PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM (PRRIP or Program)

TO: Governance Committee (GC)
FROM: Executive Director's Office (EDO)
RE: Updating the PRRIP Adaptive Management Plan (AMP) and Testing Target Flows
DATE: February 22, 2019

Discussion Questions

As the Program prepares to begin the First Increment Extension (Extension), the GC has directed the EDO to work collaboratively with Program partners to update and revise the AMP to guide management actions and science learning over the next 13 years. As discussed below, that direction includes focusing implementation of adaptive management (AM) during the Extension on flow-related activities and "testing target flows." The EDO requests further GC discussion and guidance on the following questions to help frame the specifics of a revised AMP and the structure of flow management actions during the Extension.

1) *What does "testing target flows" mean?* This is a complex policy question and the answer will have significant implications on the structure and content of the revised AMP and how Program water is utilized. Straw-man alternatives presented below provide some early insight as to these implications.

2) *What flexibility will the Program have to develop and test alternative flow management actions during the Extension for the purposes of informing GC decision-making?* There is a separation between current Program, state, and federal water accounting against current target flows and the state of science on Program water management and, more generally, the state of knowledge regarding environmental/normative flows and the natural flow regime.

3) *Can Environmental Account (EA) releases from Lake McConaughy be managed through a Program Annual Operating Plan (AOP) so that water releases can be tied to the priorities of the Program's AMP and related flow management actions?* The current separation between the Program and the annual EA AOP developed and implemented by the Service needs to be resolved or Extension learning may be significantly narrowed.

4) *How will the results of AM implementation during the Extension be used to inform the viability of current target flows and possibly the establishment of new or revised target flows for the Second Increment in 2033 and beyond?* Flow management actions and science learning during the Extension will be conducted with a mind toward providing useful information to the GC for Second Increment negotiations.

Background

During the First Increment, the only flow management action that is part of the current AMP and that has been evaluated in terms of river and species' responses is the short-duration high flow (SDHF). SDHFs are not considered a target flow and the Program has not conducted monitoring specific to implementation of the U.S. Fish and Wildlife Service's (Service) 1994 target flows. However, the Final Program Document anticipated that target flows would be evaluated and peer reviewed during the First Increment[1]. The Extension Document finalized by the GC in 2017 moved the issues of target flows and evaluating flow management actions to the top of the priority list for implementation of AM. The Extension Document

[1] Final Program Document, Page 4.

directs an evaluation of target flows and the need for 130,000 acre-feet in annual reductions of shortages to target flows[2].

In 2012, the EDO prepared a white paper on target flows, their implications for the Program, and possible ways to examine target flows (**Attachment A**). That was followed by a set of recommendations from the Program's Independent Scientific Advisory Committee (ISAC) for moving forward on target flows (**Attachment B**). These issues were discussed with the GC on more than one occasion but implementation of the AMP remained focused on evaluating the SDHF management action and related habitat creation, maintenance, and use.

That cumulative work on target flows and science learning during the First Increment Program informed development of the Extension Document. During the Extension, the Program will focus on achieving the Water Milestone with emphasis on securing at least 120,000 acre-feet in annual reductions to target flow shortages as quickly as possible and investing in the science necessary to determine if an additional 10,000 acre-feet is justified[3]. To ensure timely implementation and learning, the EDO has begun the process of beginning the Assess step of AM by identifying critical uncertainties, drafting revised Conceptual Ecological Models (CEMs) for the target species, and developing modeling tools to compare and contrast potential flow management actions. However, before unifying this work with the Technical Advisory Committee (TAC), Water Advisory Committee (WAC), and the Adaptive Management Working Group (AMWG), the EDO is seeking guidance from the GC on how to proceed with conceptualizing the testing of target flows during the Extension.

In February 2019, the ISAC provided the GC with the following set of recommendations for moving forward. These recommendations largely parallel similar ISAC recommendations on target flows from 2012:

a) Complete the State of the Platte Report for the First Increment (to be completed in 2019), providing a summary of what's been learned during the First Increment for each Big Question, with more detail on the still unresolved Big Questions (BQ 3, BQ9, BQ10). This will provide a large part of the scientific basis for new target flows.

b) Include a section of the State of Platte Report which summarizes what has been learned in the form of conceptual models of the three bird species, pallid sturgeon and their habitats. To help set the stage for an examination of target flows, these conceptual models should be organized around the life cycle of each species when present in the Central Platte, showing what flows and other actions are required to support the species, their prey and their habitats in dry, average and wet years.

c) Classification of water years should be determined through a defensible statistical process, not based on the historical criteria.

d) Conduct analyses which explore how to meet the three bird species' needs for water during an extended period of drought over several years, identifying critical management uncertainties for the AM Plan.

e) Complete tasks identified in the Proposed Approach to Pallid Sturgeon Decision Support (Compass 2018). See item 2 below for additional detail.

[2] PRRIP Addendum (Extension Document), Pages 3-4.

[3] PRRIP Addendum (Extension Document), Page 3.

f) Use items a through d to identify additional Big Questions and hypotheses for the revised AM Plan. The revised AM Plan should be short and modular, so it's easy to update over time. Restrict hypotheses to those that are actually testable.

g) Use the above items (if supported by the GC's decisions) to develop an approach for target flows for all four PRRIP species, incorporating geomorphology, differentiating based on water year, and performing comparisons with both the historical and potential future hydrographs expected in dry, average and wet water years. Organizing species' flow needs by month (or finer time scales) is a critical step prior to examining flow tradeoffs among species.

h) Rethink both the target flows themselves, and the method of accounting, so as to maintain flow variability (e.g., average flow over a certain period needs to be ≥ X cfs, but should be variable, rather than constantly at X; or using a preferred distribution of flows within each water year to inform water management decisions).

i) Use above items to develop alternative actions for the extension of the First Increment that builds on items a through g, and recognizes the use of money, water and land for each species (example shown in Table 1)

The EDO is internalizing these recommendations as part of the development of a revised AMP for the Extension but needs further guidance from the GC on the best strategy for testing target flows to adequately address all of the ISAC's recommendations.

Testing Target Flows – Possible Flow Management Alternatives

To further the discussion, the EDO created the following set of straw-man alternatives for consideration in the GC thinking about the best course of action in terms of revising the AMP and incorporating a focus of testing target flows. These straw-man alternatives were developed solely to facilitate discussion about different possible approaches to updating target flows during the Extension. They are not intended to be final recommendations, nor do they comprehensively encompass the full range of potential approaches. The EDO will discuss these options with the GC in more detail during the March 2019 GC Quarterly Meeting.

Some general caveats for all three alternatives that follow:

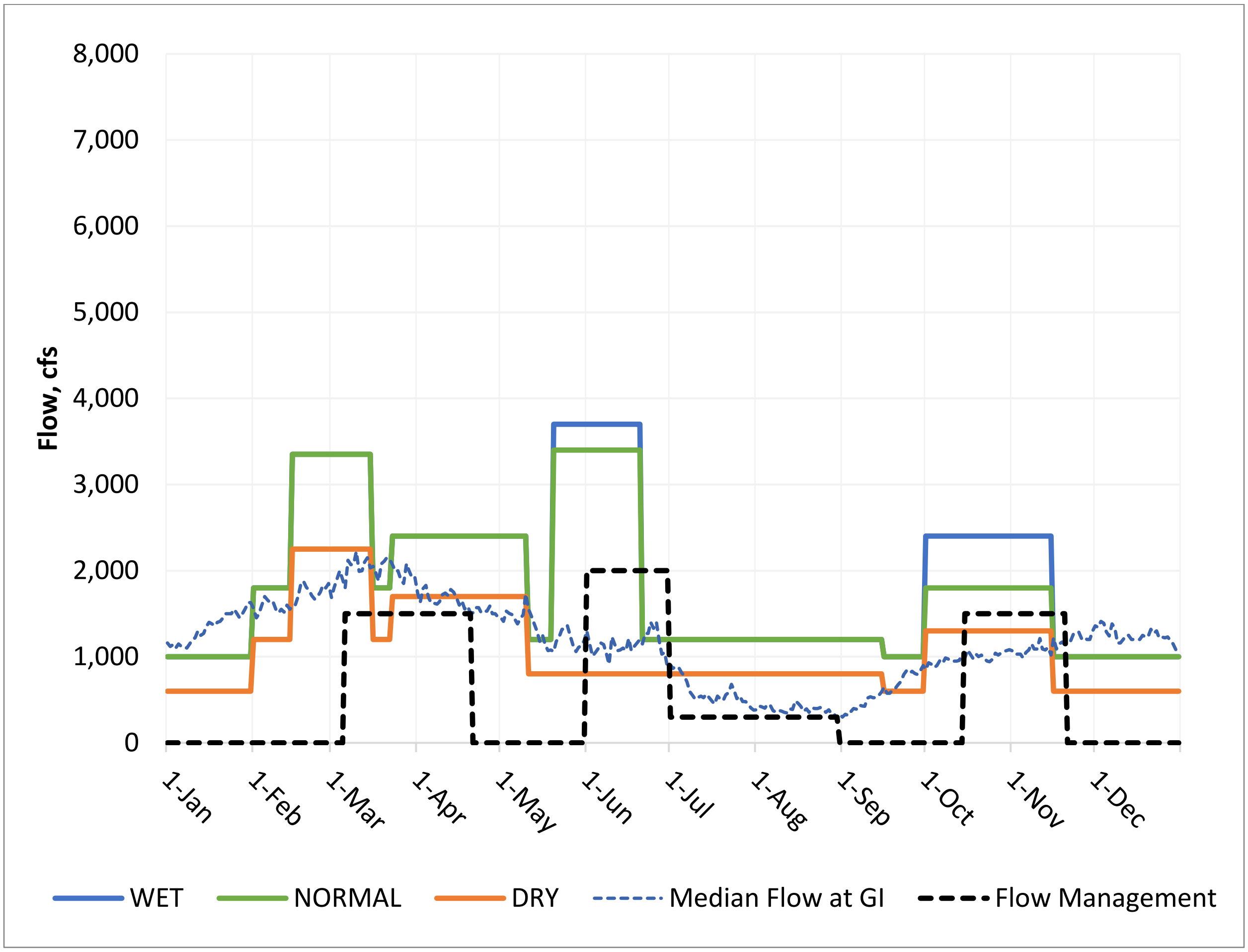
- Each alternative presents an example flow management strategy that is held constant across all alternatives. The flow management actions are just examples, but it should be noted that implementation of this strategy would utilize the full amount of available Program water in normal years and up to three times the available water in drought periods.
- Each alternative assumes all EA water would be applied through a Program AOP as directed by Program AMP priorities.
- Each alternative would have to be implemented in close coordination with the State of Nebraska, power and irrigation districts, and other entities to ensure compliance with applicable state water law and regulation (diversions, timing, etc.).

