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very critical of the existing target flows, as the assumptions, data and methods used to derive these flows in 1994 are out of date.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.** <u>Gradually</u> 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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Office of Management and Budget. 2004. Final Information Quality Bulletin for Peer Review. December 16, 2004. 45 pp. http://www.whitehouse.gov/sites/default/files/omb/memoranda/fy2005/m05-03.pdf

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PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

EXHIBIT A

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.

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].

Figure 1. Average species and annual pulse flow targets

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.

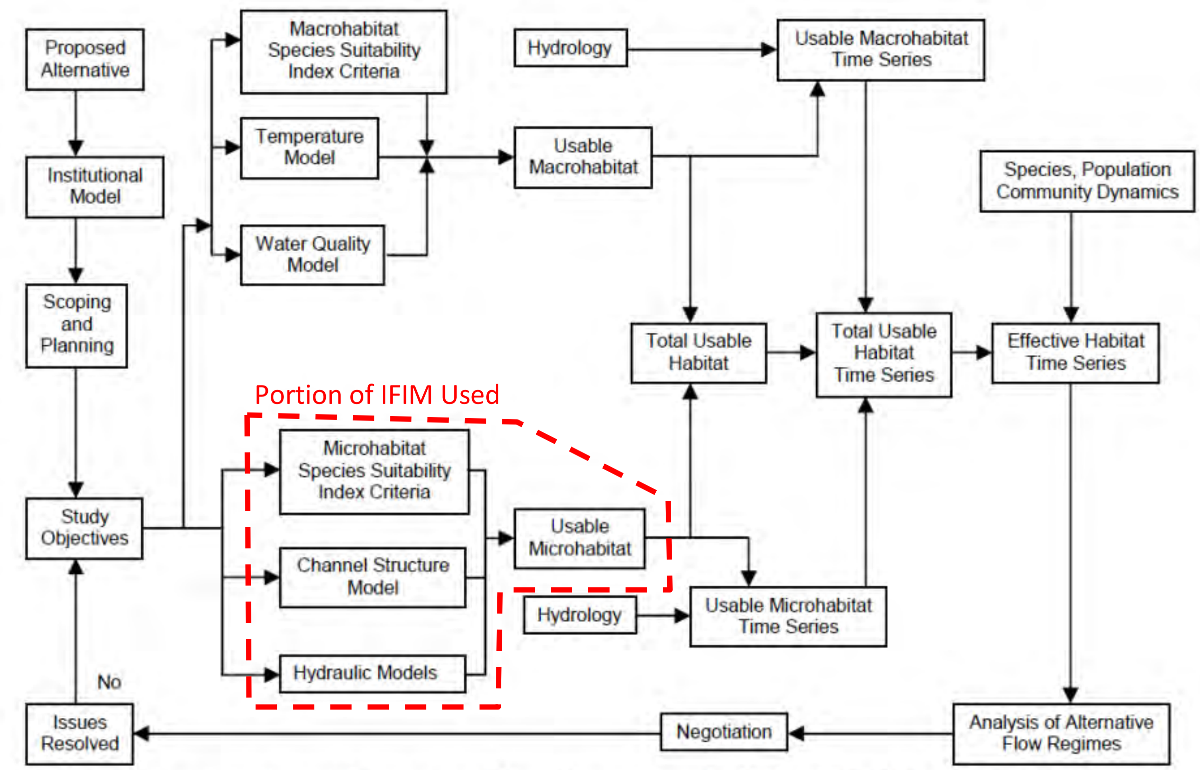

Figure 4-17 Basic operations of Instream Flow Incremental Method (IFIM) used by DOI agencies to define recommended flow magnitudes, frequency, duration, and timing. Source: Waddle 2001.

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.

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

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[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.

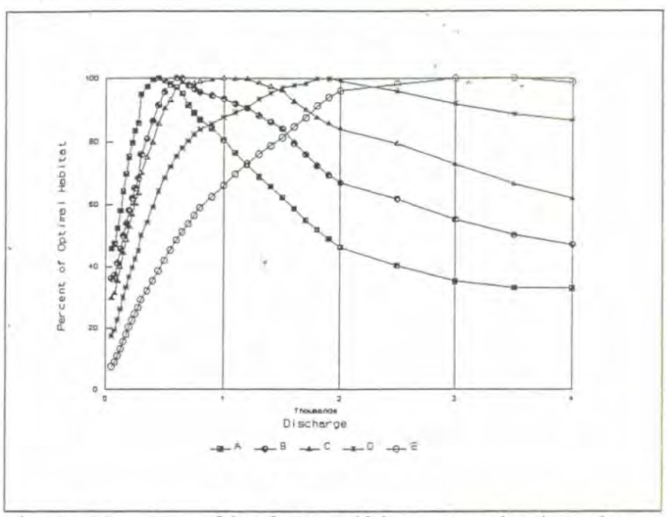

Figure B3. Normalized HA guild curves showing the percent of optimal habitat as a function of discharge for five guilds (A-E) during the fall BSP.

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.

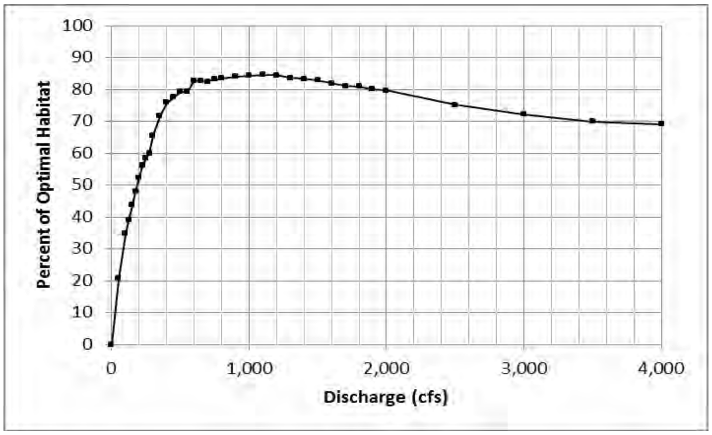

Figure 5: Averaged HA curve showing the percent of optimal habitat as a function of discharge for all guilds.

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.

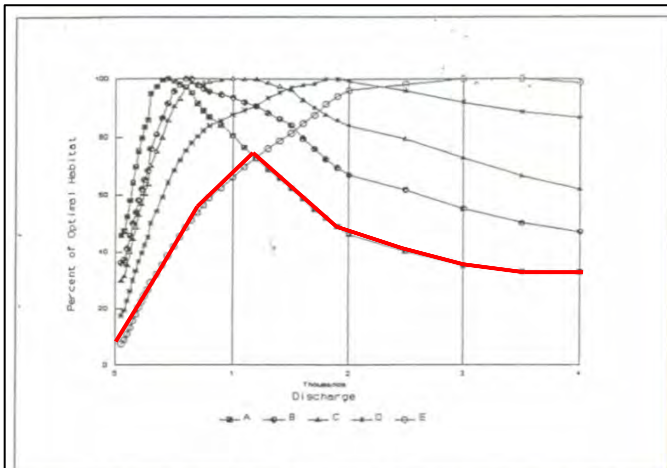

Figure B3. Normalized HA guild curves showing the percent of optimal habitat as a function of discharge for five guilds (A-E) during the fall BSP.

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.

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.

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

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.

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.

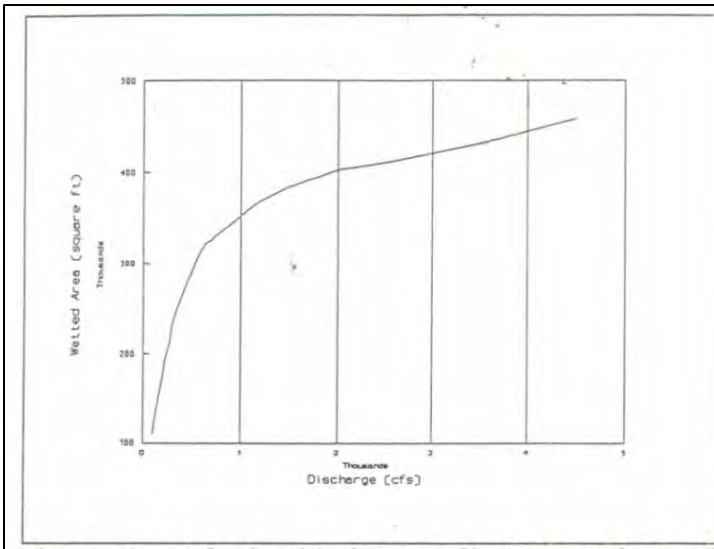

Figure E1. Relationship between discharge and wetted channel area for segments of the central Platte River frequently used by nesting least terns and piping plovers.

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.

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.

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

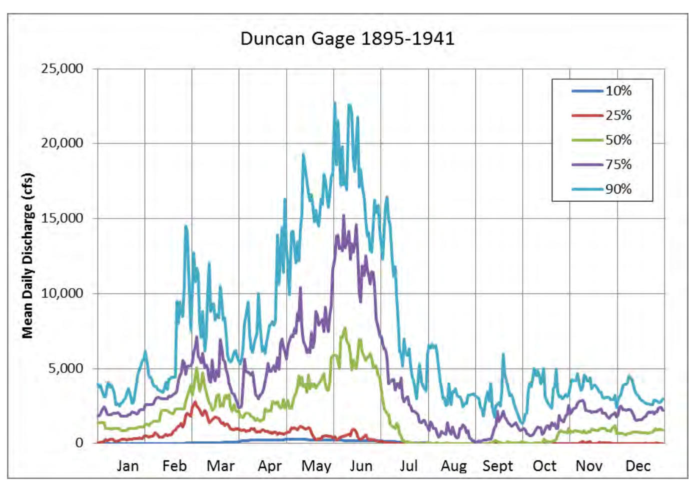

Figure 10. Duncan gage discharge percentile analysis.

(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.

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

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.

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

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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PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM

EXHIBIT B

Target Flow Background Documents:

Bowman, 1994
Bowman & Carlson, 1994

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Nebraska Public Power District (Project No. 1835)
and
Central Nebraska Public Power and Irrigation District (Project No. 1417)

THE DEPARTMENT OF THE INTERIOR'S AMENDED COMMENTS UNDER SECTION 10(j) OF THE FEDERAL POWER ACT

Comes now Intervenor Department of the Interior (Department), by and through the undersigned counsel, and respectively submits the Department's amended section 10(j) recommendations on the subject projects. These recommendations, which were prepared by the U.S. Fish and Wildlife Service (Service), are submitted for the purposes of amending the Department's original section 10(j) recommendations submitted to the Federal Energy Regulatory Commission (FERC) on November 15, 1990, and supplementing the revised section 10(j) recommendations submitted to FERC on May 19, 1994. These comments and recommendations are provided under the authority of section 10(j) of the Federal Power Act and section 2 of the Fish and Wildlife Coordination Act, 16 U.S.C. 662.

The Department reserves the right to modify, add to, or delete the recommended measures described in this filing, pending the completion of Endangered Species Act consultation, receipt of new information during the National Environmental Policy Act process, and/or completion of additional studies/analyses. This letter does not constitute the Service's biological opinion required by section 7(a)(2) of the Endangered Species Act (16 U.S.C. 1536(a)(2)) or meet the other requirements of section 7 or its regulations at 50 CFR 402.1 et seq. However, when section 7 consultation is formally initiated, this data will be used because it represents the best scientific and commercial information currently available.

The Department's revised section 10(j) recommendations, dated May 19, 1994, stated, "The Department will provide additional rationale for the prioritization of its instream flow recommendations under separate cover." That additional rationale, based on information obtained subsequent to the 1990 recommendations, is provided in Enclosure 1 to this letter and is entitled "Instream Flow Recommendations for the Central Platte River, Nebraska," dated May 23, 1994.

The Department's letter to FERC on May 19, 1994, also stated:

"The Service has determined that pulse flows are necessary to sustain the physical and biological integrity of the central Platte River ecosystem. The Service also has identified pulse flows as the highest priority for the central Platte River and is currently in the process of determining pulse flow targets. Flow recommendations for pulse flows will be forwarded to the Commission as soon as they are developed."

The recommendations and rationale for pulse flows are described in Enclosure 2 and its appendices. This information supplements the revised flow recommendations provided in the Department's May 19, 1994, letter to FERC and is being submitted to FERC because it is new, significant, pertinent scientific information that has been collected and analyzed. This information is important to consider when analyzing and mitigating the environmental impacts of the projects and when determining how to conserve fish and wildlife resources affected by the projects.

The analytical methods used to identify the pulse flow targets were selected with a view toward the river as an ecosystem. Pulse flows are needed to provide a riverine environment that will support the recovery of federally listed species and the conservation of nonlisted native species. The pulse flow targets were based on the best biological judgment of ecosystem needs. **The Department requests that the licensees manage water releases from Lake McConaughy and other project facilities to maximize the occurrence of the pulse flow targets, described in Enclosure 2, at the Grand Island gage.** However, the Department does not expect the licensees will be able to meet the flow targets 100 percent of the time.

Appendix A to Enclosure 2 is the report which presents the results of the workshop that was conducted to determine pulse flow needs. Appendix B to Enclosure 2 is a report which further supports the need for pulse flows; it describes the importance of flows which help maintain the channel in the remaining braided, unvegetated reaches of the river.

In addition to the pulse flow recommendations, the Department also is providing comments regarding changes to other license conditions recommended by the Department in its November 15, 1990, section 10(j) letter. These revisions are described in Enclosure 3 to this filing, entitled "Revisions to the Department of the Interior's Previous Section 10(j) Recommendations." These revisions are necessary because of the new information that was provided in the Revised Draft Environmental Impact Statement (RDEIS) for the subject projects.

Enclosure 3 also provides the Department's prioritization of those recommended measures. The Department believes that FERC should include all priority 1 and 2 conditions as part of the licenses for Project Nos. 1835 and 1417. Priority 1 and 2 recommendations focus on restoring and maintaining the structure and function, patterns and processes, and habitat of the Platte River ecosystem.

The Department believes that ample justification for inclusion of these recommendations as terms and conditions in the licenses has been provided to FERC. The Department also believes that these measures, which are being submitted prior to any preliminary determination of inconsistency with applicable law, can be implemented without appreciably affecting current project purposes and, thus, are not inconsistent with the requirements of the Federal Power Act.

If FERC should determine that any of the Department's recommendations are inconsistent with the purposes and requirements of the Federal Power Act, as amended by the Electric Consumers Protection Act, it is requested that Mr. Robert L. McCue, Field Supervisor, U.S. Fish and Wildlife Service, 203 W. 2nd Street, Federal Building, Grand Island, Nebraska 68801, (308) 382-6468, be contacted to resolve the inconsistencies.

Respectively submitted,

Margot Zallen

Margot Zallen
Department Counsel
August 11, 1994

Enclosures

cc: Official Service List

Enclosure 1

INSTREAM FLOW RECOMMENDATIONS
FOR THE
CENTRAL PLATTE RIVER, NEBRASKA

by David Bowman

May 23, 1994

Instream Flow Recommendations
for the
Central Platte River, Nebraska
by
David Bowman

May 23, 1994

BACKGROUND

This report presents the results of a workshop held March 8-10, 1994, at the National Ecology Research Center of the National Biological Survey (NBS), Ft. Collins, Colorado. The purposes of the workshop were: (a) to identify the U.S. Fish and Wildlife Service's (Service) resource conservation goal for which instream flow targets are needed; (b) to formulate the instream flow targets the Service will use in fulfilling its legislated responsibilities in the central Platte River Valley ecosystem; and (c) to prioritize these instream flow targets by season (see table 1) and by normal (average), wet, and dry years.

The need for this workshop was recognized by the Service during its preparation of instream flow recommendations to the Federal Energy Regulatory Commission and from comments received from representatives of the three Platte River Basin States during discussions about establishing a cooperative Platte River Recovery Implementation Program.

GOAL

The workshop participants concluded that the Service's goal related to the central Platte River Valley ecosystem is to rehabilitate and to maintain the structure and function, patterns and processes, and habitat of the central Platte River Valley ecosystem. This ecosystem-oriented approach includes the objectives of (a) recovering habitats of presently listed species, (b) preventing the need for listing of additional species, and (c) providing sufficient habitat for conservation of native biotic components of the ecosystem. This sufficiency of habitat corresponds to 10 habitat complexes described by the Biology and Management Alternative Workgroups of the Platte River Management Joint Study. Workshop participants rejected the objective of restoring the Platte River Valley ecosystem to its predevelopment condition.

This goal corresponds also with the Service's policy of conservation management at the ecosystem level and with purposes stated in section 2(b) of the Endangered Species Act of 1973, as amended: ". . . to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in subsection (a) of this section."

ASSUMPTIONS

The Service's goal incorporates five assumptions:

1. Flow targets formulated during the workshop are based upon the best information available to the Service in the form of empirical evidence, accepted scientific models, and professional judgment of Service and NBS personnel.

2. Conservation of Platte River listed and other native species is not separate from conservation of the Platte River ecosystem.

3. Conservation of the ecosystem is not separate from conservation of the biotic and abiotic components of the ecosystem.

4. Inadequate instream flows are the single most important limiting factor in the Platte River Valley ecosystem; thus, the Service's goal cannot be achieved without provision of the target flows described in table 1.

5. While the information used by the Service in formulating the target flows is the best available, continual acquisition and analysis of scientific and habitat management information are necessary.

RESULTS

The empirical evidence and accepted scientific models used by the workshop participants are described and/or referenced in the Service's correspondence dated May 18, 1994, to the Federal Energy Regulatory Commission and in the Service's draft biological opinion dated May 6, 1994, to the Rocky Mountain Region of the U.S. Forest Service.

The Service's target flows derived during the workshop are summarized in table 1. Persons who participated in the workshop and their respective role(s) are summarized in table 2. Four categories of stream flows were identified and described during the workshop: seasonal pulse, or peak, flows; seasonal flows characteristic of wet years; flows characteristic of normal, or average, years; and flows characteristic of dry years. Descriptions of normal (or average), wet, and dry years are given below, along with justifications for prioritizing target flows.

Dry Year Flows

Dry year flows were framed by using biological criteria. Dry year flows particularly limit the survival and life cycles of aquatic and wetland species, which are the species affected acutely by low flows. The fish community is the dry year target community because it is representative of aquatic species in the ecosystem and some fish species have life cycles of 3 years or less. Therefore, the judgment was made that dry year flows should not occur on the average more often than once every 4 years.

Dry year flows are intended to prevent loss of richness of aquatic species, especially fish and mollusks, and to prevent a major break in wetted width in whooping crane roosting habitat. Workshop participants relied principally on information regarding weighted usable area curves for fish guilds, data on relationship between flow and water temperature, interpretation of whooping crane model C4R, and on gauging station data from the central Platte River.

Wet Year Flows

Wet year flows were described as channel-forming flows greater than such flows in normal and dry years and as wet meadow sustaining flows. Implementation of the Service's goal requires that (wet year) channel-forming and wet meadow sustaining flows be exceeded on an average basis of 1 year out of 3 years. Wet meadows and fish and mollusks in the river channels are the wet year target communities because hydrologic and biologic processes which sustain wet meadows and fish and mollusks are dependent on higher flows. Channel characteristics and riverine community also are maintained by wet year flows. Wet year flows are thought to be more important than normal year flows because wet year flows mimic the historic hydrograph and, in so doing, produce hydraulic and biological effects critical to achieving the goal of conserving the ecosystem. The frequency and magnitude of extreme flow events in wet years should not be diminished.

Normal Year Flows

Normal year flows were described as those flows which are neither dry year nor wet year flows and which occur or are exceeded on an average basis at a frequency of 3 out of 4 years. Normal year flows provide some habitat for all communities in the ecosystem during all the seasons (time periods). Normal flows provide habitat for and sustain populations of most species in the ecosystem between episodes of dry and wet year flows. Extreme flow events, i.e., variations in magnitude, timing, and frequency of flows, in normal years should not be diminished.

Pulse Flows

Pulse flows occur at some magnitude and duration in wet, normal, and dry years. During normal and wet years, pulse flows inundate wet meadows, increase hydrophytic vegetation, scour vegetation, prevent nesting by shore birds at low elevations on sandbars, inundate backwater areas, form sandbars, and form and/or move ice. To maximize their effectiveness, pulse flows must be of sufficient timing, magnitude, and duration to scour seedlings off sandbars and prevent seed germination, as well as the response of the aquatic community, e.g., spawning fish. Pulse flows are thought to play the dominant role in the patterns and processes, structure and function, and habitat of the Platte River Valley ecosystem.

The magnitude and duration of pulse flows discussed included an average of 8,000 cfs for 5 days in June for channel maintenance; an average of 3,800 cfs during 61 days in May and June, an average of 5,800 cfs for 30 days during May and June, an average of 3,200 cfs during 60 days in February and March; and an average of 4,400 cfs during 30 days in February and March. Sandbars were formed in 1983-1984 at flows of about 20,000 cfs. Flows of 2,600-3,000 in June prevents germination of tree seeds. Flows of 6,000-8,000 cfs in February and March removes seedling vegetation. Approximately 23 percent of the time, flows in February and March are 2,950-3,700 cfs. The frequency, magnitude, and duration of extreme flow events which occur as variations in flows during February-March and May-June of normal and wet years should not be reduced.

Because of the importance of pulse flows in the Platte River ecosystem and the need to development additional, more specific information, the decision was reached to develop pulse flow targets during a separate workshop that includes other experts on this topic.

Rule Triggers

Rule triggers for determining whether a year is likely to fall in the category of wet, normal, or dry and for making water resource management decisions for each year type should be based on estimates of the present gross water supply plus estimates of independent measures of water supply, such as ground water, precipitation, and snowpack, comprising the gross water supply in the entire Platte River Basin. Rule triggers and flow management decisions based only on dependent variables such as reservoir storage, project-by-project capabilities, or projections of water availability from water projects likely would lead to water management decisions that reflect only dry year conditions and little operating flexibility.

