do not limit tern production at 799 cfs or tern production is limited by summer flows of < 50 cfs	Yes	On critical path for Program, will influence future water management
T2a	Flow rates influence the number and species diversity in tern prey base (fish).	TP-4	FWS Target flows	medium	period that covers multiple flow levels	species diversity index	Diversity Index of x,least tern fledglings per adult	tern productivity not affected by fish community species diversity	Yes	On critical path for Program, will influence future water management
P1	Additional bare sand habitat will increase the number of adult piping plover.	TP-1, TP-2, TP-3		high	1-3 years after sand created	number of adult pp	64 pp	bare sand is not currently limiting number of adults	Yes	Critical path for Program goals and objectives
P2	Plover productivity is related to the number of suitable macroinverts and macroinverts limit plover production below 800 cfs from May-Sept.	TP-4	FWS Target flows	medium	x years above 800 cfs and x years below 800 cfs	number of macroinverts	x macroinverts per meter of wet sand results in Y plover fledglings per adult?	macroinverts do not limit plover production at 799 cfs or plover production is limited by summer flows of < 50 cfs	Yes	On critical path for Program, will influence future water management
TP 1	There is an interaction of river and sandpit habitat.	TP-2	Sidle andKirsch 1992, Jenniges 2004, BO, EIS	high	1-3 years after sand created	proportion of nests/adults/fledglings relative to available habitat river and sandpits	Fledge rate of 0.7 lt, 1.13pp, 126 adult lt, 64 pp (nesting pairs)	LT and PP show no preference for the river over sandpits	Yes	Address areas of disagreement
TP 2	The central Platte River may act as a source or sink for terns and plovers.	TP-1, TP-2, TP-3	NAS	medium	10 years	Fledge ratio	Fledge rate of 0.7 lt, 1.7 pp	currently not a sink?	Yes	Will be addressed through current monitoring effort
TP 2a	A fledge ratio of 1.13 or 1.17 fledging/pair is needed to prevent the central Platte River from being a population sink for piping plover.	TP-1, TP-2, TP-3	NAS, Lutey 2003	high	3 year running average	Fledge ratio	fledge ratio of 1.13 or 1.7	some other number correct?	No	Will be addressed through current monitoring effort
TP 2b	A fledge ratio of 0.7 fledging/pair is needed to prevent the central Platte River from being a population sink for least terns.	TP-1, TP-2, TP-3	NAS, Lutey 2003	high	3 year running average	Fledge ratio	fledge ration of 0.7	some other number correct?	No	Will be addressed through current monitoring effort
TP 3	Tern and plover will select for specific elevations above current water levels compared to available elevations for nest initiation	TP-1, TP-2	Zweitz et al 1992	high	1 year of nesting	nest height	all nest established at elevation x corrected to Kearney	Terns and plovers do not select specific nest elevations	No	Higher priority when birds start nesting on river, low for on sandpits
TP 4	Increased vegetation cover decreases tern and plover use.	TP-1, TP-2	Numerous papers	low	multiple	tern use	vegetation less than 25%	general agreement	No	Identified in literature, will collect information using current protocol
TP 4a	Bare sand suitability increases with size	TP-1, TP-2	personal observation jj	dependent on availbility of different sizes	10 year of nesting	density	1 pair tern per acre and 1 plover per 6 acres	There is a maximum limit of bare sand area that is suitable for terns and plovers	No	May increase in priority for second increment
TP 4b	Least tern and piping plover use will be maximized at 50-65% water to sand combination.	TP-1, TP-2	personal observation jj	dependent on availbility of different ratios	20 nesting sites	number of nests		different ratio or not important at all	No	Will be investigated through current monitoring effort
TP 4c	Increased flow rates increase the amount of water area compared to sand area	TP-1, TP-2	physics	high				general agreement	No	
TP 4d	Correlation between river island habitat and flow.	TP-1, TP-2	Zweitz et al 1992, Target Flows	need use first to define habitat	?	Islands of x size, x height	10 acres per mile at 1200 cfs		Yes	Address areas of disagreement, potential impacts to Program management
TP 5	Use of riverine islands by least terns and piping plovers will increase with active channel width.	TP-1	Zweitz et al 1992	high	1-3 years with suitable islands in channels	number of nesting pairs	75 nesting pairs lt, 32 pair nesting pp	use will not increase with channel width	Yes	Will influence Program management
TP 6	Daily stage change impacts on tern and plover prey base	TP-4	Professional opinion	high	3 years	number of fish between 0.5 and 3 inches long, number of bugs	x fish per unit of water, bugs per unit of sand	hydrocycling does not affect forage to a limiting degree	No	Depends on determination of T2 and T2a. Has high level of disagreement.

Whooping Crane Matrix

Graph number	Description of hypothesis	Link to CEM Hypothesis	Source of information, if any	Detectability/ sensitivity (feasibility)	Time needed for measuring a response	Dependent Variable (Indicator)	Corresponding quantitative management objective	Description of alternative/competing hypotheses	Priority Hypotheses?	Rationale based on Prioritization Criteria
WC 1	Whooping Crane use will increase as function of Program land and water management activities.	WC-1, WC-2, WC-3	Land Plan Table 1. Joint Study.	Medium	After land and water activities are implemented. Could review annually	Proportion of population using Central Platte	amount of land/habitat available; Duration and magnitude of pulse flows and flow augmentation. Crane use variable (proportion of population, number, use days etc)	Whooping Crane use will not increase as function of Program land and management activities.	Yes	Influences Program management
WC 2	Whooping cranes select for flows of 2,400 cfs at Grand Island	WC-4	WS flow target (C4R)	Medium	Depends number of crane observations and site evaluations; likely 10 plus years	WC use	FWS flow target. Crane use variable (proportion of population, number, use days etc)	WC select river at flows lower than FWS target flows	No	Cannot measure cranes that do not use the Platte River. Could be done with radio tracked birds and then becomes high
WC 3	Whooping crane use is related to habitat suitability. The prediction of habitat suitability for whooping crane in channel habitat as a function of water depth (preferred depth?) and channel width (define as wetted width, open width other?)	WC-1, WC-2, WC-3	C4R. Farmer et al. 2006	Low, dependent on WC use at numerous flow rates	Depends number of crane observations and site evaluations; likely 10 plus years	WC use	Attaining Unobstructed channel widths of 1150 ft and water depths of 0.7. Achieving target flows. Estimate of WUA. Crane use variable (proportion of population, number, use days etc)	WC use of areas is not directly linked to FWS habitat suitability values	Yes	Influences Program management and Program goals and objectives
WC 3a	Whooping crane use is related to unobstructed channel width and channel depth	WC-1	Land Plan Table 1. Citations	Low, dependent on WC use at variable conditions	Depends number of crane observations and site evaluations; likely 10 plus years	WC Use	Objecitves for habitat complexes from Land Plan Table 1. Wider, braided river. Crane use variable (proportion of population, number, use days etc)	Bird use on central Platte is not limited by channel depth or widths as there is adequate range of depths and widths.	No	Will be captured in Program monitoring
WC 3b	Probability of whooping crane use increases as channel widths increase	WC-1	Professional opinion, Land Plan Table 1. Citations	Low, dependent on WC use at variable conditions	Depends number of crane observations and site evaluations; likely 10 plus years	WC use	Objectives for habitat complexes, wider river. Crane use variable (proportion of population, number, use days etc)	The proportion of WC use will not increase with increases in channel widths because range of river widths available is sufficient to fulfill crane use	No	Will be captured in Program monitoring
WC 3c	Whooping crane use is related to channel depth	WC-1	Professional opinion, Land Plan Table 1. Citations	Low, dependent on WC use at variable conditions	Depends number of crane observations and site evaluations; likely 10 plus years	WC use	Objectives for habitat complexes, wider river. Crane use variable (proportion of population, number, use days etc)	WC use of river will not increase by completing habitat complex characteristics as there is sufficient areas with adequate water depth	No	Will be captured in Program monitoring
WC 3d	Whooping crane use is related to amount of channel inundation.	WC-1	Land plan, models,	Low, dependent on WC use at variable conditions	Depends number of crane observations and site evaluations; likely 10 plus years	WC use	flow targets, habitat complexes. Crane use variable (proportion of population, number, use days etc)	Additional flows will not increase available for roosting on the river	No	Will be captured in Program monitoring

WC 4	Whooping crane use of the central Platte River study area will increase proportionally to an increase in wet meadows	WC-3	professional opinion	Low, dependent on available wet meadow and wc use	Depends number of crane observations and site evaluations; likely 10 plus years	WC use	habitat complex, meadow restoration. Crane use variable (proportion of population, number, use days etc)	WC do not use wet meadows currently and are unlikely to respond to increases in wet meadow area	Yes	Influence Program goals and objectives
WC 4a	Whooping crane use will increase with suitable wet meadow size	WC-3	professional opinion	Low, dependent on available wet meadow and wc use	Depends number of crane observations and site evaluations; likely 10 plus years	WC use	habitat complex, meadow restoration. Crane use variable (proportion of population, number, use days etc)	WC do not use wet meadows currently and are unlikely to respond to increases in wet meadow area	No	Address after WC 4
WC 4b	Whooping crane use will increase with an increase in suitable wet meadows near the channel.	WC-3	professional opinion	Low, dependent on available wet meadow and wc use	Depends number of crane observations and site evaluations; likely 10 plus years	WC use	habitat complex, meadow restoration. Crane use variable (proportion of population, number, use days etc)	WC do not use wet meadows currently and are unlikely to respond to increases in wet meadow area near or far from channel	No	Address after WC 4
WC 4c	Whooping crane use will increase with more wet meadow acreage.	WC-3	professional opinion	Low, dependent on available wet meadow and wc use	Depends number of crane observations and site evaluations; likely 10 plus years	WC use	habitat complex, meadow restoration. Crane use variable (proportion of population, number, use days etc)	WC do not use wet meadows currently and are unlikely to respond to increases in wet meadow area near or far from channel	No	Address after WC 4
WC 4d	Whooping crane use of wet meadows will increase with increased biomoass of macroinvertebrates	WC-3	professional opinion	Low, dependent on available wet meadow and wc use	Depends number of crane observations and site evaluations; likely 10 plus years	WC use	habitat complex, meadow restoration. Crane use variable (proportion of population, number, use days etc)	WC do not use wet meadows currently and are unlikely to respond to increases in wet meadow area near or far from channel	No	Address after WC 4
WC 5	Whooping cranes are adversely affected by nocturnal disturbances that lead to flushing (walking or flying) which could lead to potential mortality.	WC 4	Citations, data from other parts of range, professional opinions	Medium	Dependant on crane monitoring events	WC flushing events	WC roost monitoring,	WC are not negatively impacted by nocturnal disturbances	Yes	High degree of disagreement

Pallid Sturgeon Matrix

Graph number	Description of hypothesis	Link to CEM Hypothesis	Source of information, if any	Detectability/ sensitivity (feasibility)	Time needed for measuring a response	Dependent Variable (Indicator)	Corresponding quantitative management objective	Description of alternative/competing hypotheses	Priority Hypotheses?	Rationale based on Prioritization Criteria
PS-1	Program flow/sediment management will result in a positive species response by the pallid sturgeon in the lower Platte River.	PS-1, PS-2	professional judgement	low, due to low population numbers, difficulty in capture	8-10 years	pallid sturgeon use/occurrence	increase in use of Platte River by pallid sturgeon relative to rest of RPMA 4	Program flow/sediment management will result in no increase in species use/occurence by the pallid sturgeon in the lower Platte River.	Yes	Influences Program management and Program goals and objectives
PS-2	Program water management will result in measurable changes on flow in the lower Platte River.	PS-2	opstudy, testing the assumption analysis (aka flow transmission analysis - Anderson et al.)	Medium (5% gaging accuracy for "excellent" USGS measurements)	2-5 years	lower Platte River flow rate	increase in spring (Feb-Jul) lower Platte River flow rates	Program water management will result in statistically insignificant changes on flow in the lower Platte River	Yes	Influences Program management and Program goals and objectives
PS-3	Program flows and sediment management will result in measurable changes on sediment load in the lower Platte River	PS-2	professional judgement	Low (difficult to detect change due to flow and sedimentmanagement	5-10 years	Sediment load on the lower Platte	increase in sediment load in lower Platte River	Program flow and sediment management will have no effect on measureable changes in sediment load in the lower Platte River	No	Investigate with or after review of Program flows impacts on flows in lower Platte
PS-4	Flows in the lower Platte will affect pallid sturgeon habitat suitability.	PS-1, PS-2	Peters/Parham 2006	medium (high but for scope of effort)	3-8 years	pallid sturgeon use/occurrence	increase in connectivity and prevalence of habitat as defined in Peters/Parham 2006	Flows in the lower Platte River will have no effect on pallid sturgeon habitat suitability	Yes	Influences Program management and Program goals and objectives
PS-5	Pallid sturgeon habitat suitability is maximized between water temperatures of X and Y in the lower Platte River.	PS-1	PS propagation plan	low, due to low population numbers, difficulty in capture	8-10 years	pallid sturgeon use/occurrence	correlation between pallid sturgeon use of lower Platte River and specific temperature ranges	pallid sturgeon use is independent of river water temperature	Yes	Influences Program management and Program goals and objectives
PS-6	Increasing flow in the lower Platte will affect pallid sturgeon habitat availability.	PS-1, PS-2	Peters/Parham 2006	medium (high but for scope of effort)	3-8 years	micro and macro channel characteristics	increase in connectivity and prevalence of habitat as defined in Peters/Parham 2005	increasing flow in the lower Platte River will have no effect on pallid sturgeon habitat availability	Yes	Influences Program management and Program goals and objectives
PS-7	Increasing habitat availability in the lower Platte will increase pallid sturgeon use.	PS-1	Peters/Parham 2006	low, due to low population numbers, difficulty in capture	8-10 years	pallid sturgeon use/occurrence	increase in use of Platte River by pallid sturgeon relative to rest of RPMA 4	pallid sturgeon use is independent of lower Platte River habitat availability	Yes	Influences Program management and Program goals and objectives
PS-8	Increasing pallid sturgeon use in the lower Platte River will increase pallid sturgeon populations.	PS-1	professional judgement	low, due to low population numbers, difficulty in capture	10-13 years	pallid sturgeon reproduction and populations	local (RPMA 4) pallid sturgeon population size	pallid sturgeon population size is independent of use of the lower Platte River	No	
PS-9	Increasing Program flow releases will decrease water temperatures in the lower Platte River.	PS-2	Dinan 1992, Zander 1995, Zander 1996, Sinokrot et al. 1996, Miller 199X, King 199X	low, due to small relative contrib. of Program to LP flows	4-6 years	lower Platte River temperature	correlation between streamflow and river water temperature as per Dinan 1992	River water temperature is independent of flow rate in the lower Platte River Increases in program flow releases will increase water temperatures on the lower Platte River	Yes	Influences Program management and Program goals and objectives
PS-10	Different rates of flow in the lower Platte affect pallid sturgeon prey base.		Peters and Holland 1994, Peters/Parham 2006	medium (high but for natural interannual variation)	4-8 years	pallid sturgeon prey base	Increase abundance and diversity of small fish and drifting invertebrates	availability of pallid sturgeon prey items is independent of flow rate to the degree that it can be affected by the Program	No	
PS-11	Non-Program actions (e.g., harvest, stocking, Missouri River conditions) determine the occurrence of pallid sturgeon in the lower Platte River	PS-3	professional judgement	low, due to low population numbers, difficulty in capture	8-10 years	pallid sturgeon use/occurrence	Improve stocking, harvest management, Missouri River populations	Program actions will affect the rate of occurrence of pallid sturgeon in the lower Platte River such that use is disproportionate to external factors (e.g., stocking, harvest, local conditions) relative to local population.	Yes	Influences Program management and Program goals and objectives

Flow Matrix

Graph number	Description of hypothesis	Link to CEM Hypothesis	Source of information, if any	Scientific basis of hypothesis	Detectability/ sensitivity (feasibility)	Time needed for measuring a response	Dependent Variable (Indicator)	Corresponding quantitative management objective	Description of alternative/competing hypotheses	Priority Hypotheses?	Rationale based on Prioritization Criteria	Phasing	Notes
Flow #1	Increasing the variation between river stage at peak (indexed by Q1.5 flow at Overton) and average flows (1,200 cfs index flow), by increasing the stage of the peak (1.5-yr) flow through Program flows, will increase the height of sand bars between Overton and Chapman by 30% to 50% from existing conditions.	PP-1	Smith 1971,... EIS 2006, SedVeg model runs	Medium, model computations done, some central Platte data to be analyzed from naturally occurring events, but no planned peak flow field tests done yet.	Topographic documentation is easy	1-5 years (can assess the effect of a single flow)	height of island bars above a 1,200 cfs index flow	Hieght of island bars greater than 1.5 acres that are 1 ft above 1,200 cfs water elevation	Flow magnitudes and channel compilations are insufficient to generate bars high enough to provide habitat for LT and PP. Bars may quickly vegetate making them poor habitat for target species. Bars can be created/maintained by mechanical/other means.	Yes	Fundamental to testing the Flow, sediment, mechanical strategy	Could be a 1-3 year delay due to addressing infrastructure limitation at North Platte	Include the mechancial strategy in testing this hypothesis. Could do this in year 1-3(?) as we get the infrastructure and pulse flow issues worked out
Flow #2	After a bar has been created by whatever means, ongoing stage fluctuations will decrease the bar area that could potentially be used by terns and plovers. Erosion will be less with a balanced sediment budget. Rate, magnitude, and frequency of stage fluctuation needs to be considered	PP-1	Colorado River papers, Field observations	Medium, observed in field, but linkage back to rampdown rates and frequency not established	Detectable with area and cross section surveys, relate to gaging station data.	months to 1-year (can be assessed by small number of flows)	Sand bar area at 1,200 cfs	Minimum bar area needed by Terns and Plovers.	Different drawdown rates and frequencies then X and Y. Sand bar area is not dependent on drawdown magnitudes, rates and frequencies, or are overwhelmingly influenced by other factors and frequency of drawdown is a neglible variable. Fast drawdown rates benefit sand bar area.	No	Medium because we need bars to form first, and the USFWS-Central agreement requires a finding of bars being limiting to tern and plover production before this is tested	Dependent on a finding that bars are insufficient (limiting factor to tern and plover production), also dependent on the time lag for bars to form	
Flow #3	Increasing 1.5-yr Q with Program flows will increase local boundary shear stress and frequency of inundation at existing green line (elevation at which riparian vegetation can establish). These changes will increase riparian plant mortality along margins of channel, raising elevation of green line. Raised green line = more exposed sandbar area and wider unvegetated main channel.	PP-1	Parsons, 1960, Porter and Silberger, 1960, Parsons, 1963, Chen and Cotton, 1988, Theissen 1992, Smith 1976, Modeled with SedVeg, some field verifcation by Simons and Associates.	High for young grasses, willow and cottonwood plants, supported by literature and modeling, less certainty for other plant species.	Easily computed, and easily measured in field with multiple vegetation plots/cross section surveys.	1- 5 years	Computed local shear stress, elevation green line on banks & bars, bar area at 1,200 cfs, unvegetated width of main channel.	Produce increase in unvegetated main channel width for WC, and unvegetated sand bar area for LT and PP from Overton to Chapman.	Insufficient Program flows to adequately increase shear stress on banks. Plant mortality can be achieved by other means.	Yes	Fundamental to testing the Flow, sediment, mechanical strategy		Include the mechancial strategy in testing this hypothesis. Could do this in year 1-3(?) as we get the infrastructure and pulse flow issues worked out
Flow #4	Annual riparian seedling mortality greater than 90% is required to prevent riparian encroachment on exposed bars, thereby increasing (maintaining at least 10 acres/mile) exposed bars between Overton and Grand Island that are usable as LT and PP habitat.	PP-1	Professional judgement, no data collected yet?	Low because there is no basis that 90% is sufficient for preventing encroachment and preserving line of sight	Easily detectable for local monitoring, long-term by air photos	5-10 years	Planform surface area of exposed bars at a flow of 1,200 cfs	Increase exposed bar area at an index flow of 1,200 cfs from X acres/mile to 10 acres/mile between Overton and Grand Island	Riparian seedling mortality greater than 90% is needed to increase exposed bar area. Other factors drive exposed bar area instead of seedling mortality. Plant mortality can be achieved by other means.	Yes	Fundamental to testing the Flow, sediment, mechanical strategy		Include the mechancial strategy in testing this hypothesis. Could do this in year 1-3(?) as we get the infrastructure and pulse flow issues worked out
Flow #5	Increasing magnitude and duration of a 1.5-yr flow will increase riparian plant mortality along the margins of the river. There will be different relations (graphs) for different species.	PP-1	For magnitudes see Flow #3. For duration less info available, see Colorado River papers.	High to Medium for magnitude (see Flow #3). Medium to Low for duration.	Easily computed, and easily measured in field with multiple vegetation plots/cross section surveys.	1- 5 years depending on occurrence of pulse and natural peak flows	Computed local shear stress, plant mortality and of elevation green line on banks & bars	Channel shear stress exceeds 1.0 lbs/sqft (dependent on plant species, age) for a a 1.5 year recurrence. 90% plant mortality of various ages of plants on bars	Insufficient Program flows to maintain required flow durations. Plant mortality can be achieved by other means.	Yes	Fundamental to testing the Flow, sediment, mechanical strategy		Include the mechancial strategy in testing this hypothesis. Could do this in year 1-3(?) as we get the infrastructure and pulse flow issues worked out

Definition of braiding index for main channel (as used here) is: Average number of anabranches/flow paths in the main channel based on bisecting wetted main channel perpendicular to flow direction. The braiding index value of "greater
ve force acting perpendicular to (scrapping) the bank, lbs/sqft.

Sediment Matrix

Graph number	Description of hypothesis	Link to CEM Hypothesis	Source of information, if any	Scientific basis of hypothesis	Detectability/ sensitivity (feasibility)	Time needed for measuring a response	Dependent Variable (Indicator)	Corresponding quantitative management objective	Description of alternative/competing hypotheses	Priority Hypotheses?	Rationale based on Prioritization Criteria	Phasing	Notes
Sediment #1	Average sediment augmentation nr Overton of 185,000 tons/yr under existing flow regime and 225,000 tons/yr under Governance Committee proposed flow regime achieves a sediment balance to Kearney.	PP-2	Sed Veg, topographic differencing	High because this estimate is based on a combination of sediment transport capacity estimates as well as estimates of tributary sediment contribution	Difficult to estimate sediment contribution from tribs, Sediment budget is difficult to measure	5-10 years	channel bed elevation (storage) in different reaches	Maintain balanced sediment budget in all reaches, Prevent future systematic channel bed lowering between Overton and Grand Island, Prevent future systematic channel bed raising in downstream reaches	Augmentation greater than or less than 225,000 tons/year is needed to balance the sediment budget and increase exposed bar area. There is no sediment imbalance. Exposed bar area or occurence of braiding will not be affected by increased sediment. Sediment balance is insignificant except in local instances. Satisfactory bar areas can be created and maintained through strictly mechanical actions.	Yes	Fundamental to testing the Flow, sediment, mechanical strategy	Dependent on land acquisition or access to lease properties for sediment supply, Yearly input would vary with wetter/drier years, could be done in year 1 at Cottonwood (not ideal, but doable), One management action will test all four hypotheses	"Existing flow regime" assumes no drought conditions
Sediment #2	A balanced sediment budget (sediment augmentation of 225,000 tons/year near Overton under proposed Governance Committee flows) when implemented with mechanical actions (channel consolidation & widening) in anastomosed reaches will promote braided channel morphology with an average braiding index in the main channel of greater than 3.	PP-2	Empirical observations on the Central Platte	Medium because based on empirical observations on central/lower Platte River	Braiding index easily computed once it is defined for the central Platte Rvier	5-10 years	Braiding index of main channel	Convert average braiding index for main channel in the reach between Overton and Kearney to greater than 3.	Flows and sediment augmentation are insufficient to achieve desired braiding index.	Yes	Fundamental to testing the Flow, sediment, mechanical strategy	Would require some higher flows (either natural flows or pulse flows) to make this happen, mechanical would accelerate response, ideally do both at the same time	
Sediment #3	Increasing the average braiding index of the main channel by achieving a balanced sediment budget, increases the active unvegetated width of the main channel at an index flow of 2,000 cfs(at Overton).	PP-2	Empirical observations on the Central Platte	Medium based on empirical observations on central Platte River	Air photos for large differences, cross-section surveys for smaller differences.	5-10 years	Braiding index and unvegetated width of main channel at index flow	Widen the main channel between Overton and Kearney to greater than 750 feet, or to greater than 500 feet where channel remains divided in more than 3 channels.	Width will not change with increasing braiding index	Yes	Fundamental to testing the Flow, sediment, mechanical strategy	Would require some higher flows (either natural flows or pulse flows) to make this happen, mechanical would accelerate response, ideally do both at the same time	Include the mechancial strategy in testing this hypothesis. Could do this in year 1-3(?) as we get the infrastructure and pulse flow issues worked out
Sediment #4	Increasing the average braiding index to greater than 3 for the main channel in the sediment deficient reach near Overton will increase and maintain exposed bar area greater than 1.5 acres in the reach between Overton and Kearney at an index flow of 1,200 cfs (at Overton).	PP-2	None yet, need to develop this relationship from observations downstream of Kearney	Low because there is no basis for these numbers yet	Need existing conditions flown at index flow. Easily detectable with air photos if flown at index flow.	5-10 years	Planform surface area of exposed bars at a flow of 1,200 cfs	Increase exposed bar area (greater than 1.5 acres) at an index flow of 1,200 cfs from X acres/mile to 10 acres/mile between Overton and Grand Island	There is no relationship between braiding index and area of exposed bars. Exposed bars may be created (maintained) through mechanical means without need to change braiding index.	Yes	Fundamental to testing the Flow, sediment, mechanical strategy	Would require some higher flows (either natural flows or pulse flows) to make this happen, mechanical would accelerate response, ideally do both at the same time	Include the mechancial strategy in testing this hypothesis. Could do this in year 1-3(?) as we get the infrastructure and pulse flow issues worked out

Definition of braiding index for main channel (as used here) is: Average number of anabranches/flow paths in the main channel based on bisecting wetted main channel perpendicular to flow direction. The braiding index value of "greater than 3" is based on limited measurements from 1998 infra-red air photos.