Option 1: Focus on management of Program water and retain existing target flows (Management Focus)

- Extension focuses on management of Program water to achieve target species objectives. Example flow management actions that could be tested include:
  - Spring whooping crane release to increase proportion of population using the AHR.
  - June channel inundation release to prevent seed germination and maintain unobstructed channel width.

- Summer baseflow augmentation to support forage fish and invertebrates during tern and plover nesting season.
- Fall whooping crane release to increase proportion of population using the AHR

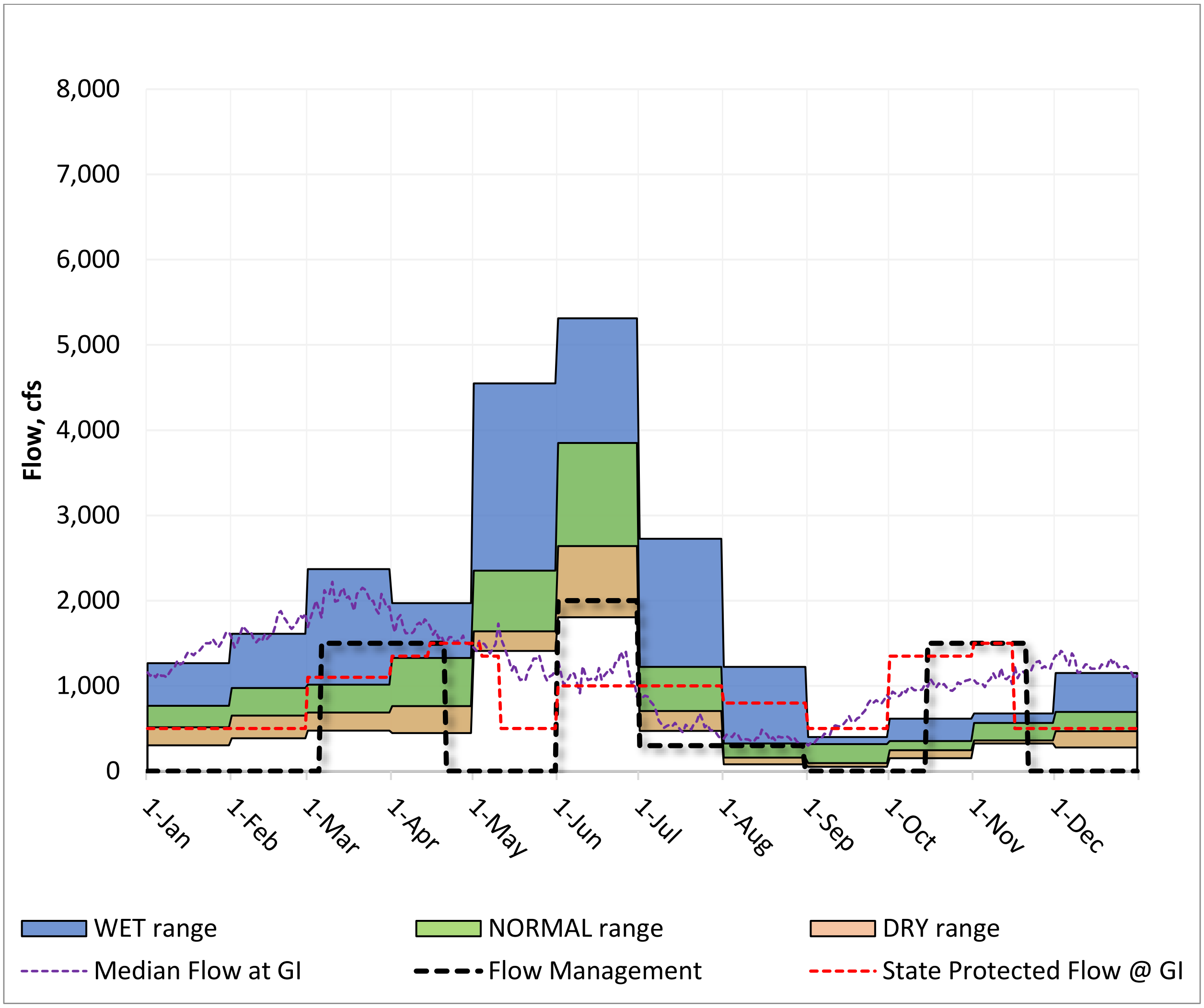
- Administrative decision to NOT test or update target flows. They will be retained in future increments for the purposes of flow protection and water administration (determining when excess flows are available for retiming projects).
- Second Increment water needs based on the Program's ability to achieve target species objectives, not offsetting all deficits to target flows.



<u>**Option 2:** Develop new target flows based on a combination of species management and normative flow approach (New Target Flows)</u>

- Focus on management of Program water to achieve target species objectives carried forward from Option 1.
- Target flows and underlying hydrologic conditions updated using some combination of building-block method and normative flow approach. Updated targets will be used for the purposes of flow protection and water administration (determining when excess flows are available for retiming projects).
  - Updated targets could accommodate temporal and discharge variability.
  - Updated targets could better reflect natural hydrologic patterns.
  - Would need to consider existing state-protected instream flow rights.

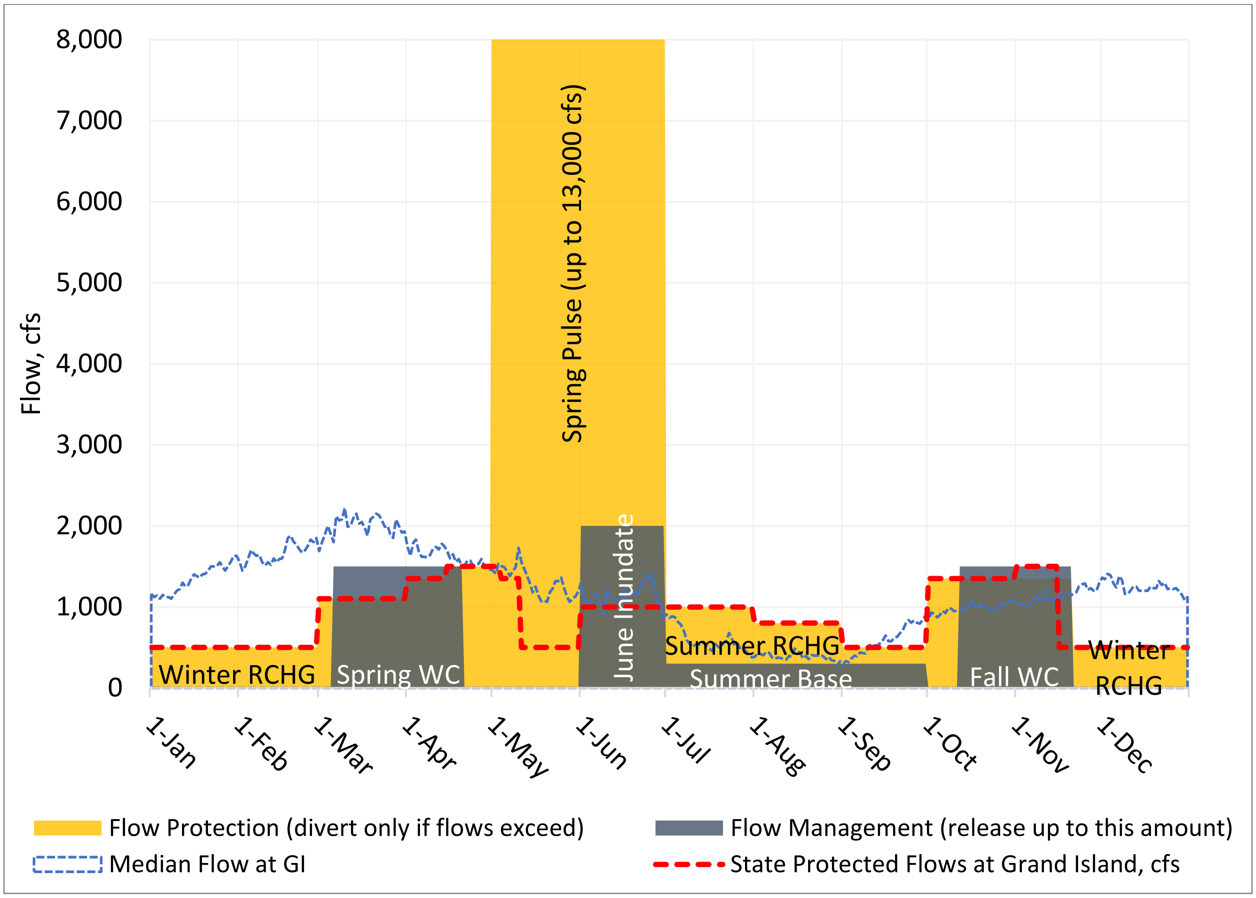
- Second Increment water needs based on the Program's ability to achieve target species objectives, not offset all deficits to target flows.



<u>**Option 3:** Develop an entirely new approach to water management and administration (Course Adjustment)</u>

- Focus on management of Program water to achieve target species objectives carried forward from Option 1.
- Target flows (as currently defined) are eliminated and replaced with a system whereby natural flow is protected or retimed in accordance with Program water management priorities (this alternative only works if Signatories agree that elimination of target flows does not change fundamental depletions assumptions).
  - No retiming could occur if flows fall below state protected instream flow rights.
  - Flow protection thresholds would be established during periods when water management (flow augmentation) would not occur. Those thresholds could correspond to existing instream flow rights or, in the case of spring pulse protections, be set at a level necessary to support channel maintenance etc.

- If flows are above flow protection thresholds, retiming projects could operate (IE, winter recharge period) at the magnitude necessary to supply sufficient water for upcoming Program water management actions.
- Second Increment water needs based on the Program's ability to achieve target species objectives.



There may be other approaches to consider as well but this set of alternatives should provide the GC with a more tangible set of options to think about when providing direction on how to proceed with development of a revised AMP.