JUSTIFICATIONS FOR FLOW TARGETS

May and June Pulse Flows:

Wet year priority = 1
Normal and dry year priorities to be determined

February and March Pulse Flows:

Wet year priority = 2
Normal and dry year priorities to be determined

Pulse flows which mimic the natural hydrograph are needed to restore, on a reduced scale, certain annual effects characteristic of the historic natural hydrograph. These natural surges in flows have been severely depleted since the predevelopment era. Pulse flows are necessary for sediment transport, for redistribution and deposition of sediment in the central Platte River, and for shaping channel morphology into wide, shallow channels. Pulse flows generate a diversity of habitats across the floodplain; 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, including threatened and endangered species. Timing of pulse flows coincide with or influence fish reproductive behavior and the availability and quality of spawning, nursery, and rearing habitat, including backwater habitat of fish and mollusks. Flow pulses, especially those which move ice and sediment, scour vegetation of different size and age classes and prevent reestablishment of vegetation.

May 11-September 15:

Wet year priority = 3
Normal year priority = 1
Dry year priority = 1

This period is when most life in the ecosystem face their most critical water shortages. Therefore, proportionately greater biological stress and ecological effects can occur if water is withdrawn or withheld from the ecosystem during this period. Maintaining the components of biological diversity, e.g., plants, invertebrates, fishes, and birds, during this period depends on the aquatic component of the ecosystem. Flows are needed to provide essential habitat components for threatened and endangered species, as well as other important native wildlife populations.

This period is when aquatic shore birds, such as the threatened piping plover and endangered least tern, are mating, nesting, and rearing young. Target flows for this period, particularly May 11 to June 15, help prevent shore birds from nesting at such low elevations in the river channel that their nests would be subject to flooding during subsequent intervals of higher flows caused by local rainfall and/or flow regulation practices. Instream flows provide a degree of barrier to terrestrial predators which would otherwise more easily prey on shore bird nests. During summer, instream flow targets prevent 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. The native fish community is a critical component in the ecosystem which has been harmed repeatedly by episodes of low flow during this time period in past years. The flow target for this period will prevent or reduce future harmful episodes to the aquatic community.

March 23-May 10:

Wet year priority = 4
Normal year priority = 2
Dry year priority = 2

Except for the earliest migrating geese, this period is the primary spring migration period for birds through this region. Flows contribute important nutritional and physiological conditions for birds preparing to breed. For example, wet meadows are undergoing primary production of invertebrates which are needed by cranes for protein. Whooping crane migration habitat has been severely degraded as a result of decreased flows and loss of night roosting habitat critical at this time. Flows during this period also provide sandhill crane habitat. This is the time of year when Eskimo curlews are most likely to use the Platte River. Flows during this period provide channel habitat for water-dependent organisms, including spawning fish, mussels, and migratory waterfowl, wading birds, and shore birds. Environmental education and ecotourism, e.g., crane watching, are very important public and economic values during this time.

February 1-March 22:

Wet year priority = 5
Normal year priority = 3
Dry year priority = 3

This is the second most important migratory bird season. Bald eagles forage in the river valley during this period. Flows provide migrating waterfowl and other bird species with suitable migration habitat. They also provide sandhill cranes with suitable roosting sites and feeding habitat in wet meadows. Water on the Platte River Valley ecosystem is of particular importance for early migrating waterfowl when Rainwater Basin wetlands are frozen, because it helps to disperse birds and reduce losses due to disease (avian cholera, botulism, etc.). Flows in this period also form and move ice, which scours vegetation and shapes the channel. Fish habitat also is provided by these flows. This period was not given a higher priority because suitable flows are often met with present conditions. However, it is important to note that other comparable springtime habitats have been eliminated or are rare, such as Platte River and North Platte River channel and wet meadow habitats west of Overton.

September 16-30:

Wet year priority = 6
Normal year priority = 4
Dry year priority = 6 (tie)

These flows will maintain and prevent loss of the native fish community and will promote survival of fish young-of-year.

October 1-November 15:

Wet year priority = 7
Normal year priority = 5
Dry year priority = 6 (tie)

Flows during this time period provide migration habitat for migrating waterfowl and other migratory bird species, e.g., fall whooping crane migration and roosting habitat. These flows also maintain aquatic life; for example, they promote growth of fish young-of-year. In prioritizing this period as number 6, it also was considered that this may have been a moderate or low flow period naturally and that whooping crane sighting data indicate that whoopers use the river less in fall than in spring. Consequently, a minority opinion was expressed that perhaps the normal and wet year targets could be the same as the present-day dry year target. However, flows in this period support waterfowl habitat and recreational activities, such as waterfowl hunting, that are important public values during this period.

November 16-December 31:

Wet year priority = 8
Normal year priority = 6
Dry year priority = 5

Flows during this period provide bald eagle feeding habitat and opportunities. These flows also maintain fish habitats necessary to support fish communities. The use of the Platte River by migratory birds and geese also was considered when prioritizing this time period. Goose hunting is an important public activity during this time period.

January 1-31:

Wet year priority = 9
Normal year priority = 7
Dry year priority = 4

Flows in this period provide foraging habitat for bald eagles and other raptors. Viewing of foraging bald eagles provides a public recreational benefit during winter conditions. January flows also promote the winter survival of the native fish community and aquatic insects. The flows form and move ice to scour vegetation and maintain the channel. Although it is recognized that base flows are important during this period, it was not ranked higher because flows are frequently adequate with present operations. A minority opinion was expressed that the dry year target flows during this period would be inadequate to sustain fish if severely cold weather occurred concurrently and froze the river to the extent that fish habitat deteriorated to the point of limiting fish survival.

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.

Table 2. Participants and their role in the March 8-10 workshop.

Name	Role	Agency
Ken Bovee	Aquatic Ecologist	NBS[1], Ft. Collins, CO
David Bowman	Platte River Coordinator	FWS[2], Grand Island, NE
Dennis Buechler	Regional Office Management	FWS, Lakewood, CO
Nina Burkardt	Process Facilitator	NBS, Ft. Collins, CO
Mark Butler	Platte River Hydrologist	FWS, Lakewood, CO
David Carlson	Fish & Wildlife Biologist	FWS, Grand Island, NE
Lee Carlson	Field Office Manager	FWS, Golden, CO
Kenny Dinan	Fish & Wildlife Biologist	FWS, Grand Island, NE
Lee Lamb	Process Facilitator	NBS, Ft. Collins, CO
Bob McCue	Field Office Manager	FWS, Grand Island, NE
John Sidle	Wildlife Biologist	FWS, Grand Island, NE
Claire Stalnaker	Aquatic Ecologist	NBS, Ft. Collins, CO
Johnathan Taylor	Process Facilitator	NBS, Ft. Collins, CO

[1] NBS = U.S. National Biological Survey

[2] FWS = U.S. Fish and Wildlife Service

Appendix A
(to Enclosure 2)

PULSE FLOW REQUIREMENTS FOR THE CENTRAL PLATTE RIVER

by

David Bowman and Dave Carlson
U.S. Fish and Wildlife Service

August 3, 1994

Pulse Flow Requirements
for the Central Platte River
by

David Bowman and Dave Carlson
U.S. Fish and Wildlife Service

August 3, 1994

INTRODUCTION

This report presents the results of a workshop held May 16-20, 1994 (May workshop), at the Midcontinent Ecological Science Center of the National Biological Survey (the Survey) in Ft. Collins, Colorado. The purpose of the workshop was to determine the pulse, or peak, flows needed to achieve the Service's flow-dependent goal for the central Platte River Valley ecosystem. This goal was established at an earlier, similar workshop held at the Survey in March 1994 (March workshop) to determine target flows for this ecosystem (Bowman 1994). This flow-dependent recovery goal is to rehabilitate and maintain the structure and function, patterns and processes, and habitat of the central Platte River Valley ecosystem. The goals for flow recovery complement landscape rehabilitation for listed species, comprising approximately 29,000 acres in 10 segments between Lexington and Chapman, Nebraska (Platte River Management Joint Study 1990 and 1993).

The Service determined at the March workshop that pulse flows in late spring and late winter were the highest and second highest priorities, respectively, for achieving its goal; however, it was decided also that a separate workshop with participation by experts on the occurrence and effects of pulse flows would be necessary to acquire and incorporate the best available information into the Service's decision on pulse flow targets.

Experts were invited to the workshop based upon recommendations to the Survey from the Service; the Service's recommendations were based upon Service contact with representatives of the three Platte River Basin States, Central Nebraska Public Power and Irrigation District, Nebraska Public Power District, Nebraska Game and Parks Commission, Platte River Trust, National Audubon Society, Bureau of Reclamation, Central Platte Natural Resources District, and Service field personnel. Survey and Service personnel participating in the workshop were selected by their respective agency. Observers also were invited to the workshop by the Survey and included any person expressing an interest in attending.

RESULTS

The results of the March workshop are presented as background information in Table 1. Table 2 includes the pulse flow recommendations from the May workshop for the highest priority annual timeframe of May and June. Table 3 includes the pulse flow recommendations for the second highest priority annual timeframe of February and March. Table 4 lists the experts who presented pulse flow-related information at the May workshop. Table 5 lists the Survey and Service personnel who participated in the May workshop, and Table 6 lists the observers who attended the May workshop.

Experts at the workshop indicated that pulse flows should occur with their natural timing, during late winter and late spring. For these periods, conditions for wet, normal, and dry hydrologic conditions were adapted from the March workshop (Bowman 1994). A fourth condition called "very wet" was added to represent those years in which peak runoff is very high, and results in surface flow in wet meadows, side channels, sloughs, and backwater areas. Occurrence of this condition is necessary to maintain and enhance the diversity, distribution, and abundance of habitats and organisms in the Platte River Valley ecosystem.

The importance of sediment movement and availability in forming and maintaining the geomorphology of the Platte River channel was emphasized by hydrological experts. The rates of channel narrowing decreased significantly during approximately 1969-1986, though some further narrowing may have occurred since that time. Whether the Platte River channel is in equilibrium, quasi-equilibrium, or will continue to narrow is still debated.

The 1969-1986 period was selected by the Service as defining minimum conditions (i.e., frequency and magnitude) of peak flows which should be retained and increased primarily for the 5-year and more frequent events. The recommended objective is for a ten-year running average of mean annual peak flows ranging from approximately 8,300 cfs to 10,800 cfs; this objective should be achieved through adaptive management of water resources if natural events are not sufficient to do so. This range is based on an average of channel maintenance properties computed for the Platte River with five different approaches. The mean annual peak at Grand Island during 1969-1986 was 9,124 cfs.

The largest pulse flow events (i.e., $\geq$ 12,000 cfs) will be natural occurrences beyond the control of water resources managers in the Platte River Basin. The pulse flow targets described herein do not imply that the Service recommends flooding along the Platte River. However, the Service realizes, and experts at the May workshop pointed out, that the capacity of some channel sections of the North Platte and the Platte Rivers have become reduced, yet high flows are still necessary to maintain channel capacity. The Service intends to work with other agencies and local interests to maintain and improve channel capacity. Public and private works projects designed to increase channel capacity through removal of woody vegetation should be encouraged. Such actions not only would reduce the likelihood of out-of-bank flooding during uncontrolled high flow events while increasing the availability of sediment but would increase and/or enhance channel habitat of waterfowl, cranes, and other migratory birds; reduce the need for bank stabilization projects; and increase and/or enhance opportunities for recreation in the channel. Specific management may be needed to protect the armor layer in the North Platte River channel below Kingsley Dam should not be removed by scouring flows.

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. Various factors contribute to seedling mortality. For purposes of seedling removal, the optimal time at which the late winter pulse flows in Table 3 should occur is during ice break-up.

River stage is most frequently the dominant influence on groundwater levels in wet meadows, and composition and structure of biological communities in grassland is most closely associated with the environmental variable of soil moisture. Pulse timing should correspond with naturally occurring periods of high runoff, and hence physical processes and critical life stages of aquatic and semi-aquatic biota. During the growing season, a duration of 7-30 consecutive days provides minimal wetland hydrology (e.g., anaerobic conditions supporting hydrophytic plants). Life stages of some aquatic and semi-aquatic wet meadow organisms require up to 30 days, and possibly longer. Some meadows are wet in a pattern similar to current flow events, i.e., the 1969-1986 flow records. Some wet meadows have elevated groundwater, and added pulse flows would rehabilitate a number of these potentially "active" wet meadows in the ecosystem.

The recommended objective during May/June is a 30-day exceedence level having a 10-year running average (the flow met or exceeded for 30 consecutive days each year, averaged over a 10-year period) of at least 3,400 cfs. The 30-day exceedence level should vary year to year. As during 1969-1986, 3,000 cfs should be exceeded for 7-30 consecutive days in at least 75 percent of the years. Pulse flows should be followed by a descending rate not exceeding 800 cfs/day. No pulse flow is required in May/June in 25% of the years; base flows identified for species in the March workshop apply instead.

NECESSARY EFFECTS OF MAY/JUNE PULSE FLOWS

Pulse flow targets for the late spring period of May and June are necessary to provide the following effects in the ecosystem:

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 for the lower trophic levels of the food chain in low grasslands, and 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.

NECESSARY EFFECTS OF FEBRUARY/MARCH PULSE FLOWS

Pulse flow targets for the late winter period of February and March are necessary to provide the following kinds of beneficial effects in the ecosystem:

1. Bring the groundwater levels in grasslands up near to soil surface in areas of grassland and above soil surface in some surface 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 years with little or no ice formation, pulse flows are necessary for soil saturation in meadows.

BASIS FOR PULSE FLOW TARGETS

The pulse flow targets presented are based on consideration and analysis of 4 kinds of information, including 1) U.S. Geological Survey stream gauging data, 2) observations of Platte River flow-related phenomena and analysis by Service field biologists, 3) similar observations and analysis reported in the literature, 3) applicable information used in formulating flow targets in Table 1, and 4) information and recommendations by the experts at the May workshop.

CONCLUSION

This report completes the Service's identification and prioritization of instream flow targets for the central Platte River Valley ecosystem.

Table 1. Instream flow targets by seasonal priorities 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% 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)
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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 & 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 & 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.

Table 2. 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%)

* 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 annual 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 years. Pulse flows should be followed by descending flows approximating a rate of 800 cfs/day.

**** No pulse flows during May and June in driest years; target flows identified in the March 1994 workshop (Bowman 1994), apply under dry year conditions.

Table 3. 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%)

* At least 50% of these pulse flows should occur during May 20 to June 20, with May 1 to June 30 as the time frame 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.

Table 4. List of experts who provided information at the May workshop.

NAME	EXPERTISE	ORGANIZATION
Dr. Paul Currier	Plant Ecology	Platte River Whooping Crane Trust
Dr. Bob Henszey	Groundwater Hydrology/ Plant Ecology	University of Wyoming
Mr. Larry Hutchinson	Fisheries Biology	Nebraska Game & Parks Commission
Dr. Carter Johnson	Plant Ecology	South Dakota State University
Mr. Joe Lyons	Hydrology/Geomorphology	Bureau of Reclamation
Dr. Jim O'Brien	Hydrology/Geomorphology	FLO Engineering
Mr. Tim Randle	Hydrology/Geomorphology	Bureau of Reclamation
Dr. Tom Seibert	Terrestrial Ecology	University of Nebraska
Dr. Bob Simons	Hydrology/Geomorphology	Simons & Associates
Dr. Tom Wesche	Groundwater Hydrology	University of Wyoming

Table 5. List of Service and Survey panelists.

NAME	ROLE	AGENCY
Greg Auble	Aquatic Ecologist	Survey
David Bowman	Platte River Coordinator	Service
Nina Burkardt	Moderator/Facilitator	Survey
Mark Butler	Platte River Hydrologist	Service
David Carlson	Assistant Platte River Coordinator	Service
Kenny Dinan	Fish and Wildlife Biologist	Service
Jonathan Friedman	Hydrologist/Geomorphologist	Survey
Lee Lamb	Moderator/Facilitator	Survey
Jim Lutey	Division Chief	Service
Bob McCue	Field Office Supervisor	Service
John Sidle	Fish and Wildlife Biologist	Service
Clair Stalnaker	Aquatic Ecologist	Survey
Jonathan Taylor	Moderator/Facilitator	Survey

Table 6. List of Observers.

NAME	ORGANIZATION
Mike Carnevale	Wyoming Water Development Commission
Steve Dougherty	ERO
Scott Ellis	ENSR
Beth Goldowitz	Platte River Whooping Crane Trust
Dick Gorton	Corps of Engineers
Jim Hall	Colorado Department of Natural Resources
Del Holz	Bureau of Reclamation
Ross Lock	Nebraska Game and Parks Commission
Jay Maher	Central Nebraska Public Power & Irrigation District
Bill McIntyre	Colorado Department of Natural Resources
Jim Merrigan	North Platte River Valley Water Coalition
Bob Milhous	National Biological Survey
Ron Moore	Soil Conservation Service
Tom Pitts	Hall, Pitts & Associates
Duane Woodward	Central Platte Natural Resources District
Steve Wolff	Wyoming Game and Fish Department

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Enclosure 1

INSTREAM FLOW RECOMMENDATIONS
FOR THE
CENTRAL PLATTE RIVER, NEBRASKA

by David Bowman

May 23, 1994

Instream Flow Recommendations
for the
Central Platte River, Nebraska
by
David Bowman

May 23, 1994

BACKGROUND

This report presents the results of a workshop held March 8-10, 1994, at the National Ecology Research Center of the National Biological Survey (NBS), Ft. Collins, Colorado. The purposes of the workshop were: (a) to identify the U.S. Fish and Wildlife Service's (Service) resource conservation goal for which instream flow targets are needed; (b) to formulate the instream flow targets the Service will use in fulfilling its legislated responsibilities in the central Platte River Valley ecosystem; and (c) to prioritize these instream flow targets by season (see table 1) and by normal (average), wet, and dry years.

The need for this workshop was recognized by the Service during its preparation of instream flow recommendations to the Federal Energy Regulatory Commission and from comments received from representatives of the three Platte River Basin States during discussions about establishing a cooperative Platte River Recovery Implementation Program.

GOAL

The workshop participants concluded that the Service's goal related to the central Platte River Valley ecosystem is to rehabilitate and to maintain the structure and function, patterns and processes, and habitat of the central Platte River Valley ecosystem. This ecosystem-oriented approach includes the objectives of (a) recovering habitats of presently listed species, (b) preventing the need for listing of additional species, and (c) providing sufficient habitat for conservation of native biotic components of the ecosystem. This sufficiency of habitat corresponds to 10 habitat complexes described by the Biology and Management Alternative Workgroups of the Platte River Management Joint Study. Workshop participants rejected the objective of restoring the Platte River Valley ecosystem to its predevelopment condition.

This goal corresponds also with the Service's policy of conservation management at the ecosystem level and with purposes stated in section 2(b) of the Endangered Species Act of 1973, as amended: ". . . to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in subsection (a) of this section."

ASSUMPTIONS

The Service's goal incorporates five assumptions:

1. Flow targets formulated during the workshop are based upon the best information available to the Service in the form of empirical evidence, accepted scientific models, and professional judgment of Service and NBS personnel.

2. Conservation of Platte River listed and other native species is not separate from conservation of the Platte River ecosystem.

3. Conservation of the ecosystem is not separate from conservation of the biotic and abiotic components of the ecosystem.

4. Inadequate instream flows are the single most important limiting factor in the Platte River Valley ecosystem; thus, the Service's goal cannot be achieved without provision of the target flows described in table 1.

5. While the information used by the Service in formulating the target flows is the best available, continual acquisition and analysis of scientific and habitat management information are necessary.

RESULTS

The empirical evidence and accepted scientific models used by the workshop participants are described and/or referenced in the Service's correspondence dated May 18, 1994, to the Federal Energy Regulatory Commission and in the Service's draft biological opinion dated May 6, 1994, to the Rocky Mountain Region of the U.S. Forest Service.

The Service's target flows derived during the workshop are summarized in table 1. Persons who participated in the workshop and their respective role(s) are summarized in table 2. Four categories of stream flows were identified and described during the workshop: seasonal pulse, or peak, flows; seasonal flows characteristic of wet years; flows characteristic of normal, or average, years; and flows characteristic of dry years. Descriptions of normal (or average), wet, and dry years are given below, along with justifications for prioritizing target flows.

Dry Year Flows

Dry year flows were framed by using biological criteria. Dry year flows particularly limit the survival and life cycles of aquatic and wetland species, which are the species affected acutely by low flows. The fish community is the dry year target community because it is representative of aquatic species in the ecosystem and some fish species have life cycles of 3 years or less. Therefore, the judgment was made that dry year flows should not occur on the average more often than once every 4 years.

Dry year flows are intended to prevent loss of richness of aquatic species, especially fish and mollusks, and to prevent a major break in wetted width in whooping crane roosting habitat. Workshop participants relied principally on information regarding weighted usable area curves for fish guilds, data on relationship between flow and water temperature, interpretation of whooping crane model C4R, and on gauging station data from the central Platte River.

Wet Year Flows

Wet year flows were described as channel-forming flows greater than such flows in normal and dry years and as wet meadow sustaining flows. Implementation of the Service's goal requires that (wet year) channel-forming and wet meadow sustaining flows be exceeded on an average basis of 1 year out of 3 years. Wet meadows and fish and mollusks in the river channels are the wet year target communities because hydrologic and biologic processes which sustain wet meadows and fish and mollusks are dependent on higher flows. Channel characteristics and riverine community also are maintained by wet year flows. Wet year flows are thought to be more important than normal year flows because wet year flows mimic the historic hydrograph and, in so doing, produce hydraulic and biological effects critical to achieving the goal of conserving the ecosystem. The frequency and magnitude of extreme flow events in wet years should not be diminished.