Mechanical Matrix

Graph number	Description of hypothesis	Link to CEM Hypothesis	Source of information, if any	Scientific basis of hypothesis	Detectability/ sensitivity (feasibility)	Time needed for measuring a response	Dependent Variable (Indicator)	Corresponding quantitative management objective	Description of alternative/competing hypotheses	Priority Hypotheses?	Rationale based on Prioritization Criteria	Phasing	Notes
Mechanical #1	Indirectly narrowing the width of the hydraulic corridor (preferred width less than 3,000 ft) by consolidating channels under proposed flow regime and balanced sediment budget will convert anastomosed reaches of the Platte River between Overton and Grand Island to a braided channel morphology.	PP-3	Empirical observations on the Central Platte	High because based on empirical observations on Central Platte River. Feasibility: medium, due to difficulties consolidating flow.	Easily detectable, braiding index easily computed	<5 years, as long as there is at least a flow greater than Q5 during that period	braiding index, width to depth ratio and width of main channel	Increase average braiding Index in the main reach between Overton and Grand Island to greater than 3.	Narrowing floodway to a width lower than 2,000 ft is needed to achieve an average braiding index in the main channel greater than 3.	No		Do channels in Mech 3 first, look at other approaches later if Mech 3 doesn't work	
Mechanical #2	Increasing the Q1.5 in the main channel by consolidatining 85% of the flow, and aided by Program flow and a sediment balance, flows will exceed stream power thresholds that will convert main channel from meander morphology in anastomosed reaches, to braided morphology with an average braiding index > 3.	PP-3	Van den Berg, 1995; Leopold and Wolman 1957	High because based on empirical observations on Central Platte River. But is site dependent on percent distribution of flow among channels in consolidated transect.	Discharge can be easily measured, discharge at flow splits need to be measured, braiding Index can be easily measured	5-10 years	braiding index, main channel width, width to depth ratio of main channel at reference flow	Convert channel morphology from anastomosed to braided, or increase average braiding index to greater than 3 in main channel.	Higher stream power (higher 1.5 yr Q and/or more consolidation of side channels) needed to convert channel to braided morphology. Lower stream power will convert channel to braided morphology	Yes	Fundamental to testing the Flow, sediment, mechanical strategy	Do this ASAP, we don't have pulse flows, but the natural flows may also be able to test this, dependent on land acquisition and sediment input	
Mechanical #3	Reducing the number of channels in a transect to 3 or less under balanced sediment budget will convert anastomosed reaches of the Platte River between Overton and Chapman to a braided channel morphology. With prposed flow regime, should occur with greater number of channels	PP-3	Empirical observations on the Central Platte	High because based on empirical observations on Central Platte River. Assumes certain percent distribution of flow among channels.	Easily detectable, braiding index easily computed	<5 years, as long as there is at least a flow greater than Q5 during that period	braiding index, width to depth ratio and width of main channel	Convert average braiding index of the main channel in the reach between Overton and Grand Island to greater than 3.	Reducing the number of channels in a transect to 1 or 2 is necessary to achieve an average braiding index in the main channel of greater than 3.	Yes	Fundamental to testing the Flow, sediment, mechanical strategy	Do this ASAP, we don't have pulse flows, but the natural flows may also be able to test this, dependent on land acquisition and sediment input	
Mechanical #4	Increasing the average braiding index to greater than 3 in the main channel by channel manipulation will promote in the Platte River at the mechanically changed sites a total main channel wetted width exceeding 500 to 750 ft at an index flow of 1,700 cfs (at Overton).	PP-3	Based on empirical observations from central Platte River	Low because preliminary numbers	Easily detectable with air photos	5-10 yrs	Total channel width at an index flow of 1,700 cfs	Increase channel width in the reach between Overton and Grand Island to at least 750 ft	A braiding index greater then 4 is needed to achieve a width greater than 500 ft There is no relation between braiding index and channel width	Yes	Fundamental to testing the Flow, sediment, mechanical strategy	Do this ASAP, we don't have pulse flows, but the natural flows may also be able to test this, dependent on land acquisition and sediment input	Include the mechancial strategy in testing this hypothesis. Could do this in year 1-3(?) as we get the infrastructure and pulse flow issues worked out
Mechanical #5	Increasing the average braiding index to greater than 3 for the main channel by mechanical channel manipulation, will increase and maintain exposed bar area greater than 1.5 acres at mechanical changed sites at an index flow of 1,200 cfs (at Overton).	PP-3	None yet	Low because there is no basis for these numbers yet	Easily detectable for individual flow by ground survey and air photos at index flow.	5-10 yrs	Area of inchannel bars at index flow of 1,200 cfs.	Flow of 6,000 cfs for 3 days will cause an increase in bar area	Mechanically consolidating flows will have no effect on areal extent of bars.	Yes	Fundamental to testing the Flow, sediment, mechanical strategy	Do this ASAP, we don't have pulse flows, but the natural flows may also be able to test this, dependent on land acquisition and sediment input	Include the mechancial strategy in testing this hypothesis. Could do this in year 1-3(?) as we get the infrastructure and pulse flow issues worked out

Definition of braiding index for main channel (as used here) is: Average number of anabranches/flow paths in the main channel based on bisecting wetted main channel perpendicular to flow direction. The braiding index value of "greater than 3" is based on limited
ned as the width from furthest wetted left bank to furthest wetted right bank, as measured at an index flow of 15,000 cfs

Wet Meadow Matrix

Graph number	Description of hypothesis	Link to CEM Hypothesis	Source of information, if any	Detectability/ sensitivity (feasibility)	Time needed for measuring a response	Dependent Variable (Indicator)	Corresponding quantitative management objective	Description of alternative/competing hypotheses	Priority Hypotheses?	Rationale based on Prioritization Criteria	Phasing	Notes
WM-1	A high productivity and diversity of macro-invertebrates in areas used by whooping cranes along the Platte River will improve WC conservation and recovery	PP-4	Walkinshaw, 1973; FWS, 1994; Johnsgaard, 1996; NRC, 2005: "Few data are available for testing [this] hypothesis"	Difficult to detect because so many variables influence conservation and recovery	> 10 years?	Possible surrogate: Frequency and duration of WC use of Platte sites with abundant and diverse macro-invertebrates		Other factors unrelated to Platte River and/or macro-invertebrates have a far greater impact on whooping crane survival and reproduction; this hypothesis, if true, cannot be detected during the first increment.	No			
WM-2	Wet meadows producing the optimum productivity and diversity of macro-invertebrates potentially consumed by WC exhibit certain characteristic combinations of soils, hydrology, size and location. Mormon Island and adjacent to Rowe Sanctuary have some of best existing combinations	PP-4, WC-3	Siebert, 1994	Medium. Study of multiple sites will allow multivariate analysis of conditions supporting aquatic and semi-aquatic invertebrates.	5-10 years	Site-specific macro-invertebrate production and diversity during March-April	Need criteria to prioritize sites suitable for acquisition, maintenance, protection, or improvement by the Program for habitat complexes. Need standards to measure the success of meadow restoration efforts.	There are too many possible combinations of site characteristics to allow for a meaningful characterization of "desirable" conditions.	Yes	Basic information need to evaluate what conditions in wet meadows are important for productivity that is meaningful to WC use, Help inform what sites to acquire and/or protect/restore.	Not dependent on pulse flows or mechanical actions, dependent on land acquisition or access agreements or lease lands	Need to document current and historic wet meadow extent and location (baseline conditions) in System hypothesis 1-c. Other biota may also be important (e.g. amphibians, fish, reptiles).
WM-3	Shallow surface water and groundwater in March and April support high productivity and diversity of macroinvertebrates as potential food sources to WC in wet meadows.	PP-4	Siebert, 1994; Wesche et al., 1994; Craig Davis' papers of the early '90s; Nagel and others	High	2-5 years	Site-specific aquatic and semi-aquatic invertebrate production and diversity during March-April	Same as above.		Yes	Basic information need to evaluate what conditions in wet meadows are important for productivity that is meaningful to WC use, Help inform what sites to aquire and/or protect/restore.	Not dependent on pulse flows or mechanical actions, dependent on land acquisition or access agreements or lease lands. This logically could be "packaged" with WM-2.	Need to document current and historic wet meadow extent and location (baseline conditions) in System hypothesis 1-c
WM-4	A predominance of organic-rich soils supports the productivity and diversity of macro-invertebrates as potential WC food sources in bottomland grasslands.	PP-4	Nagel	Moderate-High	2-5 years	Site-specific aquatic invertebrate production and diversity	Same as above.	Wet meadows and their soils are too complex and variable to allow this individual factor to be effectively assessed.	Yes	Basic information need to evaluate what conditions in wet meadows are important for productivity that is meaningful to WC use, Help inform what sites to aquire and/or protect/restore.	Not dependent on pulse flows or mechanical actions, dependent on land acquisition or access agreements or lease lands. This logically could be "packaged" with WM-2.	Need to document current and historic wet meadow extent and location (baseline conditions) in System hypothesis 1-c
WM-8	High water tables in wet meadows provide greater benefits to WC if they occur in the Feb-Jun period versus other times of year	PP-4	Wesche et al., 1994; Henszey and Wesche, 1993	Low-Med. Requires consideration of flow variability, climate variability, site variability, and multiple potential WC benefits.	5-10 years	Soil thaw at various depths. Invertebrate activity at various times. Vegetative structure and composition.	Inform habitat complex management, including management of site drainage, site irrigation, local groundwater use, management of adjacent river channel.	Potential for Program to augment or alter the magnitude and timing of water tables is too limited to have measurable wet meadow effects.	No			Could be done at the same time as testing WM 2-4 for small incremental cost
WM-9	Periodic inundation of wet meadow areas due to overbank flow increases their suitability as WC habitat and reduces risk of new species listings	PP-4	Siebert, 1994; Currier (year?)	Low because of infrequency of inundating events.	>10 years?	Diversity and productivity of WC forage species, and other meadow-dependent species	Assess the effects of changes in the frequency of overbank flows in the Central Platte, whether due to Program actions or other factors.	Frequency of wet meadow inundation is too rare and too unrelated to Program actions for this hypothesis to be meaningfully assessed.	No	Program flows would not be large enough to affect this, however the Program is proceding on the basis of certain assumptions about "acceptable" reductions in peak flows and corresponding habitat effects; these assumptions merit additional scrutiny.		Passive investigation (be prepared for random natural events, as pulse flows would not be large enough to inundate wet meadows.)
WM-8a	As the spring depth to groundwater increases, surface soils stay frozen longer. Where groundwater is closer to the surface soils thaw sooner.	PP-4	Wesche et al., 1994	High	1-2 years	Soil and groundwater temps at various depths, Feb-Apr.	See WM#8		Yes	Each site will respond to river channel stage uniquely, this hypothesis is a prerequisite to many of the other hypotheses (if there is no response from program actions, it becomes less important)	Sequentially, this should be the first WM-8 subhypothesis to evaluate.	Could be done very economically with the other research activities above
WM-8b	Areas where surface soils thaw earlier allow for increased macro-invertebrate productivity.	PP-4	Wesche et al., 1994	Moderate	> 3 years?	Invertebrate productivity.	See WM#8		No			Could be done economically with WM-2
WM-8c	As depth to groundwater increases during the Mar15-Apr15 period, the number of macroinvertebrates available as WC prey decreases.	PP-4	Wesche et al., 1994	Moderate	> 3 years?	Invertebrate availability near ground surface during WC feeding hours.	See WM#8		No			Could be done economically with WM-2

Appendix F – Protocols

Attachment 1
Draft
Monitoring whooping crane migrational habitat use in the central Platte River valley

September 16, 2005

I. INTRODUCTION

The States of Colorado, Nebraska and Wyoming and the Department of the Interior (DOI) agreed to participate in a basin-wide cooperative program relating to four target species (interior least tern, piping plover, whooping crane and pallid sturgeon) and their associated habitats in the Cooperative Agreement for Implementing a Platte River Recovery Implementation Program (Program). One of the primary purposes of the Program is to "implement certain aspects of the Fish and Wildlife Service's (FWS') 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 basin-wide cooperative approach that can be agreed to by the three states and DOI…". The Program builds upon the July 1, 1997 Cooperative Agreement for Platte River Research and Other Efforts Relating to Endangered Species Habitats Along the Central Platte River, Nebraska (July 1997 Cooperative Agreement).

Program implementation will follow a process of adaptive management to address areas of scientific uncertainty. Monitoring is an integral part of the adaptive management process. The adaptive management approach will allow for efficient modification of management actions in response to new and changing environmental conditions. The Program, with assistance from the Technical Advisory Committee will monitor and document, relative to the habitat and species conditions that existed as of the effective date of the Cooperative Agreement, habitat and species responses to habitat improvement activities. With scientific advisory assistance, the Technical Advisory Committee will review monitoring results and make recommendations to the Program's Governance Committee regarding the effects of Program activities on whooping crane habitat use in the study area. The Governance Committee, using the Technical Advisory Committee's input, will evaluate projects and the overall Program to determine what, if any, changes are needed in the management.

This monitoring protocol will be used by the Program to gather information on whooping crane habitat use and to provide an index of abundance in the study area. It is understood that regardless of survey method not all cranes are certain of being detected during migration and therefore full implementation of this or any other protocol will not represent complete use of the central Platte River valley. Information from this protocol will be used to help evaluate the biological response of whooping cranes and habitat to the land and water management activities of the Program.

This monitoring protocol addresses several July 1997 Cooperative Agreement milestones:

R2-1 A technical committee appointed by the Governance Committee will develop protocols for and initiate habitat and species monitoring and research

R3-1 the FWS and Technical Committee will identify data needed to ascertain biological response and the time frame required to evaluate those data (R3-1 milestone as revised at the August 2, 2000 Technical Committee/Governance Committee workshop)

R5-1 The Nebraska Districts (Nebraska Public Power District and Central Nebraska Public Power and Irrigation District) will implement any research and monitoring measures required by new Federal Energy Regulatory Commission (FERC) license articles for FERC Projects Nos. 1417 and 1835.

R1-2 and R1-3 A technical committee will continue monitoring to document, relative to the habitat and species conditions that existed as of the effective date of the Cooperative Agreement, habitat and species responses to activities undertaken pursuant to the Cooperative Agreement.

R3-2 and R3-3 The Nebraska Districts will continue to implement any research and monitoring measures required by FERC license articles for FERC Projects Nos. 1417 and 1835.

II. PURPOSE

The purpose of this monitoring protocol is to describe the conceptual design, study methods, and procedures that will be used annually to gather repeatable information on whooping crane stopovers in the central Platte River valley, Nebraska. Detailed Standard Operating Procedures (SOP) will be written for each task when the protocol is finalized. This is a sample survey protocol that will result in an annual index of crane use. This protocol describes the procedures to be used for these specific objectives:

1) Detect whooping crane stopovers in the study area – systematic aerial surveys of the study area will be conducted and the data will be used to comparatively evaluate changes in the frequency and the distribution of stopovers within the study area over time. Opportunistic locates will also be used to detect whooping crane stopovers in the study area.

2) Identify the locations of use and crane group movements in the study area – crane group movements will be documented in order to identify use-sites, and to describe the patterns of movement of each crane group.

3) Qualitatively document crane group activities at use-sites – observers will qualitatively document activities displayed by the crane groups. Observed activities may help identify factors that influence how cranes use the area and aid in the interpretation of crane behavior.

4) Document the physical and/or biological characteristics of use-sites – habitat parameters will be described and measured for those whooping cranes observed stopping in the central Platte River valley for comparative habitat analyses (e.g., as in determining habitat suitability or preference analyses).

5) Landscape Data Collection – Basic landscape source data of whooping crane use-sites in the study area (e.g., central Platte River valley) will be collected through this protocol. This information will be used in future use/availability analyses using aerial photography and Geographic Information System (GIS) information and appropriate landscape data collected from other protocols. Currently the Program has available a complete land use/land cover GIS analysis of 1998 color infrared photography. Continued regular collection of landscape data sources of the study area through other protocols, such as aerial photographs, geomorphology monitoring protocol and GIS data, will enable future habitat use/availability research.

The protocol also outlines what information Program personnel will collect from the FWS and state agencies throughout the whooping crane's migrational corridor.

The Technical Committee implemented the February 23, 2001 version of this protocol during the spring 2001 season, the September 12, 2001 version during the fall 2001 season, the December 20, 2001 version during the spring and fall 2002 season, and the August 21, 2003 version during the fall 2003 season. The Technical Committee did not implement a survey in spring 2003. This version of the protocol incorporates changes as a result of the previous implementation periods, independent peer review, and other comments.

III. DESIGN CONSIDERATIONS AND SPECIFICATIONS

III.A. Area of Interest

The area of interest for monitoring whooping crane migrational habitat use consists of an area 3.5-miles either side of the Platte River beginning at the junction of U.S. Highway 283 and Interstate 80 near Lexington, Nebraska, and extending eastward to Chapman, Nebraska. When side channels of the Platte River extend beyond the 3.5-mile area, a 2-mile area is included around these channels (see attached map). If crane groups being monitored move outside this study area the field crews will make a professional judgment on whether or not the cranes are migrating from the Platte River area. If the crane group is judged to be migrating from the area, ground crews will stop observations. If the crane group is judged to be just temporarily using habitat outside the primary study area the ground crew will continue to make observations.

III.B. Project Design

This protocol collects information on whooping cranes using the central Platte River, not necessarily on the entire whooping crane population. This may bias the sample for making inference to the entire whooping crane population. In addition, the results from this protocol may not be representative of the population, or subgroup of the population using the central Platte, because of the use of multiple observations per crane group and/or the lack of use by unique crane groups in the analysis (i.e., pseudo-replication). Options for addressing pseudo-replication are discussed in Section IV.D. Analysis Methods.

III.B.1. Detecting/Locating Whooping Crane Stopovers

Whooping crane stopovers will be documented using both systematic surveys and opportunistic sighting reports. Crane groups detected with systematic surveys will have known probabilities of inclusion in the sample, while crane groups detected opportunistically will compromise a non-probability based sample. Since the systematic sample covers the study area from East to West with equal effort, and from North to South with known frequency, biases in sample effort can be accounted for. The opportunistic sample will contain biases associated with the unequal sampling effort that cannot be accounted for, and therefore may not represent actual crane use of the study area.

The relative efficiency of sighting whooping crane groups using systematic aerial surveys is not known, but will become known through protocol implementation over the years (e.g., use of decoys and known birds in the area, etc). Public reports and reports from other survey efforts in the valley (e.g., Nebraska Game and Parks Commission (NGPC), Platte River Trust, FWS surveys) will also be used to identify occurrences of whooping crane stopovers in the study area. These sighting reports may increase the opportunity to gather crane movement and habitat use information. Data on movement and habitat use for birds detected through the systematic aerial survey will be analyzed separated and in conjunction with all other observations of crane movement and habitat use in the analysis of species habitat relationships.

Aerial Survey

Aerial surveys will be used to detect whooping crane stopovers in the study area. Systematic surveys are necessary to develop information on the spatial and temporal distribution of crane stopovers in the Platte River for comparative evaluations. The design of these systematic surveys is intended to provide a known chance for observing crane use throughout the study area. Daily flights will be conducted in early morning during the period when whooping cranes are most likely to be in route between the wintering and breeding grounds. Flights will take place over the main river channel (river transects) and upland regions of the study area (return transects). The "main river channel" is defined as the widest channel when all channels have flowing water. It is recognized that this protocol over-samples the river (river transects are flown daily) compared to return transects that include upland areas and the river (seven return transects are flown in a rotating order). River transects systematically survey the main channel east to west. Return transects systematically sample the entire study area north to south.

Opportunistic Locates

Birdwatchers, outdoor enthusiasts, farmers, and other survey efforts might make initial observations of whooping crane groups in the study area. Sighting reports from these and other groups (labeled "opportunistic locates") may provide additional information on crane stopover occurrences, but the conclusions are only applicable to the areas searched by the people that would report a sighting. An analysis of habitat use by cranes sighted opportunistically is outlined in this protocol. But locations of whooping cranes obtained through this method are biased and quantifying the bias due to the location and amount of effort expended to obtain these observations is not planned.

Survey Detection Rates

Whooping crane decoys will be used to estimate the accuracy of whooping crane detection from the aerial survey. Crane decoys will be placed randomly throughout the study area and the detection by the aerial survey crew will be recorded. Surveyors will not know the location of decoys while conducting the survey. Searcher efficiency will be calculated as the percentage of cranes observed. Decoys will be placed at randomly selected points in the path of the riverine and return transects. Estimates of searcher efficiency will be made for each transect strata separately (riverine and return). Individuals placing decoys will accurately map or record the

UTM of the decoy and the transect on which it was placed. If the vegetation/landscape at the decoy location is different in the field than on the mapped data provided, the individual placing the decoy will move the decoy to the closest point corresponding to the mapped vegetation/ landscape type.

III.B.2 Movement Tracking

After a crane group has been located in the study area, either through aerial surveys or opportunistically, a ground crew will be notified to confirm the sighting and begin immediate monitoring to document habitat use. The ground crew(s) will locate the cranes with directions from the sighting party and will document crane movements, document crane use-site activities, and describe the physical and biological attributes of use-sites. Each crane group will be tracked continuously until they are observed leaving the study site or are lost by the tracking crew. Cranes will be observed at a distance from vehicles to document movements. Monitoring crews will be trained to be aware of crane sensitivity to human presence, to identify behavioral responses to disturbance, and to view cranes using methods that reduce the likelihood of disturbance. Crews will strictly adhere to guidelines regarding minimization or elimination of crane disturbance, to be provided by the FWS, while conducting the monitoring.

Locations of crane groups under observation will be recorded in two categories. Instantaneous points will identify the exact location of the group every 15 minutes. Location points will identify the general location of the group during the observation period. Whenever a crane group moves from the area of one contiguous habitat type to another, a new location ID will be assigned. In the event that a crane group is observed in the same location from 2 observers (e.g., from the ground and from the air), the same location ID will be recorded by each observer.

III.B.3. Activity Monitoring

While monitoring crane movements, ground crews will collect information on crane activities. The field crew will record the activity being conducted by a whooping crane at each of the 15 minute instantaneous point mapped for the movement tracking into one of the following categories: courtship, preening, resting, feeding, alert, agonistic, or other as described. If the crane group is comprised of more than one individual, the observer will select a "focus" crane that will be used to record activity information. The observer will also video tape the crane group using a digital video camera for the entire time it is at a use site.

III.B.4. Use-Site Characteristics

Tracking crews will collect information on the physical and biological characteristics of the riverine and non-riverine whooping crane use-sites. Characteristics of crane use locations will be described and measured as soon as practical after the crane group leaves the study area. Habitat parameters will be described and measured for the purpose of comparative habitat analyses.

Use-site characteristics will also be measured at randomly selected riverine locations each year. These will typically be the same as the decoy locations used for survey detection rates. Measurements will be made using the same methods as outlined for crane use sites. The measurement of these sites will be spaced throughout the aerial survey period. Data from measurements at randomly selected locations (e.g., decoy locations) will be used as an available dataset.

III.C. Timing
Aerial surveys of the study area will be conducted in the spring from March 21 to April 29 and in the fall from October 9 to November 10 (the 5^{th} and 95^{th} percentile of initial observation dates of whooping cranes in Nebraska between 1975-1999). Opportunistic observations will be collected during all times of the year. Measurements of habitat characteristics at whooping crane use sights will occur immediately following each observation regardless of how the birds were found (aerial or opportunistic). Crane movements will be monitored until the crane group leaves the study area or is no longer observable. Measurements of habitat characteristics will be taken after the group departs the study area.

IV. METHODS
IV.A. Definitions
Crane activity- Qualitative definitions

> Feeding- any behavior suggesting the bird is in the act of feeding, such as a crane flipping over objects and/or probing for food or slow locomotion interrupted by these activities
> Loafing- crane standing still in one place
> Preening- crane preening feathers
> Agonistic - defensive or offensive display with other birds. Can be with other whooping cranes, sandhill cranes, etc.
> Courtship- crane performing unison call and/or dancing
> Alert- crane alert and scanning horizon

Crane group – one or more cranes in a migrating unit. The group may consist of an individual crane, a family unit, or small flock.

Sighting – observation of a crane group in the study area.

> Confirmed Sighting - Observation made by a State or Federal biologist or officer or by other known qualified observer (trained ornithologist or birder with experience in identification of whooping cranes). A photograph may also be used to confirm sightings. Aerial survey crew with previous aerial whooping crane observations may confirm a crane group during the survey.
>
> Probable Sighting - No confirmation made by State or Federal biologist or officer or by other known qualified observer, yet details of the sighting seem to identify the birds as whooping cranes. To be classified as a probable sighting each of the following factors must be met: (1) location of sighting is within normal migration corridor and is an appropriate site for whooping cranes, (2) date of sighting is within period of migration, (3) accurate physical description, (4) number of birds is reasonable, (5) behavior of the birds does not eliminate whooping cranes, and (6) good probability that the observer would provide a reliable report.
>
> Unconfirmed Sighting - Details of the sighting meet some, but not all of the six factors listed for a probable sighting.

Stopover – Use of the study area during spring or fall migration.

Use-site - A location of a crane group in the study area. A single crane group may have (and likely will have) more than one use-site per day.

Obstruction - objects (e.g., vegetation, bank, etc.) >1.5m above water line

Unobstructed width – The unobstructed width is defined as the area between obstructions less than 1.5m above water line and includes all water and island/sandbars <1.5m. A line will be drawn across the channel, through the use-site and will be oriented perpendicular to the general flow within the channel.

Water/Wetted Width - The water/wetted width is defined as the area covered by water between obstructions less than 1.5m. This measurement does not include sandbars and islands above the water surface but less than 1.5m. A line will be drawn across the channel, through the use-site and will be oriented perpendicular to the general flow within the channel.

IV.B. Field Techniques

IV.B.1. Detecting/Locating Whooping Crane Stopovers

Two methods will be used to locate migrating whooping crane stopovers along the central Platte River during spring and fall migration: aerial surveys and opportunistic locates. The Program's Technical Committee may choose to implement each protocol component as necessary to obtain needed information, for example changing the survey effort based on results of past surveys.