Next Steps

The EDO has begun planning for the beginning of the Extension in 2020 and a transition from the current AMP to a revised version focused on flow management. The following schedule is being used to guide activities over at least the next 18 months:

Tasks and Deliverables	Timeline	Task Completed By:
AMP Update Scoping		
Task: Identify and Explore Potential Approaches	Jan 19-Mar 19	Jason (Scott & Courtney)
Task: Approach Memorandum	Feb 19	Chad (Jason)
Task: March GC	Mar 19	Chad (Jason)

Tasks and Deliverables	Timeline	Task Completed By:
Summarization and Review of First Increment Learning		
Task: Develop Summary of First Increment Learning	Jan 19-Feb 19	Dave (Patrick & Jason)
Task: Update Conceptual Ecological Models, Uncertainties, & Management Actions	Jan 19-April 19	Chad (Dave)
Task: Draft State of the Platte Report	April 19	Chad (Dave & Patrick)
Task: AMWG Meeting	April 30, 2019	AMWG
Task: TAC Review of State of the Platte Report	May 19-June 19	TAC
Task: State of the Platte Report Revisions	Jul 19	Chad
AMP Update Tool/Model Building		
Hydrologic Conditions Update		
Task: Hydrologic Conditions & Climate Change	Jan 19-Jul 19	Courtney (Scott)
Operations Model Development		
Task: Develop Flow Routing Model Framework	Jan 19-Jul 19	Scott (Courtney & Seth)
Task: Develop WAP Operations Framework	Jan 19-Jul 19	Seth (Scott)
Task: Develop and Refine Operations Model	Jan 19-Jul 19	Scott (Seth & Courtney)
Habitat Model Development		
Task: Develop Habitat Model Framework and Integrate with Operations Model	Jan 19-Jul 19	Dave/Scott (Patrick & Tom)
Task: Habitat Modeling (Hydrodynamic & Statistical)	Jan 19-Jul 19	Tom (Patrick, Dave, & bio technicians)
Development of Management Actions/Strategies		
Task: Finalize Integrated Operations/Species Model	Jan 19-Jul 19	Scott & Dave (Courtney & Patrick)
Task: Prepare Workshop Materials & Decision Support Tools (Compass)	Jun 19-Jul 19	Chad (Team as needed)
Task: First Workshop – Focus on Management Actions/Strategies	Jul 19-Aug 19	Chad/Compass
Continued AMP Update		
Task: GC Check-in	Sep 19	Chad
Task: Second Workshop	Oct 19-Nov 19	Chad/Compass
Task: EDO Drafting of AMP Document	Nov 19-Dec 19	Chad (Team as needed)
Task: GC Check-in	Dec 19	Chad
Task: AMWG, TAC, & ISAC Review and Discussion	Jan 20-Feb 20	AMWG/TAC/ISAC
Task: Third Workshop	Feb 20	Chad/Compass
Task: GC Check-in	Mar 20	Chad
Final AMP Preparation		
Task: EDO finalization of AMP	Apr 20-Jun 20	Chad (Team as needed)
Task: AMWG, TAC, & ISAC review	Jul 20-Aug 20	AMWG/TAC/ISAC

Tasks and Deliverables	Timeline	Task Completed By:
Task: GC review and approval	Sep 20	GC

Each of the steps in this process hinges on clear agreement among Program participants as to goals, objectives, critical uncertainties, Big Questions and priority hypotheses, and a range of management actions. Each of those specifics are tightly tied to direction from the GC regarding the testing of target flows and the information the GC needs to help make decisions during the Extension and during negotiations for the Second Increment.

ATTACHMENT A

2012 EDO Target Flow White Paper

United States Fish and Wildlife Service Target Flows and the Platte River Recovery Implementation Program

Overview

A primary First Increment objective of the Platte River Recovery Implementation Program (Program) is to reduce deficits to the United States Fish and Wildlife Service (Service) central Platte River annual species and pulse target flows (Figure 1) by an average of 130,000 to 150,000 acre-feet per year at Grand Island, Nebraska (Program 2006). The target flows, in their current form, were formulated in 1994 by the Service and Submitted to the Federal Energy Regulatory Commission (FERC) as Section 10(j) (Federal Power Act) recommendations for the relicensing of Kinsley Dam and associated facilities in Nebraska[1]. The target flows were subsequently incorporated into the Program as an initial reference point for determining periods of excess and shortage in the operation of Program reregulation and Program water will be used to reduce those shortages.

Figure 1. Average species and annual pulse flow targets

The states of Colorado, Wyoming and Nebraska never agreed that the target flows are biologically or hydrologically necessary to benefit or recover the Program's target species. However, the Department of the Interior (DOI) and the states agreed that the target flows can be used as a reference to determine progress towards meeting the Program's First Increment water objectives, so long as the Service's target flows are examined through the Adaptive Management Plan (AMP).[2] During the first five years of Program implementation, little attention was given examination of target flows because testing of the Flow-Sediment-Mechanical (FSM) management strategy was the primary focus of adaptive management efforts. In late 2011, the Service indicated that they were, at least temporarily, shifting their Environmental Account (EA) release priorities away from testing of SDHF releases toward testing of target flows[3].

In response to this shift in priorities, the Executive Director's Office (EDO) has investigated the research and analyses that resulted in the specific target flows as well as developments that have occurred subsequently. There are currently few Program hypotheses that relate directly to these flow targets and documentation of the underlying technical information is first step toward understanding the nature and magnitude of the expected benefits of these releases. More simply put, this is an exercise in identifying

[1] Instream flow recommendations (now referred to as species flows) were submitted to FERC on May 19, 1994. Pulse and peak flow recommendations were submitted under separate cover on August 11, 1994.

[2] This requirement is reflected in the First Increment objectives on page 4 of the Program Document. The AMP contains no discussion related to examination of target flows.

[3] The indication of shifting priorities came with a December 6, 2011 draft of the 2012 water year Annual Operating Plan. That draft plan prioritized low-magnitude long-duration pulse flows for channel maintenance and indicated that the Service would work with the Executive Director's Office to initiate research and monitoring to test the effectiveness of the releases.

what physical and biological responses the Program needs to measure and understand if the Governance Committee determines that more emphasis needs to be placed on testing target flows. The remainder of this document provides a summarization of the EDO findings.

Target Flow Goal and Development Process

The central Platte River target flows were developed through a series of two workshops in 1994 that were held at the National Ecology Research Center of the National Biological Survey (NBS) in Fort Collins, Colorado and were facilitated by NBS personnel. The format and objectives of the two workshops differed and will be discussed separately. The Service and NBS panel considered existing technical information and expert testimony when developing the target flows but did not follow a single methodology like the Instream Flow Incremental Methodology (IFIM) or the Tennant Method. A brief review of programmatic documents indicates that there is some confusion of the role that the IFIM played in development of the target flows. As such, the role of IFIM in development of the Service's target flows will be discussed briefly before transitioning to a description of the target flow workshops.

Instream Flow Incremental Methodology and Target Flows

Upon review of the National Research Council (NRC) report on Threatened and Endangered Species of the Platte River (NRC 2005), Final EIS (DOI 2006), and Biological Opinion (USFWS 2006), there appears to be some confusion regarding the role of IFIM in the establishment of Service species, pulse and peak target flows. The following excerpt has been reproduced from the NRC 2005:

> *Application of IFIM models to the Platte River by DOI agencies produced a series of instream-flow recommendations. A 1990 workshop brought together interested researchers to discuss the problem of establishing instream-flow recommendations, partially stimulated by relicensing requests to the Federal Energy Regulatory Commission for power projects along the Platte River owned by the Nebraska Public Power District and the Central Nebraska Power and Irrigation District (M. M. Zallen, Department of Interior, unpublished material, August 11, 1994).* ***By 1994, DOI agencies had used IFIM to generate their recommendations****, and after some revisions the agencies recommended three types of discharges: species flows, annual pulse flows, and peak flows.* [Emphasis added]

In fact, the role that IFIM played in development of the target flows is much more limited than understood by the NRC and implied in other documents. Specifically, the Physical HABitat SIMulation System (PHABSIM), which is one of the modeling tools associated with IFIM, was used to quantify the amount of microhabitat for fish and whooping cranes at different flow levels. This portion of the IFIM is identified in Figure 2, which is a reproduction of NRC Report Figure 4-17 (note the implication in the figure's descriptive legend that the IFIM process was used by DOI agencies to establish all aspects of the target flows). The Service (assisted by other agencies and cooperators) compiled the microhabitat data into Habitat Availability (HA) curves for forage fish and whooping cranes. Crane and fish-related flow targets are based on optimization of HA from those curves. None of the components of the IFIM were used for establishment of pulse or peak target flows. As shown in the emphasized area of Figure 4-17, the IFIM process was not used in whole, and would have required integration of macrohabitat data, historic hydrology, analysis of alternative flow regimes and negotiation to establish flow targets that account for benefits and tradeoffs of competing water uses.

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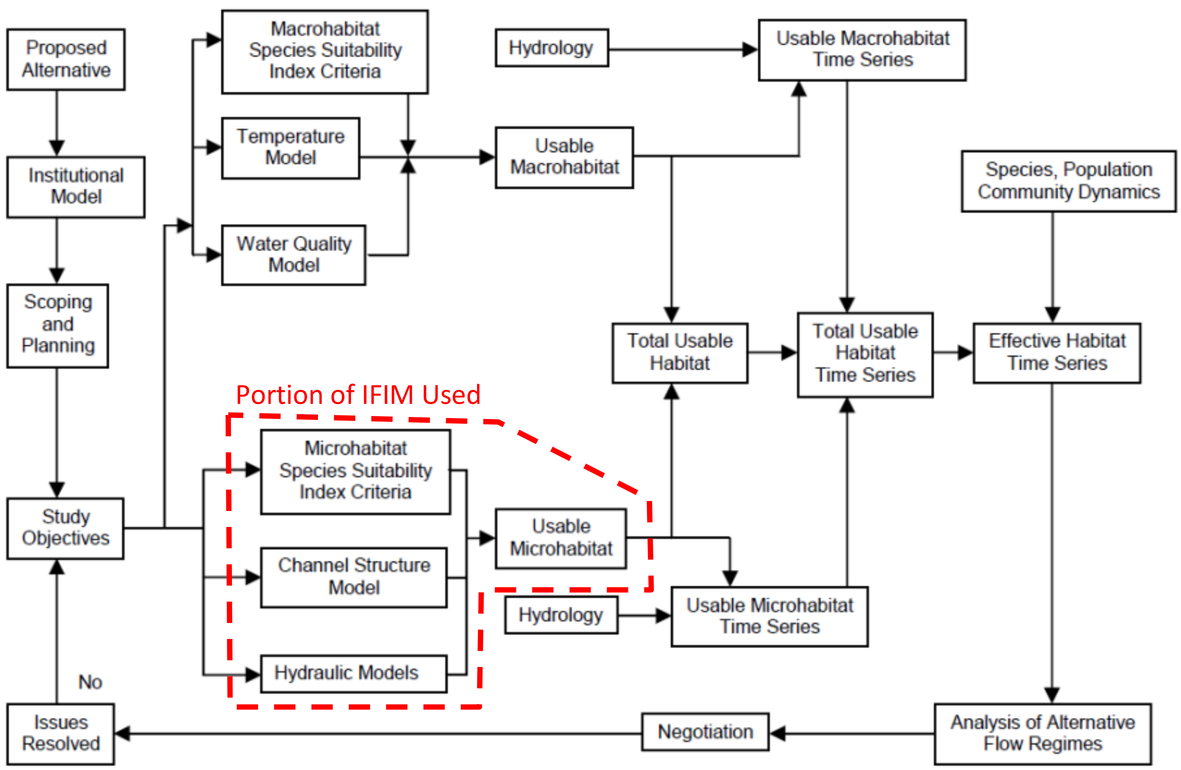

Figure 4-17 Basic operations of Instream Flow Incremental Method (IFIM) used by DOI agencies to define recommended flow magnitudes, frequency, duration, and timing. Source: Waddle 2001.