Normal Year Flows

Normal year flows were described as those flows which are neither dry year nor wet year flows and which occur or are exceeded on an average basis at a frequency of 3 out of 4 years. Normal year flows provide some habitat for all communities in the ecosystem during all the seasons (time periods). Normal flows provide habitat for and sustain populations of most species in the ecosystem between episodes of dry and wet year flows. Extreme flow events, i.e., variations in magnitude, timing, and frequency of flows, in normal years should not be diminished.

Pulse Flows

Pulse flows occur at some magnitude and duration in wet, normal, and dry years. During normal and wet years, pulse flows inundate wet meadows, increase hydrophytic vegetation, scour vegetation, prevent nesting by shore birds at low elevations on sandbars, inundate backwater areas, form sandbars, and form and/or move ice. To maximize their effectiveness, pulse flows must be of sufficient timing, magnitude, and duration to scour seedlings off sandbars and prevent seed germination, as well as the response of the aquatic community, e.g., spawning fish. Pulse flows are thought to play the dominant role in the patterns and processes, structure and function, and habitat of the Platte River Valley ecosystem. to trigger

The magnitude and duration of pulse flows discussed included an average of 8,000 cfs for 5 days in June for channel maintenance; an average of 3,800 cfs during 61 days in May and June, an average of 5,800 cfs for 30 days during May and June, an average of 3,200 cfs during 60 days in February and March; and an average of 4,400 cfs during 30 days in February and March. Sandbars were formed in 1983-1984 at flows of about 20,000 cfs. Flows of 2,600-3,000 in June prevents germination of tree seeds. Flows of 6,000-8,000 cfs in February and March removes seedling vegetation. Approximately 23 percent of the time, flows in February and March are 2,950-3,700 cfs. The frequency, magnitude, and duration of extreme flow events which occur as variations in flows during February-March and May-June of normal and wet years should not be reduced.

Because of the importance of pulse flows in the Platte River ecosystem and the need to development additional, more specific information, the decision was reached to develop pulse flow targets during a separate workshop that includes other experts on this topic.

Rule Triggers

Rule triggers for determining whether a year is likely to fall in the category of wet, normal, or dry and for making water resource management decisions for each year type should be based on estimates of the present gross water supply plus estimates of independent measures of water supply, such as ground water, precipitation, and snowpack, comprising the gross water supply in the entire Platte River Basin. Rule triggers and flow management decisions based only on dependent variables such as reservoir storage, project-by-project capabilities, or projections of water availability from water projects likely would lead to water management decisions that reflect only dry year conditions and little operating flexibility.

JUSTIFICATIONS FOR FLOW TARGETS

May and June Pulse Flows:

Wet year priority = 1
Normal and dry year priorities to be determined

February and March Pulse Flows:

Wet year priority = 2
Normal and dry year priorities to be determined

Pulse flows which mimic the natural hydrograph are needed to restore, on a reduced scale, certain annual effects characteristic of the historic natural hydrograph. These natural surges in flows have been severely depleted since the predevelopment era. Pulse flows are necessary for sediment transport, for redistribution and deposition of sediment in the central Platte River, and for shaping channel morphology into wide, shallow channels. Pulse flows generate a diversity of habitats across the floodplain; 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, including threatened and endangered species. Timing of pulse flows coincide with or influence fish reproductive behavior and the availability and quality of spawning, nursery, and rearing habitat, including backwater habitat of fish and mollusks. Flow pulses, especially those which move ice and sediment, scour vegetation of different size and age classes and prevent reestablishment of vegetation.

May 11-September 15:

Wet year priority = 3
Normal year priority = 1
Dry year priority = 1

This period is when most life in the ecosystem face their most critical water shortages. Therefore, proportionately greater biological stress and ecological effects can occur if water is withdrawn or withheld from the ecosystem during this period. Maintaining the components of biological diversity, e.g., plants, invertebrates, fishes, and birds, during this period depends on the aquatic component of the ecosystem. Flows are needed to provide essential habitat components for threatened and endangered species, as well as other important native wildlife populations.

This period is when aquatic shore birds, such as the threatened piping plover and endangered least tern, are mating, nesting, and rearing young. Target flows for this period, particularly May 11 to June 15, help prevent shore birds from nesting at such low elevations in the river channel that their nests would be subject to flooding during subsequent intervals of higher flows caused by local rainfall and/or flow regulation practices. Instream flows provide a degree of barrier to terrestrial predators which would otherwise more easily prey on shore bird nests. During summer, instream flow targets prevent 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. The native fish community is a critical component in the ecosystem which has been harmed repeatedly by episodes of low flow during this time period in past years. The flow target for this period will prevent or reduce future harmful episodes to the aquatic community.

March 23-May 10:

Wet year priority = 4
Normal year priority = 2
Dry year priority = 2

Except for the earliest migrating geese, this period is the primary spring migration period for birds through this region. Flows contribute important nutritional and physiological conditions for birds preparing to breed. For example, wet meadows are undergoing primary production of invertebrates which are needed by cranes for protein. Whooping crane migration habitat has been severely degraded as a result of decreased flows and loss of night roosting habitat critical at this time. Flows during this period also provide sandhill crane habitat. This is the time of year when Eskimo curlews are most likely to use the Platte River. Flows during this period provide channel habitat for water-dependent organisms, including spawning fish, mussels, and migratory waterfowl, wading birds, and shore birds. Environmental education and ecotourism, e.g., crane watching, are very important public and economic values during this time.

February 1-March 22:

Wet year priority = 5
Normal year priority = 3
Dry year priority = 3

This is the second most important migratory bird season. Bald eagles forage in the river valley during this period. Flows provide migrating waterfowl and other bird species with suitable migration habitat. They also provide sandhill cranes with suitable roosting sites and feeding habitat in wet meadows. Water on the Platte River Valley ecosystem is of particular importance for early migrating waterfowl when Rainwater Basin wetlands are frozen, because it helps to disperse birds and reduce losses due to disease (avian cholera, botulism, etc.). Flows in this period also form and move ice, which scours vegetation and shapes the channel. Fish habitat also is provided by these flows. This period was not given a higher priority because suitable flows are often met with present conditions. However, it is important to note that other comparable springtime habitats have been eliminated or are rare, such as Platte River and North Platte River channel and wet meadow habitats west of Overton.

September 16-30:

Wet year priority = 6
Normal year priority = 4
Dry year priority = 6 (tie)

These flows will maintain and prevent loss of the native fish community and will promote survival of fish young-of-year.

October 1-November 15:

Wet year priority = 7
Normal year priority = 5
Dry year priority = 6 (tie)

Flows during this time period provide migration habitat for migrating waterfowl and other migratory bird species, e.g., fall whooping crane migration and roosting habitat. These flows also maintain aquatic life; for example, they promote growth of fish young-of-year. In prioritizing this period as number 6, it also was considered that this may have been a moderate or low flow period naturally and that whooping crane sighting data indicate that whoopers use the river less in fall than in spring. Consequently, a minority opinion was expressed that perhaps the normal and wet year targets could be the same as the present-day dry year target. However, flows in this period support waterfowl habitat and recreational activities, such as waterfowl hunting, that are important public values during this period.

November 16-December 31:

Wet year priority = 8
Normal year priority = 6
Dry year priority = 5

Flows during this period provide bald eagle feeding habitat and opportunities. These flows also maintain fish habitats necessary to support fish communities. The use of the Platte River by migratory birds and geese also was considered when prioritizing this time period. Goose hunting is an important public activity during this time period.

January 1-31:

Wet year priority = 9
Normal year priority = 7
Dry year priority = 4

Flows in this period provide foraging habitat for bald eagles and other raptors. Viewing of foraging bald eagles provides a public recreational benefit during winter conditions. January flows also promote the winter survival of the native fish community and aquatic insects. The flows form and move ice to scour vegetation and maintain the channel. Although it is recognized that base flows are important during this period, it was not ranked higher because flows are frequently adequate with present operations. A minority opinion was expressed that the dry year target flows during this period would be inadequate to sustain fish if severely cold weather occurred concurrently and froze the river to the extent that fish habitat deteriorated to the point of limiting fish survival.

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.

Table 2. Participants and their role in the March 8-10 workshop.

Name	Role	Agency
Ken Bovee	Aquatic Ecologist	NBS[1], Ft. Collins, CO
David Bowman	Platte River Coordinator	FWS[2], Grand Island, NE
Dennis Buechler	Regional Office Management	FWS, Lakewood, CO
Nina Burkardt	Process Facilitator	NBS, Ft. Collins, CO
Mark Butler	Platte River Hydrologist	FWS, Lakewood, CO
David Carlson	Fish & Wildlife Biologist	FWS, Grand Island, NE
Lee Carlson	Field Office Manager	FWS, Golden, CO
Kenny Dinan	Fish & Wildlife Biologist	FWS, Grand Island, NE
Lee Lamb	Process Facilitator	NBS, Ft. Collins, CO
Bob McCue	Field Office Manager	FWS, Grand Island, NE
John Sidle	Wildlife Biologist	FWS, Grand Island, NE
Claire Stalnaker	Aquatic Ecologist	NBS, Ft. Collins, CO
Johnathan Taylor	Process Facilitator	NBS, Ft. Collins, CO

[1] NBS = U.S. National Biological Survey

[2] FWS = U.S. Fish and Wildlife Service

Enclosure 2

DEPARTMENT OF THE INTERIOR'S RATIONALE AND RECOMMENDATIONS FOR PULSE FLOW REQUIREMENTS*

August 10, 1994

* A supplement to the Department's revised section 10(j) recommendations submitted to the Federal Energy Regulatory Commission on May 19, 1994.

PULSE FLOW TARGETS

High spring flow (pulse flows) are elemental to the ecological maintenance of the Platte River system. The U.S. Fish and Wildlife Service (Service) has determined that pulse flows are necessary to rehabilitate and to maintain the physical and biological integrity of the Platte River. The Service also has identified pulse flows as the highest priority for central Platte River recovery (U.S. Department of the Interior 1994; Bowman 1994). Physical and biological processes associated with peak flows help maintain habitats used by nine listed species.

Present-day stream flows have been significantly modified by water development (Williams 1978; Eschner et al. 1983). Early discharge records for the central Platte River, from the U.S. Geological Survey station near Duncan, Nebraska, (1897-1938) provide an indication of the natural hydrologic pattern. The Duncan hydrograph indicates that two pulses occurred during the spring, the first generally occurred between early February and late March and the second pulse between early May and late June. A two pulse pattern for the Missouri River system in the northern Great Plains is attributed primarily to spring rain and snow melt on the plains and on mountain snow melt, respectively (U.S. Army Corps Engineers 1979).

Channel Maintenance

Major changes in the hydrologic regime and morphology of the Platte River have been described and investigated by a number of individuals. These changes have occurred following 1860, when water resources began to be developed within the Platte River basin for a variety of uses. Changes in the flow and sediment regime have made the Platte River more amenable to vegetative growth and have contributed to decreased channel width and area.

At best, the designated critical habitat reach may have achieved a state of quasi-equilibrium, and no long-term reductions in width will occur. However, the available information does not allow a definitive conclusion regarding equilibrium, and additional reductions in width may still occur in the lower portion of the Overton to Grand Island reach, even though bed material transport is roughly in equilibrium.

There is no single defining flow in terms of magnitude, duration, and frequency which can be readily specified on an annual basis to maintain the remaining braided reaches of the Platte River. With the current conditions of sediment supply and particle size, reductions in effective discharge over the long term will result in channel narrowing. Significant increases in effective discharge over the long term also will cause additional narrowing of the channel. This is due to a narrower channel being required to increase stream velocity to transport the existing coarser load.

The effective discharge histogram for the recent period of 1969-1986 shows a wide range of flows (1,000 to 20,000 cfs) as transporting the majority of bed material load. Therefore, all flows above 1,000 cfs have importance in maintaining the existing channel.

Increasing the magnitude of the more frequent flow events (generally those less than the 5-year return period) is recommended to maintain the braided characteristics of the Platte River between Overton and Grand Island. The Service's pulse flow recommendations for late winter (February and March) and late spring (May and June) are compatible with recommendations to control seedling recruitment in June and to increase the effectiveness of ice scouring in winter. A more detailed discussion is provided in Appendix B to this enclosure, entitled "Rationale for Establishment of Channel Maintenance Recommendation for the Platte River."

Wet Meadow Habitat

Characteristics of the flow pattern influencing biological communities are the timing, frequency, magnitude, and duration of peak flow events (Mitsch and Gosselink 1993). Periodic, pooled surface water or saturation near the soil surface is necessary to maintain the physical, biological, chemical, and temporal characteristics of wetland habitats (Federal Interagency Committee for Wetland Delineation 1989).

Along the Platte River, ground water levels beneath wet meadows respond rapidly to changes in river stage (Hurr 1983). Stage and discharge are most frequently the dominant influence on ground water levels of subirrigated wet meadows (Wesche et al. 1994; Henszey and Wesche 1993). Composition and structure of grassland communities is most closely associated with the environmental variable of soil moisture (T. Seibert, pers. comm). Ground water levels during February to March and during May to June are probably most important for wet meadow maintenance. Both May-June flows and the area of wetland meadows in the Platte River valley have declined substantially (Currier et al. 1985; Sidle et al. 1989; Eschner et al. 1983; Williams 1978).

Sidle et al. (1993) determined that the distribution of sandhill cranes staging along the river is associated with the distribution of low grasslands. Sandhill cranes use wet meadow habitats for loafing, socialization, mating displays, and feeding. A significant portion of sandhill cranes' feeding occurs in wet meadows where they obtain nutrients not available in other feeding areas, and moreover feed at an energy deficit to obtain these nutrients (U.S. Fish and Wildlife Service 1981). Sandhill use of the river has shifted eastward over the past 50 years, toward areas with wetter meadow conditions.

Six federally listed species are associated with central Platte River Valley wet meadow habitats (Table 1) (50 CFR 17.11-12). Wet meadows are a constituent element of critical habitat designated along the Platte River for the whooping crane (50 CFR 17.95).

Table 1. Listed species that may occur in subirrigated native grasslands of the central Platte River.

Common Name	Scientific Name	Status
Bald eagle	(*Haliaeetus leucocephalus*)	E
Peregrine falcon	(*Falco pergrinus*)	T
Eskimo curlew	(*Numenius praeclara*)	E
Western prairie fringed orchid	(*Platanthera praeclara*)	T
American burying beetle	(*Nicrophorus americanus*)	E
Whooping crane	(*Grus americana*)	E

Note: E = Endangered, T = Threatened

Least Tern and Piping Plover Nesting Habitat

High flows in large rivers of the Great Plains create bare sandbars by scouring vegetation and transporting and depositing sand and gravel. Such habitat is the nesting substrate of least terns and piping plovers.

Along the Platte River, high flows occur at a sufficient frequency to create abundant nesting habitat only along the lower Platte. The largely unencumbered inflows from the Loup and Elkhorn Rivers, combined with the inflow from the central Platte, result in sufficient instream flow to perpetuate bare sandbars of sufficient quality for nesting. High flows can result during the spring thaw before nesting, as well as during the nesting period. During June 1990, heavy precipitation in the Elkhorn River and Loup River watersheds caused the lower Platte to reach 60,000 cfs for a few days. Aerial videography taken over the river on different dates in 1990 allowed the viewing of least tern and piping plover habitat at different flows. Analysis of before and after aerial videography revealed that the high flow had scoured vegetation from most sandbars (Sidle et al. 1992). Areas that had been covered with vegetation for several years were cleared of vegetation. Similarly in 1993, flows reaching over 100,000 cfs in the spring and then again in the summer on the lower Platte created abundant nesting habitat.

Least terns and piping plovers are more abundant on the lower Platte than on the central Platte because riverine habitat opportunities are more frequent than on the central Platte (Ziewitz et al. 1992). Pulse flows during the spring and early summer are the principal ecological perturbation renewing least tern and piping plover habitat. It follows that the long-term protection of the lower Platte must ensure that high flows in the spring or summer are not diverted or curtailed in any way that reduces the river's natural ability to create new sandbars and scour existing sandbars of vegetation. The artificial creation of sandbar habitat on the lower Platte River is not necessary because the river is still creating sandbars.

The central Platte River does not offer much sandbar habitat suitable for nesting because of upstream water development. High flows to scour vegetation are uncommon and not usually of sufficient magnitude to create abundant natural nesting habitat in the channel. High flows during 1983 and 1984 created some channel habitat, and most of the least terns and piping plovers that were studied nested on the river. By 1993, there was almost no nesting on the river as habitat conditions deteriorated in the absence of high pulse flows. Accordingly, least terns and piping plovers now nest primarily at adjacent sand pits (Sidle and Kirsch 1993) that provide high, dry, bare sand and gravel nesting substrate. However, sand pit habitat poses a number of ecological problems for the birds, such as a lack of invertebrate and fish prey.

High pulse flows in spring or early summer, followed by steady or slowly declining flows through mid and late summer, benefit successful reproduction. High flows early in the nesting season prevent birds from initiating nests on low-lying areas of the channel vulnerable to flooding. Low-lying areas can be flooded by relatively small stage fluctuations caused by rain or when water is rejected by upstream diversion projects. In addition, nesting birds require water in the channel for foraging and as a predator barrier. Piping plovers must feed on damp sandbars and least terns must forage for fish.

The Service has determined that pulse flows are very important in creating and maintaining least tern and piping plover nesting habitat. The pulse flow targets determined by the Service for the May 1 to June 30 timeframe are recommended for the nest initiation period to prevent nesting on low sandbars and to create additional nesting habitat for least terns and piping plovers.

Pallid Sturgeon Habitat

No captures of pallid sturgeon subadults has occurred in recent years, and the last reported observation of possible spawning was in 1974. This species may be close to extinction. Maintenance of habitats necessary for pallid sturgeon and certain aspects of sturgeon behavior and reproduction are believed to be associated with spring and early summer high flows (U.S. Fish and Wildlife Service 1993).

The lower Platte River and Missouri River near the mouth of the Platte is one of the highest sturgeon concentrations areas that has been observed. This area is also targeted as important for recovery for this species (U.S. Fish and Wildlife Service 1993). Available evidence indicates that pallid sturgeon use of this area is associated with high spring flows. Since 1970, eight of the nine captures of pallid sturgeons in this area occurred during May and June; the ninth capture occurred in April. In addition, eight of the nine occurrences corresponded with years when May/June flows in the lower Platte were above normal for the recent period (Louisville gage, 1970-1993). Only one occurrence has been observed in lower flow years, suggesting that reduced spring flows limit functional use of the reach. Since the 1930's, the diminution of flows in the upper basin alone (above the Loup River) accounts for a 40-percent decrease in May and June flows in the lower Platte River.

Conditions prevailing during May and June are increasing river discharge and rising river stage, water temperature potentially suitable for spawning or staging for spawning, high turbidity, high concentrations of suspended sediment, and a high sediment load. Our knowledge of the life history of the sturgeon (Acipenseridae), the ecology of the pallid sturgeon and other large river fishes of the Missouri River system, and the importance of the

Missouri's major tributaries (i.e., Platte River) leads the Service to conclude that high spring flows are important for a variety of purposes including: (a) in-channel habitat structure for the pallid sturgeon and fish it preys upon; (b) turbidity affecting feeding efficiency of pallid sturgeon; (c) nutrient flow affecting composition and abundance of species of forage fish; (d) temperature, gonad maturation, and spawning behavioral cues; and (e) interspecific competition for habitat with other species such as the shovelnose sturgeon.

Recovery of the pallid sturgeon is unlikely to be successful without restoring the critical portions of morphology, hydrology, temperature regimes, and sediment/organic matter transport of the rivers that provide life requisites for pallid sturgeons (U.S. Fish and Wildlife Service 1993). Because of its importance to the Missouri River basin, Platte River spring peak flows figure prominently in the recovery plan for the pallid sturgeon.

Pulse Flow Workshop

The results of the workshop that was held May 16-20, 1994 (May workshop), at the Midcontinent Ecological Science Center of the National Biological Survey in Ft. Collins, Colorado, is described in Appendix A to this enclosure. The appendix is entitled "Pulse Flow Requirements for the Central Platte River." It was authored by David Bowman and Dave Carlson (1994) on August 3, 1994.

Pulse Flow Recommendations

Table 1 includes the pulse flow recommendations for the highest priority annual timeframe of May and June. Table 2 includes the pulse flow for the second highest priority of February and March.

May/June Pulse Recommendations

Pulse flow targets during the late spring period of May and June are necessary to provide the following beneficial effects in the ecosystem:

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.

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.

The recommended objective during the May/June time period is for a 30-day exceedence flow (i.e., a flow met or exceeded for 30 consecutive days in any one year) with a 10-year running average of no less than 3,400 cfs. The annual 30-day exceedence level should vary in magnitude, year to year, according to water supply. A flow of 3,000 cfs should be exceeded for 7-30 consecutive days in at least 75 percent of the years, followed by a descending rate approximating 800 cfs/day. No pulse flow is required in May to June during dry years; however, target flows in the revised section 10(j) recommendations submitted by the Department, May 19, 1994, apply under these conditions.

During the growing season, duration of 7-30 consecutive days provides minimal conditions for anaerobic processes required by hydrophytic plants. Duration needed by aquatic and certain life stages of semiaquatic organisms are up to 30 days or more. Some meadows are wet in a pattern similar to current flow events, i.e., the 1969-1986 flow records. Some meadows have elevated ground water, and added pulse flows rehabilitate a number of these potentially "active" wet meadows to the ecosystem.

February/March Pulse Flow Recommendations

Pulse flow targets for the late winter period of February and March are necessary to provide the following beneficial effects in the ecosystem:

1. Bring the ground water levels in grasslands up near to the soil surface in most areas of grassland and above soil surface in some surface depressions in 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 provide pooled water for other aquatic food organisms.

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 years with little or no ice formation, pulse flows are necessary for soil saturation in meadows.

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.