Aerial Survey

Daily aerial surveys, weather permitting, will be conducted along the central Platte River valley between Lexington and Chapman, Nebraska to locate spring and fall migrating whooping crane groups. The aerial surveys will take place from March 21 to April 29 in the spring and October 9 to November 10 in the fall. These dates are based on the 5^{th} and 95^{th} percentile of initial sighting dates for all recorded sightings of whooping crane groups in Nebraska from 1975 to 1999 (Jane Austin, USGS Northern Prairie Wildlife Research Center, pers. comm.). This protocol intends to collect a sample during possible migration time and does not intend to survey the entire time-period it would be possible for a crane group to migrate through the study area. Therefore, the survey dates will not be extended during times of delayed migration. However, if the survey period extends past the migration time in a given season, the surveys will be stopped using the following rules. For the spring survey, flights will be discontinued 5 days after the last normally migrating whooping cranes have departed Aransas, if no whooping cranes have been sighted in the central Platte valley for 5 days, and there are no recent (5 days) reports of whooping cranes in the Central Flyway south of the Platte River. For the fall survey, flights will be discontinued if no whooping cranes have been sighted in the central Platte valley for 5 days, and there are no recent (5 days) reports of whooping cranes in the Central Flyway north of the Platte River. The Program Manager or Biologist responsible for managing these surveys will be in contact with Tom Stehn (or other Aransas official) at (361) 286-3533 to obtain information related to bird departure/arrival from Aransas.

A Cessna 172 or similar aircraft will fly at a speed of 100 mph, as safety allows. One plane will fly the area between Chapman and the Nebraska Highway 10 (Minden) Bridge (the east leg). The second plane will fly the area between the Minden Bridge and the Lexington Bridge (the west leg). Two observers in addition to the pilot will be in each plane. Surveys will begin between ½ hour before sunrise to sunrise, unless weather during this time period precludes beginning the survey. All attempts should be made to begin the survey at ½-hour before sunrise. If the survey cannot begin during this time period, due to weather/visibility requirements, the survey start time can be extended up to 2 hours after sunrise. Surveys may be canceled due to unsafe weather conditions (e.g., rain, snow, fog, high winds) or if there is significant snow cover on the ground that greatly impedes the surveyors chances of locating a whooping crane group.

All aerial surveys will be flown such that the flight direction when flying the river transect will be away from the rising sun. To help address the concern that one end of the river transect will always be flown early and the other late, there will be two start locations for each leg (east side and west side) of the study area. Using the eastern section as an example: on day one the flight will begin at Chapman, fly the river west to Minden, fly a predetermined return transect (upland) back to Chapman. On day two the flight will begin at the Wood River bridge, fly the river transect west to Minden, fly a predetermined return transect back to Chapman, and then fly the rest of the river transect from Chapman to Wood River. This pattern will continue through the survey period. The start points for the west leg will be the Minden Bridge and Odessa Bridge. During the river transect, observers will be situated such that the main channel(s) can be clearly viewed by both observers looking out the passenger side of the plane. This will necessitate that the plane fly just south of the main channel.

There are seven return transects: one, two or three miles either north or south of the centerline of the river and one directly down the centerline of the river (Figure 1). On the return transect, observers will look out different sides of the plane so that they can survey the half-mile to the north of the transect as well as the half-mile to the south of the transect. The return transect surveyed each day will be set based on a predetermined, systematically rotating schedule. This design will provide a systematic aerial survey to locate whooping crane groups in areas outside of the channel as well as within the channel. Again, it is recognized that this sampling scheme over-samples the river compared to those areas surveyed with the return transects.

All transects will be flown at 750' altitude unless FAA regulation dictate a higher altitude (e.g., a minimum of 1000' altitude when flying over towns and cities). The 750' altitude for transects is selected for safety reasons. Extremely large numbers of migratory waterfowl are present in the central Platte River valley each spring. The 750' altitude allows pilots to fly over most of the airborne waterfowl and to decrease the chance of flushing additional waterfowl into the air as the plane approaches. If a suspected whooping crane is seen, the plane is encouraged to circle to an altitude of 500' (when safety allows) to provide a better viewing opportunity of the suspected whooping crane.

Each plane will have aerial photos, maps, and a global position system (GPS) unit to aid in the documentation of crane locations. When a whooping crane group is located, an air to ground radio will be used to immediately contact ground personnel that are geographically closest to the sighting. UTM coordinates taken either from the plane's GPS system or hand held unit will be recorded on the data sheet and relayed to the ground crew. The aerial survey crew will photograph the whooping crane group and the general location using a 35mm or digital camera. All observations will be recorded on the aerial observation datasheet. If the ground crew has not located the whooping crane group by the time the aerial survey is complete, the plane will return to the crane group's original coordinates and attempt to relocate the group. If the crane group is relocated from the air, the plane will maintain visual contact with the crane group and direct the ground crew to the location. The procedures to be followed by the ground crew once the crane group is located are in Section IV.B.2.

During the aerial flights, a ground crew will be stationed at four points in the study area. When the aerial survey crew radios a possible crane group sighting to the ground crew, the nearest two ground personnel will immediately attempt to locate the group. The ground crew will search for a minimum of two hours in the suspected area (or until dark) in an attempt to locate the sightings of crane groups made by the aerial flight crew. All effort expended by the ground crew to locate possible whooping crane groups will be documented on the datasheets and in the database.

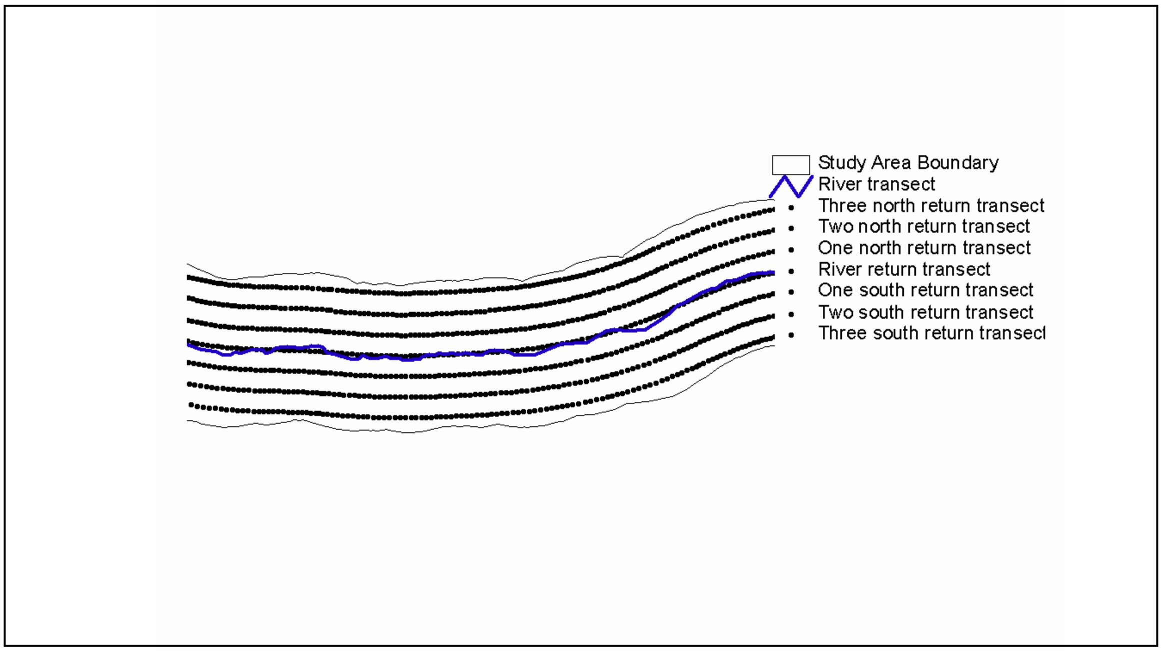


Figure 1. River flight transects and 7 return flight transects flown during the aerial surveys. Only a potion of the study area from East to West is shown.

Opportunistic Locates
The quality and timing of public sighting reports are highly variable. For example, several reports of a single group may be made by different individuals; sightings may be reported after the group has left the area; geese, white sandhill cranes, pelicans, or egrets may be reported as whooping cranes; etc. In an effort to document the validity of a sighting in a timely manner, a toll free number will be used to relay reports of possible whooping crane sightings to the ground crew. This number should be publicized at local areas frequented by birders, FWS offices, NGPC offices, and possibly in newspapers, to mail carries, bus drivers, etc. The ground monitoring crew will attempt to confirm all crane sighting reports that are in the study area and not yet confirmed. As a prioritization after confirmed sightings, the crew will check “probable” sightings, and then check “unconfirmed” sightings. The ground monitoring crew will conduct ground monitoring on all confirmed whooping cranes in the study area as described in Section IV.B.2.

All sightings relayed to the ground crew will be searched for by the ground crew for at least two hours. Incidental observations reported to the ground crew from outside the study area will be immediately forwarded to the FWS Nebraska field office, Whooping Crane Migration Information Coordinator. Information on all confirmed and probable sightings made by the ground crew will be forwarded to the FWS Nebraska field office.

The crew will fill out ground monitoring observation forms for all effort expended to locate confirmed and probable sightings of crane groups in the study area. In addition, the crew will collect use-site characteristics and fill out a use-site characteristics form for all crane sightings classified by the FWS as "confirmed".

Survey Detection Rates
Whooping crane decoys will be placed at randomly selected locations during the aerial survey. Aerial crews will not be aware of the presence of the decoys during the flight. When the aerial crew observes a decoy, the location of the sighting should be relayed to the ground crew for confirmation of the decoy location. Decoy observations will be recorded on the aerial observation datasheet.

IV.B.2 Movement Tracking
Each crane group will be continuously tracked from the roost in early morning until arriving back at roost in the evening, until the crane group leaves the study area, or until the ground crew loses the group. If a crane group is lost, observers will spend a minimum of two hours attempting to relocate the group in the suspected area or until dark. All observations of crane groups by the ground crew will take place at a distance identified in the FWS guidelines and from vehicles.

All observations of cranes will be recorded on the Instantaneous and Continuous Use-site Monitoring data sheet. Both instantaneous and continuous movement data will be collected during the movement tracking monitoring and recorded on this datasheet. Continuous locations will be recorded and documented with a sketch map on the back of the datasheet or aerial photograph. A unique location ID will be assigned to each contiguous habitat type used by the crane group during the movement tracking monitoring.

Instantaneous locations will be recorded at fifteen-minute intervals. The specific location of the crane group will be marked on the map. A unique instant point ID will be assigned during the movement tracking monitoring.

The following information will also be recorded for the observation period: crane group composition (single bird, family group, or flock); group size; age estimation if possible (adult/juvenile); weather conditions; leg band color if present; and the association of the crane group with other avian species (sandhill cranes, waterfowl, etc).

IV.B.3 Crane Group Numbering
Any time a crane group is observed in the study area by the survey crew, a *Crane Group ID* will be assigned to the group. The *Crane Group ID* will consist of the following information: year; "SP" for the spring monitoring period or an "FA" for the fall; sequential number (e.g. 2002FA01,

2002FA02, 2002FA03,… etc). Any time a crane group is observed in the study area by the survey crew, a new *Crane Group ID* will be assigned unless the surveyors note on the data sheets the reasons why they believe this is a previously recorded group (using their professional judgment). In this case, the same crane group ID will be used. FWS crane group numbers for confirmed sightings will be included in the Program database and linked to the Program crane group numbers. This will assist in future cross-referencing between FWS and Program databases.

Each field or location used by a crane group will get a new *Location ID*. *Location ID* will be a sequential alphabetical letter (A, B, etc.). The variables *Crane Group ID* and *Location ID* and *Time* will be used to connect information about sightings in a field through all the datasheets and associated data tables. Specifically, this identifier will document when the crane group used a location on the ground.

For example, if a crane group is observed in the Fall 2002 survey from the air and relayed to the ground crew, the first location observed will be assigned *Location ID* A (Crane Group ID=2002FA01) and the *Time* will be recorded. In the event that a crane group is observed by two people (e.g. from air and from the ground) in the same location and at the same time, the two observations should have the same *Crane Group ID* (Crane Group ID=2002FA01), the same *Location ID* (A), and the same *Time*. If the ground observer observes the crane group moving to another field, the location would be assigned *Location ID* B (Crane Group ID=2002FA01) and the *Time* recorded. If the ground observer observes the crane group returning to a previously used field, say A, the location would be assigned *Location ID* A (Crane Group ID=2002FA01) and the *Time* recorded. If the crane group goes out of sight, the next time a crane group is observed in the area, the crane group ID will be assigned 2 (Crane Group ID=2002FA02) (unless the observers think it is the same group as 01 and the supporting justification is documented); and the first location observed by this group will be assigned *Location ID* A. The project leader will need to continually review the datasheets to ensure the crane group ID and Location ID are correct, since field crew members may not know what the next sequential crane group ID should be.

Instantaneous data will be taken every 15 minutes at each crane group location. Each point will get a new *Instant Point ID*. The variables *Crane Group ID* and *Instant Point ID* will be used to connect information about sightings at instant points through all the datasheets and associated data tables.

IV.B.4. Activity Monitoring
Crane activity will be monitored during the course of movement tracking. As the observer watches the crane group, he/she will record the activity being conducted by the whooping crane at each of the 15 minute instantaneous points documented during the movement tracking as one of the following categories: courtship, preening, resting, feeding, alert, agonistic or other activity as defined by the observer. If the crane group is comprised of more than one individual, the observer will select a "focus" crane that will be used to record activity information from. This information will be recorded on a datasheet. The observer will also video tape the crane group using a digital video camera for the entire time it is at a use site. Each tape/disk will be numbered and this number will be recorded on the datasheet for later cross-referencing. During

the taping the observer will also verbally identify the date, time, location, and whooping crane group number that is being videoed.

IV.B.5. Use-Site Characteristics

The National Vegetation Classification Standard (NVCS) vegetation type will be documented for each continuous and instantaneous use-site using the Instantaneous and Continuous Use-site Monitoring datasheet. The time in, time out, and UTM location will also be recorded at the continuous use-sites. The time, distance to potential disturbance, and the type of disturbance will also be recorded at the instantaneous use-sites.

Additional physical and geomorphological characteristics of crane use locations will be measured for locations with standing or flowing water. These measurements will be made as soon as practical after the cranes leave the study area using the Use Site Characteristics datasheets. In all instances, proper landowner permission will be secured before Program personnel enter private property to conduct the measurements. FWS and/or NGPC personnel that have previously conducted site use evaluations will help train Program staff and contractors for future site evaluations.

Photographs taken of crane use-sites observed from the air will be used to locate the use area on the ground. A general sketch of the area and/or photograph will be taken for each use-site. The following characteristics will be recorded for each site with standing or flowing water.

The *Use Site ID* variable connects each location used by a crane group to the use characteristics measured on the ground. The *Use Site ID* is a sequential number assigned when the measurements are made (beginning with 1). The project manager will record the *Use Site ID* on the datasheets with the corresponding *Crane Grup ID*, *Location ID* and *Time*. In cases where a crane group has used the same location multiple times, there will be multiple *Location ID's* linked to one *Use Site ID* (assuming here the use characteristics were measured only once).

IV.B.5.a. Land cover class

The National Vegetation Classification Standard (NVCS) vegetation type will be documented for each continuous and instantaneous use-site.

IV.B.5.b. Distances to visual obstruction >1.5m

Distances from the crane group location to the nearest obstructions >1.5m in each of four quadrats oriented perpendicular/parallel to the channel for riverine use-sites and in the four cardinal directions for standing water will be made using a laser range finder. An obstruction is defined as objects (e.g., vegetation, bank, etc.) >1.5m above water line and encompassing more than 30 degrees of the horizontal field of view.

IV.B.5.c. Flow

The nearest upstream and downstream gage will be used to document provisional instantaneous flows during the period of crane use, and when the habitat measures are made. These data will be available from USGS gaging stations.

IV.B.5.d. Substrate

The percentage of each substrate type at a crane use-site will be documented for the four classes: less than 1mm, 1-4.9mm, 5-14.9mm, greater than 15mm.

IV.B.5.e. Unobstructed width
Channel width information will be gained by direct measurement and calculated from the water depth profile data. The distance between obstructions >1.5m along a line perpendicular to the channel and passing through the crane observation will be measured.

IV.B.5.f. Water/Wetted Width
Water or wetted width (defined the same for this protocol) will be measured directly in the field and calculated from the water depth profile data. The distance covered by water and between obstructions >1.5m along a line perpendicular to the channel and passing through the crane observation will be measured.

IV.B.5.g. Water depth profiles and sandbar location/elevation
When a crane group utilizes an area containing standing or flowing water, three parallel transects 25m apart will be established such that the middle transect crosses through the most recent crane group location. This procedure will allow the calculation of a mean and variance for each roost characteristic in the area a crane group used while acknowledging the difficulty in determining the exact crane group location when viewed from a distance.

Transects will be situated perpendicular to the general flow for river locations and perpendicular to the long axis of non-flowing water bodies. Elevation measurements will be taken along each transect using a stadia transit and rod. One measurement will be taken at approximately every 3m, when changes in topography are encountered, and at water lines. Each transect will begin and end where the transect line reaches an obstruction greater than 1.5m that a crane could not be seen through. UTMs at the bank of each transect will be documented using a GPS unit. When a sandbar is encountered along the profile transect, the distance at which the sandbar begins and ends (width) and height will be measured and the length estimated.

The channel morphology profile measurements will be interpolated during the analysis stage to produce a continuous profile of relative water surface elevation across the channel. Linear interpolation between each adjacent point along the transect will be used to sample from the profile at equally spaced increments. Water depth will be calculated as the average of equally spaced measurements of the relative water surface elevation profile that are at and below zero (water surface elevation). Sandbar elevation will be calculated as the average of equally spaced measurements of the relative water surface elevation profile that are at and above zero.

IV.B.5.h. Distances to potential disturbance features
Distance to potential disturbance will be documented in the lab using the most recent aerial photographs. Potential disturbance is defined as power lines, houses, etc.

IV.C. Data Collection from State and Federal Agencies
The report will contain a summary of all whooping crane migrational sightings within Nebraska and specifically the central Platte River corridor as obtained from the FWS, Grand Island. FWS crane group identification numbers will be recorded in the database.

IV.D. Analysis Methods

The information collected through this protocol will be used to define the habitat characteristics of whooping crane use-sites in the study area. The protocol is designed to provide information on crane groups with known probability of inclusion in the sample regardless of the crane group location in the study area. Since the aerial survey data provides this information but the opportunistically located cranes have an unknown probability of inclusion in the sample, analyses will be conducted separately for cranes located through the aerial surveys and for cranes located opportunistically.

Habitat Use

Since the whooping crane is a rare species and identifying individual cranes is usually not possible, all analyses with this data will need to balance small sample sizes with pseudo-replication. There are two options for the analysis of habitat use, one analysis will use every observation taken on each crane group, and will contain multiple observations per group. The second analysis will retain the sample size as the number of whooping cranes and average multiple observations of a crane as the first step of the analysis.

There are several analysis methods available for summarizing the habitat characteristics of whooping crane use-sites. The methods range from calculating means and variances, to modeling habitat use, to documenting changes through time, to methods that are not currently developed. With each analysis the probability sample of whooping crane use-sites collected under this protocol will provide data adequate for inferences to all cranes stopping along the Platte River in the study area.

Index of Use

An annual index of crane use will be developed using the information obtained by this protocol. The index of use will document the number of crane groups observed per survey effort (flights). The change in this index through time will estimate a change in the frequency of use throughout the first increment, if the protocol is implemented in a consistent manner.

Activity Monitoring Data

Annual analysis of activity monitoring data will only include the instantaneous data collected every 15 minutes. Videography collected will be archived for later analysis.

V. QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

QA/QC measures will be implemented at all stages of the study, including field data collection, data entry, data analysis, and report preparation. Observers will be trained and tested in the methods used and on their ability to identify whooping cranes. Data forms will be completed on a daily basis. At the end of each survey day, each observer will be responsible for inspecting his or her data forms for completeness, accuracy, and legibility. The study team leader will review data forms to insure completeness and legibility, and correct the forms as needed. Any changes made to the data forms will be initialized by the person making the change.

To help train observers that will be conducting the aerial surveys, each individual will be required to fly practice transects, or portion of transect. During this flight there will be whooping crane decoys placed in the river channel to allow observers the opportunity to see a “whooping crane” from the air at the speed and altitude of the surveys.

Data will be entered into the Program's Microsoft Access 2000 database by qualified technicians. These files will be compared to the raw data forms and checked for errors. Any irregular codes detected, or any unclear or ambiguous data will be discussed with the observer and study team leader. All changes made to the raw data will be documented.

After the data have been keyed and verified, the study team leader or QA/QC technician will check a five percent sample of data forms against the final computer file. Any problems identified will be traced back to the raw data forms, and corrections will be documented.

VI. DATA COMPILATION AND STORAGE

The Program's Microsoft Access 2000 database will be used to store, retrieve and organize field observations. The data for each survey will be incorporated within the larger Program database. All field data forms, field notebooks, and electronic data files will be retained for ready reference.

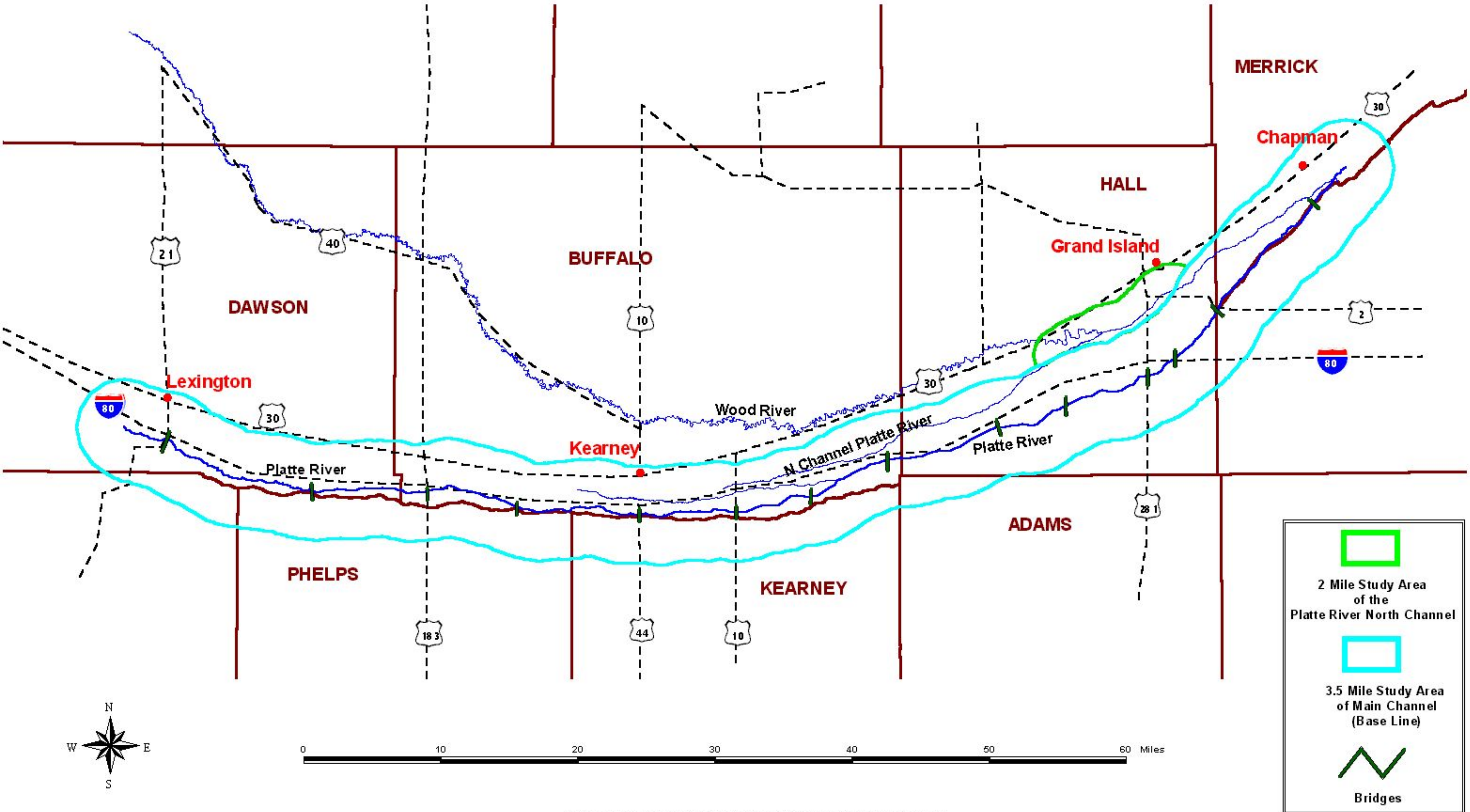
VII. REPORT FORMAT

Data on whooping crane habitat use will be compiled and summarized annually, and incorporated within the larger Program database. A draft and final report will be produced each year describing the methods employed, results, and any conclusions that can be drawn. The report will have both written and graphical components. The report will also contain maps and/or aerial photos showing crane use-sites. Descriptive statistics of whooping crane use will be prepared. Reports will be provided to both the Technical Committee and Governance Committee.

VIII. DATA SHEETS – *To be provided prior to survey implementation*

Aerial Survey
Aerial Observation
Ground Monitoring
Instantaneous and Continuous Use Site Monitoring
Use-site Characteristics Summary
Use-site Characteristics Profile

Cooperative Agreement Platte River Study Area



Maps and Analysis Prepared by Lynx Spatial Technologies Inc.

DRAFT
Protocol for
Monitoring reproductive success and reproductive habitat parameters of least terns and piping plovers in the central Platte River

May 1, 2002

I. INTRODUCTION

The States of Colorado, Nebraska and Wyoming and the Department of the Interior (DOI) agreed to participate in a basin-wide cooperative program relating to four target species (interior least tern, piping plover, whooping crane and pallid sturgeon) and their associated habitats in the Cooperative Agreement for Implementing a Platte River Recovery Implementation Program (Program). One of the primary purposes of the Program is to "implement certain aspects of the FWS' 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 basin-wide cooperative approach that can be agreed to by the three states and DOI…". The Program builds upon the July 1, 1997 Cooperative Agreement for Platte River Research and Other Efforts Relating to Endangered Species Habitats Along the Central Platte River, Nebraska (July 1997 Cooperative Agreement).

Program implementation will follow a process of adaptive management to address areas of scientific uncertainty. Monitoring is an integral part of the adaptive management process. The adaptive management approach will allow for efficient modification of management actions in response to new and changing environmental conditions. The Program's Technical Advisory Committee will monitor and document, relative to the habitat and species conditions that existed as of the effective date of the Cooperative Agreement, habitat and species responses to habitat improvement activities. The Technical Advisory Committee will review monitoring results and make recommendations to the Program's Governance Committee regarding the effects of Program activities on whooping crane habitat use in the study area. The Governance Committee, using the Technical Advisory Committee's input, will evaluate projects and the overall Program to determine what, if any, changes are needed in the management.