Figure 2. Reproduction of Figure 4-17 from NRC 2005. (Emphasis added to demonstrate portion of IFIM used)

As noted in the NRC Report, PHABSIM is a standard and accepted tool for quantification of microhabitat availability. However, the National Biological Service IFIM Primer (Stalnaker et al. 1995) cautions that "It is imprudent to use the simple, intermediate output (for example flow/habitat or flow/recreation functions) to argue for a minimum release or flow standard chosen from the maximum value on a flow versus habitat graph". IFIM documentation from the NBS repeatedly states that intermediate work products from application of the IFIM methodology (like PHABSIM) are not intended for use in standard-setting (Stalnaker, et al. 1995, Bovee, et al. 1998). Instead, they are to be used as tools that facilitate exploration of the comparative benefits and trade-offs of alternative flow regimes. Accordingly, the Program should be careful not to overstate the role that IFIM played in target flow development as it implies that a very specific incremental process (not just model output) was used in target flow development.

March 8-10 Target Flow Workshop

The three objectives of the first target flow workshop, held March 8-10, 1994, were to: (a) identify the Service's conservation goal for which instream flow targets were needed; (b) formulate the instream flow targets; and (c) prioritize instream flow targets by season and by hydrologic condition (dry, normal wet). A total of five NBS and eight Service personnel participated in the workshop. It does not appear that outside experts or observers were present at the March workshop[4]. The EDO has not been able to find any record of the workshop discussion and deliberations other than the final work products.

Workshop participants determined that the Service's conservation goal for the central Platte River was to "rehabilitate and to maintain the structure and function, patterns and processes, and habitat of the central Platte River Valley ecosystem." Within this ecosystem-focused goal, the objectives of (a) recovering listed species habitat, (b) preventing the need for listing of additional species, and (c) providing sufficient habitat for conservation of native biotic components of the ecosystem, were prioritized. Workshop participants apparently also rejected the objective of restoring the Platte River Valley ecosystem to its predevelopment condition.

The March workshop participants formulated the species flows and priority rankings that were submitted to FERC and ultimately included in the Program Water Plan[5]. During the workshop, participants concluded that pulse flows were important to ecosystem function and determined that more information was necessary to develop flow targets. Another workshop was scheduled in May of 1994 to discuss pulse flows.

May 16-20 Pulse Flow Workshop

The May workshop was conducted under a different format. The NBS invited nine experts to provide recommendations for pulse flow targets over the course of two days of testimony on May 16- 17. After hearing the expert recommendations, a panel of NBS and Service personnel[6] developed the target flow recommendations on May 18-19. Observers were allowed to attend the expert testimony portion of the workshop, but the panel met in private to craft the flow recommendations[7]. It should be noted that more than one expert indicated in their testimony that they had been given very short notice by NBS and had not been asked to develop actual flow target recommendations until the day before the workshop. Of the nine experts, three presented target flow recommendations, one provided an overview of Nebraska Game and Parks Commission (NGPC) 1993 instream flow applications to the Nebraska Department of Water Resources (NDWR), one summarized and critiqued recommendations presented by the other experts, and four presented relevant information but did not provide flow recommendations.

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Species Target Flows

Table 1 from Bowman 1994 is reproduced on the following page (Figure 3) and provides the species flow targets that were developed in the March 1994 workshop and are to be examined through the Program. Flow targets are organized by date and hydrologic condition and also include prioritization ranking for each hydrologic condition. The Program Water Plan provides clarification to the expected frequency of dry, normal and wet hydrology. Simply put, "wet" years are defined as the wettest 33%, "dry" years as the driest 25%, and "normal" years all others[8]. No discussion of rationale for prioritization rankings was found and the

[4] Information about the March workshop is derived from Bowman, 1994.
[5] Species flows can be found in the PRRIP Water Plan, Section 11 Appendix A-1, Table 1. Due to the controversy surrounding the target flows, Section 11 of the Water Plan was provided as information but purposely not made part of the Program Document.
[6] The May NBS and Service panel participants were similar but not identical to the March participants.
[7] Information about the May workshop is derived from: Bowman and Carlson, 1994 as well as from videotapes of the expert testimony portion of the workshop provided to the EDO by the Service.
[8] This clarification is provided in the Species Flows table on page 4 of the Water Plan Reference Materials.

rankings will not be discussed further except to note that the panel envisioned a system where the hydrologic condition would remain constant throughout the year. The rankings would then allow prioritization of releases within a year type. The subsequent adoption of a "real-time" process for defining hydrologic conditions makes the prioritizations essentially meaningless as hydrologic condition often changes during a year.[9] The remainder of the species target flow discussion will focus on the rationale and analysis behind each target as well as associated or relevant developments that have occurred subsequently.

Table 1. Instream flow targets by seasonal priorities (ranking) for normal (average), wet, and dry years for the central Platte River, Nebraska. Normal (average) year flows will be equaled or exceeded 3 out of 4 years. Normal and wet year target flows will be met 3 out of 4 years, and in the driest 25 percent of the years, the dry year targets will be met.

Season	Normal year Ranking & Flow (cfs)	Wet year Ranking & Flow (cfs)	Dry Year Ranking & Flow (cfs)
May and June*	***	#1*	***
Feb. and March**	***	#2**	***
May 11-Sept. 15	#1 @ 1,200	#3 @ 1,200	#1 @ 800
March 23-May 10	#2 @ 2,400	#4 @ 2,400	#2 @ 1,700[1]
Feb. 1-March 22	#3 @ 1,800	#5 @ 1,800	#3 @ 1,200[2]
Sept. 16-30	#4 @ 1,000	#6 @ 1,000	#6(tie) @ 600
Oct. 1-Nov. 15	#5 @ 1,800	#7 @ 2,400	#6(tie) @ 1,300[3]
Nov. 16-Dec. 31	#6 @ 1,000	#8 @ 1,000	#5 @ 600
Jan. 1-31	#7 @ 1,000	#9 @ 1,000	#4 @ 600

*Pulse, or peak, flows during the May and June period of wet years (1 out of 3 years) is the single highest priority flow target; specific flow targets are being determined.

** Pulse, or peak, flows during the February and March period of wet years (1 out of 3 years) is the second highest priority flow target; specific flow targets are being determined.

*** The importance of pulse, or peak, flows during normal years (3 out of 4 years) and dry years (1 out of 4 years) are being evaluated; specific flow targets will be determined, if appropriate.

[1] Includes 650 cfs for fish community.

[2] Includes 650 cfs for fish community.

[3] Includes 600 cfs for fish community.

Figure 3. Reproduction of Table 1 from Bowman 1994.

[9] The Program's process for defining real-time hydrologic conditions is located in Appendix D to the Water Plan Reference Material.

January 1-31 Species Target Flows

The Service's target flow recommendations indicate that that they would provide foraging habitat for raptors, promote winter survival of the native fish and macroinvertebrate communities, and assist in formation and movement of ice for channel maintenance.[10] However, the rationale for the specific flow targets is linked exclusively to the "maintenance of a diverse and abundant assemblage of fish species."[11] The Service used the PHABSIM to model Weighted Usable Area (WUA) for central Platte River fish species across a range of discharges. The resulting WUA versus discharge curves were then normalized and combined into guilds that exhibited curves with similar shape and peak. The resulting guilds were identified by the letters A – E (Figure 4). Guilds A and B were comprised of species like sand shiner that make up the bulk of suitable least tern forage. Guilds C – E were comprised primarily of species like common carp and channel catfish that are typically not suitable forage.

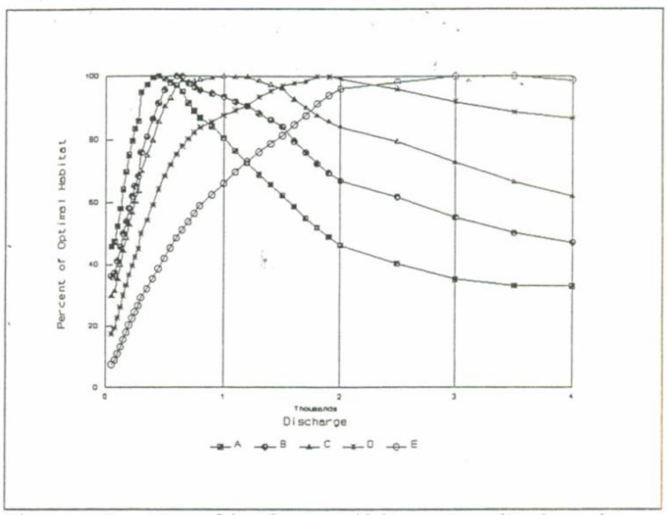

Figure B3. Normalized HA guild curves showing the percent of optimal habitat as a function of discharge for five guilds (A-E) during the fall BSP.

Figure 4. Reproduction of Figure B3 from USFWS 1994.

The individual curves in each guild were then combined into one Habitat Area (HA) curve for each guild and the flow target was determined by averaging the Habitat Area curves for all guilds. The highest average value in the fall biologically significant period[12] occurred at 1,000 cfs, which was selected as the wet and normal flow target. A flow of 600 cfs was chosen for the dry year target because the Service determined that the percent of optimum habitat diminishes most rapidly at flows below 600 cfs during the fall.[13]

After examining the guild analysis, two items stand out. First, equal weight was given to all guilds in the averaging procedure regardless of number of guild species present in the central Platte River, abundance of species that are present, or importance of guilds as tern forage. Only using guilds A and B, which comprise the bulk of least tern forage base, would reduce the flow target to 450 cfs. Retaining all guilds and weighting the average by number of species in each guild would produce a flow target of 600 cfs.

Second, the averaged HA curve indicates very little difference in percent of optimal habitat area across a range of flows. USFWS 1994 did not include a figure of the averaged HA curve so the EDO recreated it (Figure 5) from the guild HA data in DOI 2005. The averaged curve indicates that there is only a 1.9% change in the percent of optimal habitat for the range of discharges from 600 cfs to 1,200 cfs. However, over

[10] Bowman 1994. Page 7.
[11] USFWS, 1994. Page 1.
[12] The fall HA curves were used to set winter flow targets for the fish community.
[13] Suitability for Guilds A-C are near peak at 600 cfs. As such, average suitability for all guilds diminishes quickly below that flow.

the course of a year, the difference in flow volume is 434,380 acre-ft. Incremental benefit/tradeoff issues like this are one of the reasons that IFIM guidance documents recommend against standard-setting based solely on PHABSIM model output.