February/March pulse flows should exceed (a) a range of 2,000-2,500 cfs for 30 days in all years and (b) a range of 3,100-3,600 cfs for 30 days in at least 75 percent of the years. For seedling removal, the optimal time at which the late winter pulse flows should occur is during ice breakup.

The pulse flow targets presented in the above tables are based on consideration and analysis of the following: (a) U.S. Geological Survey stream gauging data, (b) observations of Platte River flow-related phenomena and analysis by Service field biologists, (c) similar observations and analysis reported in the literature, (d) applicable information used in formulating the Department's revised section 10(j) recommendations (May 19, 1994), and (e) information and recommendations by the experts at the May workshop.

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Appendix B
(for Enclosure 2)

RATIONALE FOR ESTABLISHMENT OF CHANNEL MAINTENANCE REQUIREMENTS FOR THE PLATTE RIVER

August 10, 1994

This paper is intended to document the rationale used to establish the U.S. Fish and Wildlife Service's (Service) channel maintenance recommendation for the Overton to Grand Island reach of the Platte River, including the designated critical habitat. Material used herein has been freely copied from other reports, biological opinions, and other available sources cited in the references.

REASON FOR SELECTION OF CHANNEL MAINTENANCE FLOWS

The Service believes that channel maintenance flows are needed to maintain the remaining braided, unvegetated reaches of the Platte River. The braided, unvegetated characteristics are critical to provide habitat on the central Platte River for whooping cranes, piping plovers, and interior least terns. Maintenance requirements are primarily based upon the roosting habitat needs of the whooping crane, in fact, portions of the Platte River are designated critical habitat for migrating whooping cranes under section 4(a)(3) of the Endangered Species Act. The critical habitat determination made by the Director and published in the Federal Register on May 15, 1978, was based upon the following factor (among others): "Generally, whooping cranes (as do most cranes in the world) require an open expanse for nightly roosting comprised of sand and gravel bars of very shallow water in rivers and lakes. Nightly roosting areas appear to be one of the major factors in whooping crane habitat selection."

Permanent reductions in the discharge and sediment supply of alluvial streams results in altered channel morphology as the stream adjusts to the prevailing water and sediment regime. The historic response of the Platte River to reductions in discharge and bed material supply has been to alter its form from a braided river to an anabranching stream, with a concurrent increase in sinuosity, reduction in width, reduction in width/depth ratio (including slight channel degradation), and a coarsening of the bed material. Reductions in discharge and an increase in low flows and seed sources have allowed vegetation to initiate new growth, encroach on the inactive river channel, and stabilize inactive areas. The timing and magnitude of discharge determines the inundated channel area before, during, and after seedling dispersal, and peak flows influence the establishment of cottonwood and willow seedlings. Subsequent erosion by ice movement and peak flow appears to be the dominant processes in removing established vegetation. Desiccation appears to have more bearing on thinning the ranks of seedlings rather than on removing larger classes of established vegetation (Johnson 1994).

Diminished flow results in vegetation responding to favorable conditions in a short period of time and encroachment may be relatively permanent, depending upon subsequent flow related events. Three to five years of reduced flow levels appear to be sufficient to permit vegetation to stabilize above the stages not scoured by subsequent peak flows.

The following sections summarize changes in channel and flow characteristics which have occurred in the central Platte River. Subsequent sections discuss (1) the use of flood frequency curves and effective discharge to quantify the range and frequency of channel forming discharges and (2) the magnitude and timing of flows to lessen seedling establishment and encourage the erosion of established seedlings. These flows are believed necessary to maintain the remaining braided, unvegetated reaches of the Platte River.

CHANGES IN CHANNEL CHARACTERISTICS

Channel Width

Changes in river channel width are the best available measure of historical channel geometry in the Platte River. Changes in channel width for the Platte River in the Big Bend reach have been studied and reported by Williams (1978), Eschner et al. (1983), Peake et al. (1985), Becker (1986), and Sidle et al. (1989). Lyons and Randle (1988) reviewed all the data contained in the above reports and concluded the Peak et al. data was the most comprehensive.

Peake et al. (1985) provided estimates of channel narrowing at six locations along the Platte River from 1865 through 1983, based on interpretation of historical aerial photographs and maps (figure 1). The rate of channel narrowing increased at all six sites from 1938 to 1957 but has decreased since then.

The four upstream sites (Brady, Gothenburg, Cozad, and Overton) show little change in channel width from 1957 to 1983. From 1865 to 1983, channel width at Overton has decreased 78 percent, from 4,795 feet to 1,050 feet. For the later portion of the period, from 1957 to 1983, mean channel width at Overton has remained relatively unchanged, showing an 8-percent decrease from 1,139 feet to 1,050 feet (Lyons and Randle 1988).

In contrast to the upper portions of the Platte River, the downstream sites at Odessa and Grand Island have continued to narrow. The channel width at Grand Island has decreased 50 percent from a mean of 2,707 feet to 1,339 feet during 1865 to 1983. For the later portion of the period, from 1957 to 1983, mean channel width at Grand Island has continued to narrow, showing a 25-percent decrease from 1,799 feet to 1,339 feet.

The decrease in width at Odessa during the 1957 to 1983 period is greater than the reduction at Grand Island. In 1957, both sites showed the same approximate width (1,799 feet and 1,756 feet), while in 1983 the channel near Odessa was over 500 feet less in width. The decrease in width at Odessa for the 1957 to 1983 period is 49 percent.

Table 1. Summary of Historical Platte River Channel Width

Gaging Station	1865 Width (ft)	1938 Width (ft)	1957 Width (ft)	1983 Width (ft)
Brady	3,415	1,449	676	632
Gothenburg	4,041	1,613	361	583
Cozad	3,746	2,356	403	476
Overton	4,795	2,313	1,139	1,05 0
Odessa	4,988	3,138	1,756	893
Grand Island	2,707	2,186	1,799	1,33 9

(From Lyons and Randle, 1988)

Based on the trends in width data and an approximate balance in sediment transport between Overton and Grand Island (discussed later), Lyons and Randle (1988) concluded that channel width has stabilized at the upstream portion of the reach and has probably adjusted to the new quasi-equilibrium in the downstream portion of the reach. They noted that future adjustments in channel width are possible in the downstream portion of this reach.

Simons and Associates (1990) also assembled width data for reaches of the Platte River which was intermediate and subsequent to the photo dates shown in Table 1. They state that when the data between 1957 and 1983 is considered, a continuous decline in width is not apparent, and no significant changes in channel width are apparent following the short period of decline from 1957 to 1966. They further state that when post-1983 data are taken into account, the data confirm the conclusion of no further decline in width for the lower portion of the Overton to Grand Island reach. Johnson's (1994) conclusions on changes in active channel area through 1986 are similar.

Although future channel changes can be debated, regardless of whether one accepts that quasi-equilibrium has been attained or width is still adjusting, it is reasonable to use the 1969-1986 period of record as representative of minimum conditions in flow which should be retained and perhaps improved upon.

Channel Sinuosity

Trends in channel sinuosity and a measure of channel braiding were presented in Williams (1978). A braided channel consists of numerous, interconnected small channels between shifting gravel bars and sandbars. Braided channels characterize streams with a large sediment load and easily erodible banks and have a relatively steep gradient compared to meandering streams. Williams reported a more sinuous channel through the Big Bend reach, as measured from

1969 aerial photography as compared to 1938 photography, with two exceptions. On a short reach below the J-2 Hydro Powerplant Return (J-2 Return), the Platte River was straighter in 1969 than in 1938, and downstream of Gibbon to Grand Island, a 31-mile reach showed no change in sinuosity from 1938-1969. Williams' braiding index (the ratio of vegetated and unvegetated island length in a reach to the total reach length) showed a less braided channel from 1938-1969, except for the Overton to Grand Island reach where portions of the channel had become slightly more braided (Lyons and Randle 1988).

Bed Material Size

O'Brien and Currier (1987) concluded the bed material of the Platte River has progressively coarsened as sediments are trapped in main stem reservoirs and flows have gradually winnowed finer sediments from the bed. They summarized 159 bed material samples taken by the Corps of Engineers in 1931 and cited a median particle size (D_{50}) of 0.40 millimeters (mm). The average D_{50} for samples collected by the U.S. Geological Survey and U.S. Bureau of Reclamation between years 1952 and 1983 (115 samples) had median particle sizes ranging from 0.66 mm to 0.89 mm.

Lyons and Randle partitioned the bed material samples collected by the U.S. Geological Survey into three periods (1952-1956, 1965-1969, and 1979-1980). They concluded that from 1952 to 1980, the average bed material near Overton appeared to have coarsened, although uncertainty about the sampling locations limited their conclusion. They stated that the 1979-1980 data was collected at a bridge site which may have had a coarser bed due to influences of the bridge. Prior to the 1979 data, the bed material samples were presumed to be from transects either upstream or downstream of the bridge, except for discharges above 2,500 cfs which were probably collected at the bridge. The median particle sizes reported for the 1952-1956, 1964-1969, and 1979-1980 periods were approximately 0.7 mm, 0.8 mm, and 1.0 mm, respectively.

Bed Elevation

The Bureau of Reclamation summarized average channel slope using elevation contours as plotted on U.S. Geological Survey 30-minute topographic maps published during the 1890's, similar data from 7.5-minute maps published in 1962, and supplemental data from sediment ranges and highway surveys. From these data, approximate profiles of the Platte River were drawn for 1890 and 1962. The average channel slope of the Platte River was 0.00116 in 1890 and 0.00121 in 1962. Based on this analysis, it was concluded that bed elevation has lowered in the Overton to Grand Island reach, with degradation ranging from 3 to 10 feet (Lyons and Randle, 1988). The accuracy of the earlier maps may not be reliable, and the magnitude of estimated degradation appears to be high when bed elevation data at gaging stations, discussed below, is considered.

Even though scour and aggradation due to high and low flow periods are evident in stream gaging records at bridges, long-term changes in river stage at bridges can be good indicators of bed elevation changes in the adjoining natural reaches. The records are more reliable if (1) the structure has been in place throughout the gaging record, (2) the change in bed elevation has been continuous throughout the period, and (3) the period of record is long enough so that short-term hydraulic response to scour and fill cycles can be ignored. By considering the gage height at low or moderate flows over a long period of record, it can be assumed that the bed elevation has adjusted to the effects of bridge hydraulics (FLO Engineering 1992). This is a common technique which has been used in many aggradation/degradation studies (e.g., see Simons, Li, and Associates 1984).

Williams (1978) estimated the channel bed elevation corresponding to the level of zero discharge by extrapolating rating curves at 12 gaging stations located between Minatare, Nebraska, on the North Platte River and Grand Island located on the Platte River.

The Service has extended the analysis of bed elevation at long-term gaging stations. To avoid problems with extrapolating the rating curves to a zero discharge, the elevation of various discharges, such as 1,000 cfs, was plotted. Because gage datums are generally not available for the period of record prior to approximately 1930, changes in bed elevation are limited to the post-1930 period. Determining elevation changes from the predevelopment period using stream gage data is not possible without reliable datums.

The elevation plots agree in general with the patterns noted by Williams (1978) using the zero-discharge method. Figures for the North Platte River stations (figures 2 through 9) are included here; however, the reader is referred to Williams (1978) and FLO Engineering (1992) for further discussion of bed elevation changes along the North Platte River.

The Platte River at Brady today flows mainly in two channels. Williams (1978) described the North Channel as fluctuating several tenths of a meter over the 1939-1977 period with the bed being approximately 0.5 meter lower than in-1939-1940. The South Channel scoured about 0.3 meter, then regained 0.1 to 0.2 meter and remained fairly stable since 1959. Figure 10 shows an approximate 0.5-foot drop in elevation for the 1,000 cfs discharge for the North Channel between 1939 and 1988.

Flow at Cozad is also split between two main channels, and Williams (1978) noted the greatest scour of any station he examined at the South Channel. Although the gage location has moved during the period of record, figure 11 shows the North Channel as relatively stable, and figure 12 shows approximately 2 feet of scour from 1940 to 1966. Long-term trends are not apparent for the subsequent period due to movement of the gage.

At Overton, movement of the gage complicates interpretation (figure 13).

Williams (1978) described the river bed at Odessa as fluctuating about $\pm$ 0.2 meter from 1938 to 1977. Figure 14 shows elevation of the 1,000 cfs discharge as decreasing by approximately 0.5 foot during the 1938 to 1984 period.

Williams (1978) described the river bed at Grand Island as fluctuating about ± 0.1 meter from 1936 to 1977. Figure 15 shows elevation of the 1,000 cfs discharge as decreasing by approximately 0.6 foot over the 1936 to 1984 period.

Elevation of the 1,000-cfs discharge at the Duncan gage (figure 16) appears relatively stable over the 1928 to 1984 period.

Williams (1978) concluded that the various and inconsistent changes of bed elevation with time means that channel gradient and depth alos have changed in a similarly complex way and that the observed fluctuations probably reflect the complex regulation of water and sediment delivery to the river. The bed elevation plots for the lower portion of the Overton to Grand Island reach (e.g., Odessa and Grand Island) indicate long-term channel degradation on the order of 0.5 foot since 1935.

CHANGES IN FLOW AND SEDIMENT TRANSPORT

Flow Frequency and Magnitude

A number of investigations have summarized the available flow record of the North Platte, South Platte, and Platte Rivers in terms of peak flow, low flow, mean annual flow, and flow duration. Reductions in peak flow and mean annual flow, in combination with diminished sediment transport and supply, have often been cited as important factors in the changing morphology of the Platte River. The U.S. Geological Survey (Eschner et. al. 1983) summarized the post-settlement peak flow and mean flow regime as follows:

> Diversion and storage of surface water for irrigation and hydropower generation have changed patterns of streamflow in some reaches in the Platte River basin. At some stations changes in flood peaks, annual mean discharge, and the shape of flow-duration curves have been recorded. These changes are not found uniformly throughout the Platte River basin, because development of water resources has progressed differently along the North Platte, South Platte, and Platte Rivers.
>
> Construction of large onstream reservoirs in Wyoming and Nebraska has decreased peak flows of the North Platte River. Four gaging stations on the North Platte River with long periods of record show that peak discharge decreased progressively after the closure of each of four major dams (Williams 1978). Kircher and Karlinger (1981) determined statistically that changes in annual peak flows on the North Platte River at North Platte, Nebraska, are better described by two regression models, one corresponding to the period prior to construction of Kingsley Dam (1895-1935) and one corresponding to the period following construction (1936-1979), than by a single model. Kircher and Karlinger did not test the significance of differences in peak flows following each period of

dam construction, but peak flows from 1895 to 1935 decreased with time. There has been no significant change in peak flows since 1935.

Reservoir development has been less extensive in the South Platte River basin than in the North Platte River basin. Total reservoir storage in the South Platte River basin increased about 100 percent from 1915 to the present (figure 17) with the majority of storage in offstream reservoirs. Kircher and Karlinger (1981) showed that peak flows of the South Platte River near Kersey and Julesburg, Colorado, have not changed significantly since 1902, the beginning of the record. However, a statistically significant decrease in peak flows with time was observed on the South Platte River at North Platte, Nebraska, probably due to surface-water diversions downstream of Julesburg.

Peak flows of the Platte River are influenced by flows from both the North Platte and South Platte Rivers. Since the reduction of flood peaks on the North Platte River, flood peaks on the South Platte River have become a more significant component of flow on the Platte River. Peak flows on the Platte River near Overton, Nebraska, have decreased over the period of record, 1915-1979, but have shown no statistically significant decrease since 1935 (Kircher and Karlinger 1981). No long-term change is apparent in peak flows near Grand Island, Nebraska, since the record began in 1935. However, changes may have occurred prior to 1935.

If the entire period of record is considered, annual mean flows have decreased on the North Platte and Platte Rivers. However, since 1935, annual mean flows on these rivers have either not changed significantly or have increased. Records for the North Platte River at North Platte and the Platte River near Overton show no statistically significant change in annual mean flows for the period 1935-1979 (Kircher and Karlinger 1981). Annual mean flows of the Platte River near Grand Island have increased significantly since 1935. No long-term change is apparent in annual mean flows of the South Platte River, although changes may have occurred prior to the period of record. Importation of water into the South Platte River basin apparently has counteracted the effects of water development within the basin.

Kircher and Karlinger (1981) investigated changes in flow duration for a number of sites using 10-year intervals. They concluded that hydrologic changes are identified by shifts in levels of low flow and high flows and the flattening of flow duration curves. The hydrologic and channel changes have occurred in such a manner that the upstream reaches were affected earliest in the period of record. Observing the 10-year flow duration curves and low flows at the sites studied indicate the stations upstream of the Platte River near Overton were maintaining relative stability, while those sites downstream of Overton were still adjusting to changes in the upstream hydrologic system.

Bed Material Transport

Lake McConaughy is the most recent downstream barrier to sediment sizes which are found in significant percentages in the Platte River bed. Historically, the North Platte River contributed at least 60 percent of the bed material load at Overton. The estimated bed material load at Overton for the 1926-1939 period was 2.1 million tons/year and 603,000 tons/year for the more recent 1953 to 1985 period. Present day bed material loads at Overton are 30 percent of the estimated historical values (Lyons and Randle 1988). Bed material transport is also discussed in the section entitled "Effective discharge."

Lyons and Randle (1988) reported an approximate balance in bed material transport between Overton and Grand Island for the 1958 to 1986 period (698,000 tons/year and 706,000 tons/year, respectively). They reported that the quasi-equilibrium, in terms of bed material transport, is in part a reflection of the similarity of the flow-duration curves for the two gages during that time period. In addition, only six sediment measurements were available at the Grand Island gage, and because an analysis of covariance between the two rating curves was not significantly different, the Overton rating curve also was used for the lower station in their mass balance calculations.

Effective Discharge

The concept of an effective discharge was described by Wolman and Miller (1960). In essence, the effective discharge is the flow that occurs frequently enough and carries sufficient sediment to maximize sediment transport over a period of time; it is an index to the range of flows that influence the shape of the river channel. Larger discharges may transport more sediment but occur with far less frequency, and lower discharges, which occur more frequently, do not have as much capacity to transport sediment. For this report, effective discharge is defined as the increment of sediment-transporting discharge that transports the largest portion of bed material load over a period of years.

To compute effective discharge, Lyons and Randle (1988) expanded the flow duration curves at Overton and Grand Island by including discharge data for water years 1926-1930 and 1980-1986 for Overton and 1980-1986 for Grand Island. Figures 18 and 19 show the duration curves for Overton and Grand Island, respectively. They cite three aspects concerning the two curves as being noteworthy: (1) low flows have increased over time at both stations, (2) the 1958-1986 flow duration curves are very similar at both sites, and (3) in the range of 1,000 cfs to 10,000 cfs, the 1940-1957 period had flows that equalled or exceeded the least amount of time.

Figure 20 displays the effective discharge curve for the three time periods, 1926 to 1939, 1940 to 1957, and 1958 to 1986. Note that the shaded area under each curve represents the total bed material transported during each period. The effective discharges for each period are 3,900 cfs, 1,650 cfs, and 1,600 cfs, respectively. For the earliest period in which effective discharge can be computed (1926-1939), the curve is unimodal with a distinguishable peak of approximately 3,900 cfs. For the later periods, a single effective discharge value does not adequately characterize the range of channel-forming flows. Lyons and Randle concluded that flows in the 1,000-cfs to 10,000-cfs range provide a good span of channel-forming flows in the Platte River between Overton and Grand Island. However, examining figure 21 shows that only 55 percent of the bed material load was transported by flows within the 1,000-cfs to 10,000-cfs range for the 1958 to 1986 period. Therefore, a significant portion of the bed material load is transported by flows exceeding 10,000 cfs, and the frequency of these flows also is critical in maintaining the existing channel dimensions. For example, the span of flows which transported approximately 85 percent of the sand load during the same period is 1,000 to 19,000 cfs.

Randle and Woodward (1991) concluded that channel narrowing of the Platte River can be described primarily by changes in water discharge and sediment load, even when the effects of vegetation, streambank protection, or bridges are ignored. They determined relationships between effective discharge and channel width for the Platte River near Overton for conditions during 1938 and 1983. They concluded that channel width varied considerably with discharge for the 1938 conditions. Changes in hydrology during that period, either natural or human-caused, would have a direct impact on channel width. For example, a reduction in the effective discharge, from 3,900 cfs to 1,600 cfs, would account for 89 percent of the channel narrowing that occurred between 1938 and 1983, even if the sediment discharge relationship had remained constant. The Platte River channel during this period responded to changes in discharge mainly by changes in channel width.

For the 1983 conditions, channel width varied slightly with discharge for flows greater than 1,600 cfs. The differences between the two relationships of 1938 and 1983 (figure 22) were concluded to be due to the reduction in bed material load supplied to the Platte River and the coarsening of the streambed. The curve representing the 1983 conditions shows a decrease in channel width for increases in effective discharge beyond 1,600 cfs. The negative relation is due to the coarser bed material requiring a narrower channel, with greater velocities, to enable transport under equilibrium conditions. Changing the bed material to a finer particle size distribution can eliminate the negative slope of the width-discharge curve representing the 1983 conditions (figure 22).

Randle and Woodward summarized their conclusions as follows:

> The initial width-discharge relationship shown in figure 22 for the Platte River near Overton is qualitatively correct.
>
> Comparison of the width-discharge curves for the 1938 and 1983 conditions shows that the channel has primarily remained narrow due to a reduction in the bed material load supplied to the Platte River. The reduction in bed material load also has resulted in coarsening the bed with concurrent narrowing.
>
> Changes in hydrology in 1938 would cause changes in channel width. Because of the reduction in supply of sediments from 1938 to 1983, an increase in the effective discharge will not result in a substantial change in channel

width. However, a decrease in the effective discharge would cause further narrowing of the channel under 1983 conditions.

The methodology can by used to qualitatively predict the impacts of future changes in hydrology or sediment for specific reaches of the Platte River.