This monitoring protocol will be used by the Technical Advisory Committee to gather information on least tern and piping plover reproductive success and reproductive habitat parameters in the study area. It is understood that regardless of survey method not all terns and plovers are certain of being detected and therefore full implementation of this or any other protocol will not represent complete use of the central Platte River valley. Information from this protocol will be used to help evaluate the biological response of terns and plovers and habitat to the land and water management activities of the Program.

This monitoring protocol addresses several July 1997 Cooperative Agreement milestones:

<u>R2-1</u> A technical advisory committee appointed by the Governance Committee will develop protocols for and initiate habitat and species monitoring and research

R3-1 the FWS and TC will identify data needed to ascertain biological response and the time frame required to evaluate those data (R3-1 milestone as revised at the August 2, 2000 TC/GC workshop)

R5-1 The Nebraska Districts will implement any research and monitoring measures required by new FERC license articles for FERC Projects Nos. 1417 and 1835.

R1-2 and R1-3 A technical advisory committee will continue monitoring to document, relative to the habitat and species conditions that existed as of the effective date of the Cooperative Agreement, habitat and species responses to activities undertaken pursuant to the Cooperative Agreement.

R3-2 and R3-3 The Nebraska Districts will continue to implement any research and monitoring measures required by FERC license articles for FERC Projects Nos. 1417 and 1835.

II. PURPOSE

This document describes the conceptual design and study methods for locating tern and plover nests and monitoring the reproductive success and reproductive habitat parameters at least tern and piping plover colonies in the central Platte River valley, Nebraska. The monitoring is designed to document long term trends in reproductive and habitat parameters throughout the time the protocol is implemented.

This protocol will also be used by Nebraska Public Power District (NPPD) and Central Nebraska Public Power and Irrigation District (Central), collectively "the Districts", as part of their compliance with Federal Energy Regulatory Commission (FERC) licensing.

III. DESIGN CONSIDERATIONS AND SPECIFICATIONS

III.A. Area of Interest

The area of interest for monitoring the reproductive success and reproductive habitat of least terns and piping plovers consists of the Platte River beginning at the junction of U.S. Highway 283 and Interstate 80 near Lexington, Nebraska, and extending eastward to Chapman, Nebraska. This includes approximately 90 miles of the Platte River and sandpits within 3.5 miles of the main channel or 2 miles of a side channel if the side channel extends beyond 3.5 miles of the main channel.

III.B. Statistical Design

The design consists of two main components: 1) effort-based census of the Platte River between Lexington and Chapman, and 2) census of historic (pre-Program) nesting areas and potential nesting areas on sandpits and constructed islands. These two monitoring components were designed along with a research component that was designed to evaluate the efficiency of each survey. Data will exist both prior to and after Program initiation for some of the 2^{rd} component, with data collected only after Program implementation for the 1^{st} component and the research component. Information from all components will be used to make informed judgments regarding the trends in tern and plover reproductive parameters associated with Program activities. Habitat parameters will be measured at all located nests.

III.B.1. Component 1, Effort-based Census of River (Extensive Survey)
To make statistical inferences to the entire study area, an effort-based survey will be conducted along the entire river corridor. The survey will involve locating nests from an airboat. Every channel with an active width (bare sand and/or water) greater than 75m on the Platte River between Lexington and Chapman, Nebraska will be surveyed. The boat will be directed through the channels in such a manner that observers can view all sand areas, making the total survey time dependant on the amount of sand present (i.e., more sand visible at low flows will require longer survey periods).

The entire river will be searched three times per breeding season (mid May, mid June, and mid July). Windows are provided as guidelines to determine when to survey (10 May-25 May, 10 June-25 June, and 10 July-25 July), but exact timing of the surveys will be dependent on flow and safety conditions. Before each survey an aerial flight will be conducted over the study area to determine the availability of bare sand, if its presence is in doubt. If there is no bare sand visible at the end of the airboat survey window, an airboat survey will not be conducted and the number of nests will be recorded as 0. If any bare sand is visible, regardless of size or condition, the airboat survey will be conducted when it is determined that flows have been at or below flight-day flows for three consecutive days.

III.B.2. Component 2, Census of Sandpits and Constructed Riverine Islands
All sandpits that have areas of bare sand (<20% vegetative cover) greater than one acre, and for which access can be gained, will be surveyed 3 times for active tern and plover colonies. Also, any nesting area constructed and maintained by the Program will be visited weekly between May 15 and July 15 for active tern and plover colonies. Reproductive areas (colonies) that were located and monitored prior to Program initiation will be monitored under this component. Since every accessible sandpit will be monitored we will have a census of colonies and a sample of nests at each colony. The nest is the sample unit for calculation of reproductive parameters, and inference will be to accessible sandpits with areas of bare sand greater than one acre.

Each of these areas will be searched three times per breeding season (mid May, mid June, and mid July) for tern and plover adults and nests. These surveys will be conducted regardless of the survey activity on the river. Nests located during these surveys will be monitored as described below. Monitoring all sandpits and constructed islands will allow unbiased estimation of trends in reproductive parameters at these areas. Only the areas that were monitored prior to Program initiation will be used in analytical comparisons of data collected before and after Program implementation. Areas that were not monitored prior to Program initiation will not be used in the before-after analysis but will be used in the trend analysis. Continuing surveys of these areas using the same methods to locate and monitor nests will facilitate detecting trends in reproduction during the Program.

III.C. Timing
Surveys of the river and sandpits to document nest presence will be conducted three times annually (mid May, mid June, and mid July). Least tern or piping plover nests found in any survey will be visited every three days to evaluate the nest status. Information to be collected during each site visit is described below.

IV. METHODS
IV.A. Biological, Reproductive, and Habitat Definitions

- Biological parameters

Brood – An active nest or clutch of chicks.

Nesting colony – The area encompassed by multiple nests within which disturbance to one nest results in a disturbance reaction by adults of other nests. In cases where only a single nest is present, the nest will serve as the "colony" for habitat measurements.

Nest Initiation – A nest is initiated when it is constructed and at least one egg is laid.

Nest success – A nest is successful when at least one egg hatches.

Fledge – A least tern chick has fledged when it is covered in unsheathed feathers, has a black eyestripe, and has a short tail, or flight is observed, or nestling is 15 days old. A piping plover chick is fledged when it is covered in unsheathed feathers and has a short tail, or flight is observed, or nestling is 15 days old.

- Reproductive Parameters

Total Nests Initiated – The total number of nests initiated whether successful or not. This total includes first nesting attempts as well as re-nesting attempts.

Nest-based Hatching success – The total number of hatched eggs (chicks) divided by the total number of nests initiated (i.e., if there were 60 chicks and 75 nests, the hatching rate would be 0.80 or 80%). Using the number of nests in the denominator of this statistic recognizes the greater independence of fate between nests than between eggs.

Nesting loss – The total number of unsuccessful nests divided by the total number of nests initiated (i.e., if there were 125 nests initiated and 25 nests were unsuccessful, nest loss would be 0.20 or 20%).

Nesting success – The total number of successful nests divided by the total number of nests initiated (i.e., if there were 125 nests initiated and 100 nests were successful, nest success would be 0.80 or 80%).

Number of Pairs – The number of pairs will be estimated one of two ways; 1) the maximum number of nests and number of broods at any one survey, or 2) half of the maximum number of adults counted at any one survey. Data collection will allow the estimation of the number of pairs using either method.

Nest-based Fledging success – the number of fledged birds per initiated nest (i.e., if 60 chicks were fledged from 50 nests, the fledging success would be 1.2 fledged birds per nest).

Pair-based Fledgling success – the number of fledged birds per bird pair (i.e., if 60 chicks were fledged from 50 pairs, the fledging success would be 1.2 fledged birds per pair).

- Nest-level Habitat Parameters

Nearest bank – Distance to the nearest bank across water estimated from a distance (riverine only).

Nest elevation – The elevation of each nest above the water surface estimated from a distance.

Nest management – Management activities applied specifically to nests (i.e. exclosures).

Vegetation composition – Percentage of vegetation cover in grass, forb, and woody vegetation types in a $1m^2$ and $5m^2$ area around the nest.

Vegetation density – The number of stems of grass, forb, and woody vegetation types in a $1m^2$ and $5m^2$ area around the nest divided by the area.

Vegetation height – Average height of all vegetation in a $1m^2$ and $5m^2$ area around the nest.

- Colony-level Habitat Parameters

Colony management – Management activities applied to the colony (i.e. predator fencing, predator trapping, herbicide, mowing).

Adjacent land use – The general description of land uses immediately next to as well as in close proximity to the colony.

Bare sand area – The total area with <20% vegetative cover at the colony site.

Pond size – Size of pond adjacent to the colony's nesting substrate (sandpits only). This parameter can be measured using aerial photographs or GIS.

Distance from colony to river – Distance between centroid of the colony and closest active river channel. An active river channel is defined as a channel carrying water when the entire river has a minimum flow of 1200 cfs. This parameter can be measured using aerial photographs or GIS.

Sandbar/Island height – The elevation of the sandbar/island recorded three transects perpendicular to the flow of the water and centered on the centroid of the river colony. The survey will be conducted after all terns and plovers leave the colony and with the use of a transit or survey grade GPS unit.

Channel width – Width of entire open-channel, including land, measured at the colony. This measurement will be derived from the elevation transect.

IV.B. Field Techniques

Standard field practices will be followed during each visit to a nesting area. The following information will be recorded: date, time of day, weather conditions (both for previous day and observation day), length of visit, number of adults and chicks, other species of wildlife present in area, and other information as needed. No more than a total of eight visits will be made within any one colony site and activity within the colony areas will be limited to less than 20 minutes in duration. Within colony visits will be conducted no more than once during a seven day period. All observations will be conducted when the temperature is less than 90^{o}F (32^{o}C) to reduce stress and mortality to eggs and chicks. If daily temperatures remain below 75^{o}F, nests may be checked either in the morning or afternoon. If temperatures go above 75^{o}F, nest will only be checked in the morning. If predatory animals (e.g., hawks, raccoons) are visible or fresh sign of predatory animals is observed (e.g., fresh tracks) nests will not be approached.

IV.B.1. Nest location

Component 1, Effort-based Census of River (Extensive Survey)

Effort-based census of the river to determine nest initiation will be conducted three times during each breeding season on the central Platte River between Lexington and Chapman, Nebraska. Surveys will be conducted in mid May, mid June, and mid July. An airboat will be used to access the river habitat within each bridge segment. The operator of the boat and a minimum of one observer will cover each active channel greater than 75m (as described above) searching for least tern and piping plover nests. The airboat will be operated such that observations of all bare sand areas can be made. Names of observers and time spent conducted the survey will be recorded on datasheets. GPS units will be used to accurately record which channels are surveyed.

If an adult piping plover(s) or least tern(s) is observed, the boat will be driven upstream of the location and the motor turned off. As the boat drifts by the location of the bird observation, both observers will attempt to locate the nesting bird. This method will enable the nests to be located without entering land before permission is granted. If the nest is located, or if the observers can not confirm the absence of a nest, the point will be mapped on an aerial photograph or 7.5-minute quadrangle map and a hand drawn map. The hand drawn map will include vegetative cover, distinguishing features of the area, estimated channel widths, and approximate topography. A GPS unit will be used to determine the UTM coordinates. Subsequent relocation of the nest will use the UTMs for the general location within the river and site maps or photos will be used to locate specific nest sites. After the nest is located the survey will begin from where the bird was first observed. As soon as possible after completion of the survey, the landowner will be contacted in an attempt to gain access to the property for monitoring of the nest. If landowner permission is not obtained, the area will be excluded from estimates of nesting success if monitoring cannot occur from a distance but will be included in estimates of total nests.

The number of terns and plovers detected during each airboat survey will be recorded and their likely association (reproductively) with a river, sandpit, or constructed island nesting colony will be noted. The surveyors will attempt to keep individual birds separated and only counted once.

Component 2, Census of Sandpits and Constructed Riverine Islands

Surveys for tern and plover nests at sandpits will be conducted in mid May, mid June, and mid July. Observations will be made using binoculars and/or spotting scope at a distance great enough to not cause disturbance of nesting birds (usually > 50 m, but closer or further as terrain dictates) and of duration of at least 1/2 hour. The observations will be done from multiple locations to provide complete coverage of the colony. In addition to recording the nests found during the survey, the monthly survey will be used to collect information on the number of adults, active nests, chicks, broods, and fledglings.

Once nests are located locations will be mapped on aerial photographs and hand drawn maps. Nests will not be marked with visible markers. Relocation of nests for monitoring purposes will be based on hand drawn maps and written descriptions. On the visit on which a nest is located, the number of eggs will be counted if viewable from a distance and habitat parameters will be estimated. Subsequent monitoring for hatching success and fledging success is described below. Each colony location will be recorded using a GPS unit and the UTM coordinates recorded.

If a sandpit or constructed island has active nests that are monitored every three days, it will not be necessary to do an additional survey of the area on June 15 or July 15. The information obtained on the visit to the colony nearest the June or July survey date will be used for the monthly survey data. The surveyor will mark the nearest survey date on the datasheet and spend duration of at least 1/2 hour to record the number of adults, active nests, chicks, broods, and fledglings at the site.

IV.B.2. Nest monitoring

Monitoring active nests will begin immediately after the first nests are initiated and will be conducted for nests located in components 1 and 2 described above. When permission is obtained to enter a nest location, the nest will be approached only to determine cause of predation. The number of eggs in each nest will be recorded if viewed using binoculars or spotting scope or if the colony is entered to investigate predation. Active nests will be viewed from a distance great enough not to disturb the birds and at least every third day to confirm nest status. Monitoring will continue until the nest becomes inactive either through nest success or nest failure. Colonies will not be entered more than eight times in any one year and not more than one time in a seven-day period.

When a nest is no longer active (as observed by using binoculars or spotting scope from a distance), the observer will determine if the nest hatched, was abandoned, or was predated. If the observer suspects nest failure, he/she will enter the colony to check the nest for evidence of the outcome. Indications that the nest was abandoned include no disturbance to the nest, and eggs intact in the nest, intact eggs not at incubation temperature. Evidence that the nest was depredated includes broken eggs, disturbed nest site, and predator tracks. All evidence (type of tracks, condition of egg fragments, scat, and any other sign) relating to potential nest predators will be recorded on data sheets. If the nest was successful, there may be small eggshell fragments in the bottom of the nest but the adult will have removed the larger pieces from the nest. Another indication that the nest was successful is that there will be a chick(s) in the area with the adults, and fecal material in the immediate vicinity of the nest. The outcome of each nest, including an estimate of the number of hatched eggs, will be documented on data sheets.

Timing of visits to determine fledging success will depend on obtaining the date of hatching from nest success monitoring (see above). Because tern and plover chicks require approximately 18-20 days to fledge (Murphy 1999), visits will be timed to begin before chicks leave the natal areas.

Fledging status of least terns and piping plovers will be determined by observation of the natal area from a distance great enough to minimize disturbance to adults or chicks (usually > 50 m). The entire natal area will be watched for fledglings and a complete, or nearly complete, count of chicks and adults will be made at each site. The observer will spend a minimum of 0.5 hour at each colony location and will scan the area using binoculars and/or spotting scope a minimum of 5 passes over the area. During each pass of the area the observer will count all adults and chicks and estimate the age of chicks.

Number of adults, nests, chicks, broods, and fledglings, estimated time until fledging for each chick, and any other pertinent information for each site will be recorded on data sheets (attached). An estimate of the number of successfully fledged chicks will be based on age and the date chicks were last observed or directly counted if chicks are observed flying from natal areas. Each site will be monitored every 3 days until all chicks are no longer observed at the natal area.

IV.B.3. Habitat Measurements

The colony will not be entered to conduct habitat measurements until after all of the chicks have fledged and all the birds have left the area. Nest-level habitat measurements will be estimated/recorded from outside the colony using binoculars or a spotting scope. Colony-level habitat measurements will be measured after all birds have left the nesting area.

For each nest in the study area, five habitat parameters will be estimated from outside the colony at the time the nest is located: 1) the distance between the nest and the nearest water, including the type of water, 2) the elevation of the nest above the water level, 3) nest specific management activities, 3) estimates of the percentage of grass, forb, or woody vegetation types within $1m^2$ and within $5m^2$ of the nest, 4) number of stems (to get density) within $1m^2$ and within $5m^2$ of the nest, and 5) vegetation height within $1m^2$ and within $5m^2$ of the nest.

For each colony (one or more nests) located in the study area, colony-level management activities will be recorded along with the adjacent land use. The bare sand area, size of adjacent pond, and distance from the colony to the river will be measured in a GIS for each colony. The location of each nest in the colony will be drawn on a copy of an aerial photograph to estimate the centroid of the colony.

For each colony located on the river, three parallel cross-sectional transects will be used to measure a depth profile perpendicular to the flow. The middle transect will pass through the centroid of the colony, the upstream and downstream two transects will pass through the remaining thirds of the colony. For areas with only one nest, the middle transect will pass through the nest location, one transect 25 m upstream and one transect 25 m downstream. A survey grade GPS unit or transit/rod will be used to record distance and elevation at 3 m intervals, slope breaks, and water lines from permanent bank to permanent bank or permanent obstruction (e.g., woody vegetation, bank) greater than 1.5m. The colony location will be noted on the data sheet or on the computer used to capture the cross sectional data. Estimates of active channel width will be obtained from the elevation transect data.

IV.C. Analysis Methods

Estimates of reproductive parameters will be summarized separately for the river survey (component 1) and for the sandpit and constructed island surveys (component 2) because the different methods used to locate nests will most likely result in different probabilities of inclusion of a nest in each sample. In both cases, the nest will be the sample unit for the calculation of reproductive parameters by colony, river segment, bridge segment or the entire river. Associations between reproductive parameters and habitat variables will use the nest or the colony as the experimental unit depending on the habitat variable. Inference for these analyses will be to the sandpits within the study area or colonies on the Platte River within the study area. For the trend analysis on sandpits and constructed islands, the experimental unit will be the colonies because the location of the colony will be the same every year. For the trend analysis on the river, the experimental unit will be the river segment because colonies will not be in the same location of the river every year.

The total number of nests initiated will be calculated for each site (riverine, sandpit or constructed island). The variance will be calculated using the variance of a total from a simple random sample (Thompson 1992).

Hatching success
The total number of hatched eggs will be calculated for each site. The variance will be calculated using the variance of a total from a simple random sample (Thompson 1992). The nest-based hatching success will be calculated as the ratio of the total number of hatched eggs to the total number of nests initiated.

Nesting loss
The total number of unsuccessful nests will be calculated for each site. The variance will be calculated using the variance of a total from a simple random sample (Thompson 1992). The estimate of nesting loss will be calculated as the ratio of the total number of unsuccessful nests to the total number of nests initiated. The variance will be calculated by the variance of the ratio of totals (Cochran 1977).

Nesting success
The total number of successful nests will be calculated for each site. The variance will be calculated using the variance of a total from a simple random sample (Thompson 1992). The estimate of nesting success will be calculated as the ratio of the total number of successful nests to the total number of nests initiated. The variance will be calculated by the variance of the ratio of totals (Cochran 1977).

Fledging success
The total number of fledglings will be calculated for each site. The variance will be calculated using the variance of a total from a simple random sample (Thompson 1992). The estimate of fledging success will be calculated two ways. Nest-based fledgling success will be calculated as the ratio of the total number of fledglings to the total number of nests initiated. Pair-based fledgling success will be calculated as the ratio of the total number of fledglings to the total number of breeding pairs. The variance of each estimate will be calculated by the variance of the ratio of totals (Cochran 1977).

Mayfield Estimators
The Mayfield estimate of daily mortality rate will be calculated as the ratio of total number of unsuccessful nests to the total number of exposure days. The variance of the daily mortality rate will be calculated as the variance of a maximum likelihood estimator (Johnson 1979). Daily

survival rate will be calculated as one minus the daily mortality rate, and hatching success will be calculated as the daily survival rate raised to the power of the length of the incubation period.

Associations with reproductive parameters
Physical habitat measurements made at the colony level can be used in regression equations to predict reproductive parameters (hatching success, nesting success, fledgling success). One scale of this analysis will be a regression of the habitat covariates measured on each site to the mean parameters calculated by site. The sample unit for this analysis will be the site (riverine, sandpit, or constructed islands). Possible covariates include the size of the site (water) and the distance to the river. This analysis will be conducted within each year and across years (using site averages).

A second scale of analysis would be to use regression to relate habitat covariates measured at a nest to the reproductive parameters for the corresponding nest. The sample unit for this analysis would be the nest. We can determine the association of changes in habitat variables with changes in response variables. These regressions will include a site indicator variable to detect site influences on the reproductive parameters. The number of chicks from a nest can be related to habitat using normal linear regression, while success of a nest (yes or no) can be related to habitat using logistic regression. Again, this analysis will be conducted within each year and across years.

Trend Detection
Using both the historic data from monitoring these colonies and data collected under this protocol, the slope of the least squares regression line against time will be estimated for each colony. The average and standard error of the slope statistic across colonies will provide an estimate and confidence interval of average trend.

Note that without a reference area there will be a tendency for the effects of the increased flows and habitat management to be confounded with trends in the reproductive parameters due to other factors not measured. For example, the reproductive success may increase immediately after Program initiation because the weather was more conducive to the birds successfully fledging young for those years. With data collected over time, the effects of other factors will diminish and the inferences regarding the effects of the Program will get stronger.

Before-After Analyses
Data from sites (colonies) that were monitored before Program initiation can be compared to data collected under this protocol in the same areas. Since the Program influences all colonies in the study area, cause and effect relationships can not be established by this analysis. Reproductive parameters will be calculated without adjustments for comparison with pre-Program survey data.

Before-after analyses will be conducted by averaging the values of the reproductive parameters before Program implementation and after implementation for each sandpit. The slope between these two numbers will be calculated and the average slope (over sandpits) will be an estimate of the before to after change in the parameter. Inferences are to the sandpits involved in this analysis.

Nest Habitat Characteristics
Habitat measurements made at the nests will be summarized using means across nests and normal based confidence intervals (Zar 1984).

Colony level habitat measurements will be summarized using means across colonies and normal based confidence intervals (Zar 1984).

V. RESEARCH ASSOCIATED WITH THIS MONITORING PROTOCOL

An intensive nest survey of portions of the river will be conducted to augment the monitoring activities *(CITE RESEARCH PROTOCOL)*. This research is intended to determine the effectiveness of the riverine survey by documenting habitat characteristics associated with nests located under component 1 of this protocol and nests not located (double sampling). The data will enable the development of an adjustment factor for river survey data to accurately estimate the number of nests on the river. This research will be conducted during the implementation of the monitoring protocol for a duration necessary to adequately model the sampling effectiveness. The intensive survey will be most useful if it is implemented after the river survey has detected nests on the river.

VI. QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

QA/QC measures will be implemented at all stages of the study, including field data collection, data entry, data analysis, and report preparation. Observers will be trained in the methods used and tested on their ability to locate and identify nests. At the end of each survey day, each observer will be responsible for inspecting his or her data forms for completeness, accuracy, and legibility. The study team leader will review data forms to insure completeness and legibility, and any problems detected will be corrected. Any changes made to the data forms will be initialized by the person making the change.

Data will be entered into electronic files at a centralized database by qualified technicians. These files will be compared to the raw data forms and any errors detected will be corrected. Any irregular codes detected, or any unclear or ambiguous data will be discussed with the observer and study team leader. All changes made to the raw data must be documented for future reference.

After the data have been keyed and verified, the study team leader or QA/QC technician will check a five percent sample of data forms against the final computer file. Any problems identified in later stages of analysis will be traced back to the raw data forms, and appropriate changes in all steps will be made.

VII. DATA COMPILATION AND STORAGE

A centralized database will be established to store, retrieve and organize field observations. Data from field forms will be keyed into electronic data files using a pre-defined format that will make subsequent data analysis straightforward. All field data forms, field notebooks, and electronic data files will be retained for ready reference.

VIII. REPORT FORMAT

A draft and final report will be produced each year describing the methods employed, results, and any conclusions that can be drawn. The report will have both written and graphical components. Graphs will show trends from year to year in such things as number of nests initiated, nesting success, and fledging success. The report will also contain maps showing areas searched for nests and areas that contained nests.

IX. ADMINISTRATION

The Program will be responsible for implementation of the protocol and obtaining the necessary permits.

X. EXISTING DATA EVALUATION

Nebraska Public Power District (NPPD) collected least tern and piping plover reproduction data on 3 islands (Elm Creek, Lexington, Overton) and 3 sandpits (Johnson's, Lexington, and Blue Hole) from 1991 to 2000. This data is located in a Microsoft excel file *t&p tables00.xls* house in the Kearney office. The file contains the number of initiated nests, number of hatched nests, number of hatched chicks, and the number of fledged chicks at each of the 6 sites for each year. Various forms of reproductive success statistics can be created from this data.

As a check on the existing data, trends through time were estimated for hatching success defined as the ratio of the number of hatched chicks to the number of nests, and for fledging success defined as the ratio of the number of fledglings to the number of nests. The slope of the regression of success parameters on year (estimate of trend) were graphed and averaged by species to get an average trend. 95% confidence intervals on both of these averages included zero.

XI. DATA SHEETS

(Attached)

XI. BIBLIOGRAPHY

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Draft
Monitoring the vegetation of the central Platte River valley

September 19, 2006

System-Level Monitoring

I. PURPOSE
The purpose of system-level vegetation monitoring is to document the vegetation community in the Program study area.

I.A. Land Cover/Use Survey
The purpose of the land cover/use survey is to document system-wide status in large-scale areal coverage of land cover/use. This monitoring is designed to detect land use changes during the First Increment.

I.B. In-channel Seedling Survey
The purpose of the in-channel seedling survey is to provide system-wide status in areal coverage of seedlings in the main channel. This information is designed for use in the annual management plan of the Environmental Account.

II. DESIGN CONSIDERATIONS AND SPECIFICATIONS
II.A. Area of Interest
The area of interest for system-level vegetation monitoring consists of the area 3.5-miles on either side of the Platte River centerline beginning at the junction of U.S. Highway 283 near Lexington, Nebraska, and extending eastward to Chapman, Nebraska (approximately 90 miles). When side channels of the Platte River extend beyond the 3.5-mile area, an additional 2-mile area is included around these channels.