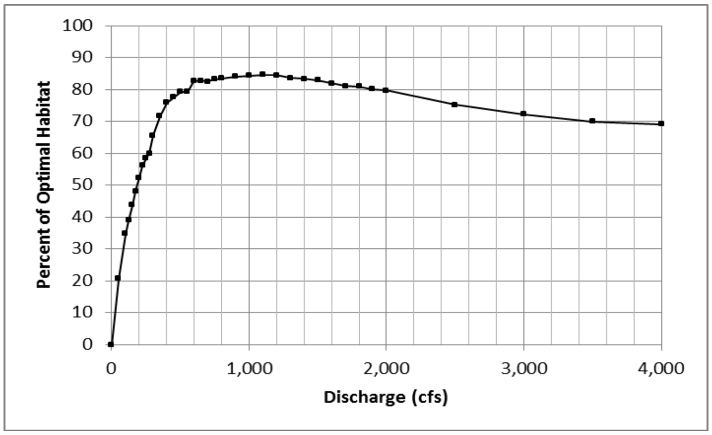

Figure 5: Averaged HA curve showing the percent of optimal habitat as a function of discharge for all guilds.

The PHABSIM analysis was subsequently updated by the Service for the 1997 Kingsley Dam Biological Opinion (USFWS 1997). The updated analysis produced a slightly higher flow target of 1,200 cfs. This is due to the use of a different optimization technique. Instead of identifying the highest average (or optimized) value for all guild HA curves, the Service chose to minimize the negative impacts to any single guild by drawing a "composite" suitability curve that corresponded to the lowest percent of optimal habitat among all guilds across the range of modeled discharges.

Because of this, the BO analysis is driven entirely by Guilds A and E. Up to 1,200 cfs, the relationship is based on the HA curve for Guild E and above 1,200 cfs it is based on the curve for Guild A (see Figure 6). Leonard and Orth (1998) was cited as the source of this optimization method in Appendix J of the Kingsley BO. Upon examination, Leonard and Orth (1988) did not include any discussion of the method other than to apply it for the purpose of demonstrating the sensitivity of flow recommendations to the target species (or guilds) used in the analysis. That document includes the following statement: "When target species are being selected, consideration should be given to the profound effect that the selections may have on the resulting flow recommendation. It is possible to "stack the deck," either intentionally or accidentally, in favor of a specific flow recommendation." This sensitivity is apparent in Figure 6. If Guild E (channel catfish and gizzard shad) are removed from the analysis, the optimized flow would drop by approximately 400 cfs. If Guild D is also removed (common carp and chub species) from the analysis, the optimized flow would be on the order of 600 cfs.

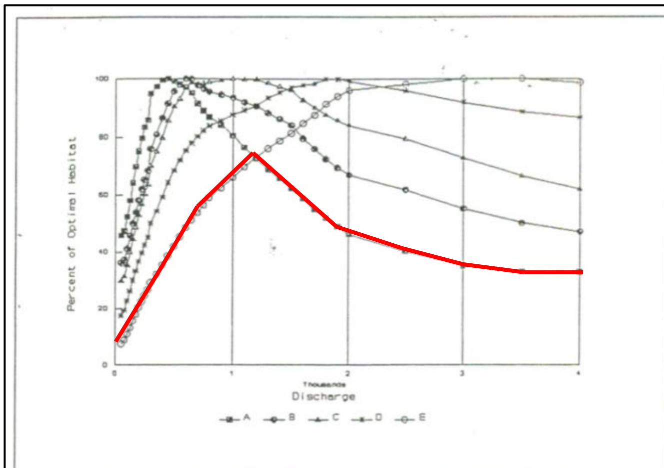

Figure B3. Normalized HA guild curves showing the percent of optimal habitat as a function of discharge for five guilds (A-E) during the fall BSP.

Figure 6. Reproduction of Figure B3 from USFWS 1994 with emphasis added to show Kingsley BO HA curve.

The original source of the above referenced optimization method is Bovee 1982 with the Service using a simplified version of the author's matrix-based optimization method. Bovee 1982 called for a monthly analysis constrained by historic hydrology and recommended weighting species and life stage HA curves to reflect spatial requirements. If this optimization approach is used in the future, application of the full method should be considered.

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February 1 – March 22 Species Target Flows

The Service's target flow recommendations indicate that flows during this period are intended to provide forage habitat for bald eagles, migration habitat for waterfowl, and suitable roosting sites and feeding habitat in wet meadows. As with the January target flows, ice formation and movement and fish habitat are also discussed.[14] However, the rationale for the flow target is linked solely to maintenance of sandhill crane roosting habitat.

The target itself was not based on a sandhill crane roost model or similar analysis. Instead, the target was linked to the whooping crane habitat model C4R, a PHABSIM model, which was used to develop target flows during the whooping crane migration periods. That model indicated that the availability of whooping crane roosting habitat is optimized at a flow of 2,400 cfs, decreases gradually from 2,400 cfs to a transitional range from about 2,000 to 1,700 cfs, and declines rapidly below 1,700 cfs. The Service stated that because sandhill and whooping cranes use similar roosting habitat, and whooping crane habitat declines rapidly below 1,700 cfs, it was appropriate to identify a flow of 1,800 cfs as the flow target during sandhill crane migration during wet and normal years. During dry years, the target was set at 1,200 cfs. The EDO could not discern how the dry year target was derived. This could be discussed further with the Service.

At this point, it is important to note that the pulse flow recommendations developed subsequent to the species targets largely override the recommendations presented above. The pulse flow recommendations include a 30-day flow exceedance target for the period of February 15 to March 15 of 3,100 to 3,600 cfs during normal years and 2,000 to 2,500 cfs during dry years (Bowman and Carlson 1994). Incidentally, the whooping crane C4R model indicates that roosting habitat suitability is lower at flows of 3,100 to 3,600 cfs than at a flow of 1,800 cfs. The February 15 to March 15 pulse flow recommendation will be discussed at greater length later in this document.

March 23 to May 10 Species Target Flows

The Service's target flow recommendations indicate that this period is the primary spring migration period for birds through this region and flows contribute important nutritional and physiological conditions for birds including sandhill and whooping cranes and Eskimo curlews, migratory waterfowl, wading birds, and shore birds. The Service also indicated that flows during this period provide channel habitat for spawning fish and mussels and this period is very important for environmental education and ecotourism.[15]

The rationale for the flow target is optimization of suitable whooping crane channel roosting habitat availability in the associated habitat reach. As mentioned previously, the Service's CR4 whooping crane model was used to model the relationship between habitat and flow. Generally speaking, the model calculates habitat suitability based on channel wetted width and cumulative depth distribution functions. The C4R model indicates that roosting habitat availability is optimized at a flow of 2,400 cfs, which was selected as the wet and normal year flow target. The dry year target was set at 1,700 cfs because the model indicates that suitability declines rapidly below that discharge.

[14] Bowman 1994. Page 6.
[15] Bowman 1994. Page 5.

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The C4R model, specifically the cumulative depth distribution function, has been the subject of much criticism since the time the target flows were established. The NGPC filed a 2,400 cfs instream flow application with NDWR in 1993 for protection of whooping crane roosting habitat based on the C4R model output. That application was contested and a significant portion of the testimony focused on whether or not the depth distribution function was inherently flawed. The NDWR ultimately concluded that the NGPC analysis did overestimate the flow necessary to protect roosting habitat and ruled that a discharge of 1,350 cfs was appropriate for protection of roosting habitat. [16]

Following the NDWR ruling, the United States Geological Survey (USGS) undertook an independent evaluation of the C4R model. The results of that evaluation were published as Scientific Investigations Report 2005-5123 (Farmer et al 2005). The evaluation indicated that the C4R model has some utility for predicting river channels more likely to be used by cranes. However, the authors concluded that model's depth function leads to a serious numerical bias in the estimated optimal flow. This because the depth profile from a single group of cranes that roosted in a narrow channel during high flows drives all model analyses. The authors modified the depth function to remove the bias and the resulting optimal flow estimates ranged from 1,350 cfs to 1,850 cfs.

In their evaluation, the USGS improved and updated the C4R model and made several recommendations for future data gathering and analyses. The improved model would be a likely starting point for the Program's evaluation of whooping crane-related target flows given that the evaluation addresses long-standing concerns about the C4R model and Service personnel coauthored the USGS investigation.[17]

May 11 to September 15 Species Target Flows

The Service's target flow recommendations indicate that this is the period when water shortages are most critical and proportionately greater biological stress and ecological effects can occur. Maintaining flow during this period can also help prevent shore birds (terns and plovers) from nesting at low elevations in the channel, provide a barrier to terrestrial predators, and maintain the native fish community by curtailing rises in water temperature which would be detrimental or lethal[18]. The Service rationale for the flow targets during this period appears to be the convergence of flows thought to be necessary for protection of the fish community and maintenance of tern and plover habitat.

The fish community protection rationale is based on modeling performed as part of a master's thesis (Dinan 1992). The thesis analysis utilized data from 1989-1990 in conjunction with the Stream Network Temperature (SNTEMP) model to predict changes in water temperature in relation to increases and decreases in flow. The modeling indicated that water temperature during the summer is correlated with flow. Dinan also concluded that flows of 400 cfs at Grand Island provided little or no protection to the fish community; flows of 800 cfs reduced the average daily maximum water temperatures and the number of days when temperature exceeded lethal levels; and a flow of 1,200 cfs further reduced daily maximum temperature as well as the number of days when temperatures exceeded lethal levels. The Service documentation does not indicate

[16] This is based on the June 26, 1998 order that granted instream flow rights to NGPC. That order contains a record of the discussion of the hearings conducted by NDWR in relation to the flow applications.
[17] Jeff Runge of the USFWS Grand Island Field Office is a coauthor.
[18] Bowman 1994. Page 5.

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whether there is a minimum level of protection that must be maintained or discuss the magnitude or duration of impacts to the fish community if lethal temperatures are exceeded.

Sinokrot, Gu and Gulliver (1996) performed additional analyses to validate Dinan's evaluation of the relationship between flow and water temperature in the central Platte. That study indicated that water depth plays a significant role in water temperature with wide, shallow reaches exhibiting higher temperatures because of low thermal inertia. This finding (when viewed with the context of the Service's desire to restore the natural hydrograph to the degree possible) highlights the need to better understand the nature of temperature-related fish community degradation as well as the objective of temperature reductions. Prior to construction of Kingsley Dam, a lower median discharge during the summer (reference Figure 10 for flow percentile analysis at Duncan) was distributed across a much wider active channel. Qualitatively, this indicates that temperature-related stress and mortality should be lower under current hydrologic and channel regimes.

The tern and plover habitat component of the rationale includes two parts. The first is related to the fish community as the Service states that "at 1,200 cfs, optimum habitat is achieved for the forage fish of the least tern."[19] This statement is presumably linked to the PHABSIM modeling discussed earlier. The optimized flow in that model for the summer biologically significant period was 1,200 cfs. It should be noted that the PHABSIM model optimization was based on all guilds, not solely on the guilds that include forage fish species. If the guilds that include common carp and channel catfish are removed from the analysis, optimal habitat would be achieved at a flow of approximately 600 cfs.