EFFECTIVE DISCHARGE AND FLOOD FREQUENCY, 1969 TO 1986

The 1969 through 1986 period of record is representative of flow conditions between Overton and Grand Island, in terms of effective discharge and peak flow frequency, which should be retained, and in some instances augmented. Based on the past occurrence and magnitude of discharges necessary to produce incipient motion, scour vegetation, and produce bankfull discharge, O'Brien (Bowman and Carlson 1994) recommended that the magnitude of the 5-year and more frequent annual events be increased to maintain the Platte River's remaining braided character between Overton and Grand Island. His recommendation includes:

A mean peak flow over a 10-year period averaging 8,300 to 10,800 cfs.

A 2.5-year to 3-year return period peak flow of 12,000 cfs.

A 5-year return period peak flow of 16,000 cfs.

Figure 23 shows the peak flow frequency curve for the 1969-1986 period along with the above recommendations plotted for comparison purposes. Discharge values for the 1969-1986 reference period and the recommended conditions are shown below (Table 2).

Table 2. Recommended Peak Flow and Frequency

RETURN PERIOD	1969-1986 PERIOD	RECOMMENDED DISCHARGE
Mean Annual Peak*	5,685 to 9,120 cfs	8,300 to 10,800 cfs
2.5-Year	8,600 cfs	12,000 cfs
5-Year	12,840 cfs	16,000 cfs

*Mean Annual Peak using a 10-year moving average.

The 10-year moving average for the mean annual peak flow during the 1969 to 1986 period was below the recommended level in 12 of the 18 years. The deficit in the 10-year moving average (difference from 9,550 cfs) ranged from 450 cfs to 4,040 cfs, and the 2-year and 5-year events were approximately 3,400 cfs and 3,160 cfs short from their respective targets.

One possible management strategy could be to augment those flows less than approximately 10,000 cfs by the deficit amount in the 10-year running average.

Effective discharge of the 1969 through 1986 period of record at Overton is shown in figure 24. The earlier 1943 through 1968 period also is shown for comparison purposes. Figure 24 shows that all discharges above 1,000 cfs were important in transporting bed material during the 1969-1986 period and not just the annual peak flow. Although augmentation of annual peak flow may be used as an appropriate management strategy, significant reductions of other flow events could adversely reduce effective discharge and allow additional channel narrowing.

VEGETATION AND CHANNEL CHANGE

Statistical models to investigate woodland expansion in the Platte River found that environmental variables were significantly correlated with colonization (rate of establishment of new vegetation patches from channel) and channel area (net change in channel area). Results indicate that sandbar succession to woodland is regulated by three environmental factors: (a) June flows, including mean flow and peak flow, (b) summer drought, and (c) ice (Johnson, 1994). The following section summarizes the research conducted by Johnson.

Colonization

The spatial and temporal pattern of colonization was best explained by a two-variable, log-transformed model using mean June flow and maximum peak flow that occurred during May 15 through July 15. Both variables were inversely correlated with colonization, indicating that the formation of new vegetation patches was favored by lower mean and peak flows during the seed dispersal period. Both variables were of comparable strength in the model.

The ecological interpretation is that both higher average and peak flows during June cover more of the riverbed, thereby reducing the area available for successful colonization by pioneer tree seedlings. The fact that the two variables were of comparable weight in the model and were themselves highly correlated ($r = 0.832$) means that the analysis cannot distinguish between the influence of higher June flows in restricting germination by covering the riverbed while also possibly eroding previously established seedlings. It is concluded that flows during the seed germination period (centered on June) determine colonization rates and, therefore, the prospects for vegetation encroachment and channel narrowing (Johnson, 1990).

Splitting the colonization data into reaches above or below the J-2 Return produced a stronger model for the downstream sites of Odessa, Kearney-west, Shelton, and Wood River. Maximum peak flow was the dominant explanatory variable, while effects of ice entered as a second significant but weaker variable.

Erosion

In general, the erosion models were weaker than the colonization models and were more difficult to interpret. The statistical model that best explained historical variation in the net percent change in channel area included mean June flow and total active channel width (again using log-transformed values). Rates of channel loss were higher during periods of lower June flow and in wider reaches. Width was a significant, yet minor, component of the model. Flow estimates to prohibit woodland expansion were determined using the erosion model for various reaches of the Platte River (Table 3).

Table 3. Estimation of Mean June Flow Needed for No Net Change in Channel Width

Site	1986 Mean Width, Feet	Mean June Flow, CFS
Reach Average	---	2,825
Gothenburg	290	1,105
Cozad	376	1,229
Odessa	797	2,733
Kearney-west	813	2,758
Shelton	960	2,973
Wood River	799	2,737

Adapted from Johnson 1994

The range for the downstream half of the Big Bend reach of the Platte River was approximately 2,650 cfs to 3,000 cfs. Johnson (1994) concluded that mean flows need not be within this range each year to produce stability in total channel width. For example, mean flow was within this range during 1969-1978, but annual June flows exhibited considerable year-to-year variation. Mean June flows during this period at Odessa ranged from approximately 140 cfs to 10,880 cfs, while peak flows ranged from approximately 565 cfs to 17,900 cfs.

Seedling Mortality and Environmental Factors

Other statistical models based on demographic field data indicated other flow and climate factors may affect tree seedling survivorship. The predominant mortality factor was ice, and its degree of influence was strongly affected by environmental factors including (1) cold winter temperatures necessary to form thick cake ice, (2) relatively high winter flows of approximately 2,470 cfs to 3,000 cfs which caused higher ice formation and therefore more effective scouring, and (3) the elevational distribution of seedlings in the riverbed. Johnson stressed that high base flows in winter, which enable higher and more effective scouring, are necessary before ice can cause widespread seedling mortality.

Negative correlations were found between mortality and flow. This indicated that low flow, which deprived seedlings of moisture, was a stronger mortality factor than was submergence, erosion, or sedimentation caused by high flow. High flows of the magnitude experienced during the study actually contributed to seedling survival. The 1985-1989 period, however, did not include large peak events such as those of 17,650 cfs to 26,500 cfs which occurred in the late 1970's and early 1980's and which probably would have resulted in higher seedling mortality.

Johnson also noted that summertime peaks in the range of 4,400 cfs to 8,000 cfs were effective in scouring new germinants, but the timing of such peaks relative to the seed germination period determined whether they were effective or not. Summertime peaks were generally ineffective in removing previous-year or older seedlings.

In contrast to ice, which often completely removed seedlings from extensive areas of the riverbed, at least a few seedlings in most plots survived summer drought. Drought acted more to thin the ranks of seedlings rather than eliminating seedlings from large areas.

Flow Management

Johnson suggested several management options could be used to reduce woodland expansion, including (1) prohibit recruitment in the active channel by augmenting June flows to maintain a several-year average of at least 2,650 cfs to 3,000 cfs below the J2 Return, and 1,060 cfs to 1,410 cfs above the J2 Return, (2) raising winter flows to increase ice scouring, (3) increasing spring peak erosive flows to remove seedlings, (4) reducing late-summer flows to increase seedling desiccation, and (5) a combination of the above options.

Johnson concluded option 1 as perhaps being the best, because prohibiting recruitment obviates the need to use options 2 through 4. He suggested that perhaps the most effective management strategy may be to combine options, based on knowledge of recruitment success and seedling survivorship from a permanent plot sampling network.

SUMMARY AND RECOMMENDATION

Major changes in the hydrologic regime and morphology of the Platte River have been described and investigated by a number of individuals. These changes have occurred following 1860, when water resources began to be developed within the Platte River basin for a variety of uses. Changes in the flow and sediment regime have made the Platte River more amenable to vegetative growth and have contributed to decreased channel width and area.

At best, the designated critical habitat reach may have achieved a state of quasi-equilibrium, and no long-term reductions in width will occur. However, the available information does not allow a definitive conclusion regarding equilibrium, and additional reductions in width may still occur in the lower portion of the Overton to Grand Island reach, even though bed material transport is roughly in equilibrium.

There is no single defining flow in terms of magnitude, duration, and frequency which can be readily specified on an annual basis to maintain the remaining braided reaches of the Platte River. With the current conditions of sediment supply and particle size, reductions in effective discharge over the long term will result in channel narrowing. Significant increases in effective discharge over the long term also will cause additional narrowing of the channel. This is due to a narrower channel being required to increase stream velocity to transport the existing coarser load.

The effective discharge histogram for the recent period of 1969-1986 shows a wide range of flows (1,000 to 20,000 cfs) as transporting the majority of bed material load. Therefore, all flows above 1,000 cfs have importance in maintaining the existing channel.

Increasing the magnitude of the more frequent flow events (generally those less than the 5-year return period) is recommended to maintain the braided characteristics of the Platte River between Overton and Grand Island (see Table 2). The Service's pulse flow recommendation for late winter (February and March) and late spring (May and June) is compatible with recommendations to control seedling recruitment in June and to increase the effectiveness of ice scouring in winter.

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Historical Trends in Channel Width at gauging locations in the Big Bend Reach of the Platte River, Nebraska

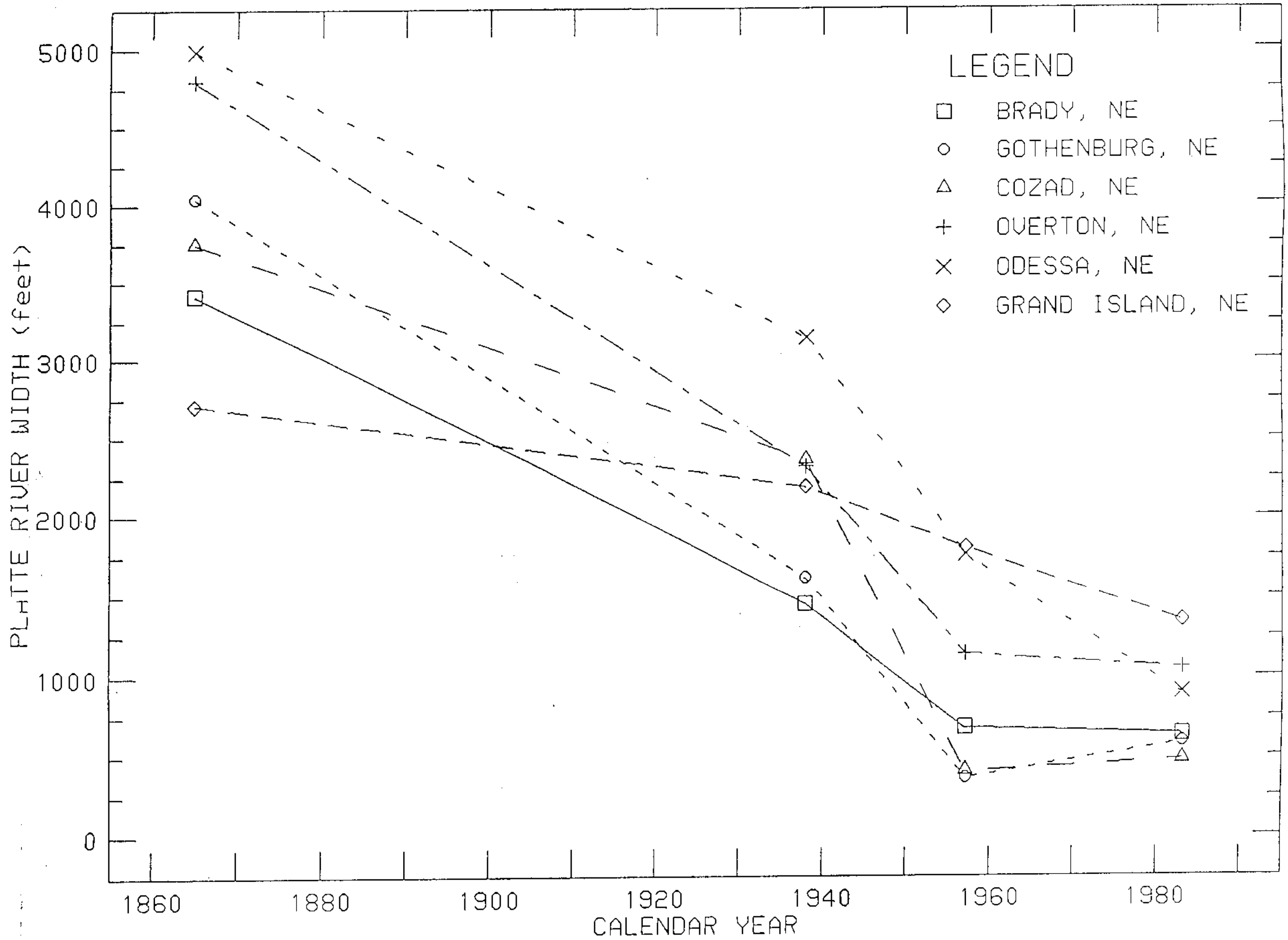


Figure 1

North Platte River near Mitchell, NE
Elevation of 1000 cfs Discharge

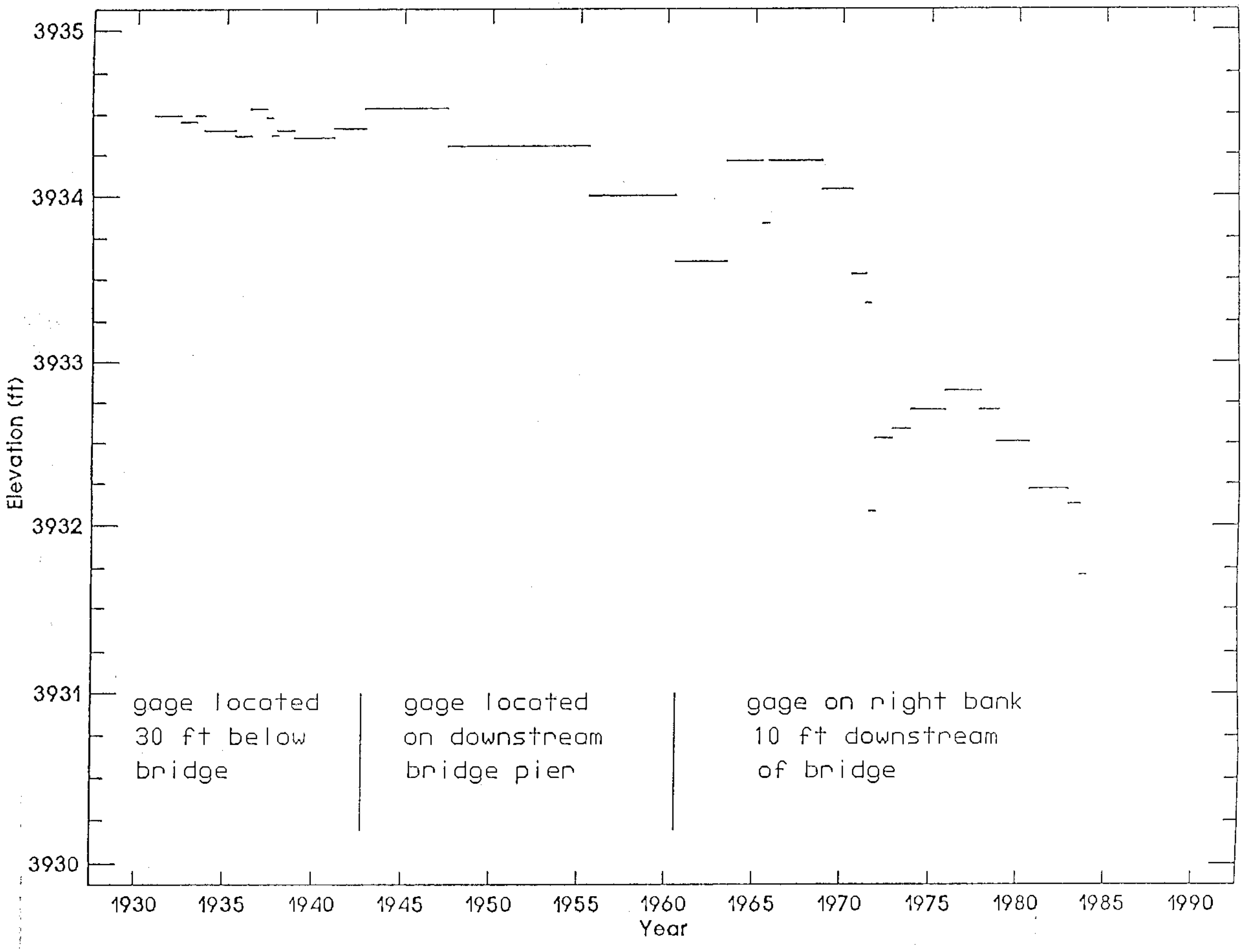


Figure 2

North Platte River near Bridgeport, NE
Elevation of 1000 cfs Discharge

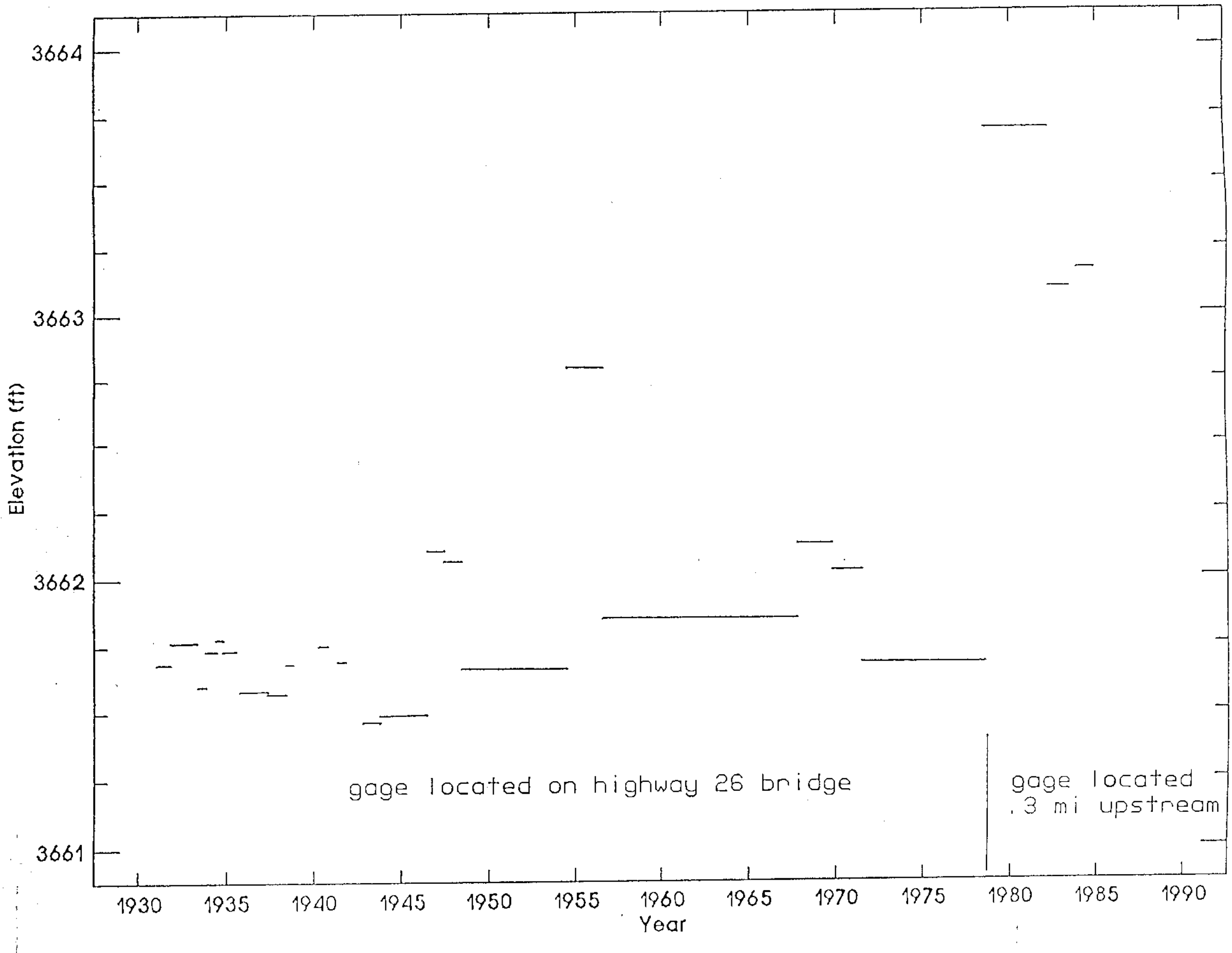


Figure 3

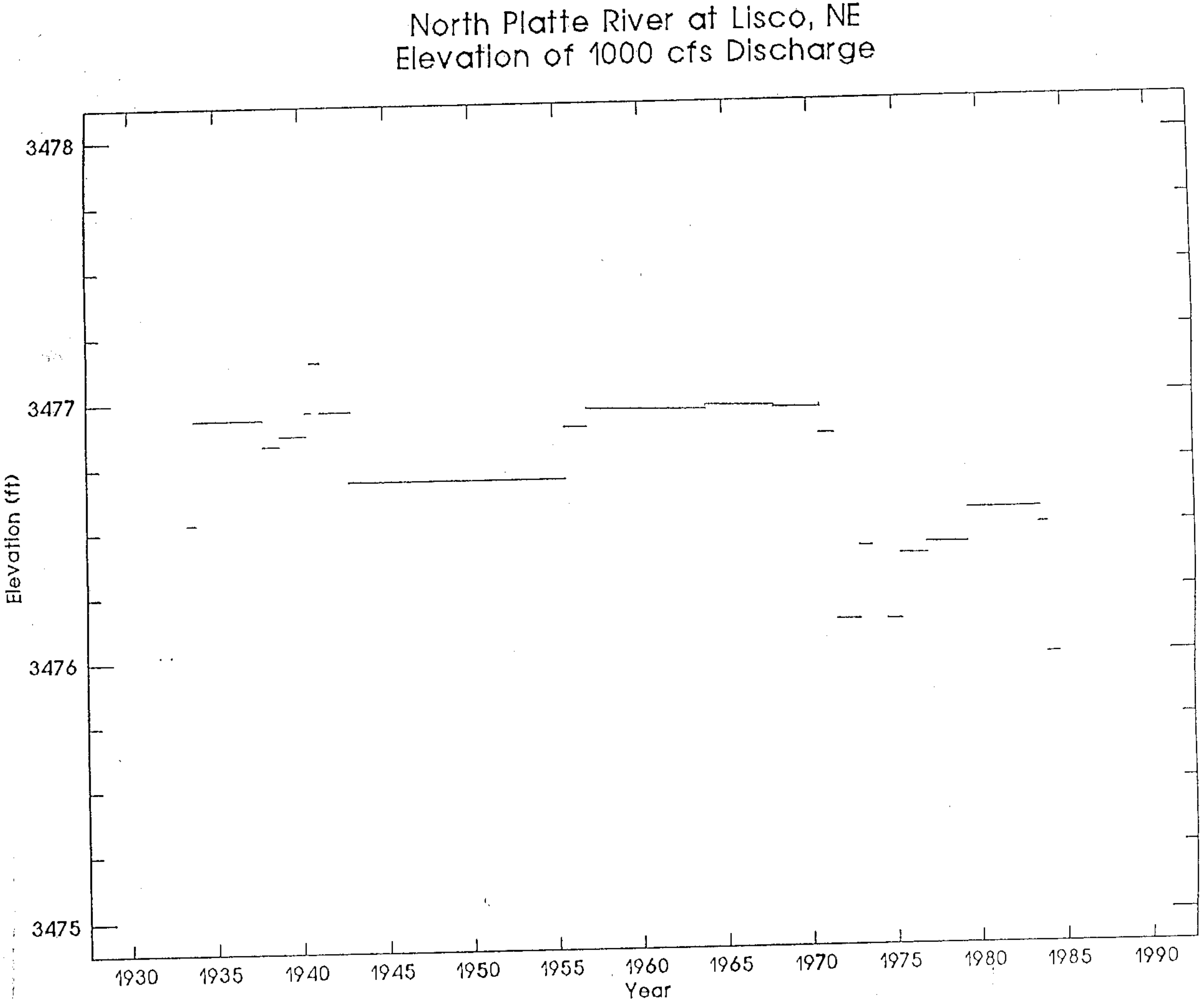

North Platte River at Lisco, NE
Elevation of 1000 cfs Discharge
3478
3477
3476
3475
Elevation (ft)
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
Year