II.B. Parameters of Interest
The monitoring will collect data appropriate to estimate land cover class acreage, and frequency distribution of elevation (above a base flow) for seedlings in the channel.

II.C. Sampling Design
II.C.1. Land Cover/Use
The system-level land cover/use monitoring is designed to document status by repeating the development of a land cover/use GIS layer at the end of the first increment. The same methods used in the development of the pre-Program land cover/use layer with the 1998 ortho-rectified color infra-red photographs will be employed. The pre-Program land cover/use GIS layer was developed by the Bureau of Reclamation, Great Plains Region, Platte River EIS Office (USDI BOR 2000). The same cover types, with updates as possible, will be used during the Program.

Trends in land cover class acreage can be assessed by comparing the post-first increment GIS layer to the layer created from the 1998 photographs. An estimate of net change in the areal extent of each cover class will be made with the study area-wide estimates of land cover/use area (e.g. the hectares of wetted channel increased by 10). Evaluating a sample of points in the study area will allow estimates of gross change (e.g. 20 hectares changed from forest to wetted channel, 10 hectares changed from wetted channel to lowland grasses) (Duncan and Kalton 1987).

In addition, estimates of the areal extent of each cover class will be made during the First Increment using non-rectified aerial photographs. These estimates will be made every three years and will be used to interpret the trends detected with the land cover/use GIS layer at the beginning and ending of the First Increment. Transects spaced evenly throughout the study area and positioned at the anchor points will be used to estimate the areal extent of each cover class. The distance of each cover class along each transect will be measured on the aerial photographs and the areal extent of each land cover/use class will be inferred from this data.

II.C.2. In-channel Seedling Survey

The system-level seedling survey is designed to document the areal extent of the study area main channel with willow and cottonwood seedlings less than 3 years old or purple loosestrife or false indigo. The monitoring will locate areas with seedlings (willows, cottonwoods, purple loosestrife, and false indigo less than 1 meter in height) and without other well-established woody vegetation (greater than 1 meter in height). An estimate of the seedling area will be made annually and will include the elevations associated with seedling areas. The main channel in the study area forms the population (area) of interest for this monitoring.

The system-wide anchor points will be used to locate the data collection in order to obtain estimates that are representative of the entire study area. The survey will utilize the topography survey conducted as part of the annual geomorphology monitoring. Since the objective of this monitoring is to estimate status, the in-channel seedling monitoring design will be conducted at the sites in the rotating panel of the geomorphology survey.

One fixed width (belt) transect at each anchor point will be used to estimate the area of the channel with seedlings present. The transect will be centered on an anchor point and be oriented perpendicular to the flow. The length of each transect will be the width of the channel. The width of each transect will be 300 meters, extending for 150 meters up and downstream of the anchor point.

All areas within the belt transect that contain seedlings, and do not contain permanent woody vegetation greater than 1 meter in height will be recorded. The size and elevation of each area and the presence of each of the four species of seedlings (willow, cottonwood, purple loosestrife, and false indigo) will be documented.

III. METHODS

III.A. Definitions

Seedling- Willow tree less than 1 meter high, cottonwood tree less than 1 meter high, purple loosestrife plant, or false indigo plant.

III.B. Field Techniques

III.B.1. Land Cover/Use

Field techniques for the land cover/use GIS will follow those used in the development of the pre-Program land cover/use GIS layer from the 1998 ortho-rectified color infra-red photographs. Field work will be required to develop vegetation classification signatures for the photographs, field check the preliminary classification, and to perform an accuracy assessment of the classification.

III.B.2. In-channel Seedling Survey

Three hundred meter wide belt transects (150 meters on either side of the topography transect) will be visited once a year during the time frame specified in Section III.C.2. to document the areas without permanent woody vegetation containing seedlings. There will be one transect at each anchor point in the rotating panel of the topography survey.

Within the belt transect, specific areas with seedlings will be delineated. The presence or absence of each type of seedling will be documented for each area. In each area, the topography will be measured along two axes with a survey-grade global positioning system (GPS). The longest axis of the polygon will be the first axis surveyed. The longest axis that is perpendicular to the first axis will also be surveyed. The survey data will be used to estimate the size of the area and the elevation of the area. One GPS reading will be taken at the ends of each transect and every 3 meters along each transect. One GPS point will be captured at the highest point in the area, and if neither axis of the area meets water level, one reading of the water level nearest the area will be taken.

III.C. Timing

III.C.1. Land Cover/Use

The development of a land cover/use GIS layer will take place during the last years of the First Increment. Color infra-red photographs will be taken according to the Aerial Photography Protocol.

III.C.2. In-channel Seedling Survey

The in-channel seedling survey will take place annually between July 1 and August 31 and at the same time as the annual topography survey. The elevation information will come from the topography survey as outlined in the geomorphology protocol. The information gained from this monitoring will be summarized for inclusion in the Draft Environmental Account annual operating plan in November.

IV. Analysis Methods

IV.1. Land Cover/Use

A before-after comparison analysis of the net change and gross change in the areal coverage of each land cover/use class will be conducted. This analysis will attempt to incorporate the accuracy of the pre and post-First Increment land cover/use classifications. The areal extent of each land cover/use class will be the sum of each polygon in the coverage. The net change will be calculated as the difference of the area of each land cover/use class in the pre-Program and post- First Increment GIS coverages.

Estimates of gross change will be estimated using a set of points randomly placed throughout the study area. Each point will be classified according to the land cover/use in the pre-Program and post- First Increment GIS coverages. A matrix of pre to post land cover/use classes will be used to indicate the extent of land cover/use class conversions that occurred over the course of the First Increment.

IV.2. In-channel Seedling Survey

The average elevation and areal extent of seedlings will be estimated with the in-channel seedling survey. The GPS survey information will be transformed to provide the distance from the transect end and elevation for each point along each of the two transects at each seedling area. The areal extent of the seedling area will be estimated by the formula for the area of an ellipse using the length of the two transects. The elevation of the seedling area will be calculated as the average of the elevation readings along the two transects and converted to the elevation above water at a base flow.

The elevation and areal estimates will be combined across the seedling areas delineated at each anchor point. The area will be summed and the elevations averaged (weighted by area) for an anchor point estimate. The proportion of area covered by seedlings will be calculated for each transect by dividing the area covered by an estimate of the area surveyed. The area surveyed will be 300 meters by the width of the channel at the anchor point (calculated from topography data collected for the geomorphology monitoring).

The proportion of area covered will be estimated for the entire main channel of the system by summing the area covered across anchor points and dividing by the sum of the area surveyed across anchor points. The variance of this estimate will be calculated using the variance of a ratio of totals (Cochran 1965; page 158).

The average and highest elevation of seedling areas at each anchor point will be converted to the elevation above water level at a base flow using nearby gaging information. To combine across areas at an anchor point, the elevations for all the areas with seedlings will be averaged using the areas as the weight. The area covered (in hectares) and average elevation above water at a base flow at each anchor point will be combined across anchor points to obtain a frequency distribution of elevation for seedlings in the study area channel. This distribution will be created using hectares as the basic unit and will be used to determine the proportion of seedlings present in the main channel at each elevation above the base flow water level.

Program-Level Monitoring

I. PURPOSE

The purpose of Program-level vegetation monitoring is to document the vegetation community on Program lands. The land cover survey in conjunction with the vegetation community survey will provide the coverage area and a species list for each land cover type. The emergent wetland quality survey will provide a complete species list including rare species. When the land cover survey is repeated on a Program land, changes in the amount of each land cover class will be estimated for the Program land. When the vegetation community or emergent wetland quality survey is repeated on a Program land, the similarity of species composition will be estimated for the Program land. These comparisons may take place after a land or water management plan has been implemented, or near the end of the First Increment. The same design and field methods will be implemented each time the lands are surveyed.

I.A. Land Cover Survey

The purpose of the land cover survey is to document the areal extent of each land cover class.

I.B. Vegetation Community Survey

The purpose of the vegetation community survey is to document species composition in each land cover class.

I.C. Emergent Wetland Quality Survey

The purpose of the emergent wetland quality survey is to document the total species composition in the emergent wetland cover type for an assessment of emergent wetland vegetation quality.

II. DESIGN CONSIDERATIONS AND SPECIFICATIONS

II.A. Area of Interest

The study areas for the Program-level monitoring are the blocks of land managed by the Program. It is expected that Program lands will be near one of the channels of the central Platte River between the junction of U.S. Highway 283 near Lexington, Nebraska, and Chapman, Nebraska. Each contiguous block of Program land will be sampled in a separate survey.

II.B. Parameters of Interest

The monitoring will collect data appropriate to estimate land cover class acreage, plant species composition, tree density, shrub/sapling density, percent plant cover (by species), percent non-plant cover, relative percent plant cover (by species), emergent wetland plant species composition and emergent wetland plant diversity.

II.C. Sampling Design

The Program-level monitoring is designed to collect vegetation data that is representative of each Program land. The monitoring will take place systematically throughout the Program land and will focus on estimating the above parameters. The system-wide anchor points will be used to locate the data collection.

II.C.1. Land Cover Survey

Transects will be surveyed to document the amount of land in each land cover class. The land cover transects will begin and end at property boundaries and will be oriented in the north to south direction. Each transect will be centered on a systematically placed anchor point along the centerline of the river.

Each Program land will contain 20 systematically placed transects. Transects will be surveyed using line-intercept methods (Bonham 1989). The linear distance of each land cover class along the transect will be recorded by marking the boundary with a GPS. The land cover classes used for this survey will be agriculture field, exposed sand beach/bar, emergent wetland, forest, grassland, open water (pit, pond or lake), open water canal, and wetted channel.

For the exposed sand beach/bar, emergent wetland, open water canal, and wetted channel cover types, the linear distance along the transect must be at least 5 meters to be discerned as a separate land cover type. For the agriculture field, forest, and grassland cover types, the linear distance along the transect must be at least 10 meters to be discerned as a separate land cover type. For example, a grassland four meters wide within the forest cover type would not be designated as a separate cover type.

II.C.2. Vegetation Community Survey

The land cover transect will be surveyed to document the species composition in each vegetated land cover class. The land cover classes will be identified using the methods in III.A.1. Step-point sampling will be used to determine the percent plant cover, percent non-plant cover, and relative percent plant cover in exposed sand beach/bar, emergent wetland, forest, and grassland cover types. Point-centered-quarter sampling will be used to estimate tree density and shrub/sapling density for the forest cover type.

Agriculture

The agriculture cover type is defined as areas under cultivation during the time of the vegetation survey. This cover type may also include irrigation ditches, access lanes, and haystacks. When the land cover transect crosses through an actively planted monoculture, the crop type will be recorded. When the land cover transect crosses through a fallow agriculture field, a step-point sample will be taken every 10 meters along the land cover transect.

Exposed sand beach/bar

The exposed sand beach/bar cover type is defined as an area with exposed sandy soils and low vegetative cover (typically less than 50%). This may include inactive channels, islands, point bars, and areas adjacent to some active channels. When the land cover transect crosses through the exposed beach/bar cover type, a step-point sample will be taken every 2 meters.

Emergent wetland

The emergent wetland cover type is defined by saturated and inundated soils where water depths do not exceed one meter (e.g. on/near seeps, springs, drainages, pond margins, swales, riverbanks, and in ditches). When the land cover transect crosses through the emergent wetland cover type, step point samples will be taken every 2 meters.

Forest

The forest cover type is defined as the area on river terraces and large and small islands within the floodplain that have sufficient substrate over ground water to allow root development and sufficient aeration. Where the land cover transect crosses through the forest cover type, a point-centered-quarter plot will be established every 200 meters (Laycock and Batcheler, 1973). The first plot will be established a minimum of 50 meters in from the edge of the forest cover type to avoid edge effect and there will be no plots when the forest does not cross the land cover transect for a length longer than 100 meters. In addition, two forest step-point transects will cross at right angles to each other, centered on the point-centered-quarter plot, and extending in the four cardinal directions. Each forest transect will be 50 meters in length and a step-point sample will be taken every 2 meters for a total of 25 hits per transect and a total of 50 hits per plot.

Grassland
The grassland cover type is defined by herbaceous vegetation with native tall grasses and introduced grass species. This definition encompasses both upland and lowland grasslands. Upland grasslands are defined by drier and often elevated soils that are not subirrigated; lowland grasslands occur on subirrigated soils within the floodplain. Where the land cover transect crosses through the grassland cover type, a step-point sample will be taken every 10m.

II.C.3. Emergent Wetland Quality Survey
The emergent wetland will be surveyed to document rare species presence, species diversity, and the percent plant cover in the emergent wetland cover type. The emergent wetland areas will be identified using the methods in III.A.1. Emergent wetland quadrat sampling will take place in 2x2 meter quadrats established along the land cover transect. Quadrats will be spaced 10 meters apart along the transect within the emergent wetland section(s). The distance between the quadrat locations will be accumulated over all the sections of emergent wetland along a land cover transect. Every species observed in the quadrat will be recorded along with ocular estimates of the coverage area.

III. METHODS
III.A. Field Techniques
III.A.1. Land Cover Survey
Before the survey begins, the anchor point corresponding to each land cover transect will be identified using a geographic information system (GIS). The 20 transects will be systematically spaced along the centerline of the river as it runs through or adjacent to the property. The location of the junction of the land cover transect with every property boundary (north and south ends) will be identified for use in locating the endpoints in the field. Surveyors will begin at one end of the land cover transect and walk to the other end. The line-intercept survey method will identify the location of the beginning/end of each land cover class boundary along the transect with GPS (using the above definitions).

For the exposed sand beach/bar, emergent wetland, open water canal, and wetted channel cover types, the linear distance along the transect must be at least 5 meters to be discerned as a separate land cover type. For the agriculture field, forest, and grassland cover types, the linear distance along the transect must be at least 10 meters to be discerned as a separate land cover type.

III.A.2. Vegetation Community Survey

All species information will be recorded using *Flora of the Great Plains* (Great Plains Flora Association 1986) as the authority for plant species identification. Plant species that are unknown to the surveyors will be collected and numbered for later identification and rectification on the datasheets or in the database.

III.A.2.a. Step-point Sampling

Step-point sampling will be used to define the species composition and percent cover within each land cover/use cover type (Bonham 1989). Step point samples will be taken along the land cover transects in the exposed sand beach/bar, emergent wetland, and grassland cover types. Step point samples will also be taken along specifically defined transects in the forest cover types.

The step point samples will be taken using an apparatus described in Evans and Love (1957) and modified by Owensby (1973). At each location a step-point sample is to be taken, the surveyor will place the hind legs of the step-pointer on the ground, and then bring the front leg down and record the species of the first piece of vegetation touched by the pointer. One species will be recorded at each step-point location.

If the pointer touches a non-vegetated item (bare ground, building, debris pile, downed woody debris, leaf litter, or open water), this non-vegetated item will be recorded. There will not be any additional vegetated hit information recorded when the first hit is non-vegetated. (Note: this differs from the method described in Evans and Love, but will facilitate the calculation of more precise estimates of percent plant cover).

Step-point data will be composed of a list of vegetation species and non-vegetated items and the number of hits for each. The step-point lists will be recorded separately for each section of the land cover transect. For example, if there are two sections of grassland cover type along the same land cover transect, the step-point data will be recorded separately for the two sections of grassland cover type. These sections will be identified using the UTMs of the endpoints of the cover types. Step point data will also be recorded separately for the emergent wetland transect and the land cover transect through the same emergent wetland. Likewise, step point data will also be recorded separately for the forest transect and the land cover transect through the same forest.

III.A.2.b. Point-centered-quarter Sampling

Point-centered-quarter sampling will be used to define the species composition and density in the forest community. Point-centered-quarter plots will be established every 200 meters along the land cover transect in the forest cover type and at least 50 meters from the edge of the forest. The location of each point-centered quarter plot will be captured with a GPS at the time of sampling.

The area around each point-centered-quarter plot will be divided into four imaginary quarters, with the transect line as the north-south bisector. In each quarter, the distance from the center point to the nearest live tree greater than 5-cm dbh (diameter at breast height) will be recorded, along with its dbh and species. In addition, the distance to the nearest live shrub/sapling (dbh less than 5 cm) and the species will be recorded in each quadrat. Each quarter of the plot will extend as far as needed to locate the nearest tree and a laser rangefinder will be used to record all distances.

III.A.3. Emergent Wetland Quality Survey

All species information will be recorded using *Flora of the Great Plains* (Great Plains Flora Association 1986) as the authority for plant species identification. Plant species that are unknown to the surveyors will be collected and numbered for later identification and rectification on the datasheets or in the database.

Quadrat sampling will be used to quantify the species composition in the emergent wetland cover type. Quadrat sampling locations will occur every 10 meters along the emergent wetland sections of the land cover transect. A running tally of length of emergent wetland thus far traversed along the land cover transect will be kept by the field surveyors. When the 10m point is reached, a $2m^2$ quadrat frame will be placed with one edge at the 10m point and the frame extending to the 12m point, with 1 meter of the frame falling on either side of the transect. When the 20m point is reached, another quadrat sampling location will be established. The sampling will continue in this manner (30m, 40m, etc.) until the end of the transect. For each land cover transect, the tally of the length of the emergent wetland cover type will begin at 0.

A $2m^2$ quadrat frame will be used to delineate the survey area. The centerpoint of each quadrat sampling location will be recorded with a GPS. Ocular estimation will be used to quantify the cover of each species present in the quadrat. All vegetation species should be recorded and assigned a minimum of 1% cover. The sum of the cover of all vegetation species can add to more than 100% if the vegetation is layered in the vertical dimension.

III.B. Timing

The land cover survey, the vegetation community survey, and the wetland quality survey will take place at the same time, between June 1 and July 31. The land cover survey and vegetation community survey will be conducted on each Program land when they are acquired and will be conducted again for a comparison of the vegetation community at a later time. The emergent wetland quality survey will take place annually between June 1 and July 31.

IV. Analysis Methods

IV.A. Data Summarization Methods

IV.A.1. Land Cover Survey

The percentage and areal extent of each land cover type will be estimated with the land cover survey. The length of each land cover section along the transect will be calculated using the UTMs of the endpoints. The percentage of each land cover type will be calculated as the length covered by each land cover type divided by the total length of all cover types. The cover estimates can be calculated for each land cover transect, the property, or for all properties combined. The areal extent of each land cover type on the property will be calculated by multiplying each proportion by the number of hectares of the property. The variance of these estimates will be calculated using the variance of a ratio of totals (Cochran 1965; page 158).

IV.A.2. Vegetation Community Survey

IV.A.2.a. Step-point Sampling

Percent plant cover by species, relative percent plant cover by species, and total cover will be estimated with the step-point data. Percent plant cover by species will be calculated as the number of hits of each species divided by the total number of hits. Percent non-plant cover by category type will be calculated as the number of hits of each non-plant type (bare ground, leaf litter, downed woody material, or open water) divided by the total number of hits. The relative percent plant cover by species will be calculated as the number of hits of each species divided by the total number of vegetative hits. The frequency of a species estimated as the percentage of points from point data gives an absolute frequency that can be reported as a frequency or cover (Bonham 1989).

The cover estimates can be calculated for each land cover transect, the property, or for all properties combined. In each case the estimates of the population proportions are calculated by summing the hits of a particular species and dividing by the total number of hits. The variance of these estimates will be calculated using the variance of a proportion (Thompson 1992; page 36).

IV.A.2.b. Point-centered-quarter Sampling

Tree density and shrub/sapling density will be estimated with the point-centered-quarter data. Total tree density estimates will be the inverse of the squared average distance to the trees across all quarters (Laycock and Batcheler, 1973) or using the unbiased estimator of Pollard (1971). Density for each tree species will be calculated by multiplying total tree density by the relative abundance of each species detected during the point-centered-quarter sampling. The variance of these estimates will be obtained by averaging the density estimates across transects and using the variance of a mean (Thompson 1992; page 15).

IV.A.3. Emergent Wetland Quality Survey

Species diversity, percent plant cover by species, relative percent plant cover by species, and total cover will be estimated with the quadrat data. Species diversity will be calculated and averaged across all quadrats on the transect. Percent plant cover by species will be calculated as the average of the cover of each species across all quadrats on the transect. The quadrat-level relative percent plant cover by species will be calculated as the ratio of the cover of the species divided by the total vegetative cover observed in the quadrat. The relative percent plant cover by species will be calculated as the average of the relative cover of each species across all quadrats on the transect.

The diversity and cover estimates can be calculated for each land cover transect, the property, or for all properties combined. In each case the estimates of the population proportions are calculated by summing the hits of a particular species and dividing by the total number of hits. The variance of these estimates will be calculated using the variance of a proportion (Thompson 1992; page 36).

IV.B. Statistical Analysis Methods

This vegetation monitoring plan is designed to document the vegetation community on a Program land at a point in time. For each metric estimated with this monitoring data, the value and associated confidence interval will be calculated each year the sampling is conducted. After an area has been sampled over multiple years, trend analyses can be conducted to determine if a change in the values of these metrics has occurred. Inferences developed as part of this monitoring will be to each Program land sampled, and for Program-lands combined.

Management-Level Monitoring and Research

I. PURPOSE
The purpose of the management-level monitoring and research is to evaluate the effectiveness of land and water management actions on the vegetation community. Examples of land management actions that might be implemented include clearing a forest to an open channel, clearing a forest to a grassland, or creating an emergent wetland. An example of a water management action that might be implemented is the removal of seedlings with the Environmental Account (EA).

II. DESIGN CONSIDERATIONS AND SPECIFICATIONS
II.A. Area of Interest
The area of interest for the land management monitoring and research consists of specific study areas that have been managed by the Program. These areas will generally be delineated prior to the management activity. The area of interest for the water management monitoring and research consists of the Program study area.

II.B. Sampling Design
The management-level monitoring and research is designed to provide information for making adaptive management decisions related to the impact of land and water management actions on the vegetation community. Ideally, there will be vegetation sampling both before and after the management action is implemented. In addition, sampling both managed and control areas will facilitate the analysis of vegetation data for determining the influence of management on the vegetation community. It is not expected that every area receiving management actions will require vegetation sampling.

II.B.1. Land Management Monitoring and Research
In general, the land management monitoring will involve vegetation sampling at locations throughout the management area. Each management action will have a different vegetation sampling plan depending on the vegetation community before the management and the desired vegetation community after management. Control areas (similar sized areas that do not undergo management actions) will be measured for comparison purposes when there is high annual variation in the vegetation community. Measurements in control areas will be used to evaluate the effectiveness of treatments while accounting for changes that occurred in the study area regardless of the management actions.

II.B.2. Water Management Monitoring and Research
In general, the water management monitoring will involve vegetation sampling at locations throughout the Program study area. The sampling plan for evaluation of each management action will depend on the vegetation community before the management and the desired vegetation community after management. It will not be possible to establish control areas to evaluate the effectiveness of water actions, since water management will be applied to the entire study area.

To evaluate the effectiveness of a pulse flow or an ice scour to remove seedlings from the main channel, the seedling areas located in the system-level seedling survey will be revisited after the management event of interest occurs. This monitoring will be designed to evaluate the effectiveness of the pulse flow whether the event is produced by the environmental account or other flow management. Since the system-level seedling survey will be conducted annually between July 1 and August 31, the most recently delineated seedling areas will be used to evaluate the management.

III. METHODS

III.A. Definitions

Exposed sand beach/bar- The exposed sand beach/bar cover type is defined as an area with exposed sandy soils and low vegetative cover (typically less than 50%). This may include inactive channels, islands, point bars, and areas adjacent to some active channels.

Emergent wetland- The emergent wetland cover type is defined by saturated and inundated soils where water depths do not exceed one meter (e.g. on/near seeps, springs, drainages, pond margins, swales, riverbanks, and in ditches).

Forest- The forest cover type is defined as the area on river terraces and large and small islands within the floodplain that have sufficient substrate over ground water to allow root development and sufficient aeration.

Grassland- The grassland cover type is defined by herbaceous vegetation with native tall grasses and introduced grass species.

III.B. Field Techniques

III.B.1. Land Management Monitoring and Research

Each managed area will require different sampling methodology depending on the goal of the management action. Step-point sampling will be used to determine the percent plant cover, percent non-plant cover, and relative percent plant cover in areas with low growing vegetation. Point-centered-quarter sampling will be used to estimate tree density and shrub/sapling density in forested areas. Quadrat sampling will be used to estimate plant species composition and diversity. The following sampling strategies will be used to evaluate the vegetation community in the desired cover type.

Exposed sand beach/bar

When a management action is implemented to obtain an exposed beach/bar, step-point sampling will be used to document the vegetation community. A systematic grid will be placed in the management area with spacing of one point per 15 acres. At each point, step-point samples will be taken every 2 meters along four 25m transects radiating out in each cardinal direction. Each point in the grid will have a total of 50 step-point samples.

Emergent wetland

When a management action is implemented to obtain an emergent wetland, step-point sampling will be used to document the vegetation community. Emergent wetland sampling transects will be established along the dominant direction of the wetland and extend for 100 meters. A step-point sample will be taken every 2 meters along each emergent wetland transect for a total of 50 hits. Emergent wetland quadrats will be placed every 10 meters for a total of 10 quadrats. Ideally several emergent wetland transects will be placed throughout the management area.

Grassland
When a management action is implemented to obtain a grassland, step-point sampling will be used to document the vegetation community. A systematic grid will be placed in the management area with spacing of one point per 15 acres. At each point, step-point samples will be taken every 2 meters along two 50 meter transects crossing on the point and extending in the four cardinal directions. Each point will have a total of 50 step-point samples.

III.B.2. Water Management Monitoring and Research
Each seedling area identified during the system-level seedling survey will be visited after the event of interest occurs to document the presence or absence of willow or cottonwood seedlings. If all the anchor points can not be visited during the survey, a random sample of anchor points will be selected for sampling.

Within each seedling area, the presence or absence of seedlings will be recorded and the topography will be re-measured along the same two axes measured before the management activity of interest using a survey-grade global positioning system (GPS). The UTM locations of the ends of each transect will be used to re-locate the transect. One GPS reading will be taken at the ends of each transect and every 3 meters along each transect. One GPS point will be captured at the highest point in the area, and if neither axis through the seedling area meets water level, one reading of the water level nearest the area will be taken.