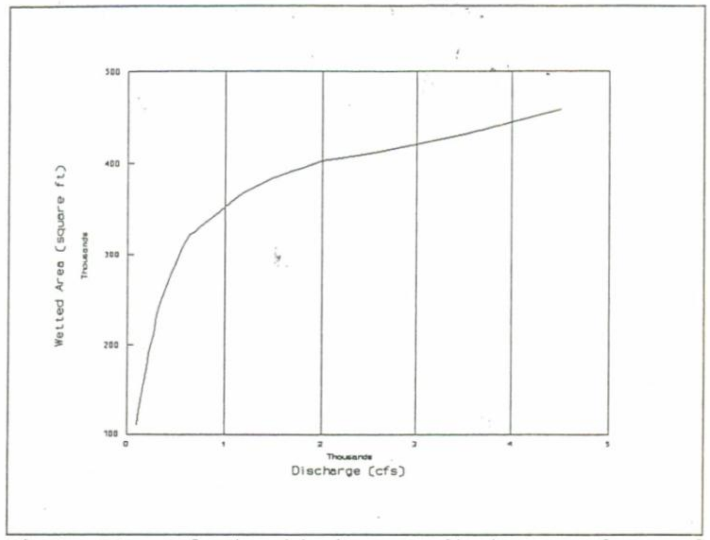

Figure E1. Relationship between discharge and wetted channel area for segments of the central Platte River frequently used by nesting least terns and piping plovers.

Figure 7. Reproduction of Figure E1 from USFWS 1994.

The second tern and plover habitat rationale is based on habitat versus discharge relationship for segments of the central Platte River frequently occupied by nesting terns and plovers.[20] In USFWS 1994, the Service indicates that the water surface area within the channel in these areas increases most rapidly from 0 to 800 cfs, continues to increase at a slower rate up to 1,300 cfs, and increases at a uniform rate above that level. Additionally, between 1,200 and 1,500 cfs, nesting habitat receives a predator barrier and varying amounts of damp sandbars are exposed for piping plover foraging. And finally, beyond 1,500 cfs, damp sandbars disappear. Figure 7 provides the wetted area versus stage relationship from USFWS 1994. No data was provided in support of the predator barrier or foraging habitat versus flow relationships.

[19] USFWS 1994. Page 10.

[20] The Service documentation does not indicate where these segments are located within the associated habitat reach.

Overall, the wet and normal year flow target of 1,200 cfs and dry year target of 800 cfs appear to be based on the PHABSIM fish analysis which the Service corroborated with the water quality (temperature) and channel habitat versus discharge relationships. This assumption is based on the fact that the fish analysis was the only one of the three that involved an optimization objective. As with the February 1 to March 22 flow targets, a portion of this flow target period is overwritten by the subsequent pulse flow recommendations. Those targets call for a 7 – 30 day flow exceedance of greater than 3,000 cfs for the period of May 20 – June 20 during 75% of years. Pulse flow targets for May and June will be discussed in greater detail later in this document.

September 16- 30 Species Target Flows

The Service's rationale for September 16 – 30 target flows is maintenance of the native fish community. The analyses used to establish the wet and normal flow target of 1,000 cfs and dry condition target of 800 cfs are identical to that of the January 1 – 31 period.

October 1 to November 15 Species Target Flows

The Service's target flow recommendations indicate that flows during this time provide migration habitat for waterfowl and other migratory bird species like whooping cranes and sandhill cranes. In addition, fall flows maintain aquatic life and promote growth of fish young-of-year. The rationale for the flow selected as targets during this period is maintenance of whooping crane roosting habitat. As with the spring targets during the whooping crane migration period, the targets are based on the C4R habitat model.

The target during wet conditions is 2,400 cfs, which is intended to optimize roosting habitat availability. The flow target during normal conditions is 1,800 cfs, which corresponds to dry conditions during the spring migration, and the dry target is 1,300 cfs. The Service does not explain why normal and dry year targets are lower than in the spring although the likely candidate is the hydrologic record which indicates that flows during the fall migration period are typically lower than during the spring migration period. This discrepancy in targets should be an area of Program focus as it was a significant area of contention during the NGPC instream flow application hearings and played a role in final outcome of that application process. The basic NDWR question was this: If one magnitude of flow is critical to protect whooping crane roost habitat in the spring, why would some lesser flow be adequate in the fall? Conversely, why are higher flows needed in the spring if lower flows are sufficient in the fall?

November 16 to December 31 Species Target Flows

The Service's rationale for November 16 to December 31 target flows is identical to that of the January 1 – 31 target flows. The analyses used to establish the wet and normal flow target of 1,000 cfs and dry condition target of 800 cfs are identical to that of the January 1 – 31 period.

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Pulse and Peak Target Flows

At the March 1994 workshop, the NSB and Service panel ranked February – March and May – June pulse flows as their top two priorities in wet years. The panel discussed a range of pulse flow magnitudes and durations to achieve a variety of objectives including wet meadow recharge, sandbar formation and channel maintenance through vegetation scour. Overall, the participants concluded that pulse flows play the dominant role in the patterns and processes, structure and function, and habitat the of the Platte River Valley ecosystem.[21] Given the importance of pulse flows, the participants delayed development of flow targets pending a separate workshop that included outside experts on this topic. The format of that workshop has been discussed previously.

Capturing the rationale and analyses that led to the development of pulse and peak target flows has been more difficult than for the species flows. The primary information sources include:

- Department of the Interior's Rationale and Recommendations for Pulse Flow Requirements (DOI 1994a) – This document presents the flow targets developed at the May 1994 workshop as well as general descriptions of the anticipated beneficial effects of the flow targets.
- Pulse Flow Requirements for the Central Platte River (Bowman and Carlson 1994) – This document is Appendix A to DOI 1994a. It is similar to DOI 1994a but expands slightly on the "necessary effects" of the flow targets.
- Rationale for Establishment of Channel Maintenance Requirements for the Platte River (DOI 1994b) – This document is Appendix B to DOI 1994a. It provides a summarization of the technical information, analyses and recommendations brought forward by experts at the May 1994 workshop.
- Videotape of May 1994 Workshop Expert Testimony – The NBS videotaped the expert testimony brought forward at the May workshop.

It has been difficult to link the specific pulse and peak target flow recommendations to a specific channel maintenance approach or response objective such as a targeted width. It appears that that the Service relied heavily on the expert testimony at the May workshop, melding the various channel maintenance approaches, objectives and flow recommendations (magnitude, timing and duration) into the final target flows. The result is a pulse and peak flow regimen that includes many of the flow magnitudes presented by experts at the workshop, but not always with the same rationale, timing, or duration. Tables 1 and 2 from DOI 1994a have been reproduced on the following pages as Figures 8 and 9 and present the pulse and peak target flow recommendations for the May – June and February – March periods.

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[21] Bowman 1994. Page 4.

Table 1. Pulse flow recommendation for the central Platte River Valley ecosystem during May and June.[+]

	Period	Flow (cfs)	Duration (days)	Frequency (yrs) Exceedence (%)
very wet	May 1 - June 30*	≥ 16,000	5**	1 in 5 (20%)
wet	May 1 - June 30*	≥ 12,000	5**	1 in 2.5 (40%)
normal	May 20 - June 20	≥ 3,000	7-30***	3 in 4 (75%)
dry	May 11 - June 30	none****		all remaining(100%)

+ Pulse flows build upon base instream flows provided by the Department in May 19, 1994, revised section 10(j) recommendations.

* At least 50% of these pulse flows should occur during May 20 to June 20, with May 1 to June 30 as the timeframe for broadest benefit for channel maintenance and instream and wet meadow habitats. Occurrence between February 1 and June 30 would accomplish the necessary effects for channel maintenance. The 10-year running average for the mean annual pulse flow targets should range from approximately 8,300 cfs to 10,800 cfs.

** The duration of these pulse flows should emulate the historic, natural pattern: (a) ascended over approximately 10 days, (b) cresting for approximately 5 days, and (c) descending over approximately 12 days.

*** The target is for a 10-year running average for the 30-day exceedence flow (i.e., 10-year running average of the level exceeded for 30 consecutive days) of at least 3,400 cfs. A flow of 3,000 cfs should be exceeded for 7-30 days in at least 75% of the years. These flows should be followed by descending rate approximating 800 cfs/day.

**** No pulse flows during May and June in driest years; target flows in the Department's revised section 10(j) recommendations May 18, 1994, apply under dry year conditions.

Figure 8. Reproduction of Table 1 from DOI 1994a.

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Table 2. Pulse flow recommendation for the central Platte River Valley ecosystem during February and March.[+]

	Period	Flow (cfs)	Duration (days)	Recurrence(yrs) Exceedence (%)
very wet	Feb 1 - March 31	≥ 16,000*	5**	1 in 5 (20%)
wet	Feb 15 - March 15	≥ 12,000*	5**	1 in 2.5 (40%)
normal	Feb 15 - March 15	3,100-3,600	30	3 in 4 (75%)
dry	Feb 15 - March 15	2,000-2,500	30	all remaining (100%)

+ Pulse flows build upon base instream flows provided by the Department in May 19, 1994, revised section 10(j) recommendations.

* At least 50% of these pulse flows should occur during May 20 to June 20, with May 1 to June 30 as the timeframe for broadest benefit for channel maintenance and instream and wet meadow habitats. Occurrence between February 1 and June 30 would accomplish the necessary effects for channel maintenance. The 10-year running average for the mean annual pulse flow targets should range from approximately 8,300 cfs to 10,800 cfs.

** The duration of these pulse flows should emulate the historic, natural pattern: (a) ascended over approximately 10 days, (b) cresting for approximately 5 days, and (c) descending over approximately 12 days.

Figure 9. Reproduction of Table 2 from DOI 1994a.

Since publishing these target flows, the Service has further divided them into pulse flow and peak flow categories, classifying lower magnitude (<4,000 cfs) and longer duration (> 7 days) flows as pulse flows. The higher magnitude and shorter duration flows have been classified as peak flows. Although not a component of the original target flow recommendations, the Service has indicated in the Program Water Plan Reference Materials that they consider the Short-Duration High Flow to be a peak flow. For the sake of consistency with the current recommendations, the two categories of flow targets will be discussed separately.