Figure 4

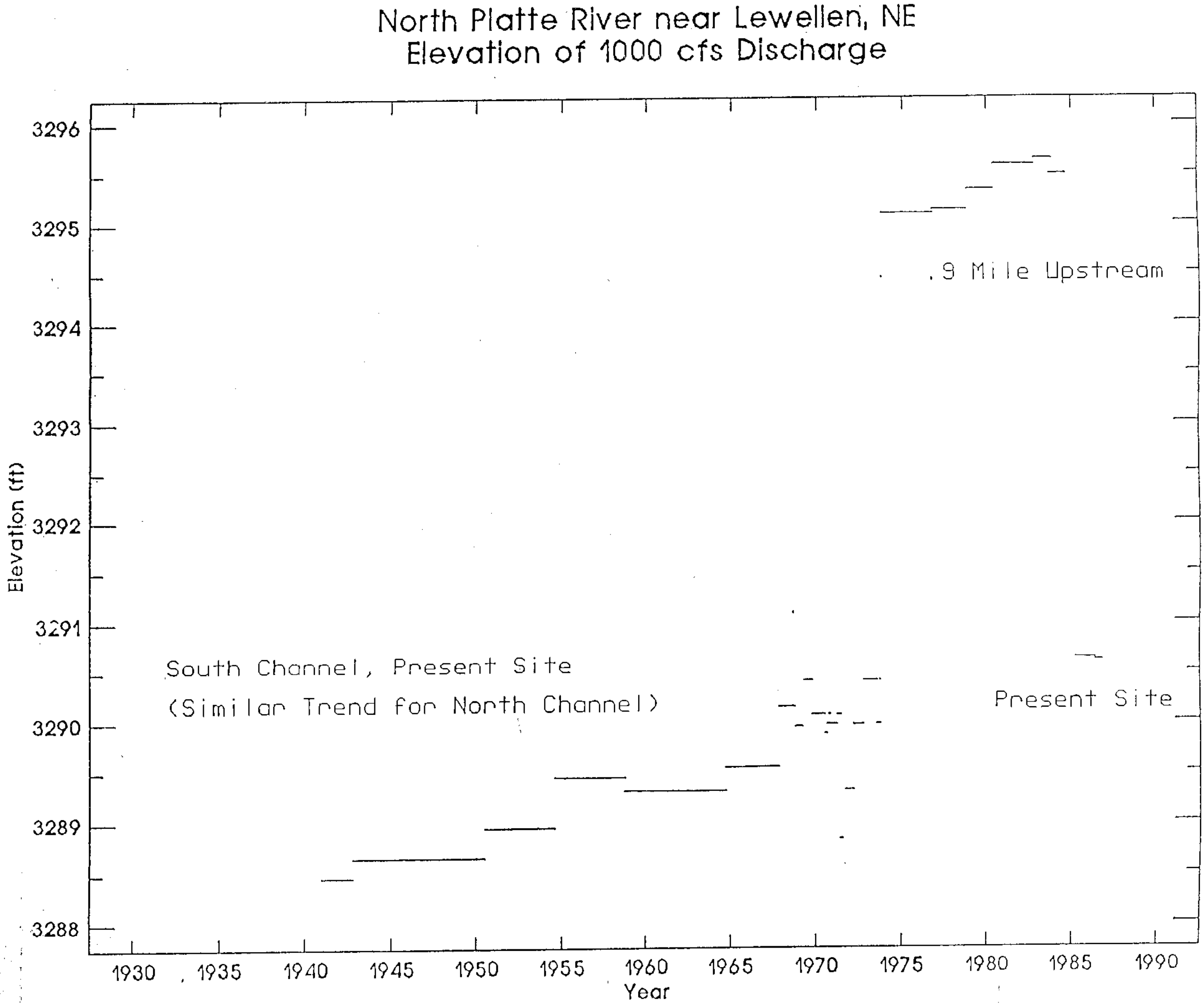

North Platte River near Lewellen, NE
Elevation of 1000 cfs Discharge
Elevation (ft)
3288
3289
3290
3291
3292
3293
3294
3295
3296
Year
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
South Channel, Present Site
(Similar Trend for North Channel)
.9 Mile Upstream
Present Site

Figure 5

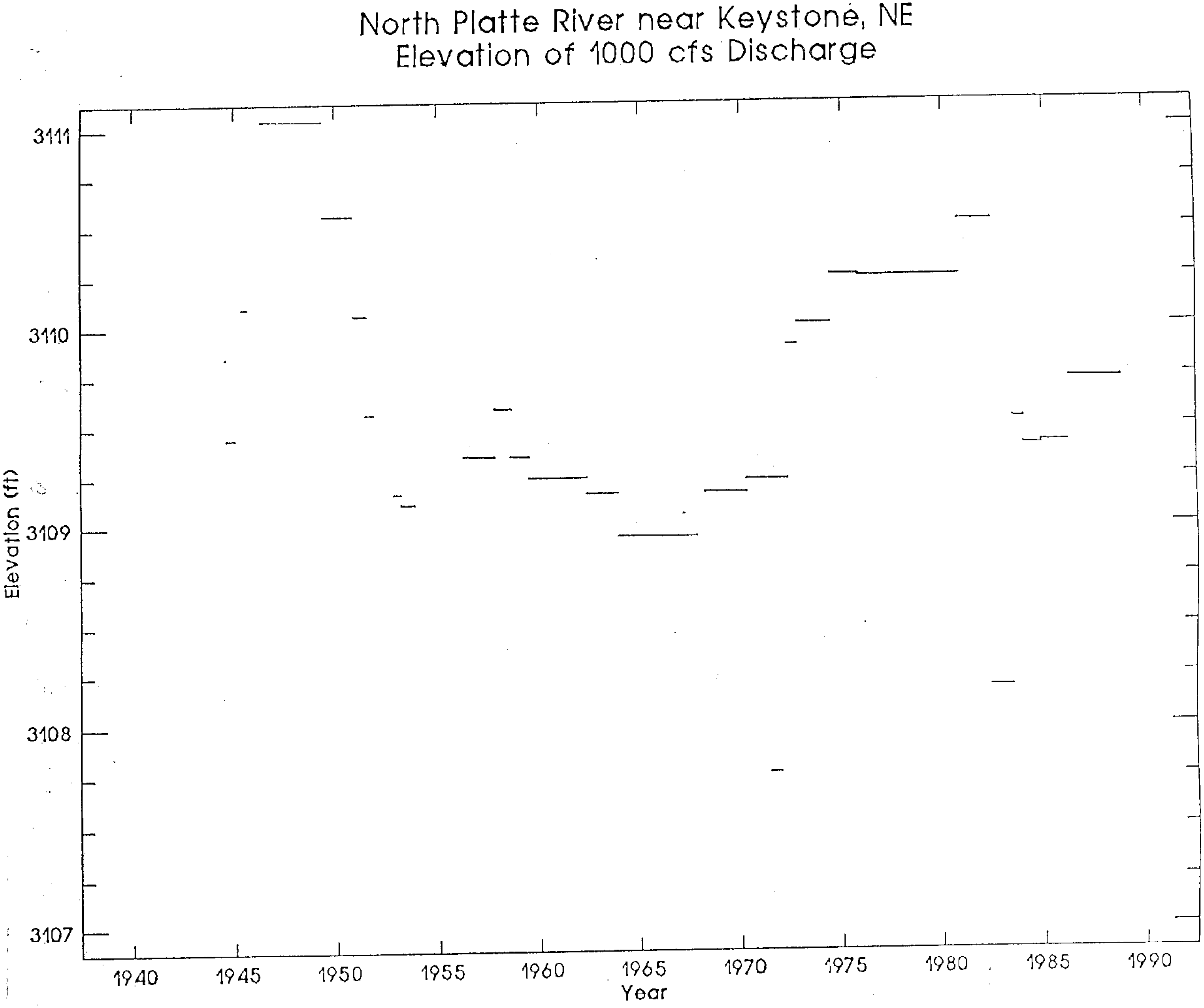

North Platte River near Keystone, NE
Elevation of 1000 cfs Discharge
Elevation (ft)
3111
3110
3109
3108
3107
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
Year

Figure 6

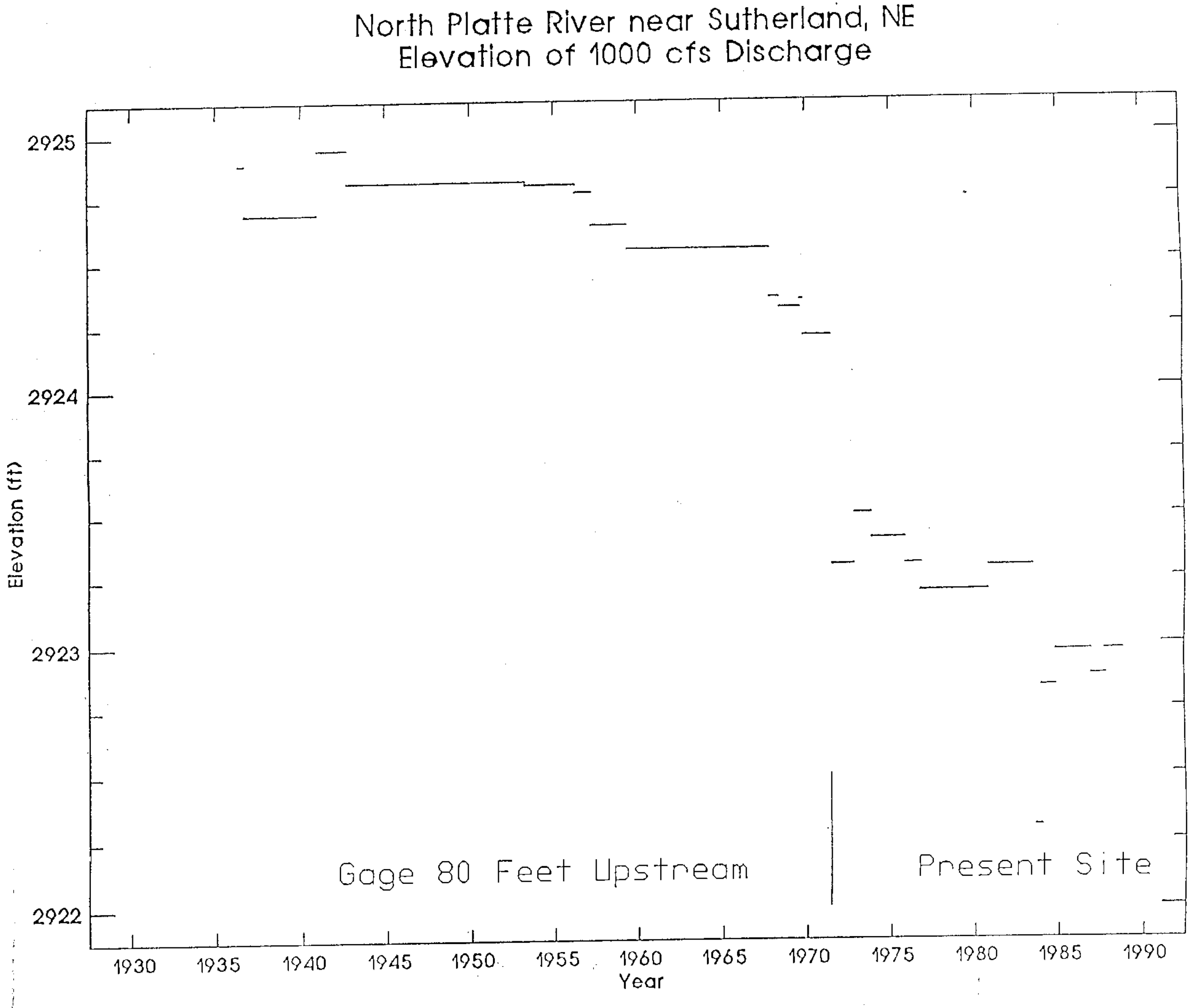

North Platte River near Sutherland, NE
Elevation of 1000 cfs Discharge
Elevation (ft)
2925
2924
2923
2922
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
Year
Gage 80 Feet Upstream
Present Site

Figure 7

North Platte River near North Platte, NE
Elevation of 1000 cfs Discharge

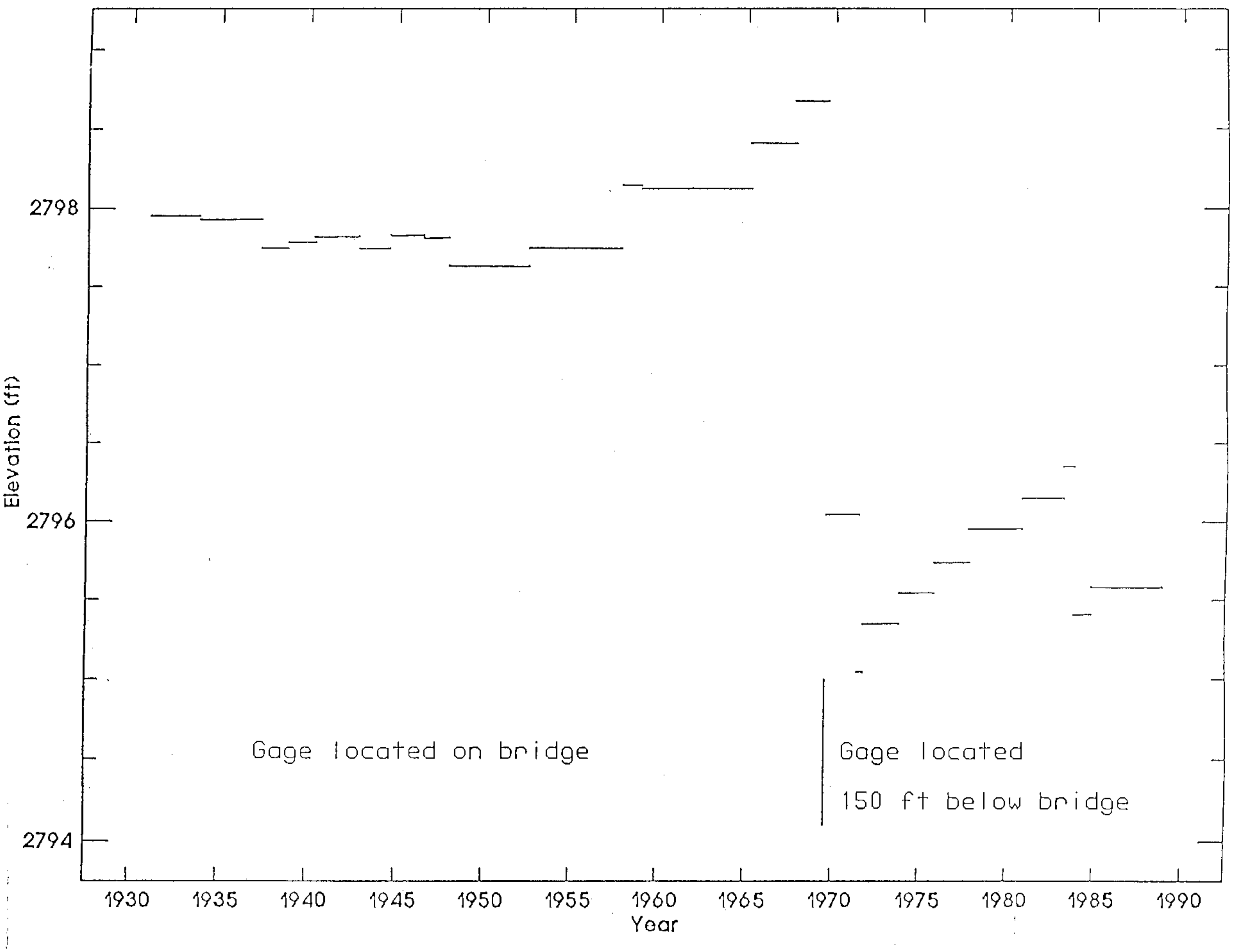
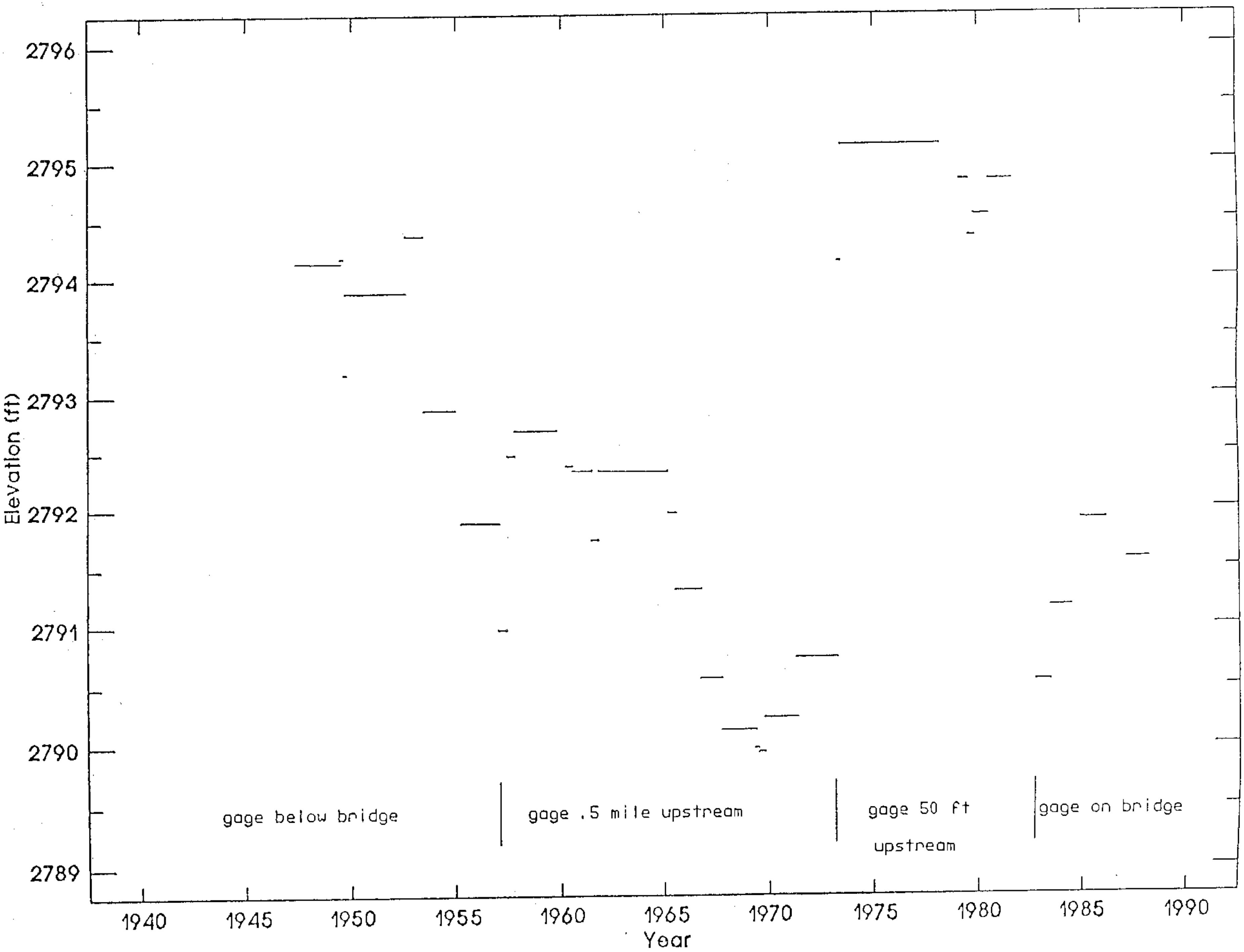