III.C. Timing
The timing of vegetation surveys for land management actions will depend on the type and chronology of management actions. In general, vegetation sampling will take place from June 15 to August 15.

The timing of vegetation surveys for water management actions will depend on the event of interest. To facilitate inferences, the vegetation sampling should occur as soon as possible after the event of interest occurs.

IV. Analysis Methods
IV.A. Data Summarization Methods
Calculation of plant cover estimates by species using the step-point sampling data will follow the procedures outlined in the Program-land section of this protocol. In the management-level analysis, summation of the numerator and denominator will be over the sample points instead of transects. Variance estimates will be the same.

Calculation of density estimates by species using the point-centered-quarter sampling data will follow the procedures outlined in the Program-land section of this protocol.

Calculation of the average elevation of each seedling area will follow the procedures outlined in the system-level section of this protocol. The success of the management will be summarized across all seedling areas at the anchor point with the calculation of the proportion of area with seedlings present before the management on which seedlings were absent after the management. A summary over the anchor points will involve the ratio of the two areas and the variance of the ratio of totals (Cochran 1965; page 158).

IV.B. Statistical Analysis Methods

When the vegetation is sampled before and after management, before-after analyses will be used to document the change in a vegetation community response variable (i.e. presence of seedlings, number of species, tree density). When a control area has also been sampled, before-after control-impact analyses will be used to determine the association of a management action (impact) with a vegetation community response variable (i.e. presence of seedlings, number of species, tree density). In both these analyses, associations will be based on correlations. Since the land and water management actions will not be applied in random locations throughout the study area, the inferences can only be made to the areas managed. Applying the conclusions in an adaptive management decision making context for the entire study area will require professional judgment of applicability.

We will use the proportion of the seedling area defined during the first survey (before the management) that did not have seedlings present after the management to evaluate the effectiveness of seedling removal. The area at each anchor point still covered in seedlings and average elevation above water at a base flow will be combined across anchor points to obtain a frequency distribution of elevation for seedlings in the study area channel after the event of interest. The contrast of the frequency distributions before and after the event of interest will summarize the effectiveness of the water management. The conclusions from this analysis will be based on the seedling data collected at two sequential time periods, and will be associated with all the water management actions that occurred between the two times of the vegetation sampling. Applying the conclusions to one specific event that occurred between the two sampling periods will require professional judgment.

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Draft
Monitoring the channel geomorphology of the Central Platte River valley

March 12, 2003

The States of Colorado, Nebraska and Wyoming and the Department of the Interior (DOI) agreed to participate in a basin-wide cooperative program relating to four target species (interior least tern, piping plover, whooping crane and pallid sturgeon) and their associated habitats in the Cooperative Agreement for Implementing a Platte River Recovery Implementation Program (Program). One of the primary purposes of the Program is to "implement certain aspects of the FWS's 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 basin-wide cooperative approach that can be agreed to by the three states and DOI…". The Program builds upon the July 1, 1997 Cooperative Agreement for Platte River Research and Other Efforts Relating to Endangered Species Habitats Along the Central Platte River, Nebraska (July 1997 Cooperative Agreement).

Program implementation will follow a process of adaptive management to address areas of scientific uncertainty. Monitoring is an integral part of the adaptive management process. The adaptive management approach will allow for efficient modification of management actions in response to new and changing environmental conditions. The Program will monitor and document, relative to the habitat and species conditions that existed as of the effective date of the Cooperative Agreement, habitat and species responses to habitat improvement activities. The Program's Technical Advisory Committee will review monitoring results and make recommendations to the Program's Governance Committee regarding the effects of Program activities on whooping crane, least tern, and piping plover habitat use in the study area. The Governance Committee, using the Technical Advisory Committee's input, will evaluate projects and the overall Program to determine what, if any, changes are needed in the management. This evaluation will occur during the First Increment of the Program to support adaptive management and at the end of the First Increment to assist in the development of milestones for the Second Increment.

This monitoring protocol describes the study design and field methods for monitoring channel geomorphology in the central Platte River valley. The protocol is designed to enable Program participants to document changes in the Platte River system associated with the Program at three spatial scales: system-level, Program-level, and the management-specific level.

This monitoring protocol addresses several July 1997 Cooperative Agreement milestones:

<u>R2-1</u> A technical committee appointed by the Governance Committee will develop protocols for and initiate habitat and species monitoring and research

<u>R3-1</u> FWS will develop procedures to determine the means of ascertaining biological response of species and habitat to mitigation measures, and the time frame required to measure such biological response. The GC interpreted the milestone as

meaning, FWS and TC will identify data needed to ascertain biological response and the time frame required to evaluate those data (August 2, 2000 TC/GC workshop)

R5-1 The Nebraska Districts will implement any research and monitoring measures required by new FERC license articles for FERC Projects Nos. 1417 and 1835.

R1-2 and R1-3 A technical committee will continue monitoring to document, relative to the habitat and species conditions that existed as of the effective date of the Cooperative Agreement, habitat and species responses to activities undertaken pursuant to the Cooperative Agreement.

R3-2 and R3-3 The Nebraska Districts will continue to implement any research and monitoring measures required by FERC license articles for FERC Projects Nos. 1417 and 1835.

System-Level Monitoring

I. PURPOSE

The purpose of the system-level monitoring is to document trends in channel geomorphology parameters in the Cooperative Agreement study area during the First Increment of the Program, including documenting channel width, channel degradation or aggradation, grain sizes and suspended sediment loads.

II. DESIGN CONSIDERATIONS AND SPECIFICATIONS

II.A. Area of Interest

The area of interest for system-level channel geomorphology monitoring consists of channels within an area 3.5-miles either side of the centerline of the Platte River beginning at the junction of U.S. Highway 283 and Interstate 80 near Lexington, Nebraska, and extending eastward to Chapman, Nebraska (approximately 90 miles). When side channels of the Platte River extend beyond the 3.5-mile area, an additional 2-mile area is included around these channels.

II.B. Monitoring Design

The system-level geomorphology monitoring is designed to document trends in the channel within the entire study area throughout the First Increment. In addition, the data will provide information on trends at specific sites or groups of sites within the entire river. Monitoring will focus on measuring and tracking changes in bed elevation, grain size distribution, channel width, stage, suspended sediment concentration, and suspended sediment load using raw data. The monitoring data will be collected through a topographic survey, bed material survey, aerial and ground photography, gaging stations, and staff gages.

A probability based systematic sample of points along the river will be "anchors" for data collection. These anchor points were systematically placed along the centerline of the main channel of the river as described in the IMRP. The anchor points are spaced at 400 m intervals along the centerline, and each point has been labeled with a UTM location and a Corps of Engineers river mile (using COE river mile shape file obtained from BOR/EIS office). The geomorphology monitoring outlined in this protocol will use a sample of these points as the basic sampling unit for data collection and analyses.

The anchor points sampled in any year under this protocol will be components of a pure panel and a rotating panel of sites. A panel is made of a group of sampling sites that are always visited at the same time. The pure panel will consist of a group of sites that are visited at each sampling time. The rotating panel will consist of 4 groups of sites, with only one group visited at each sampling time and each group revisited once every 4 sampling times.

When a sampling point is established near a pre-existing geomorphology transect with historic data; a decision rule will be used to determine if the historic locations will be included in the survey during first-increment monitoring instead of the systematically selected location. The decision rule will be based on an analysis of previously measured cross sections (e.g., BOR transects and Cottonwood Ranch Monitoring and Research transects). The analysis will attempt to define a set of easily measured characteristics, including distance between transects, that indicate the similarity of the sampling locations. If the sites are similar the historic location will be used and if the sites are not similar the systematically selected site will be retained in the sample. All historical sampling locations will be sampled during the first increment (as a separate "historic" panel) and the historical sites not serving as permanent transects will be phased out by year 4 of the First Increment. Historic transects that were surveyed in the study area are listed in the Baseline section of the Program document.

II.B.1. Topographic Survey

An annual low flow (ideally between 250 and 500 cubic feet per second (cfs)) topographic survey will be made between July 1 and August 31 to track changes in measures of bed elevation and depth. Changes in this measurement over time will indicate aggradation or degradation at a point in the river. A group of 10 cross sections (transects) will be measured at each anchor point selected for sampling. Each transect will continue across all channels and islands of the Platte River in the accretion zone and will be oriented perpendicular to the general alignment of all channels. Actual measurements will only be taken along the transects in the potential bank erosion zone. Out of channel areas will be documented using conventional aerial photography or potentially a light detection and ranging (LIDAR) system.

There will be 15 sample points in the pure panel and 20 sample points in the rotating panel (5 visited each year) for a total of 20 locations visited in a year and 35 locations visited during the First Increment. The sample points in the pure panel will be visited each year while the sample points in the rotating panel will be visited every four years. Each point in the rotating panel will be surveyed three times in the First Increment.

There will be 10 topographic survey transects spaced 50 meters apart at each sampling point. This nest of transects will extend for 250m on either side of the sampling point. The topographic surveys on each transect will cross the entire accretion zone through measurements will only be recorded within the potential bank-erosion zone. When the transect is re-visited in the First Increment, the repeated measurements will be taken along the same orientation as the original transect and include the channels, banks, and small islands within the accretion zone but will not include the upland portions of the transect beyond the potential bank-erosion zone.

The use of multiple transects at an anchor point will create a mapped area of topography at the point. This data will provide a surface of topography, which when viewed in contrast to a surface at another time can result in the calculation of a change in the volume of sediment. These estimates will be used to indicate aggradation or degradation within the sampled area. Estimates across all anchor points will be used to obtain a system-level estimate.

II.B.2. Bed and Bank Material Survey

Bed and bank material samples will be taken at the topographic survey points to track changes in measures of bed material grain size distribution. Changes in grain size distribution over time will indicate coarsening or fining of the sediment at the system level. Each sample will be sent to a lab when the collection process is complete to estimate the grain size distribution.

Thirty samples of bed material (verticals) will be taken per sampling point. There will be 3 samples taken per transect in the main channel at each sampling point. Five additional samples will be taken from the bed of the other channels for multi-channel locations, one from every other transect. The 30 samples for each point should be sufficient to represent the bed material population. Previous sampling in the central Platte River indicates that there is a great deal of variability in the grain sizes of bed material sampled along a cross section. The number of samples needed to characterize the mean grain size of the bed was chosen as a compromise between sampling practicality and statistical confidence.

Bank material will be documented using stratigraphy and grain size distribution of the bank material. One drawing will be created for each bank in the main channel at each sample point. There will be one sediment sample taken from each layer in the stratigraphy.

II.B.3. Photography

Aerial photographs will be used to document changes in the channel width. This protocol requires no additional aerial photography than what has been outlined by the Program's aerial photography protocol. The April 24, 2001 draft aerial photography protocol calls for CIR photography to be taken at 1:24,000 scale in alternative years with black and white photography taken at 1:12,000 scale. The procedures for measurement of channel width from aerial photographs will follow recommendations made by the Parsons EIS team and included in the IMRP for research into the correct and relevant definitions of width and the accuracy and reliability of width measurements. Measurements of width on the photographs will occur at each anchor point in the Cooperative Agreement study area to obtain a system-level estimate.

Channel widths measured from aerial photographs will enable repeatable estimates that are obtained using the same techniques through time. Widths can also be obtained from the topography survey data though this data may not facilitate documentation of trends of the desired width measurement. Since the topography survey transects will not change orientation as the channel changes, a measurement of width from this data may not be exactly perpendicular to the flow of the river. Though this width measurement will be an index of width and will be measured at a higher resolution that the aerial photograph measurements.

Ground photography and ground measurements taken during the topographic survey (Section II.B.1) will be used to document and describe bank condition, vegetation type and structure, and the location of the main channel. Three photographs will be taken on each bank of the main channel from the survey point. These photographs will be archived by the Program for use in clarifying changes detected by the topography survey. The vegetation measurements will also be documented by the photographs for use in the interpretation of aerial photographs.

II.B.4. Gaging Stations

Discharge and stage will be monitored using real-time gaging station data from existing gages at Cozad, Overton, Cottonwood Ranch (main channel only), Odessa, Kearney, and Grand Island. River stage is measured approximately hourly at these gaging stations, and discharge is estimated using rating curves. The rating curves will be maintained by periodic measurements of depth and flow rate and by shifting the rating curves as needed. The uncorrected hourly discharge and stage values, along with corrected daily summaries will be stored in either the Nebraska Department of Natural Resources or the U.S. Geological Survey database (depending on the entity overseeing the operation of the gaging station). The rating curves used for predicting discharge will be documented and stored with the data to detect changes in channel morphology (Wahl and Weiss 1995).

Suspended sediment will be monitored at gaging stations at Lexington, Overton, Kearney, and Grand Island throughout the year. Suspended sediment samples will be collected with a computer controlled pumping sampler. Selection at list time (SALT) sampling procedures will be programmed into the sampler to obtain unbiased estimates of annual suspended sediment load with known variance at each point (Thomas and Lewis 1993). This selection procedure uses an auxiliary variable (stage) to select sample times with probability proportional to sediment transport (more samples during high flow). Changes in the concentration of suspended sediment and annual suspended sediment load will be documented through time. Since the gaging stations are not placed randomly throughout the study area, inferences about suspended sediment load in the entire study area will be up to the judgment of professionals.

Real-time water temperature measurements will be made continuously at the Cozad, Overton, Cottonwood Ranch (main channel only), Odessa, Kearney, and Grand Island gages. This data will be displayed with the gaging data on the USGS website, if possible, and will provide information to assist in management of the Environmental Account.

II.B.5. Staff gages

Water surface elevation will be monitored to determine if significant changes have occurred in the channel bottom elevation at each topography survey point in the pure panel. If a change of more than 0.15 meters (0.5 feet) is detected with the staff gage data at any point, a topography survey will be conducted as soon as possible. If a change in channel bottom elevation is confirmed by the topography survey, topography surveys will be conducted at each monitoring point in the adjacent 5 miles.

Data from the staff gage at each sample point in the pure panel will be combined with the estimated discharge at the adjacent transects using the nearest real-time stream gage to develop a rating curve for each of the points. The relationship will be developed using measurements taken 10 times a year for the first 3 years of the First Increment. After that time, there will be four measurements of stage taken a year at each staff gage to monitor changes in the channel bottom elevation.

II.C. Timing

II.C.1. Topographic Survey

Annual low flow topographic surveys will be made between July 1 and August 31 while the flow is between 250 and 500 cfs. The sample points in the pure panel and one of the rotating panels will be surveyed each year.

II.C.2. Bed and Bank Material Survey

Bed and bank material surveys will be collected with each topographic survey.

II.C.3. Photography

Aerial photographs will be taken as part of the Program's aerial photography protocol. The April 24, 2001 draft protocol calls for CIR photography to be taken every other year in odd number years in late-May and July with flows around 1200 cfs. The protocol also calls for black and white photography to be taken every other year in even number years between November (even year) and April with flows around 1000 cfs. Interpretation of aerial photographs for a trend analysis of width will take place after all the photographs involved in the analysis have been taken.

II.C.4. Gaging Stations

The stream gages in the area will be operated continuously to record stage. Discharge measurements will be made periodically to update the rating curve according to the gage operating plan. Suspended sediment will be measured periodically throughout the year according to SALT sampling procedures.

II.C.5. Staff gages

Stage readings at staff gages will take place throughout the year during the first three years of the First Increment to establish a rating curve, and then four times a year during the remainder of the First Increment.

III. METHODS

III.A. Definitions

Accretion zone- area encompassed by the former channels of the river.

Active channel- portion of the channel where inundation by water and movement of bed sediment occurs sufficiently often to maintain the area devoid of vegetation.

Geomorphology- the study of the earth's landforms and the land shaping processes operating upon the surface of the earth. Specifically, fluvial geomorphology is the study of landforms and processes associated with rivers and other water.

Rating curve- the relationship between stage and discharge at one location in the river.

Stratigraphy- the arrangement of strata as related to origin, composition, distribution, and succession.

III.B. Field Techniques

III.B.1. Topographic Survey

The topography of river cross-sections will be surveyed using a survey-grade global positioning system (GPS) to document the location and elevation of features within the accretion zone of the floodplain, including the elevation and location of beds, banks, bars, and islands. The GPS will compute the position of a rover unit relative to a known horizontal and vertical datum or base station using a satellite network and real time radio communication between the base and rover. Positions will be precise to within 2 centimeters in the vertical direction and 1 centimeter in the horizontal direction. The GPS requires a coordinate seed (known initial point) from which to begin making measurements, such as a reference marker set by the National Geodetic Service (NGS). Horizontal reference for the GPS will be related to NAD 1983 and vertical reference will be to NGVD 1988.

Each cross-section will be oriented perpendicular to the principal flow direction and will pass through all channels and the anchor point. The location of the cross-section will be delineated on both banks with a permanent marker (pin) set above the flood elevation and far enough from the active channel to avoid all but the most severe erosion effects. The goal of the survey is to adequately define the cross section of the channel and delineate geomorphic features. The surveyor will take GPS readings and appropriately identify in the data recorder the top of bank, toe of bank, left and right edge of water, water surface at exposed bars and islands, bed elevation, and any other significant geomorphic feature in the cross section. In order to adequately define the channel bed, GPS readings will be taken at any break in slope. If the channel bed or portion of the channel bed is flat with no breaks in slope, a GPS reading will be taken every 2 meters.

III.B.2. Bed and Bank Material Survey

Bed sediment will be surveyed along the topography survey transects using procedures from Edwards and Glysson (1999) and Vanoni (1977). Each of the ten transects will be divided into equally spaced increments to locate 3 verticals for sampling, for a total of 30 samples per sample point. Sediment samples will be collected using a steel cylinder sampler 7 centimeters in diameter and 20 centimeters in length welded to a steel pipe 155 centimeters long. At each increment, the sampler is plunged into the bed of the river until the can portion of the sampler is filled with sediment. The sampled depth will be the top 7 cm of the surface of the bed in order to provide similar data to the BM54 sampler used at bridge sections (Edwards and Glysson 1999) and to sample bed material that is most readily available for transport. The sample is then transferred to a sample bag that is labeled with the sampled section, sample number, and the date and time the sample was taken.

Bank sediment will be surveyed from the left and right banks on the main channel at each topography survey point. At each bank, the sediment stratigraphy will be described in a notebook and the steel cylinder sampler will be used to take one sample in each layer. The stratigraphy will document the color, texture and length of each layer along the vertical axis of the bank.

III.B.3. Photography

Aerial photographs will be taken according to the Program's protocol. The April 24, 2001 draft protocol calls for CIR photography at 1:24,000 scale to be taken every other year in odd number years in late-May and July with flows around 1200 cfs. The protocol also calls for black and white photography at 1:12,000 scale to be taken every other year in even number years between November (even years) and April with flows around 1000 cfs.

Ground photography stations on each bank adjacent to the topography survey point will be taken with a 35mm film camera and a 28mm lens. Photographs will be taken from the transect pin looking upstream (with bank in center of the frame), downstream (with bank in center of the frame), and across stream (with the pin of the other bank in the center of the frame). Additional photographs will document the other banks of multi-channel sections. Transect and point identification, date, time, film type, lens, and azimuth will be recorded for each photograph. Photographs will be developed, examined and cataloged immediately after field work is completed.

III.B.4. Gaging Stations

The stream gages in the area will be operated according to USGS guidelines (Buchanan and Somers 1968, Buchanan and Somers 1969, Carter and Davidian 1968). Discharge and stage will be measured at each gaging station to estimate a standard USGS rating curve (Kennedy 1984).

Suspended sediment and sediment load will be measured using procedures from Edwards and Glysson (1999) and Thomas and Lewis (1993).

III.B.5. Staff gages

Staff gages will be installed and operated according to USGS guidelines (Buchanan and Somers 1968). Discharge will be estimated using data from the nearest, appropriate, real-time stream gage (Carter and Davidian 1968).

IV. Analysis Methods

IV.A. Laboratory Analysis Methods

The sediment samples will be analyzed by dry sieving to determine their mechanical composition. Each sample will be dried and weighed to determine total weight. The sample will be placed in a sieve stack with ½ phi gradations and agitated for 25 minutes using a Rotap. The weight of material retained on each sieve will be recorded after transferring the material to a tared dish. The process will be repeated for every sieve in the stacks to yield the grain-size distribution for a sample (Guy 1969).

Bank samples in each strata will be mathematically combined to get one estimate of grain-size distribution for each bank. The length of each layer in the bank stratigraphy will be used as the weight when combining across strata.

Aerial photographs will be analyzed after several years of data collection. The use of photographs for measuring channel width parameters has not been standardized. The IMRP research component that investigates this issue will be conducted prior to the analysis of the monitoring data. This investigation will include determining the most accurate and reliable way to measure the following parameters on aerial photographs: active channel width, unvegetated channel width, and unobstructed channel width.

IV.B. Data Summarization Methods

All raw data will be retained in the Program database, though summaries of raw data will be calculated for each sample point. Below is a list of the summarization metrics that will be calculated with this data, though it is expected there will be other metrics calculated. In addition, difference metrics will be calculated for each sample unit as the difference of any metric between two time periods.

IV.B.1. Topographic Survey

Mean channel bed elevation- the average of equally spaced measures of elevation throughout the surveyed channel. A linear interpolation between actual data points will be used to estimate elevation at any point.

Mean depth- the average of equally spaced measures of depth below water line throughout the surveyed channel. A linear interpolation between actual data points will be used to estimate depth at a standardized flow and at any point.

IV.B.2. Bed and Bank Material Survey

Median particle size (d_{50})- the particle size for which 50 percent of the sample is finer.

Cumulative frequency distribution of particle size- the percent of the sample with particles finer than each sediment size. Percentages used to represent the variability in particle size are $d_{16,}$ the particle size for which 16 percent of the sample is finer, and $d_{84,}$ the particle size for which 84 percent of the sample is finer.
Geometric mean particle size- the square root of the product of $d_{84.1}$ and $d_{15.9}$.
Geometric standard deviation of particle size - the square root of the ratio of $d_{84.1}$ to $d_{15.9}$.

IV.B.3. Photography

Active channel width- the distance across the channel from bank to bank.
Bank vegetation- the presence or absence of vegetation documented by ground photographs taken on the bank of each transect.
Bank stability- the change in bank position documented by ground photographs taken on the bank of each transect.
Mean open-view width- the total area of open (unvegetated) channels divided by the channel length. This metric will be calculated by river section.

IV.B.4. Gaging Stations

Daily mean discharge- the average discharge documented at a gaging station in a 24 hour period.
Daily peak flow- the maximum discharge documented at a gaging station in a 24 hour period.
Hourly uncorrected discharge- predicted discharge from a stage-discharge relationship that has not been finalized by the gage operator.
Hourly uncorrected stage- measured water surface elevation that has not been finalized by the gage operator.
Stage-discharge relationship- a relationship created by sampling stage and discharge throughout the range of observed values. This rating curve is developed using standard USGS methods.
Suspended sediment concentration- the number of sediment particles per cubic foot of water.
Total annual suspended sediment load- the integral (sum) of the product of suspended sediment concentration and discharge over a year.

IV.B.5. Staff gages

Water surface elevation- the height of the water surface as measured at the staff gage.

IV.C. Statistical Analysis Methods

The monitoring transects described in this protocol are designed as an observational study through time. There is no comparison of control and treatment. This monitoring plan is designed to detect trends in physical habitat and geomorphology measures. Data will be summarized for each anchor point and statistics such as the mean and standard deviation will be compiled using anchor points as the sample unit. In system-level monitoring, inferences will be made to the entire study area (or a river reach of interest) since each point will be placed systematically along the length of the river.

Analysis of trends for each parameter will follow the recommendations in the IMRP. Difference metrics will be calculated between survey times for each sampling unit. Trend analyses will be conducted using non-parametric techniques, least squares regression, or mixed models for longitudinal data (Chen et al. 1999, Helsel and Hirsch 1992). The selection of the method used to determine if trends are statistically significant will depend on the amount of missing data, the distribution of the data, and historical use of methods for each parameter.

Post-stratification of the river by classifying points into strata will enable analyses of the data within each stratum (Thompson 1992). Points can be grouped into geomorphological or bridge segments for analyses that are consistent with analyses that were conducted previously. Alternatively, points can be grouped into areas with high influence of human structures (bridges, diversions, etc.) and points not directly influenced by human structures. Points will be classified into strata before each analysis so that points that have changed strata affiliation will be in the correct stratum for analysis.

Program-Level Monitoring

I. PURPOSE

The purpose of Program-level monitoring is to estimate trends in the physical conditions on Program lands. The monitoring will involve the same general survey procedures used in system-level monitoring with a greater intensity of sampling effort on Program lands.

II. DESIGN CONSIDERATIONS AND SPECIFICATIONS

II.A. Area of Interest

The study areas for the Program-level monitoring are the discrete blocks of land protected by the Program.

II.B. Monitoring Design

The Program-level monitoring is designed to collect data that is representative of each Program land. Program-level monitoring will take place systematically throughout each area. Monitoring will focus on tracking changes in bed elevation, grain size distribution, channel width, and stage at a more spatially intensive scale. Suspended sediment concentration monitoring will not be intensified for Program-level monitoring.

The system of anchor points will be used for anchors of data collection at the Program-level of monitoring. The anchor points chosen for inclusion in the sample will be comprised of a pure panel and a rotating panel in any one year. Half the survey effort will go into each panel. The pure panel will consist of a group of sites that are visited each year. The rotating panel consists of 4 groups of sites, only one of which is visited in a year with each group revisited every 4 years. The number of sample points in each group will be determined through analyses of pilot data and an evaluation of monetary and logistical constraints.

II.B.1. Topographic Survey

The design for the Program-level annual low flow topographic survey will follow the system-level design above. There will be a pure panel and a rotating panel established for the First Increment. The number of transects in each panel will depend on the size of the Program land.

II.B.2. Bed and Bank Material Survey

The design for the Program-level bed material sampling will follow the system-level design above. There will be verticals sampled throughout the channels in proportion to the amount of flow in each channel (with at least 2 verticals in each channel).

II.B.3. Photography

Ground photography at each Program-level monitoring transect will follow the system-level design above.

II.C. Timing

The timing for surveys conducted for Program-level monitoring will follow the system-level design.

III. METHODS

III.A. Field Techniques
III.A.1. Topographic Survey
The topography of river cross-sections will be surveyed using the methods outlined in the system-level monitoring.

III.A.2. Bed and Bank Material Survey
Bed sediment will be surveyed using the methods outlined in the system-level monitoring.