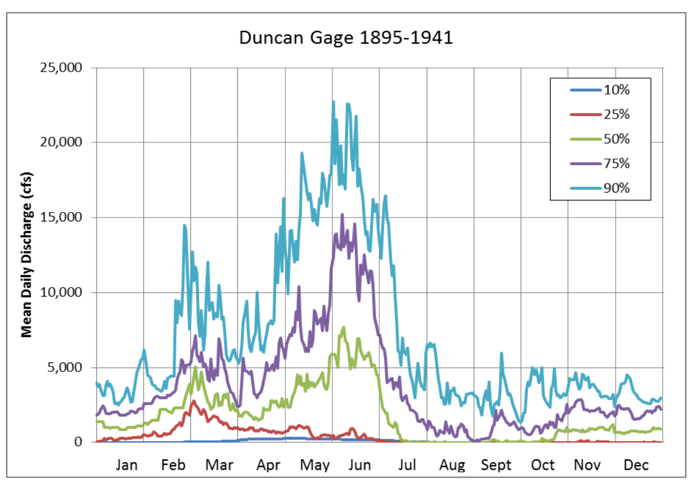

Figure 10. Duncan gage discharge percentile analysis.

Pulse and Peak Flow Periods

As mentioned previously, during the March 1994 workshop the Service identified and prioritized two pulse/peak flow periods of February - March and May – June. Although not explicitly stated, two flow periods were likely identified in order to mimic the natural hydrograph of the central Platte River. See Figure 10 for an EDO percentile analysis of discharge records for the Duncan gage

(USGS 06774000) from 1895-1941, which shows evidence of two runoff periods. The early runoff period was likely driven by local snowmelt and a late runoff period driven by snowmelt in the mountainous headwaters of the river. Analysis of Overton gage (USGS 06768000) records prior to the construction of Kingsley Dam (1930-1941) does not show two clearly defined runoff periods. However, the period of record is much shorter at 11 years and occurs during the drought years of the 1930s.

February/March Pulse Flows

The Service's pulse flow recommendations indicate that releases in the late winter period of February and March are necessary to provide the following beneficial effects[22]:

1. Bring groundwater levels in grasslands up near to soil surface in areas of grassland and above soil surface in lowest areas of grasslands. One effect of this is to bring up soil organisms to near or above the soil surface for predation by migratory birds and other animals, and to provide pooled water for other aquatic organisms preyed upon.
2. Cause and/or contribute to break up of ice and move ice for the effect of scouring vegetation off sandbars in the active channel; this effect is especially important in years of low flow.
3. Redistribute sediment in the active channel and maintain the geomorphology of the channel.
4. In year with little or no ice formation, pulse flows are necessary for soil saturation in meadows.

These beneficial effects are generally associated with the flow period and not the specific pulse or peak flow targets. As such, it is challenging to determine which beneficial effects are associated with each target. For example, it is unclear what level of channel maintenance the Service expected a flow of 3,600 cfs for 30 days to accomplish as compared to a flow of 16,000 cfs for 5 days. The only way to associate the anticipated beneficial effects to the various targets is to link the specific discharges to the expert testimony and DOI 1994b. For example, if one of the experts testified at the workshop that a flow of 3,100 cfs in February was necessary for wet meadow recharge, and that was the sole mention of a low magnitude release during that period, the target would necessarily be associated with beneficial effects 1 and 4 above.

February 15 – March 15 Normal Conditions Target Flow (3,100-3,600 cfs for 30 Days)

This flow target can be linked to three of the four beneficial effects discussed above. The primary rationale for the flow target is related to effects 1 and 4, which are essentially wet meadow maintenance.

Wet Meadow Maintenance

At the May workshop, Larry Hutchinson of NGPC provided testimony regarding that agency's 1993 instream flow application to NDWR for wet meadow maintenance. NGPC requested flow allocations of 3,100 cfs in February, 3,600 cfs in March, and 3,200 cfs in April. None of the other experts recommended late winter targets of this magnitude. The Service and NBS panel questioned Mr. Hutchinson about the analysis that led to the discharges in the instream flow application. He stated that Ross Locke of NGPC had been responsible for the wet meadow analysis but he (Hutchinson) thought that it was based on groundwater elevations in wet meadows and studies of the hydrograph, possibly protection of some flow exceedance level.

[22] Bowman and Carlson 1994. Page 4.

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Review of the 1998 NDWR order regarding the NGPC instream flow application indicates that NGPC developed the flow targets based on research conducted by Thomas Wesche, Quentin Skinner and Robert Henszey, which was published in a document titled Platte River Wetland Hydrology Study (Wesche et al 1993). Mr. Henszey provided testimony at the May workshop but did not elaborate on the methodology used to develop the flow targets. He did state that the analysis was not based on targeting a range of groundwater distributions for maintenance of specific biologic processes but did recommend doing so in the future if the processes could be identified and quantified.

A related document (Zuerlein et al. 2001) indicates that the requests were based on a monthly flow exceedance analysis at the Grand Island gage for the period of 1942 to 1992. NGPC staff presented that document on instream flow rights for the Platte River at the 2001 Platte River Basin Ecosystem Symposium. It states that the original flow application was based on protection of mean monthly flows that occurred 85% of the time during the period of 1942 to 1992. After recreating the analysis (see Table 1), it appears that the application was based on protection of 85th percentile flows, which are flows that occurred 15% of the time during that period. The flow application was subsequently reduced by NGPC prior to being denied by NDWR.

Table 1. 1942-1992 Flow Exceedance at Grand Island.

Month	85% Exceedance	15% Exceedance	NGPC Instream Flow Application
February	1,090 cfs	3,070 cfs	3,100 cfs
March	1,286 cfs	3,593 cfs	3,600 cfs
April	837 cfs	3,155 cfs	3,200 cfs

Ice Scour of Vegetation

During his testimony at the May workshop, Carter Johnson related key findings of his long-running tree demography study in the central Platte River (Johnson 1994). He stated that ice scour was the primary cottonwood seedling mortality factor during the study, accounting for up to 98% of annual mortality. He recommended flows on the order of 2,000 – 2,500 cfs at the time of ice breakup to facilitate ice scour at higher elevations in the channel. He also warned that reductions in winter flows would negatively impact ice-related vegetation scour, which currently plays an important role in channel width maintenance.

Redistribution of Sediment in Active Channel

It is not clear if or how the Service envisioned a flow of 3,100 - 3,600 cfs contributing to maintenance of channel morphology through sediment redistribution. DOI 1994b does not include any mention of 3,100 – 3,600 cfs magnitude flows during the February – March timeframe. The only relevant discussion in that document is in relation to effective discharge calculations performed by Lyons and Randle (1988) for water years 1926-1939, 1940-1957, and 1958-1986 at the Overton gage. Effective discharge is the flow (during some period of time) that transports the largest fraction of the bed-material load and can be used as an estimator for channel-forming discharge (Biedenharn et al. 2000). Lyons and Randle concluded from their analysis that for the period of 1926-1939, effective discharge was 3,900 cfs and subsequent periods both had effective discharges of approximately 1,600 cfs. However, a unimodal distribution with a distinguishable peak was absent for the later periods; leading them to conclude that a range from 1,000 cfs to 10,000 cfs now provides a good span of channel-forming flows in the Platte River. The Service subsequently indicated in

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DOI 1994b that this analysis demonstrates that all flows above 1,000 cfs have importance in maintaining the existing channel.[23]

The EDO attempted to recreate the effective discharge analysis and was unable to do so as the USGS does not provide published flow records for 1926-1930 at the Overton gage. The analysis was recreated for the period of 1931-1941 and the computed effective discharge was 2,600 cfs. This demonstrates the challenge of attempting to associate historic channel characteristics like width with effective discharge.

February 15 – March 15 Dry Conditions Target Flow (2,000 – 2,500 cfs for 30 Days)

The primary rationale for this flow target appears to be related to beneficial effect 2, ice scour of vegetation. The 2,000 – 2,500 cfs magnitude matches Carter Johnson's flow recommendation at the May workshop to encourage ice scour of vegetation in the active channel.

May/June Pulse Flows

The Service's pulse flow recommendations indicate that releases in May and June are necessary to provide the following beneficial effects[24]:

1. Maintain and enhance the physical structure of wide, open unvegetated, and braided river channel characteristics for resting, feeding, and roosting by migratory birds
2. Maintain and enhance the occurrence of soil moisture and pooled water during the growing season for lower trophic levels of the food chain in low grasslands and for biologically diverse communities in the ecosystem over the long term.
3. Help maintain and rehabilitate aquatic characteristics of large river habitats in the lower Platte River for animals such as the endangered pallid sturgeon.
4. Maintain and rehabilitate backwaters and side channels as spawning and nursery habitats; to promote critical stages in the life cycles of fishes, mollusks, and other aquatic organisms; to promote movement and (re)distribution of fishes, mollusks, and other aquatic organisms; and to facilitate nutrient recycling in the floodplain.

As with the February – March period, these beneficial effects are associated with the flow period and not the specific pulse or peak flow targets. Accordingly, the expert testimony and supporting documentation was used to identify the rationale behind the recommendations. The beneficial effect of channel maintenance can be linked to all of the May – June peak flow recommendations based on the expert testimony at the May workshop. No information was found that links the flow recommendations to specific improvements associated with beneficial effects 2 – 4.

May 20 – June 20 Normal Conditions Target Flow (>3,000 cfs for 7-30 Days)

The rationale behind the magnitude of this target flow appears to be testimony by Carter Johnson at the May workshop. He recommended mean flows of 3,000 cfs during the month of June for channel maintenance, indicating that flows of this magnitude cover the majority of the active channel and prevent cottonwood

[23] DOI 1994b. Page 14.
[24] Bowman and Carlson 1994. Page 3.

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seedlings from germinating. This testimony was corroborated by Bob Simons, who testified that episodes of vegetation encroachment into the active channel in the 20th century correlate more closely to mean June flows than to the magnitude of peak flows. Both experts testified that once vegetation becomes established, it is very hard to remove. This is demonstrated by the tendency of the central Platte to episodically narrow but not substantially re-widen during periods like the 1970's and early 1980's when significant flow events occur (Simons & Associates 2000).

Although the magnitude of this target matches Johnson's recommendation, the timing does not. Johnson testified that it is critical to maintain flows on the order of 3,000 cfs through the end of June because that is the peak period for cottonwood germination. He warned that peak flows that descend through the later part of June would actually encourage cottonwood recruitment as seeds would be deposited on bare moist sandbars that are ideal for germination.

The rationale behind the selection of the period of May 20 – June 20 for the flow target is not known and would be an area where Service clarification would be useful. In Bowman and Carlson 1994, the Service states that; "Recruitment of cottonwoods should be managed by the magnitude of pulse flows rather than by continuous inundation of the active channel during the period of seed deposition and viability." The document does not elaborate further on this statement or provide justification. This statement does, however, provide a possible indication of why this pulse flow period does not match the recommendations by Johnson and Simons. The stated rationale for the duration of 7-30 days is based on providing "minimal conditions for anaerobic processes required by hydrophytic plants." No additional information is provided in relation to this minimal requirement.