Figure 8

South Platte River near North Platte, NE
Elevation of 1000 cfs Discharge



Platte River near Brady, NE (North Channel)
Elevation of 1000 cfs Discharge

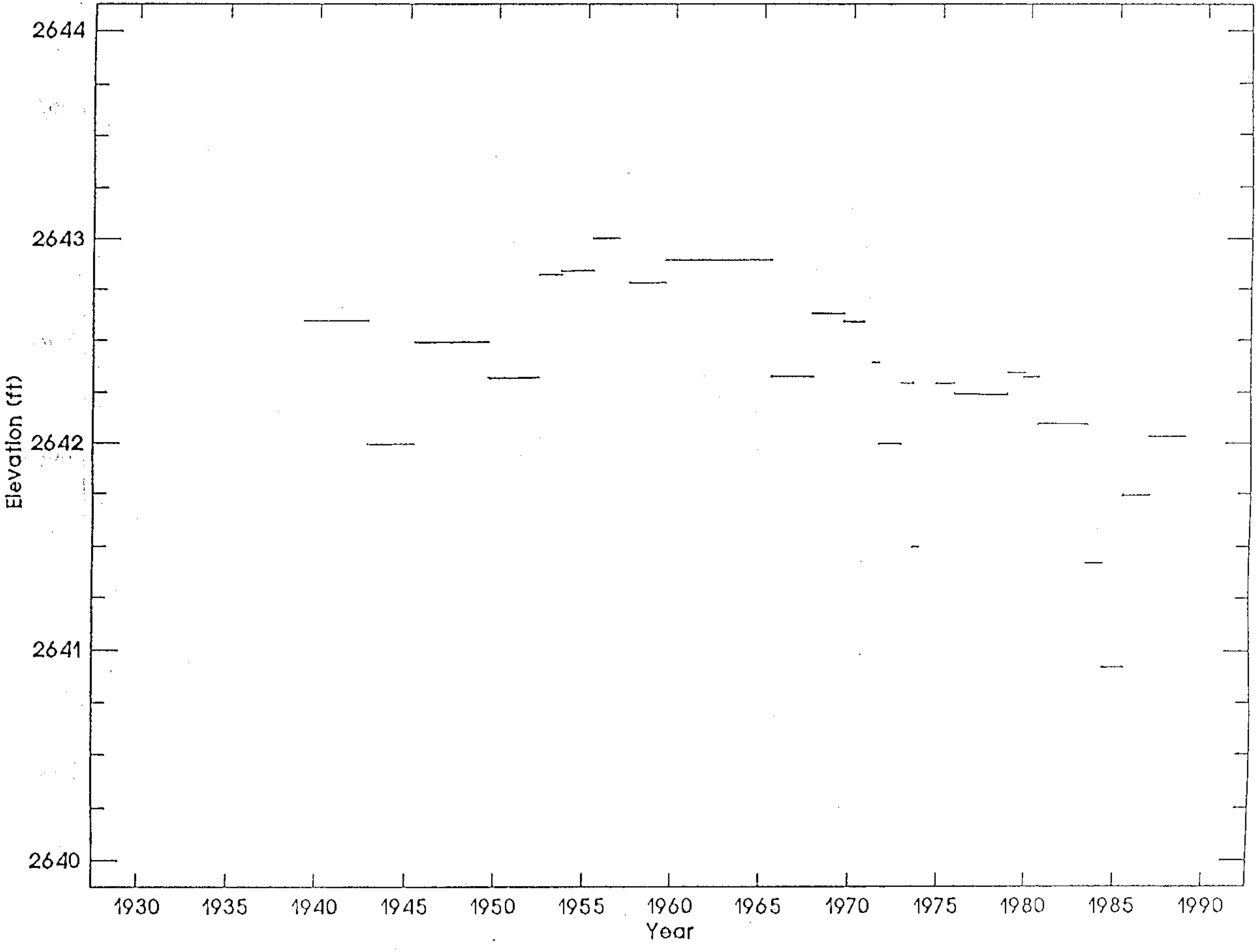


Figure 10

Platte River near Cozad, NE (North Channel)
Elevation of 1000 cfs Discharge

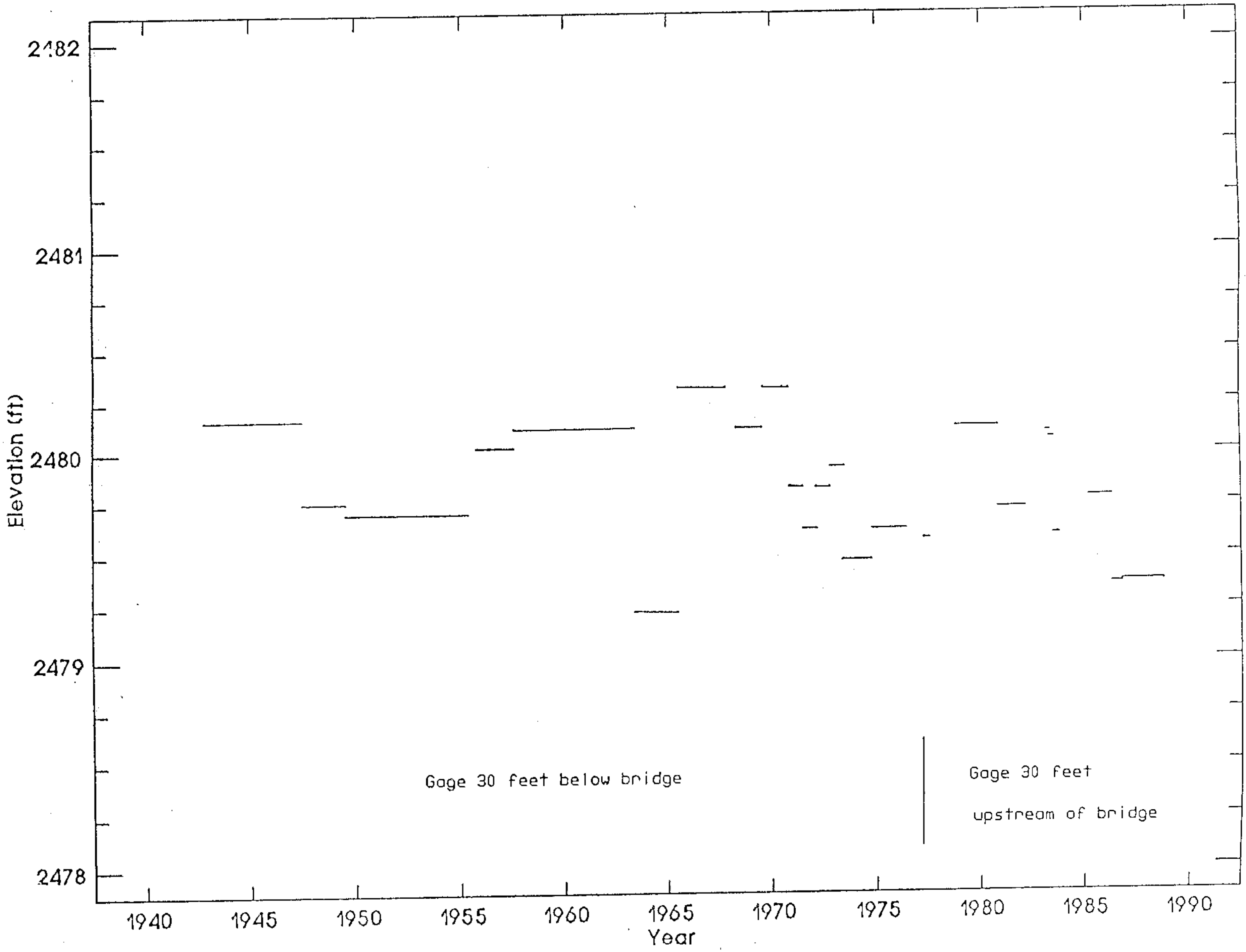
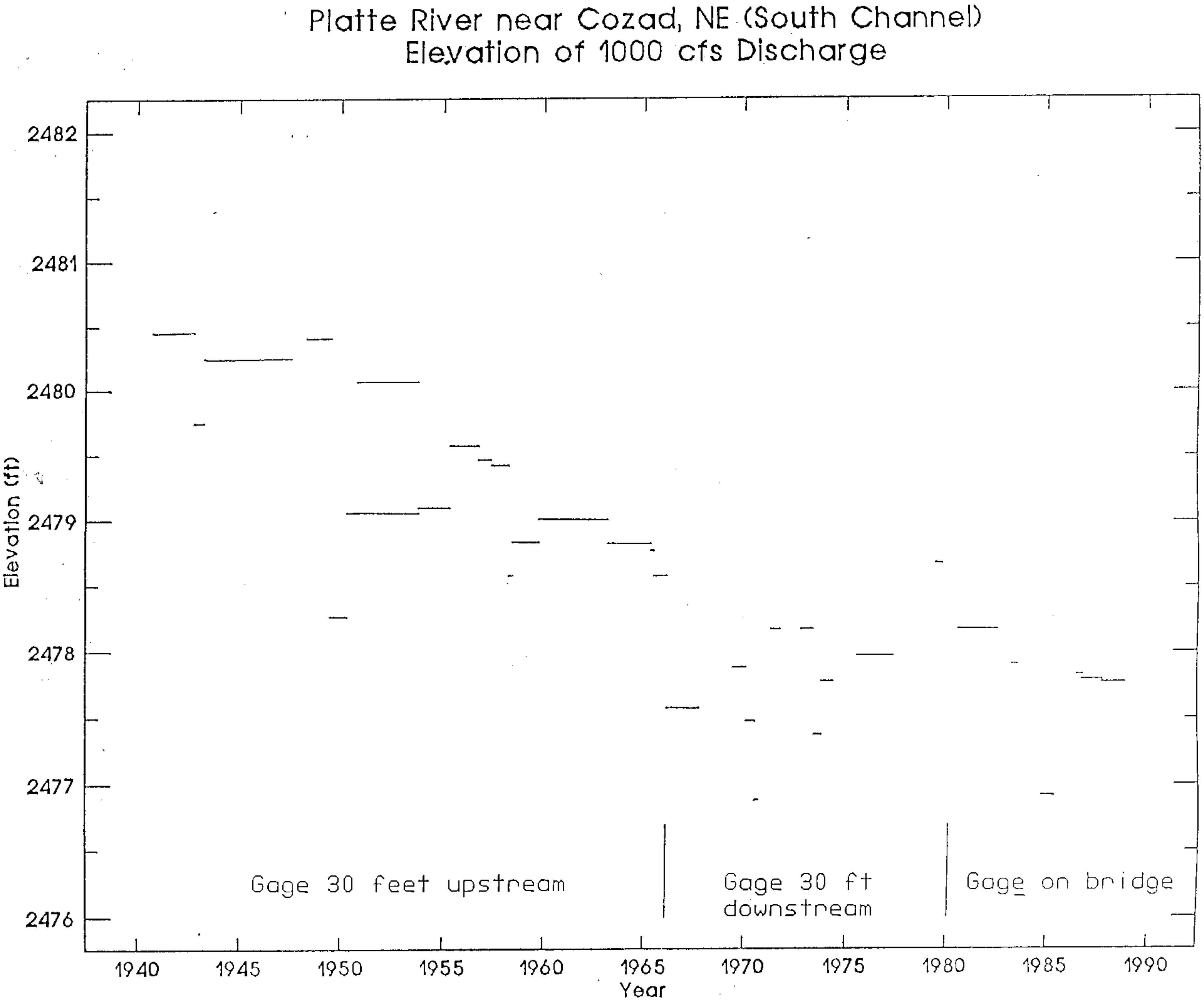


Figure 11



Platte River near Cozad, NE (South Channel)
Elevation of 1000 cfs Discharge
Elevation (ft)
2482
2481
2480
2479
2478
2477
2476
Gage 30 feet upstream
Gage 30 ft downstream
Gage on bridge
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
Year

Figure 12

Platte River near Overton, NE
Elevation of 1000 cfs Discharge

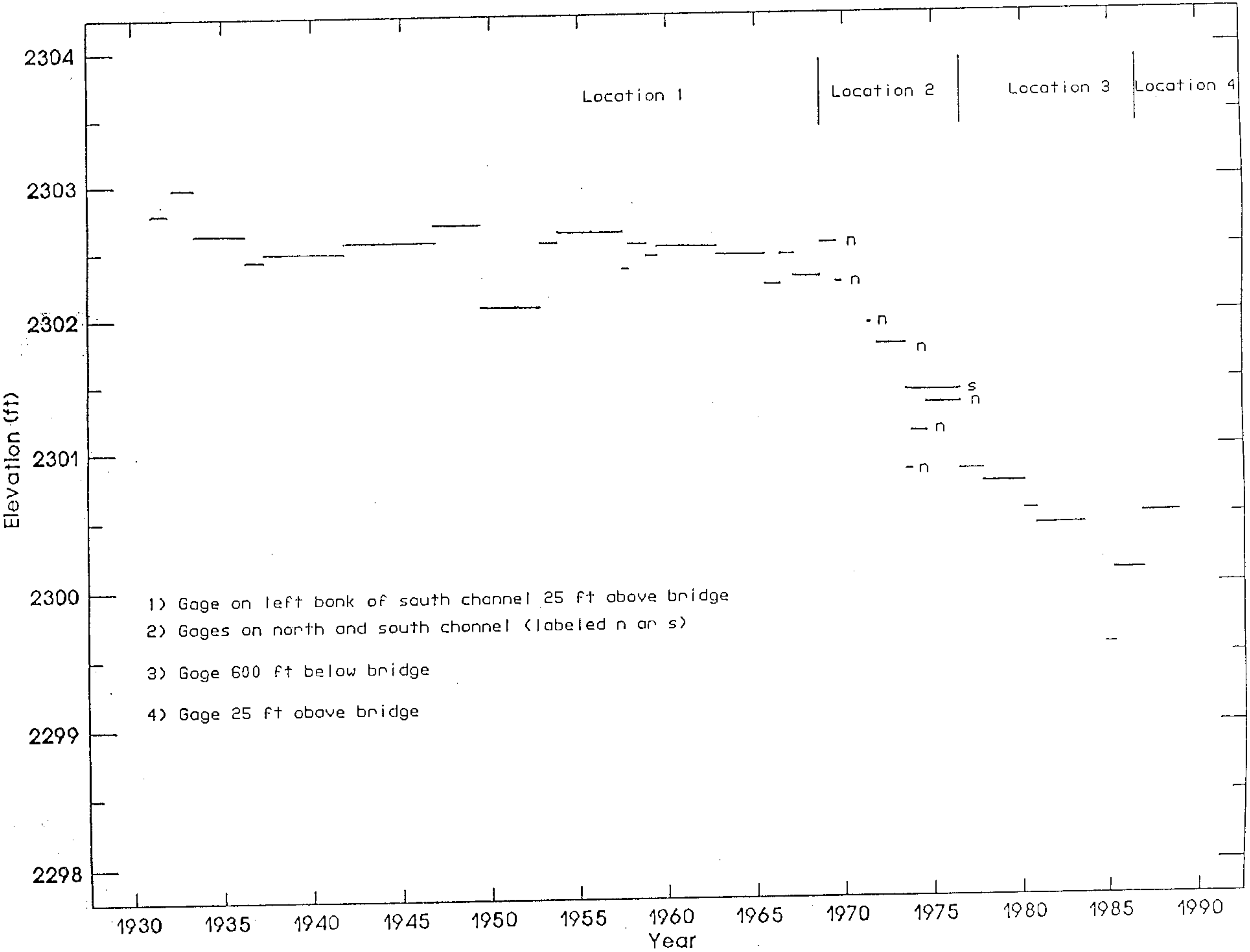
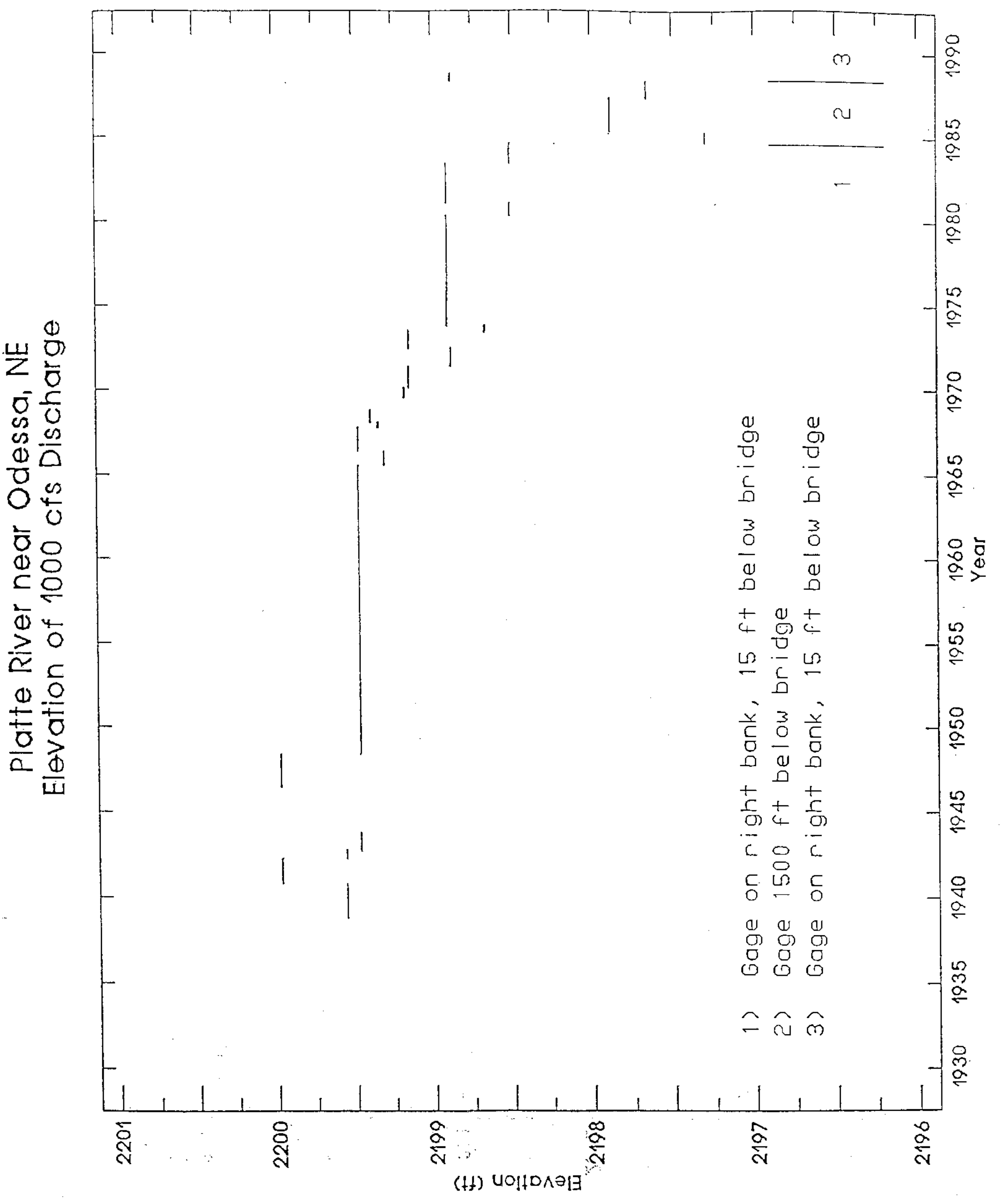


Figure 13



Platte River near Odessa, NE
Elevation of 1000 cfs Discharge
1) Gage on right bank, 15 ft below bridge
2) Gage 1500 ft below bridge
3) Gage on right bank, 15 ft below bridge
1
2
3
Year
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
Elevation (ft)
2196
2197
2198
2199
2200
2201