III.A.3. Photography
Ground photography will be collected at each transect using the methods outlined in the system-level monitoring.

IV. ANALYSIS METHODS
IV.A. Laboratory Analysis Methods
The sediment samples will be analyzed according the system-level monitoring methods.

IV.B. Data Summarization Methods
All raw data will be retained in the program database, though estimates across raw data will be calculated for each sample unit. In addition, metrics involving the difference between two time periods will be calculated for each sample unit. Program-level metrics for the topographic survey will be the same as mentioned above for the system-level surveys.

IV.C. Statistical Analysis Methods
The monitoring transects described in this protocol are designed as an observational study through time. There is no comparison of control and treatment. This monitoring plan is designed to detect trends in physical habitat and geomorphology measures. Data will be summarized for each anchor point and statistics such as the mean and standard deviation will be compiled using anchor points as the sample unit. In Program-level monitoring, inferences will be made to each Program land and for Program-lands combined.

Analysis of trends for each parameter will follow the recommendations in the IMRP. Difference metrics will be calculated between survey times for each sampling unit. Trend analyses will be conducted using non-parametric techniques (Kendall's Tau), least squares regression, or mixed models for longitudinal data. The selection of the method used to determine if trends are statistically significant will depend on the amount of missing data, the distribution of the data, and historical use of methods for each parameter.

Post-stratification of the river by classifying transects into strata will enable analyses of the data within each stratum (Thompson 1992). Transects can be grouped into geomorphological or bridge segments for analyses that are consistent with analyses that were conducted previously. Alternatively, transects can be grouped into areas with high influence of human structures (bridges, diversions, etc.) and transects are not directly influenced by human structures. Transects will be classified into strata before each analysis so that transects that have changed will be in the correct stratum for analysis.

Project-Level Monitoring and Research

The management-level monitoring and research will be designed to document the changes in the geomorphologic conditions in managed areas on Program lands. The monitoring will document changes associated with management activities. It is anticipated that some management activities will be adequately covered by the Program level monitoring, while some activities may require more intensive monitoring. In addition, intensive short term research may be implemented to investigate specific effects of management activities (changes in water surface elevation after a short term stochastic event). If the Program identifies the need to conduct further geomorphologic monitoring or research related to specific management actions, further protocols will be written (e.g., Technical Committees Research Protocol for Nebraska Public Power District's Cottonwood Ranch Property, dated August 1, 2000.)

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Draft
Protocol for Aerial Photography in the Central Platte River Valley

I. INTRODUCTION
The States of Colorado, Nebraska and Wyoming and the Department of the Interior (DOI) agreed to participate in a basin-wide cooperative program relating to four target species (interior least tern, piping plover, whooping crane and pallid sturgeon) and their associated habitats in the Cooperative Agreement for Implementing a Platte River Recovery Implementation Program (Program). One of the primary purposes of the Program is to "implement certain aspects of the FWS' 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 basin-wide cooperative approach that can be agreed to by the three states and DOI…". The Program builds upon the July 1, 1997 Cooperative Agreement for Platte River Research and Other Efforts Relating to Endangered Species Habitats Along the Central Platte River, Nebraska (July 1997 Cooperative Agreement).

Program implementation will follow a process of adaptive management to address areas of scientific uncertainty. Monitoring is an integral part of the adaptive management process. The adaptive management approach will allow for efficient modification of management actions in response to new and changing environmental conditions. The Program's Technical Committee will monitor and document, relative to the habitat and species conditions that existed as of the effective date of the Cooperative Agreement, habitat and species responses to habitat improvement activities. With scientific advisory assistance, the Technical Committee will review monitoring results and make recommendations to the Program's Governance Committee regarding the effects of Program activities on habitat conditions in the study area. The Governance Committee, using the Technical Committee's input, will evaluate projects and the overall Program to determine what, if any, changes are needed in the management.

The Technical Committee (TC) has identified monitoring and research needs of the proposed Program in the Integrated Management and Research Plan (IMRP). Many of the identified activities will require up-to-date and standardized aerial photos. In addition, the TC has initiated a demonstration research and monitoring project on Nebraska Public Power Districts Cottonwood Ranch that requires photography.

Aerial photography is available along the central Platte River at differing intervals from 1938 to present. To date, these photographs have not been taken at consistent intervals using standard guidelines. Because of this inconsistency, comparison of these photos is difficult and may lead to differing interpretations of basic habitat conditions on the River. In 1998 Color Infrared (CIR) photography was used to document existing conditions in the area of concern for the proposed Program. These photos were photo-rectified and converted to orthophotographs that can be used for spatial analysis with a Geographic Information System (GIS).

This monitoring protocol addresses several July 1997 Cooperative Agreement milestones:

R2-1 A technical committee appointed by the Governance Committee will develop protocols for and initiate habitat and species monitoring and research

R3-1 The FWS and TC will identify data needed to ascertain biological response and the time frame required to evaluate those data (R3-1 milestone as revised at the August 2, 2000 TC/GC workshop)

R5-1 The Nebraska Districts will implement any research and monitoring measures required by new FERC license articles for FERC Projects Nos. 1417 and 1835.

R1-2 and R1-3 A technical committee will continue monitoring to document, relative to the habitat and species conditions that existed as of the effective date of the Cooperative Agreement, habitat and species responses to activities undertaken pursuant to the Cooperative Agreement.

R3-2 and R3-3 The Nebraska Districts will continue to implement any research and monitoring measures required by FERC license articles for FERC Projects Nos. 1417 and 1835.

II. PURPOSE

The purpose of this protocol is to describe the conceptual design, methods, and procedures that will be used to document vegetative and geomorphologic conditions of the central Platte River valley, Nebraska using aerial photography. The photography as outlined in this protocol is sufficient to fulfill the purposes as currently defined in Technical Committee protocols; however, this does not preclude the possible need for additional remote sensing in the future (e.g., LIDAR, videography, etc). Currently the Cooperative Agreement and proposed Program has available a complete land use/land cover GIS analysis of 1998 color infrared photography. Long-term, consistent collection of landscape data for the study area through aerial photographs will enable future habitat use/availability research. This protocol describes the procedures to be used as follows:

1. CIR orthophotographs for comparison of conditions at the end of the First Increment with the existing conditions photography of 1998.

2. CIR photography taken at regular intervals during full vegetative cover in late May-July.
   a. Photos will be used for evaluating vegetation and channel conditions during least tern and piping plover nesting seasons
   b. Photos will be used for sampling land use/land cover classes in the system level portion of the General Monitoring Protocol and documenting vegetation characteristics on Program lands and within managed areas.
   c. Photos will be used to estimated the amount of grassland areas for whooping crane habitat

3. Black and white photos taken at regular intervals during low flow periods and when vegetative matter is dormant (i.e., leaf-off) (November-April) for channel morphology comparisons.
    a. Photos will be used to document the physical and/or biological characteristics of use sites and these habitat parameters will be described and measured for the purpose of comparative habitat analyses (e.g., as in comparing used sites from available sites selected randomly on photographs). This information is required in the Cottonwood Ranch Monitoring and Research Project and will likely be needed in similar research projects in the future.
    b. Photos will result in landscape data collection. for whooping crane use sites in the study area. This information will be used in future use/availability analyses using aerial photography and GIS information.

III. DESIGN CONSIDERATIONS AND SPECIFICATIONS

III.A. Area of Interest

The area of interest for aerial photography includes the entire 90-mile length defined in the proposed Program and includes an area 3.5-miles either side of the centerline of the Platte River. When side channels of the Platte River extend beyond the 3.5-mile area, a 2-mile area is included around these channels.

III.B. Project Design

III.B.1. CIR Orthophotography

Aerial CIR orthophotography will be conducted to replicate the 1998 CIR orthophotography at the end of the First Increment. This photography will be obtained in time to finalize geospatial analyses by the end of the First Increment for use in the analysis of all data for the establishment of milestones for the Second Increment. It is difficult to predict all the data needs at this point, but at a minimum the land cover, land use, and species use layers of the 1998 GIS analysis will be repeated. Conditions of photography should closely match the 1998 existing condition photography (i.e., late summer with flows at or below 1,000 cfs) and methods for creation of the data layers will be repeated for optimal comparison with the 1998 data (e.g., insure same criteria are used for establishing various land cover types). The EIS Team is documenting these methods.

III.B.2 CIR Photography

Summertime CIR photos will be used to document habitat conditions for least terns and piping plovers, amount of grassland areas for whooping crane habitat, and summertime vegetation characteristics throughout the system, on Program lands, and within managed areas. For example, bare sand substrates will be identified that may be potential least tern and piping plover nesting habitat. The Technical Committee anticipates that changes in available nesting habitat will be tracked throughout the First Increment. Information gained from aerial photography will also be used in conjunction with measurements taken at specific sites on the ground that relate to vegetation establishment on the bars, height of bars, etc. CIR photos will be used to estimate by line transect methods the land use/land cover types present as described in the General Monitoring Protocol (e.g., amount of grassland, forest, etc). Use and analysis of the aerial photography will be described in protocols that are written for the specific activities outlined in the IMRP. Photos will be taken on a bi-annual basis between late-May and July with flows at or near 1200 cfs (i.e., target flow levels during this time of year).

III.B.3 Black and White Photography
Black and white photos will be used for channel morphology measurements. These photos will be taken during times when riparian vegetation is dormant and flows are as low as possible to facilitate measurement of channel morphological characteristics. The photos will be used to help measure parameters such as channel width, bank position, island position and stability, hydraulic geometry characteristics of width and track changes associated with management techniques. This is consistent with the use of black and white aerial photographs in the Cottonwood Ranch Property Monitoring and Research Protocol to be implemented in 2000. Black and white photography will be taken on a bi-annual basis between November and April as dictated by vegetative conditions. If possible, flows will be at or below 1000 cfs when photographs are taken.

III.C. Timing
CIR orthophotography should be taken 2 years before the end of the First Increment in late summer (e.g., August) when flows are approximately 1000 cfs.

CIR photography will be obtained between late-May and July. Photography should be obtained at flows as close to 1200 cfs as possible. CIR photography will be flown in odd number years (i.e. 2001, 2003). CIR Photography will start in 2001.

Black and White photography should be obtained between November and April with flows ideally at or below 1000 cfs. Black and white photography should be flown in even number years (i.e. 2000, 2002) and will begin in winter 2000-2001.

IV. METHODS
IV.A. Definitions

IV.B. Field Techniques
Three types of aerial photography will be used to document and monitor habitat conditions along the central Platte River: CIR orthophotographs, CIR photography and black and white photos. The Program's Technical Committee may choose to implement each protocol component as necessary to obtain needed information, for example changing the number of aerial surveys based on results of past surveys. Exact survey dates will be adjusted as more data is collected. The flight schedule will be dependent on suitable conditions for operating a small plane (weather and mechanical), snow cover, and other environmental conditions.

IV.B.1 CIR Orthophotography
CIR orthophotography planned for the end of the First Increment will use methods comparable to the CIR photography conducted for GIS analysis in 1998 (U.S. Department of the Interior 2000).

IV.B.2. CIR Photography
CIR photos will be taken at a scale of 1:24,000 and converted to 1:12,000 and will include the entire 90-mile length defined in the proposed Program, plus 3.5 miles either side of the centerline of the river. This scale and area will require approximately 332 exposures. These photos will not be rectified.

IV.B.3. Black and White Photography
Black and white photos will be taken at a scale of 1:12,000 and converted to 1:6,000 and will include the entire 90-mile length defined in the proposed Program plus one mile either side of the centerline of the river. Neither the CIR or black and white photography identified will be rectified. Past studies on the Platte River have used control points (in this instance the rectified images in the 1998 will be used) to match photos and adjust scale (Johnson 1994, Randy Parker pers. Comm. 2000). This will require approximately 465 exposures.

IV.D. Analysis Methods
This protocol describes the collection of aerial photographs and is not meant to detail how the photographs will be used or analyzed. The use and analysis of aerial photography information is described in the individual species and habitat research/monitoring protocols developed in the IMRP.

V. QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)
QA/QC measures will be implemented at all stages of the study, including field data collection, data entry, and report preparation.

VI. DATA COMPILATION AND STORAGE
- To be completed when Program staff and structure is defined.

VII. REPORT FORMAT
A draft and final report will be produced each year describing the methods employed, results of taking aerial photos, and types of photos taken. Information derived from aerial photographs by other protocols (e.g., Least Tern and Piping Plover Monitoring, Vegetation Monitoring) will be compiled and summarized annually in those reports, and incorporated within the larger Program database. All report will have both written and graphical components. Reports will be provided to both the Technical Committee and Governance Committee.

VIII. ADMINSTRATION
- To be completed when Program staff and structure is defined.

IX. EXISTING DATA EVALUATION
- To be completed when revised R1-1 Baseline information available

X. DATA SHEETS
No Program data sheets will be utilized in implementation of this protocol. Qualified contractors will supply all aircraft, personnel, and other necessary equipment.

XI. BIBLIOGRAPHY
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XII. ESTIMATED BUDGET
Cost estimates to capture the different photographs are presented below and are based on 2000 dollars. Inflation and other factors may increase these costs during the Program. Costs associated with analyzing the different types of photographs will be included in the protocols that use these photos (e.g., General Monitoring Protocols use for geomorphology measurements). Costs of interpreting the Orthophotography CIR near the end of the first increment are also not included in this protocol.

Black and white photography will include the entire 90-mile length defined in the proposed Program and include a width of 1 mile either side of the centerline of the river. This will require 465 exposures and cost $13,000.

CIR Photos may be taken at a scale of 1:24,000 and converted to 1:12,000. Photography will include the entire 90-mile length defined in the proposed Program and include 3.5 miles either side of the centerline of the river. This will require 332 exposures and cost $18,000.

Orthophotography CIR should be taken 2 years before the end of the first increment of the Program. Cost is $80,000.

Annual Cost [a]

2000 – Black and White	$13,000
2001 – CIR	$18,000
2002 – BW	$13,000
2003 – CIR	$18,000
2004 - BW	$13,000
2005 – CIR	$18,000
2006 – BW	$13,000
2007 – CIR	$18,000
2008 – BW	$13,000
2009 – CIR	$18,000
2010 – BW	$13,000
2011 - Ortho CIR	$80,000
2012 – BW	$13,000
2013 – CIR	$18,000

[a] Cost estimates are based on the current dollar value for services and supplies and are subject to change due to inflation, cost increases etc.

Draft Protocol for
Monitoring Riverine Prey Base for Least Terns: Fish Species Composition, Spatial Distribution, and Habitat Utilization in the central Platte River

September 25, 2006

I. PURPOSE

The purpose of this protocol is to monitor the riverine prey base (forage fish) for least terns during the nesting season in the Platte River Recovery Implementation study area (Lexington to Chapman, Nebraska). Fish sampling will be conducted and the data will be summarized as forage fish abundance parameters, community structure parameters, and population structure parameters. Spatial and temporal changes in the forage fish parameters will be documented with annual monitoring. Habitat utilization will be quantified by sampling the range of channel habitats and comparing physical attributes with the observed abundance. Physical attributes of the sampled areas will be collected.

II. DESIGN CONSIDERATIONS AND SPECIFICATIONS

II.A. Area of Interest

Water areas that are within 3.5-miles either side of the Platte River beginning at the junction of U.S. Highway 283 and Interstate 80 near Lexington, Nebraska, and extending eastward to Chapman, Nebraska. When side channels of the Platte River extend beyond the 3.5-mile area, a 2-mile area is included around these channels (cite map). Water areas of interest include all areas that have a stage change due to flow manipulation. Chadwick et al. (1997) define this area as "closely associated off-channel habitats within the floodplain with some degree of hydraulic connection to the mainstem, such as ponds, sloughs, and side-channels." Water areas of interest do not include manmade features such as dredged sandpits, drains or canals. The Chadwick definition also excludes tributary streams or other bodies of water.

II.B. Parameters of Interest

II.B.1. Fish Parameters

The monitoring program will collect data appropriate to estimate forage fish abundance parameters such as absolute abundance, density, and relative abundance. Community structure parameters such as the relative abundance of each species, richness, and diversity will be estimated. Population structure parameters such as age and size distribution will be estimated. The data will be appropriate to estimate spatial distributions such as the range of the study area where the forage fish occur. The data will be appropriate to estimate habitat utilization to document the type of water area in which the forage fish occur.

II.B.1. Physical Attribute Parameters

The monitoring program will collect data to estimate these physical attribute parameters: water width, water depth, water velocity, water temperature, water dissolved oxygen content, water pH, water transparency/turbidity, water conductivity, and substrate size. Flow characteristics such as the magnitude of a pulse flow, daily discharge and stage will be summarized from gage data as estimates of physical attribute parameters.

II.C. Sampling Design

Sampling will take place at system-wide anchor points and at historic locations previously sampled by Chadwicks & Associates Inc. (Chadwick & Associates, Inc. 1990). The fish survey will target the forage fish of least terns and is timed to occur during the nesting season. Water areas of interest that are crossed by the anchor transect will be sampled within a set distance from the transect, depending on the water habitat type. Fish and physical attribute sampling will be collocated in each water area crossed by the anchor transect.

Habitat specific fish sampling will be conducted at each of these water habitat types: open channel, open channel bank, open channel snag, side channel, side channel bank, backwater, isolated backwater, pond, and slough. Fish sampling will be conducted using seining nets and electrofishing. Seining is known to favor the inclusion of small fish in the sample (Hayes et al. 1996, Gutreuter et al. 1995, Bayley and Herendeen 2000) and will be implemented to gather size distribution data of forage fish (Reynolds 1996). Electrofishing is known to favor the inclusion of large fish in the sample (Reynolds 1996, Wiley and Tsai 1983) and will be implemented in habitats where seining is not practical. The use of both methods will maximize the probability of capture of fish given the selectivity of each method.

The sampling methods will be standardized to enable comparisons over time (Hayes et al. 1996) and the sampling effort will be quantified enabling comparisons on a per unit of effort basis (Reynolds 1996). Electrofishing effort will be quantified with the number of minutes and seining effort will be quantified with the area encompassed by the seining grid. Electrofishing power will be standardized to facilitate consistency in fish collection effort (Reynolds 2000).

Two nationally known long-term monitoring programs: the EPA's Environmental Monitoring and Assessment Program (EMAP) (McCormick and Hughes 1998) and the USGS's National Water Quality Assessment (NAWQA) (Moulton et al. 2002) provided general guidance on fish monitoring in wadeable streams. However, the uniqueness of the central Platte River, specifically the shallow depths, fluctuating sand substrate, lack of riffle–pool complexes (Chadwicks & Associates Inc. 1993) and the scarcity of pools (Morris 1960 in Chadwick & Associates Inc. 1994) mandate a protocol unique for this study area.

The forage fish monitoring study conducted by Chadwicks & Associates Inc., Littleton, Colorado, from 1989 to 1993 provided specific guidance for forage fish sampling methods within the study area (Chadwick & Associates, Inc. 1990, Chadwick & Associates, Inc. 1991, Chadwick & Associates, Inc. 1992, Chadwick & Associates, Inc. 1993). Chadwick defined three habitat types in 1989 (main channel, river banks/island edges, and low velocity pools) with sampling methods specific to each. The study delineating the main channel into 4 habitat types in 1990 (open channel, bank, snag, and backwater) and added bridges, sloughs, side channels, and ponds as habitat types to be sampled (Chadwick & Associates, Inc. 1990, Chadwick & Associates, Inc. 1991). The study further delineated isolated backwaters from backwaters in 1991 (Chadwick & Associates, Inc. 1992). Sampling in 1992 was limited to the five main channel habitat types (open channel, bank, snag, backwater and isolated backwater) since sampling in the off-channel habitat types (sloughs, side channels, and ponds) reveal numerous non-forage species and the species composition of bridge habitats resembled the main channel

(Chadwick & Associates, Inc. 1993). [Extension of this paragraph to the 1995 survey effort will be included when the reports are obtained.]

The specific fish sampling methods also changed throughout the span of Chadwick's forage fish monitoring study from 1989 to 1993. Most notably, electrofishing of the open channel habitat type was dropped in favor of seining (Chadwick & Associates, Inc. 1992) based on comparisons of data collected. Also, the original 23 sites were reduced to 6 main channel sites (Chadwick & Associates, Inc. 1993). Their final study design was effective in sampling the fish community as evidenced by the inclusion of only one new species to the cumulative species list in the 4th year of sampling (Chadwick & Associates, Inc. 1992). [Extension of this paragraph to the 1995 survey effort will be included when the reports are obtained.]

III. METHODS

III.A. Definitions

Anchor transect- North to south oriented line centered on a sample point (anchor point or historic location) and extending through the area of interest.

Backwater- Aquatic habitat type characterized by a naturally or artificially formed arm or area of standing or slow moving water partially isolated from the main flow of the channel but directly connected to the a channel at either the upstream or downstream end (Armantrout 1998).

Isolated backwater- Aquatic habitat type characterized by standing or slow moving flow isolated from the main flow of the channel but not directly connected to the a channel at either the upstream or downstream end.

Open channel- Aquatic habitat type characterized by unobstructed moving flow wider than 75 feet.

Open channel Bank- Aquatic habitat type characterized by bank structure with permanent vegetation or rip-rap.

Open channel Snag- Aquatic habitat type characterized by the presence of woody debris (log, stumps, branches, etc.) in the open channel.

Pond- Aquatic habitat type characterized by standing water out of the main channel.

Side channel- Aquatic habitat type characterized by unobstructed moving flow with width less than 75 feet.

Side channel bank- Aquatic habitat type characterized by a side channel with a bank structure with permanent vegetation or rip-rap.

Slough- Aquatic habitat type characterized by standing or slow moving water out of the main channel. Low swamp or swamp-like area in a marshy or reedy backwater with marsh characteristics such as abundant vegetation (Armantrout 1998).

III.B. Field Techniques
III.B.1. Fish Survey
Fish sampling methods will be specific to each water type traversed by the anchor transect. When a water area of interest is encountered along the anchor transect, is will be classified into one of the aquatic habitat types and sampled according to the methods below.

Open channel – Open channels will be sampled within 90 meters on either side of the anchor point (a 180 meter (590.5 feet) section of channel) (Chadwick 1997, Matthews 1990). Six seining grids will be placed within the reach. The six grids will be located 15m, 45m, and 75m upstream and downstream of the anchor point. Two grids will be in the center of the channel, two will be in the northern quarter of the channel (one-quarter of the wetted width from the northern bank), and two will be in the southern quarter of the channel (one-quarter of the wetted width from the southern bank).

Open channel snag – Backpack electrofishing around snags within 90 meters of the anchor transect where it crosses an open channel. A random sample of 3 snags will be made after all snags are identified. The area sampled around each snag will be estimated by the surveyors.

Open channel bank or side channel bank - Backpack electrofishing for 15 meters along bank where the anchor transect enters the channel from land. Both banks will be sampled resulting in two locations sampled each time a channel is crossed by the anchor transect.

Backwater, isolated backwater, slough, or pond – Backpack electroshocking within 15 meters (either side) along the anchor transect where it crosses through the aquatic habitat. The width of the water area will be measured at the anchor transect and the area surveyed will be estimated.

Side channel- Backpack electrofishing for 25 meters upstream and downstream of the anchor transect. The width of each side channel will be measured at the anchor transect and the area surveyed will be estimated.

Electrofishing
Electrofishing will start at the downstream end and proceed upstream (Hendricks et al. 1980, Reynolds 1996, McCormick and Hughes 1998). The backpack electrofishing units will contain an electrofishing device mounted on a backpack frame. The power source will be either a 24-volt deep cycle battery or a 115-volt gasoline-powered generator. Direct current (DC) with an appropriate pulse rate range (e.g., 30 to 60 pps) will be used to minimize damage to fish and maximize collection effectiveness (Moulton et al. 2002). The voltage and minutes of electrofishing (start and end times) will be recorded.

Exact electrofishing voltage and amperage (current) settings will be dictated by water conditions at the time of sampling. Power output in the form of wattage will be standardized at 3000 watts. Current water temperature and conductivity will be measured prior to sampling and the applicable power settings will be taken from charts in Burkhardt and Gutreuter (1995) or Gutreuter et al. (1995).

Fish handling and electrofishing safety protocols will be written including details as in McCormick and Hughes (1998), Moulton et al. (2002), and USFWS (1992).

Seining
Seining grids will be deployed in the manner used by Chadwick & Associates, Inc. A 25 ft. x 50 ft. rectangular enclosure will be formed by two 50 ft. and two 30 ft. fine mesh (1/8") seines. The 50 ft. side of the enclosure will run parallel to the direction of flow and the 25 ft side of the enclosure (with 5 feet of sag) will be moved downstream through the enclosure to trap fish at the end. The six seining grids within a reach will be sampled in a downstream to upstream direction.

When seining grid lands in an unsuitable location, the grid will be moved to the nearest suitable locations. Reasons for moving a grid include deep water, uneven bottom, or snags.

Fish Handling
All affected fish will be collected and placed in buckets filled with ambient water, taxonomically identified to species, weighed and measured for length, checked for external abnormalities, and released downstream. Fish collection information will be recorded separately for each habitat type. The most recent American Fisheries Society taxonomic names will be used (Robins et al. 1991). Collections will be made for fish that can not be identified to species. Maximum total length is the greatest possible length of the fish with mouth closed and caudal rays squeezed together to give the maximum overall measurement (Anderson and Neumann 1996).

III.B.2. Physical Attribute Survey
Physical attribute sampling methods will be specific to each parameter.

Width (meters)- meter tape
Depth (meters)- meter stick
Velocity (meter/second)- water velocity meter 20 cm below water surface
Temperature (Centigrade degree)- thermometer
Dissolved oxygen (mg/l)- dissolved oxygen meter
pH- pH meter
Turbidity (NTU)- Nephelometric turbidity unit
Conductivity (S/cm)- Temperature-level-conductivity meter for temperature compensated conductivity
Substrate size- (estimate in classes)

The location of physical attribute sampling will be specific to each water type traversed by the anchor transect:

Open channel – Width, depth, and velocity will be measured at the six seining locations. Temperature, dissolved oxygen content, pH, transparency/turbidity, conductivity, and substrate size will be measured mid-point of the channel at the anchor point.

Backwater, isolated backwater, slough, or pond - Width will be measured along the anchor transect as it crosses the water area. Depth, velocity, temperature, dissolved oxygen content, pH, transparency/turbidity, conductivity, and substrate size will be measured at the center of the width of water area along the anchor transect.