Peak Flow Recommendations

The Service's peak flow recommendations appear to be based on testimony by Jim O'Brien at the May workshop. However, in Bowman and Carlson 1994, the Service modified some dates associated with O'Brien's testimony. It is not clear if O'Brien provided additional documentation at the workshop that supplemented his testimony or if the Service modified O'Brien's testimony for some reason. The Service also states in Bowman and Carlson 1994 that the peak flow recommendations were "based on an average of channel maintenance properties computed for the Platte River with five different approaches." No additional information is provided in the Service documentation and O'Brien provided no testimony regarding channel maintenance computations so the nature of these analyses is not known.

Peak Flow Magnitude and Frequency

During his testimony, O'Brien recommended the following peak flow magnitudes and associated rationale:

1) 10-year mean peak of 8,300 to 10,800 cfs – O'Brien recommended this range of mean annual peaks as a slight improvement of hydrology during the period of 1957-1983 which produced a mean annual peak of 7,300 at Overton and 8,100 at Grand Island. O'Brien did not associate specific channel maintenance objectives or benefits with this target other than to say that it is an improvement over existing hydrology.
2) 12,000 - 16,000 cfs peak in approximately 1 out of 1.5 - 3 years – O'Brien indicated that he calculated bankfull discharge in the Overton to Grand Island Reach and it ranged from 12,000 to

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16,000 cfs. The flow target was intended to slightly exceed bankfull discharge for the purpose of maintaining biological integrity of bottomland areas like sloughs and wet meadows and at least cover all in-channel sandbar features with flow. During his testimony, he identified several potential frequencies for this magnitude of flow ranging from every 1.5 years to every 3 years. No specific channel maintenance benefits or expected responses were discussed.

3) Periodic peaks exceeding 16,000 cfs – O'Brien referred to this magnitude of flow as "slug flows" and recommended it because he felt the system responded favorably to large flows in the early 1980s. He did not discuss specific responses or benefits of those flow events or of flows of this magnitude generally.

The Service incorporated all of these recommendations into their final pulse flow targets; assigning a frequency of 1 in 2.5 years to the 12,000 cfs recommendation and 1 in 5 years to the 16,000 cfs recommendation.

Peak Flow Duration and Timing

The duration of the pulse flow recommendations was also taken from O'Brien's testimony. He testified that an analysis of flow events at Overton for the period of 1918-1930 identified an average duration at peak of 5 days with a rising limb lasting 10 days and a receding limb that lasted 12 days on average. He also indicated that peak flows should occur during the second or third week in June. When asked about the importance of a February – March peak, he indicated that it was not important unless it mimicked ice breakup conditions. It is not known how the Service determined that a portion of the peak flows should occur in the February – March period as opposed to the May – June period.

Average Peak Flows versus Peak Flow Recurrence

The Service's peak flow recommendations include a mix of average flow recommendations and peak flow recurrence recommendations. It is important to understand the difference between these calculations and the potential implications for flow management. The average peak flow is simply an average of the peak discharge over some number of years. This calculation provides little insight into the actual distribution of peak flow magnitudes over the period of analysis. Alternatively, a peak flow recurrence (or exceedance) analysis provides an estimation of the frequency of the full range of peak discharges for the period of interest. For example, the average annual peak flow at Grand Island for the period of 1969-1986 is 9,124 cfs. The exceedance probability of a discharge of 9,100 cfs during the same period is approximately 38%, which equates to a frequency of 1 in 2.6 years. The Q1.5 during that period was 6,000 cfs.

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Possible Next Steps

There at least four potential approaches to examining the Service's target flows:

1. Undertake an independent peer review of the science used as the rationale for each of the targets.
2. Expand the PHABSIM modeling into a full IFIM analysis for the central Platte River including all of the steps that were not used by the Service during the development of the original target flows.
3. Abandon the current models and methods in favor of an alternative approach like normative flow analysis that focuses on shifting the hydrograph toward pre-development conditions.
4. Test target flows within a rigorous adaptive management framework.

Each one of these approaches would have obvious (and not so obvious) challenges and advantages and would have to be vetted and agreed to by the Governance Committee. A logical next step would be to begin the discussion of possible approaches at the committee level culminating in a recommendation to the Governance Committee.

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ATTACHMENT B

2012 ISAC Recommendations on Target Flows

ISAC Answers to Questions on Target Flows (from ISAC/TAC meeting on July 11, 2012 in Kearney NE)

1. Do we push ahead with existing target flows using objective from May / June 2012 workshops?
    a. No. Focus on implementing SDHF flows to the degree that you can, given the conveyance constraints. SDHF is a priority of the AMP, and until it's tested, the AMP will not be implemented.
    b. Continue to evaluate key issues that have implications for target flows (e.g., lateral erosion, bird habitat selection) by analyzing monitoring data, and doing other analyses of target flows.

2. Do we "peer review" target flows and consider revising / updating existing target flows?
    a. We don't think that a peer review would be the best way forward at this time; a peer review would be very critical of the existing target flows, as the assumptions, data and methods used to derive these flows in 1994 are out of date. A peer review of methods derived in 1994 would not provide a way forward, and parts of these methods have already been peer-reviewed. The form and timing of an alternative process should be determined by the Program, but could easily take 2 years to complete. A possible Target Flows Process is outlined below under Oct. 9 Discussion. This draft Target Flows Process includes peer review and the gradual evaluation of alternatives and the selection, application, and documentation of an agreed-upon approach.

3. Do we consider a normative flow approach as suggested in the NRC report?
    a. We think that a hybrid approach (revised species-specific flow targets + normative approach for ecosystem processes supporting these species) should be considered as an option to meet the species-focus of the PRRIP. By including aspects of normative flow, the PRRIP can move towards an integrated, species-focused, and ecosystem-based approach, as recommended by Bowman (1994) and Bowman and Carlson (1994), but building on recent knowledge. Bowman (1994, pg. 2) noted that: "while the information used by the Service in formulating target flows is the best available, continual acquisition and analysis of scientific and habitat management information are necessary". The process described below would help to organize new information and concepts in a structured manner. (See **Exhibit B** for the two documents referenced in this section.)

ISAC - Oct 9, 2012 discussion of Target Flows Process (Omaha): rationale and timeline, expectations management, steps and outputs

4. **Rationale - Why do this process?**
    a. Program Document says that target flows will be evaluated through AM (Program Document (pg. 4): "DOI and the states agree that FWS' target flows will be examined through the Adaptive Management Plan and peer review and may be modified by FWS accordingly." Doing the target flow evaluation as part of the preparation for the Second

Increment will be more efficient, as it will provide a defensible scientific foundation for negotiations.

b. PRRIP and investigations in other rivers have provided a lot more information and tools than existed in 1994, which can be helpful for determining target flows. The 1994 report said that target flows should be revised as knowledge increases. Assumptions in the 1994 report could easily be challenged with new information by outside parties. The channel has changed considerably since the late 1980's and early 1990's. Existing target flows cannot be met with the hydrology of the last 70 water years (1941-2011; see **Exhibit A**).

c. Updating target flows with more recent knowledge can lead to more creative and effective decisions about water use (from both a cost and species perspective), with increased flexibility to examine options that could meet these targets in a practicable manner. Federal agencies are required to use best available science (e.g., ESA Section 7), which has advanced considerably since 1994.

d. The Program has functioned well through continued collaboration and involvement of all parties at both technical and GC levels. Re-examination of target flows would continue the well-functioning process in the Platte, moving at a gradual pace with close GC collaboration. A possible timeline could be:

- **i.** 2013: education about process and planning for target flow evaluation; GC review, revision and (hopefully) approval
- **ii.** 2014-2015: target flow evaluation process gradually ramps up, applying tools and knowledge developed in First Increment to develop revised target flows.
- **iii.** 2016-2018: negotiations for Second Increment, including implementation of revised target flows.

e. A scientifically defensible, carefully-considered approach can provide long term stability and certainty for the Second Increment, providing a smooth transition from the First to Second Increment. Without the proposed Target Flow Process, there won't be a firm scientific foundation for the Second Increment.

f. The scoring of alternative projects and the other decisions based on existing Target Flows in the First Increment would not be affected; application of revised Target Flows in the Second Increment would affect scoring and other decisions, but only in the Second Increment.

5. Manage expectations

a. Gain knowledge about alternative approaches (not necessarily getting THE answer)

b. Look at strengths and weaknesses of different approaches

c. Evaluate and potentially revise existing PRRIP conceptual models for the target species based on habitat needs, life histories, and important riverine process (e.g. flow regime, sediment transport, nutrient supply) that create/maintain habitat and the target species' survival, growth, and reproduction.

d. Gradually converge to small set of approaches that are worth applying to the Platte River

6. **Draft Steps in the Target Flows Process (Outputs bolded)**
   - **a.** EDO does further homework on target flows and distributes a **summary of relevant info** to TAC (e.g., EDO analysis, IHA, Anderson report, etc.)
   - **b.** **Carefully select leading scientists** who are practical, neutral, have applied concepts in different systems, and who won't just present same old stuff.
   - **c.** **Pre-symposium webinars** to prep all of the potential presenters on all of the hard and soft **constraints in the Platte River**; push presenters toward addressing real context of Platte River.
   - **d.** **Pre-symposium webinars** to brief Program participants on **scientific basis of dominant environmental flow approaches**
   - **e.** **Symposium**: focus on presentations and discussion of approaches that provide practical adaptations of environmental flows to Platte River. Purpose of symposium would be educational. Educate everyone on:
     - **i.** natural flow regime
       1. Environmental Flow Methodologies (E-flows)hydrological
       2. hydraulic rating
       3. habitat simulation
          - a. IFIM
          - b. PHABSIM
       4. holistic methodologies
          - a. Building Block Methodology (BBM)
          - b. Downstream Response to Imposed Flow Transformations (DRIFT)
          - c. Savannah Process
     - **ii.** hybrid approaches [Trinity, Sacramento, others]
     - **iii.** retrospective modeling approaches to apply different methods
     - **iv.** comparison of different approaches
     - **v.** **better understanding of methods**, strengths and weaknesses of alternative approaches for the Platte, ability to combine species' needs and ecosystem process needs
     - **vi.** <u>**Report to GC**</u> **–** summary of symposium, recommendation on way forward (includes written review by ISAC), potential peer review
   - **f.** **PRRIP workshops** to develop conceptual model & hypotheses, using a variety of approaches (e.g., building on previous conceptual models for each focal species and the AMP, vs. beginning with whole system and then whittling down what's required for focal species), with frequent GC updates;
   - **g.** sequence of PPRIP analyses (e.g., retrospective & prospective modeling) and meetings to explore, develop and converge on **species-specific flow targets**, building support gradually, with frequent GC updates;
   - **h.** **technical report** documenting results and rationale, with summary to GC;

i. **peer review** of the technical report, following the methods described in Attachment A of the AMP. As revised flow targets would potentially have bearing on major policy decisions, the peer review of the revised target flow document should follow the OMB and USFWS guidelines for such documents (see OMB 2004, USFWS 2004).
j. **Provide support to negotiations** on management actions and operating rules for the Second Increment.

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