Side channel- Width will be measured along the anchor transect as it crosses the water area. Depth, velocity, temperature, dissolved oxygen content, pH, transparency/turbidity, conductivity, and substrate size will be measured at the center of the width of water area along the anchor transect.

III.C. Annual Timing

Annual sampling will take place once between July 1 to August 31, to cover the time period when chicks and juvenile least terns are present in the study area. This time frame coincides with low flows and stability in the fish community (Meador et al. 1993). All fish sampling will take place when the nearest gage reports flows below 500 cfs.

IV. Analysis Methods

Estimates of each forage fish abundance parameters, community structure parameters, and population structure parameters and associated confidence intervals will be calculated each year the sampling is conducted. Data from multiple samples in a water habitat type will be averaged to form one estimate per anchor transect. Data will be averaged across the anchor transects to obtain annual status estimates with associated confidence intervals. The spatial distribution of forage fish species and taxonomic groups will be graphically displayed from the annual status estimates. Habitat utilization for forage fish species will be quantified through analyses of the presence/absence data with the water habitat type and physical attribute information.

After several years of data collection, trend analyses will be conducted to determine if a change in the values of the forage fish parameters has occurred. Inferences developed as part of this monitoring will be to the study area.

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Research Protocol for Nebraska Public Power District's Cottonwood Ranch Property

Approved by the Platte River Cooperative Agreement
Technical Committee on
August 1, 2000

Introduction

The Platte River Endangered Species Partnership (PRESP) is developing a proposed Program that will undertake a number of management activities to modify both land and water to increase or improve habitat for least terns, piping plovers, and whooping cranes. As directed under the Federal Energy Regulatory Commission (FERC) License for Project 1835, Article 407, Nebraska Public Power District (NPPD) will provide to PRESP approximately 2,650 contiguous acres of land on the central Platte River between the J-2 Return and Elm Creek, known as the Cottonwood Ranch Property. This property will count towards the Program's first increment goal of 10,000 acres. A conceptual plan for development and enhancement of the Cottonwood Ranch Property was developed by NPPD in consultation with the Nebraska Game and Parks Commission (NGPC), the Governance Committee and their representatives, Central Nebraska Public Power and Irrigation District (Central) and the U. S. Fish and Wildlife Service (FWS). Development and enhancement of NPPD's Cottonwood Ranch Property is anticipated to begin in September or October 2000.

NPPD's implementation of the Cottonwood Ranch Development and Enhancement Plan will help fulfill milestones L3-1, L1-2 and L1-3 of the Cooperative Agreement. The Development and Enhancement Plan is also consistent with the direction given in Section III.C.2 of the Proposed Program (e.g., restoration initially based on recommendations in the Platte River Management Joint Study). The major components of the Development and Enhancement Plan are to modify existing channel structure to improve nesting conditions for least terns and piping plovers and roosting habitat for whooping cranes. At this time the conceptual basis of the plan is to convert approximately 220 total acres of bottomland to produce active channel and nesting habitat as well as backwaters and sloughs. Purposes of the woodland removal are to improve unobstructed views within the channels and to promote channel widening. In addition, NPPD will excavate 7000 linear feet of 'pilot' channels in abandoned channels of accretion land. Pilot channels are intended to convey river flows and promote channel expansion by increasing the amount of bankline exposed to river erosion.

The removal of channel bank vegetation on Cottonwood Ranch is intended to effect bank erosion and channel widening. Bank-stored sediment is, thus, expected to be reintroduced into the channel. Deposition of this material may occur downstream. The mechanics of river sediment transport processes need to be examined to determine the effects of channel management actions on bank erosion and sediment transport, and to detect and evaluate possible impacts of deposition.

This proposal implements monitoring and research on NPPD's Cottonwood Ranch property. The overall goal of this monitoring and research is to provide data necessary to evaluate channel rehabilitation practices. Specific questions focus on whether management actions cause the channel to widen, whether measurable changes in the channel structure occur downstream, whether these changes can be linked to the management action, and whether widened channels can be sustained by river processes.

This protocol outlines how the research and system-level monitoring programs will combine to provide information about the effects of the demonstration project on the mechanics of river processes. Study design and data collection for the research program are described below. Also, components of General Monitoring within and immediately downstream of the Cottonwood Ranch are outlined and described in further detail in the Platte River General Monitoring Protocol. Specific methods or standard operating procedures (SOPs) will be documented so that field and laboratory practices are repeatable.

Management Action

NPPD and the Management Oversight Committee for the Cottonwood Ranch Property have designed management methods to remove woody vegetation from islands and banks within the Cottonwood Ranch property. In addition to the vegetation removal, some abandoned channels will be excavated as pilot channels to convey river flows. The management activity is scheduled to begin in September or October 2000 after one visit to the research and monitoring transects has been completed under this protocol.

Goals and Objectives for Monitoring and Research

The monitoring and research program is designed to link the detection of geomorphologic response with a mechanism to investigate its cause. Two components of data collection allow the necessary temporal and spatial resolution: 1) A general monitoring component that focuses on the integrated effects of management within the Cottonwood Ranch property and associated impacts downstream and provides initial information to the long term monitoring program devised for adaptive management, and 2) an intensive research component that examines the combined management activity in order to understand direct affects on the local channel system.

The general monitoring component focuses on collecting information from cross sections of the river and examining serial aerial photography. Measurements at these cross sections include channel topography, vegetation, bed and bank material grain size, and ground photography. These measurements will provide a baseline of information regarding the natural variability present in this reach of the river, the need for additional parameters, and specifically in the management reach, the potential for trend detection throughout the first increment of the Program.

The intensive research component will focus on collecting data sets with fine spatial resolution on three reaches of the middle channel undergoing riparian vegetation modification of the Platte River within the Cottonwood Ranch. Data collection will consist of detailed topographic surveying, bed and bank sediment sampling, observations of in-channel and bank vegetation, and ground photography. The three reaches were selected to represent the conditions of the river above the management area, in the management area, and below the management area. Results of the intensive research component will be used to separate normal variability in the channel from changes that are specifically produced by the management activities.

Specific objectives are as follows:

Objective 1) General river monitoring within Cottonwood Ranch that will become part of the overall adaptive management program along the central Platte River

A) To document physical characteristics of the Platte River channels both within the Cottonwood Ranch and immediately downstream.

B) To integrate the general monitoring program within Cottonwood Ranch Property into the monitoring scheme devised for adaptive management within the PRESP's area of interest.

Objective 2) Intensive research aimed at estimating channel changes and sediment movement resulting from integrated management practices

A) To evaluate channel changes (e.g. changes in channel width, distribution of depths within cross sections, and bank stability) resulting from specific vegetation clearing activities along islands and river banks

B) To determine the sediment budget and sediment movement of mobilized bed and bank material to downstream areas from the managed channel before and after vegetation removal in the management channel.

C) To evaluate the effects of natural river processes (eg. seasonal distribution of flow depths and erosion potential on banks) to maintain or augment the management activities.

The monitoring and research in this protocol does not evaluate species response to habitat development and enhancement but does evaluate the response of the existing environment to management actions. The Cottonwood Ranch Property Development and Enhancement Plan was developed based upon current knowledge of habitat needs by the target species with the assumption that ultimately this Plan will result in benefits to the target species. This approach is consistent with adaptive management. While species response to habitat management will take multiple years to evaluate it is imperative to the success of the proposed Program that this initial management action be evaluated to guide future land management and improve understanding of river processes that create and maintain channel habitat. The Districts have and will continue to monitor wildlife use of the site including fish abundance and diversity, breeding and migratory bird use and bald eagle use of an adjacent roost site.

General Monitoring Protocol

Data Collection

Transects across the middle channel of the Platte River will be surveyed at low flow following the Cottonwood Ranch research protocol outlined below. Low flows are needed to provide easier working conditions and for safety. Stream discharge of the Platte River at Overton, NE, gage will be used to identify appropriate working conditions and these flows will be recorded in the SOP. General Monitoring transects to be surveyed include eight research cross sections spaced one mile apart. Three of these transects are on the Cottonwood Ranch property and five are located downstream of Cottonwood Ranch and upstream of the Kearney Canal Diversion. Five of these eight monitoring transects are to be located at the anchor points of the probability based sample taken for the General Monitoring. The Universal Transversal Mercator (UTM) locations of these 5 points are the intersection of the main channel of the Platte and eastings 461003.49, 462593.20, 464146.15, 468659.43, and 470167.71. General Monitoring cross sections are shown in Figure 1. The channel variables for these eight General Monitoring cross sections will be collected through the research project. The Platte River General Monitoring Program will maintain data collection at some or all of these cross sections after the completion of this research project.

The data collection in year 2000 will serve as the pilot year for purposes of refining the Platte River General Monitoring Protocol. Data collected at these initial General Monitoring cross sections will: 1) Provide first year data for long term monitoring, 2) refine estimates of costs for collecting data at these widely spaced monitoring cross sections, and 3) identify statistical characteristics of variables including variance and dependence estimates and the sensitivity of trend detection. Data collected at each transect will include topographic survey, bed sediment sampling, and ground photography.

Data Analysis

Data will be summarized at the transect level and statistics such as the mean and standard deviation will be compiled using transects as the sample size. These data will be included in an annual data report. Post-stratification of the transects into managed, unmanaged, and downstream strata will enable pilot analyses of the data for each strata, although the sample sizes are insufficient for making changes across a broad spatial scale. Trend detection will involve computing the least squares regression line through all the data points in a regression of any summary measure against year. Statistically significant increases or decreases in trend will be defined as a nonzero regression line.

Research Protocol

Data Collection
Transect types are outlined in Table 1 and locations of these transects are shown in Figure 1. There are two types of transects identified: 1) Temporal intensive cross sections that are surveyed four to six times a year (including before and after high flow season and a survey in the Fall) along with ancillary data (i.e. bed and bank material sampling and ground photography),

and provide information on intra-annual variability; and 2) spatial intensive cross sections that are surveyed and ancillary data collected once a year on a series of tightly spaced cross section to provide information on changes within specific channel reaches. The spatially intensive cross sections are placed upstream of the managed area, within the managed area, and downstream of the managed area. The temporally intensive cross sections are a subset of the spatially intensive cross sections.

Streamflow will be collected at a stream gage to be placed on the middle channel of the Cottonwood Ranch property below the management activities. The gage will provide streamflow discharge for that specific channel and total river flow comparisons with the gage, Platte River at Overton, NE. Suspended-sediment concentration is collected at the streamflow gage on the middle channel. Suspended-sediment concentration and the size distribution of the suspended material provide information on changes in fine-grained sediment movement and changes from the managed section upstream. To provide a continuous record of fine-grained sediment transport, an Optical Backscatter sensor will be used.

Methods

1) Topographic survey - The procedure for surveying river cross-sections employs a survey-grade global positioning system (GPS) to measure the location of bed, bank, and bar locations relative to a fixed horizontal and vertical datum. The cross-section will be oriented orthogonal to the principal flow direction in the reach considered, with the extents of the section delineated on either bank with a permanent marker.

Cross section will be measured from either river left or river right depending on the surveyor's field and office data reduction preferences. The surveyor will begin at a marker on one bank and proceeds in a straight line toward the corresponding marker on the opposite bank. Rather than making equally spaced measurements of position along the section the practice is to instead define the 'slope breaks' encountered. An example of a slope break could be the top of a bank and the corresponding toe of the bank. The point at which the water surface intersects an island or bank will also delineated. An important aspect of measuring these cross sections requires an ability of the surveyor to recognize and delineate geomorphic features such as banks, bars, high water marks, and water edge.

The GPS used in the topographic survey computes the position of a rover unit relative to a known horizontal and vertical datum or base station using a satellite network and real time radio communication between the base and rover. Positions will be precise to within 2 centimeters in the vertical direction and 1 centimeter in the horizontal direction. The GPS requires a 'coordinate seed' or a known initial point from which to begin making measurements. An arbitrary position could be selected but the best practice is to relate a survey to a reference marker set by the National Geodetic Service (NGS). A listing of NGS benchmarks near the Cottonwood Ranch property and the quality of the horizontal and vertical values are compiled in Table 2. In addition, a number of UGSG elevation benchmarks are located in the vicinity. To relate the research cross sections to a common reference, NPPD will set a series of bench marks near the research activity.

2) Bed /Bank Sediment Sampling- The procedures for measuring bed sediment are taken from Edwards and Glysson, 1999. The type of bed material sediment sampler selected for use is a function of the size of the bed sediment measured and the depth and velocity of the river considered. The Platte River can be safely waded during most months of a typical water year. Previous experience has shown it is practical to do wading bed material sampling in the Platte River. The sampler used consists of a steel cylinder 7 centimeters in diameter and 20 centimeters in length welded to a steel pipe 155 centimeters long.

The general procedure for sampling with this sampler involves dividing the cross section into a series of equally spaced increments or verticals. A sufficient number of verticals should be sampled as to provide a representative statistical population. Previous sampling in this reach of the Platte River indicates that there is a great deal of variability in the sizes of bed material sampled along a section. We have calculated the number of samples (n) needed to characterize the mean grain size given the standard deviation of a sample from this population. Based on this data set we have computed that between 10 and 15 samples should provide a compromise between sampling practicality and statistical confidence. Given the bank material is generally more homogeneous than the bed material fewer of these samples are needed. Two samples taken from each bank, above bankfull stage, along the section should provide a representative population.

The cross-section will be divided into equally spaced increments to encompass the 15 samples. At each increment the sampler is plunged into the bed of the river until the can portion of the sampler is filled with sediment. Sample depths are 2 inches in order to provide similar data to the BM54 sampler used at bridge sections and to sample bed material that is most readily available for transport. The sample is then transferred to a sample bag that is labeled with the sampled section, sample number, as well as the date and time the sample was taken. Care must be taken to transfer the entire sample to the sample bag with special attention not to lose any of the fine material. The procedure is identical for bank sampling.

The samples are analyzed by dry sieving to determine their mechanical composition. Each sample is dried and weighed to determine total weight. The sample is placed in a sieve stack with ½ phi gradations and agitated for 25 minutes using a Rotap. The weight of material retained on each sieve is recorded after transferring the material to a tared dish. The process is repeated for every sieve in the stacks to ultimately yield the grain-size distribution for that sample (Guy, 1969).

3) Ground photography - Photo stations are identified as metal USGS bench marks set in 18 inches of concrete. Photo stations are located on each bank of cross sections. Photographs are taken upstream, downstream, and cross-stream to document the cross section and the condition of the banks upstream and downstream of the cross section. Photographs are taken with 4x5 or 35mm film cameras or digital cameras with a minimum resolution of 1712 X 1368 pixels. Each photo requires the following information: bench mark identification, date, time, film type, lens, azimuth, and any remarks needed.

4) Gaging streamflow - Gaging station procedures are found in Buchanan and Somers (1969), Buchanan and Somers (1968), and Carter and Davidian (1968). These procedures will be followed.

5) Suspended sediment concentration - Fine-grained sediment will be monitored using Optical Backscatter (OBS) sensors connected to a CR21 data collection platform.

Calibration – a correlation between OBS readings and suspended-sediment concentration needs to be defined. Suspended sediment concentrations are obtained for various streamflows along with an OBS value. Suspended sediment concentration is obtained using the equal width methods as defined in Edwards and Glysson (1999, p.48).

Sensor maintenance – sensor must be cleaned once a month to prevent and reduce biological fouling. Readings shall be collected before and after cleaning to establish changes from fouling

Data Analysis

Data from the topographic survey will be exported from the surveying software (Trimble Survey Office) and summarized as the distance from the bank and the elevation at every transect. Graphs can be made using a plotting software package (Microsoft Excel) of the distance versus elevation to reveal the outline of the bottom of each cross section. From the bed sediment sampling, each transect will have 15 samples analyzed and lab statistics will be returned for each. Statistics include d_{16}, d_{50}, and $d_{84.}$ Information gathered from the stream gaging stations will result in discharge data that can be summarized to the daily measures.

Statistical models will be used to summarize sediment and channel measurements for each of the three reaches.

Research Budget Summary for the First Year Activities
(All figures in gross dollars)

Data Collection / Analysis

1. **Cross sections, bed material sampling, and ground photography**
   a. **Spatial sections (50 sections, one time)**
      - **Field/analysis……………………………………15,400**
      - **Laboratory……………………………………... 9,060**
      - **Subtotal……………………………………….…24,460**

   b. **Temporal (8 sections, 2 times)**
      - **Field/analysis…………………………………15,400**
      - **Laboratory……………………………………. 5,750**
      - **Subtotal ………………………………………21,150**

   c. **General sections (5 sections, 1 time)***
      - **Field/analysis……………………………………6,165**
      - **Laboratory………………………………………1,460**
      - **Subtotal…………………………………………7,625**

2. **Stream gage (1 gage on middle channel)**
   a. **Installation………………………………………………………6,480**
   b. **Operation/record published….……………………………..17,000**
   c. **OBS Operation/data reduction…………………………………..11,600**
   d. **Subtotal………………….………………………………………35,080**

3. **Equipment…………………………………………………………………8,487**

Data Report (1st year data on CDROM, 1,200 copies)……………………………..…3,000

First year total………………………………………………………………….....99,802

Second year total (approx.)…………………………………………..……….....100,000
Third year total (approx.).………………………………………………….....100,000

*** Totals assume easy access to sections with transport assistance using airboat from NPPD.**

Table 1. Data to be collected at each transect type and the gaging station. Temporal intensive cross sections are surveyed four to six times a year, spatial intensive cross sections are surveyed once a year. Both types of transects will be placed upstream of the managed area, within the managed area, and downstream of the managed area.

TEMPORAL INTENSIVE MONITORING

FIELD ACTIVITY	FREQUENCY	VARIABLE QUANTIFIED / QUALIFIED	WHAT YOU LEARN FROM THE DATA
TOPOGRAPHIC SURVEY	4-6 TIMES / YR @	BED ELEVATION	HOW MUCH HAS THE BED AGGRADED/DEGRADED BETWEEN FIELD VISITS
	8 SECTIONS	BANK POSITION	HOW MUCH HAVE THE BANKS INCISED BETWEEN FIELD VISITS
		WETTED WIDTH	HOW WIDE IS THE CHANNEL AT THAT FLOW
		BAR/ ISLAND POSITION / ELEVATION	BARS/ISLANDS MOVED, AGGRADED OR DEGRADED BETWEEN FIELD VISITS
BED/BANK SEDIMENT SAMPLING	4-6 TIMES / YR @	GRAIN SIZE	HOW MUCH DO THESE VALUES CHANGE BETWEEN FIELD VISITS
	8 SECTIONS	GRADATION	WHAT ARE THE STATISTICS
		PERCENT SILT AND CLAY	WHAT TRENDS ARE SIGNIFICANT
GROUND PHOTOGRAPHY	4-6 TIMES / YR @	BANK STABILITY	ARE THE BANKS STABLE/UNSTABLE FROM ONE FIELD VISIT TO THE NEXT
	8 SECTIONS	VEGETATION	VEGETATION CHANGE FROM ONE FIELD VISIT TO THE NEXT

SPATIAL INTENSIVE MONITORING / GENERAL MONITORING

FIELD ACTIVITY	FREQUENCY	VARIABLE QUANTIFIED / QUALIFIED	WHAT YOU LEARN FROM THE DATA
TOPOGRAPHIC SURVEY	1 TIME / YR @	BED/BANK ELEVATION/POSITION	THE INTEGRATED YEARLY CHANGE IN THESE VARIABLES IN EACH REACH
	50 / 8 SECTIONS	WETTED WIDTH	
		BAR/ISLAND POSITION/ELEVATION	
BED/BANK SEDIMENT SAMPLING	1 TIME / YR @	GRAIN SIZE	WHAT TRENDS ARE PRESENT ALONG EACH REACH
	25 / 8 SECTIONS	GRADATION	WHAT ARE THE STATISTICS
		PERCENT SILT AND CLAY	WHAT TRENDS ARE SIGNIFICANT
GROUND PHOTOGRAPHY	1 TIME / YR @	BANK STABILITY	THE INTEGRATED CHANGE IN APPEARANCE OF EACH REACH
	50 / 8 SECTIONS	VEGETATION	WITH RESPECT TO THESE VARIABLES

Table 1 cont.

STREAMFLOW / SUSPENDED-SEDIMENT CONCENTRATION			
FIELD ACTIVITY	**FREQUENCY**	**VARIABLE QUANTIFIED / QUALIFIED**	**WHAT YOU LEARN FROM THE DATA**
STREAM GAGING	12 TIMES / YR @	STAGE / DISCHARGE RELATIONSHIP	HOW MUCH WATER IS MOVING THROUGH THE MAIN CHANNEL
	1 GAGE		WHAT ARE THE STATISTICS OF FLOW
			CAN RELATE UPSTREAM GAGE AT OVERTON TO THE GAGE
			TRACK THE TIMING AND MAGNITUDE OF HIGH FLOW EVENTS
GAGE HEIGHT	CONTINUOUS REC.	STAGE	CONTINUOUS FLOW INFORMATION
OBS MONITOR	CONTINUOUS REC.	OBS VALUES	OBS IS A SURRAGATE FOR FINE-GRAINED SUSPENDED SEDIMENT CONC.

Table 2. Horizontal and vertical control near Cottonwood Ranch.

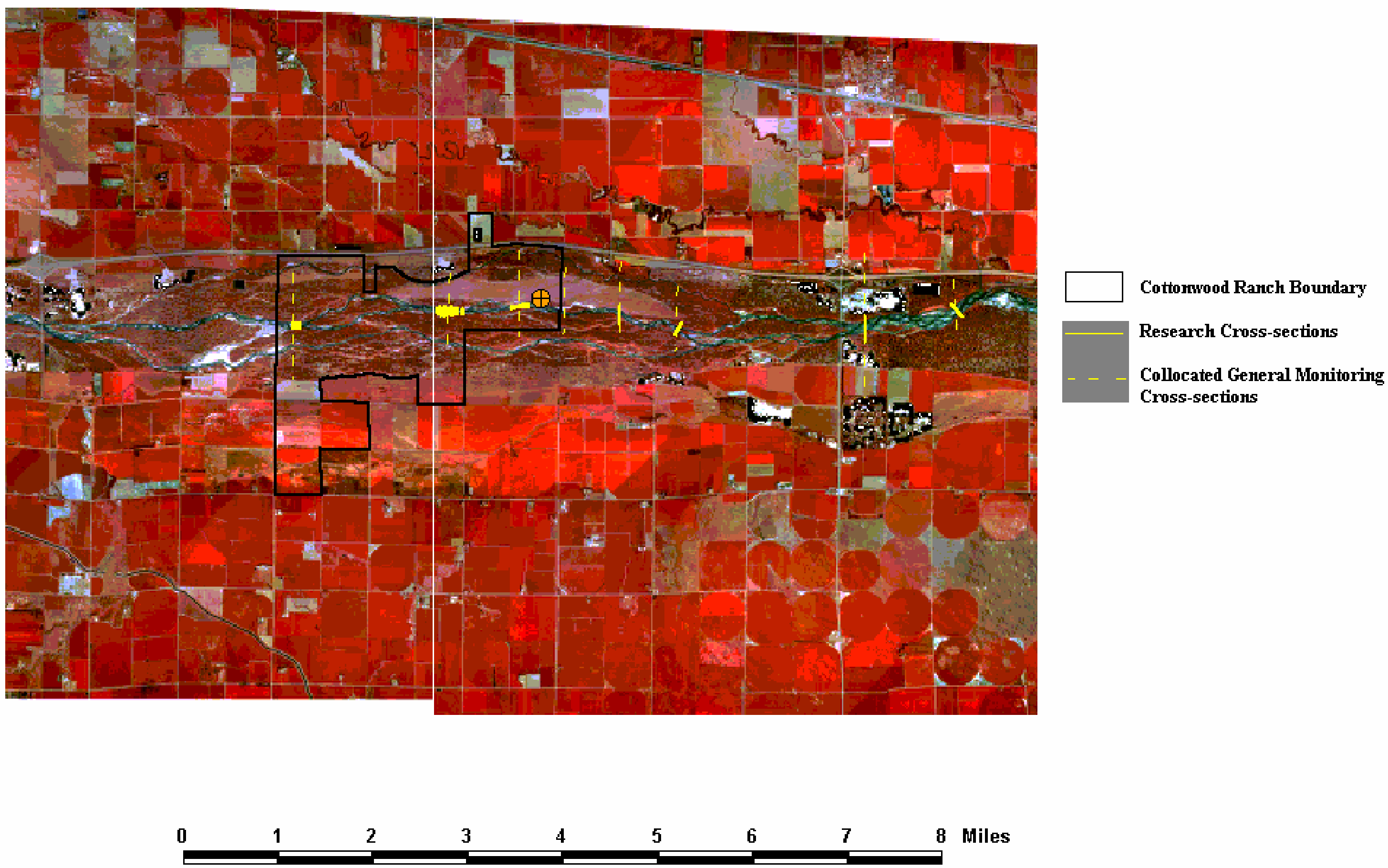
NGS VERTICAL AND HORIZONTAL CONTROL

DESIGNATION	PID	QUAD	LATITUDE	LONGITUDE	NAVD 88 (FEET)	HORZ ORDER	VERT ORDER
WESTSIDE	LH1050	OVERTON	403945.5202	993727.323	2445.7	THIRD	THIRD
80 11	LH1052	OVERTON	404138.8115	993226.301	2305.3	SECOND	THIRD
80 10A	LH1329	ELM CREEK W.	404153.4278	992715.891	2279	SECOND	NA
80 10	LH 1330	ELM CREEK W.	404140.5509	992246.67	2253	SECOND	NA
80 10 A AZ MK	LH 1331	ELM CREEK W.	404136.7199	992716.642	2279	SECOND	NA
Z 434	LH1435	ELM CREEK W.	404343	992752	2304.56	SCALED	FIRST
A 435	LH1436	ELM CREEK W.	404334	992643	2287.07	SCALED	FIRST

USGS VERTICAL CONTROL

DESIGNATION	QUAD	ELEVATION (FASL)
8RLW 1960	OVERTON	2347
80-11-1959	OVERTON	2311
80-11-1959	OVERTON	2304
13 RLW 1960	OVERTON	2296
12 RLW 1960	OVERTON	2305
3 RGW 1960	ELM CREEK W.	2247
80-9-1959	ELM CREEK E.	2209

Figure 1. Cottonwood Ranch Monitoring and Research Sections



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