Figure 14

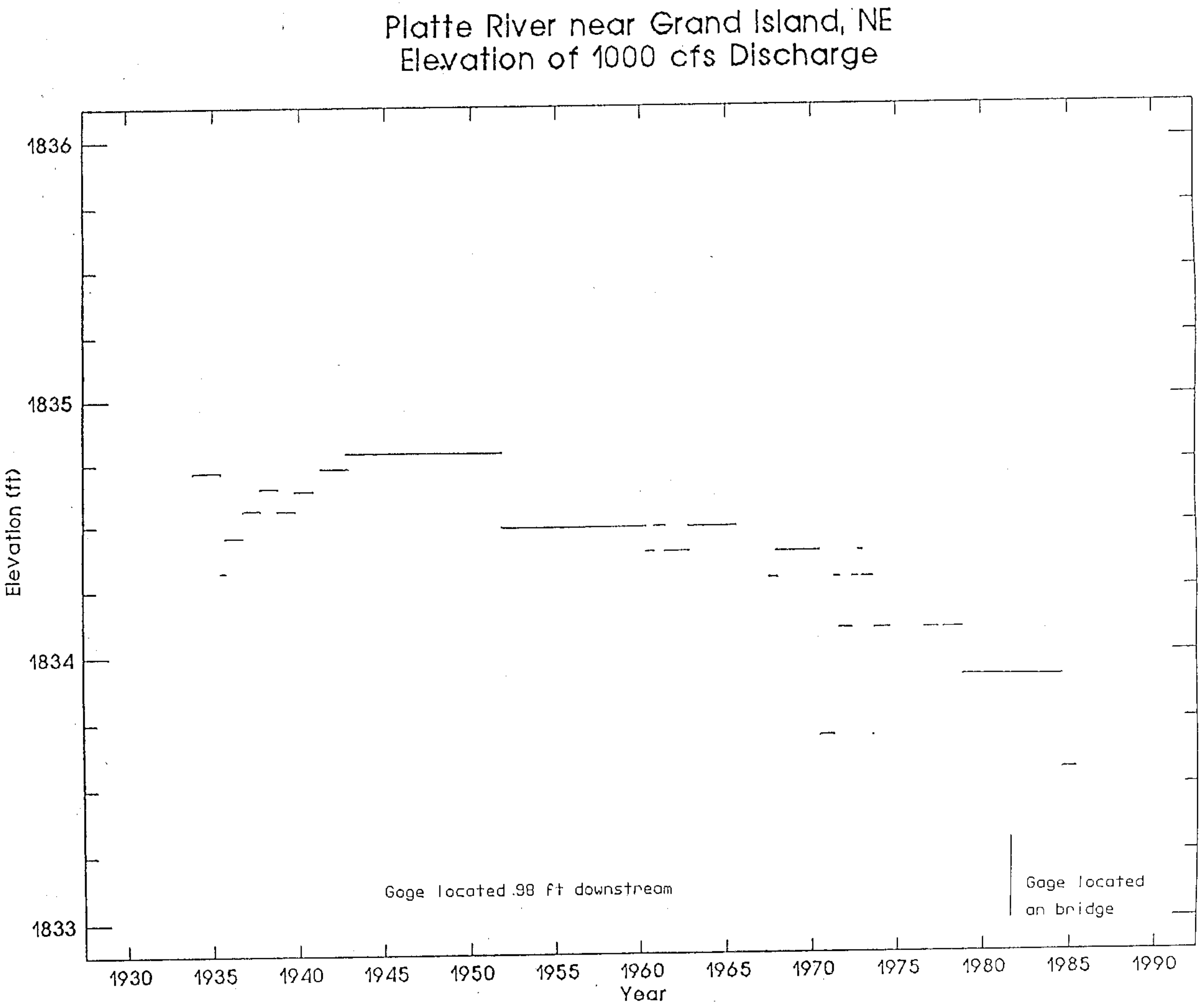

Platte River near Grand Island, NE
Elevation of 1000 cfs Discharge
1836
1835
1834
1833
Elevation (ft)
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
Year
Gage located 98 ft downstream
Gage located
on bridge

Figure 15

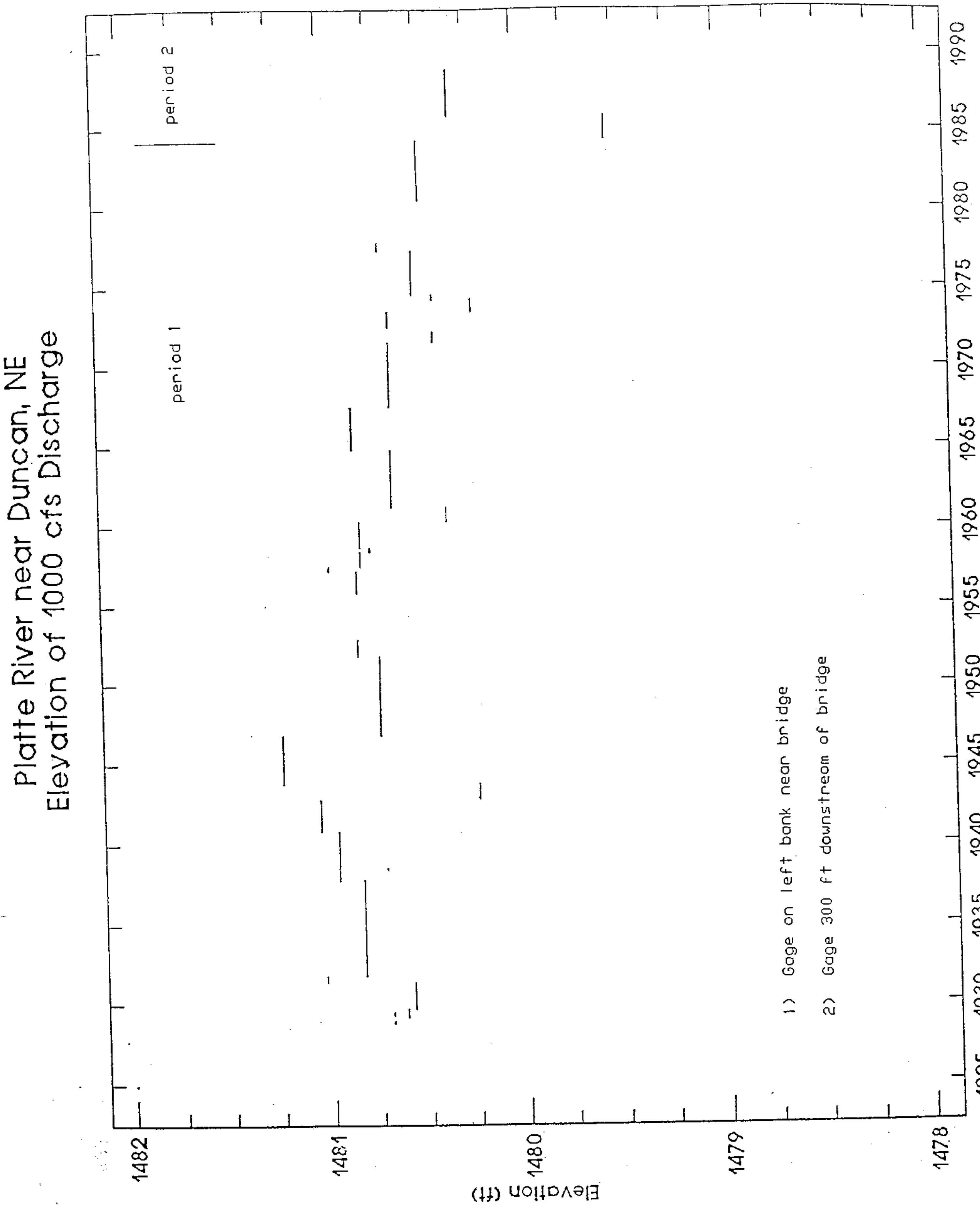

Platte River near Duncan, NE
Elevation of 1000 cfs Discharge
period 1
period 2
1) Gage on left bank near bridge
2) Gage 300 ft downstream of bridge
Year
Elevation (ft)
1482
1481
1480
1479
1478
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990

Figure 16

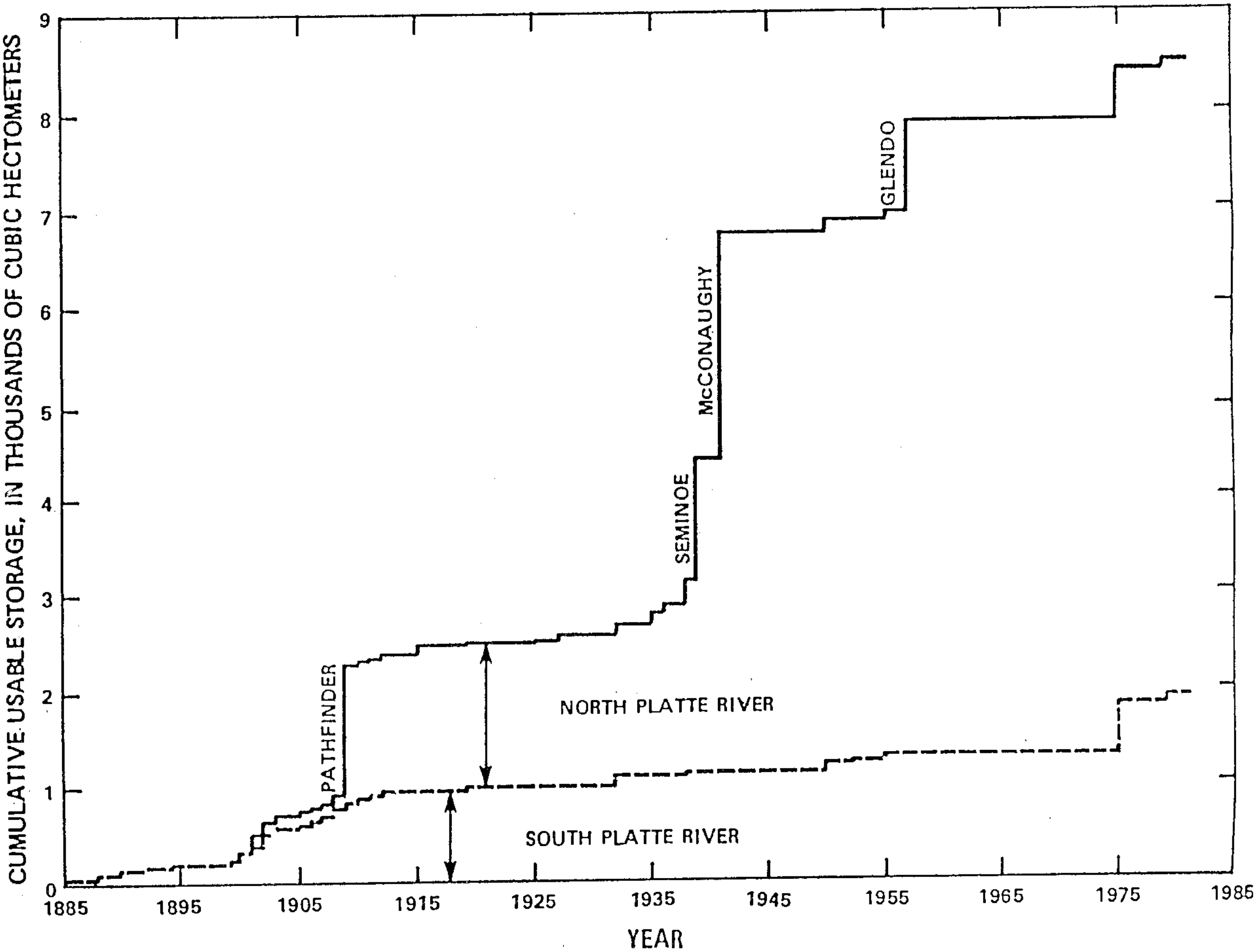

CUMULATIVE USABLE STORAGE, IN THOUSANDS OF CUBIC HECTOMETERS
0
1
2
3
4
5
6
7
8
9
1885
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
YEAR
PATHFINDER
SEMINOE
McCONAUGHY
GLENDO
NORTH PLATTE RIVER
SOUTH PLATTE RIVER

Figure 17

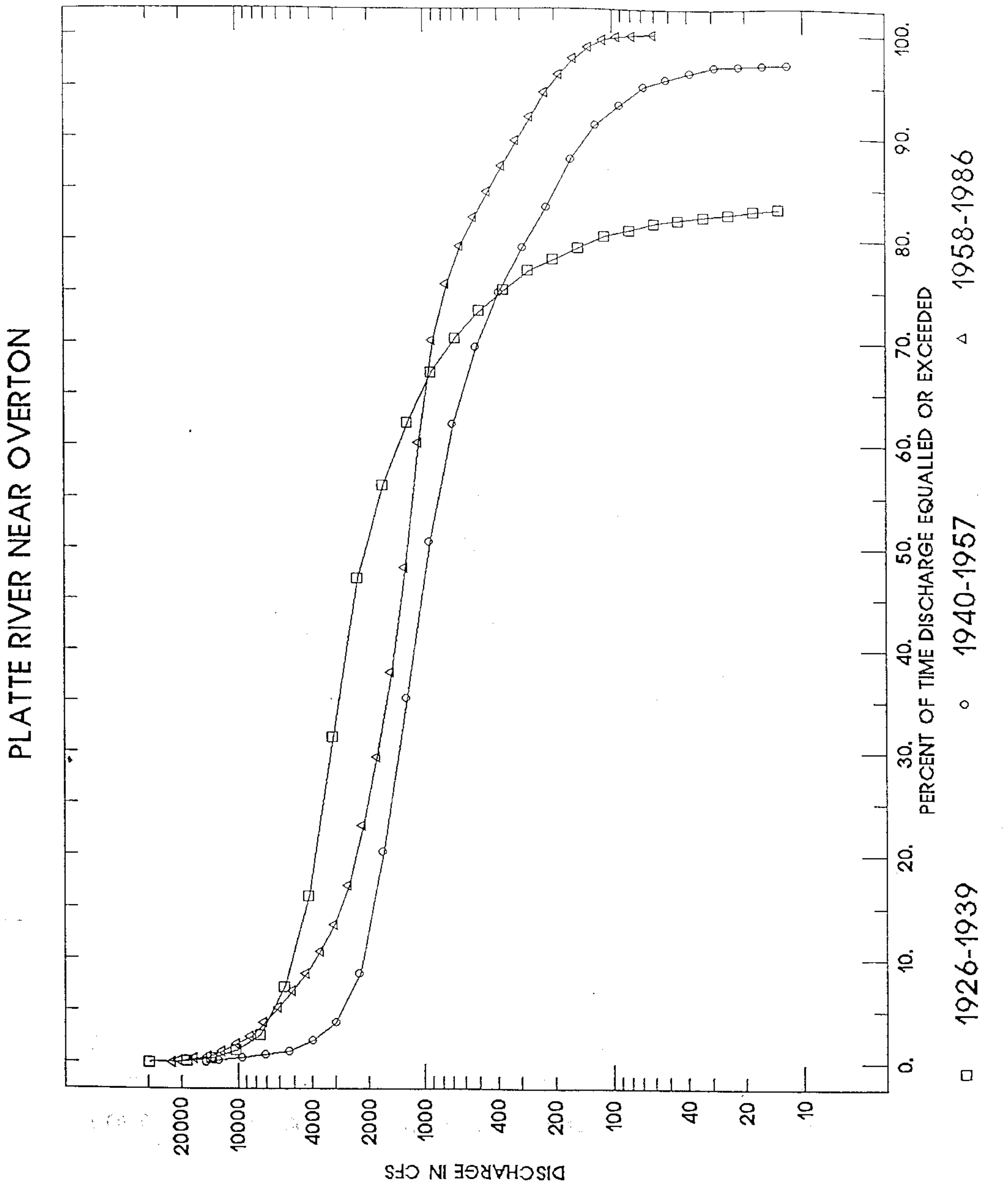
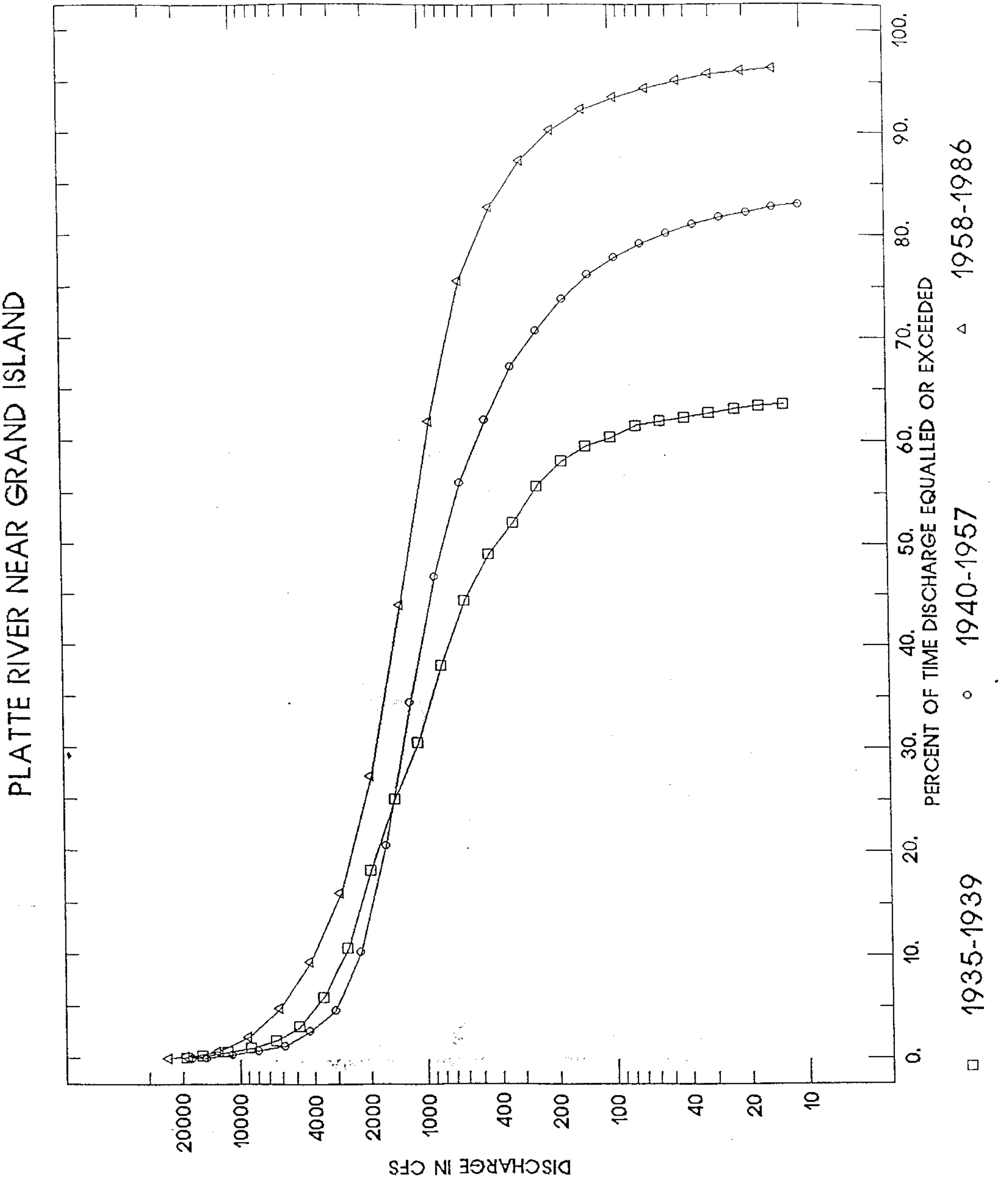
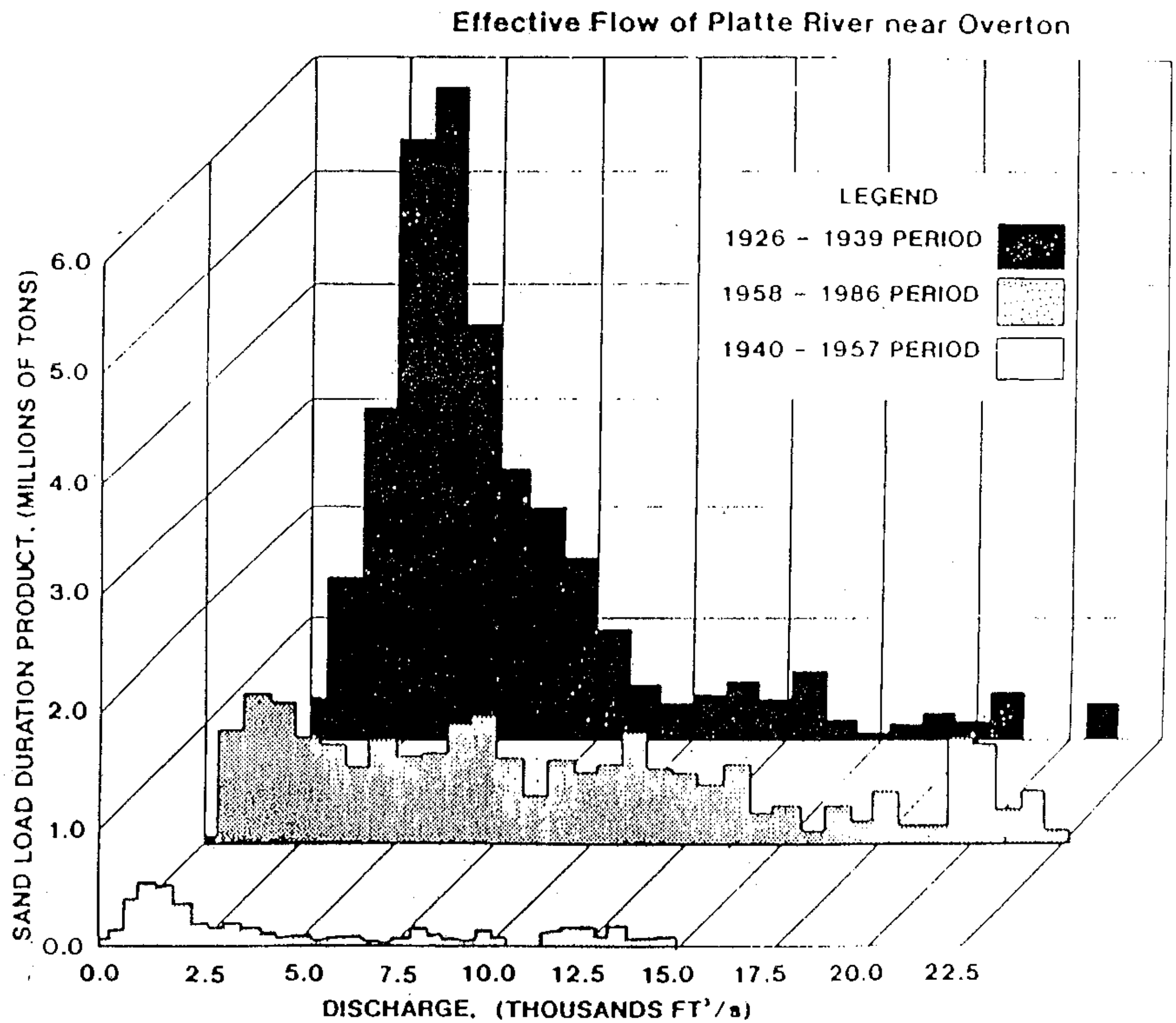

PLATTE RIVER NEAR OVERTON
DISCHARGE IN CFS
20000
10000
4000
2000
1000
400
200
100
40
20
10
PERCENT OF TIME DISCHARGE EQUALLED OR EXCEEDED
0.
10.
20.
30.
40.
50.
60.
70.
80.
90.
100.
1926-1939
1940-1957
1958-1986

Figure 18



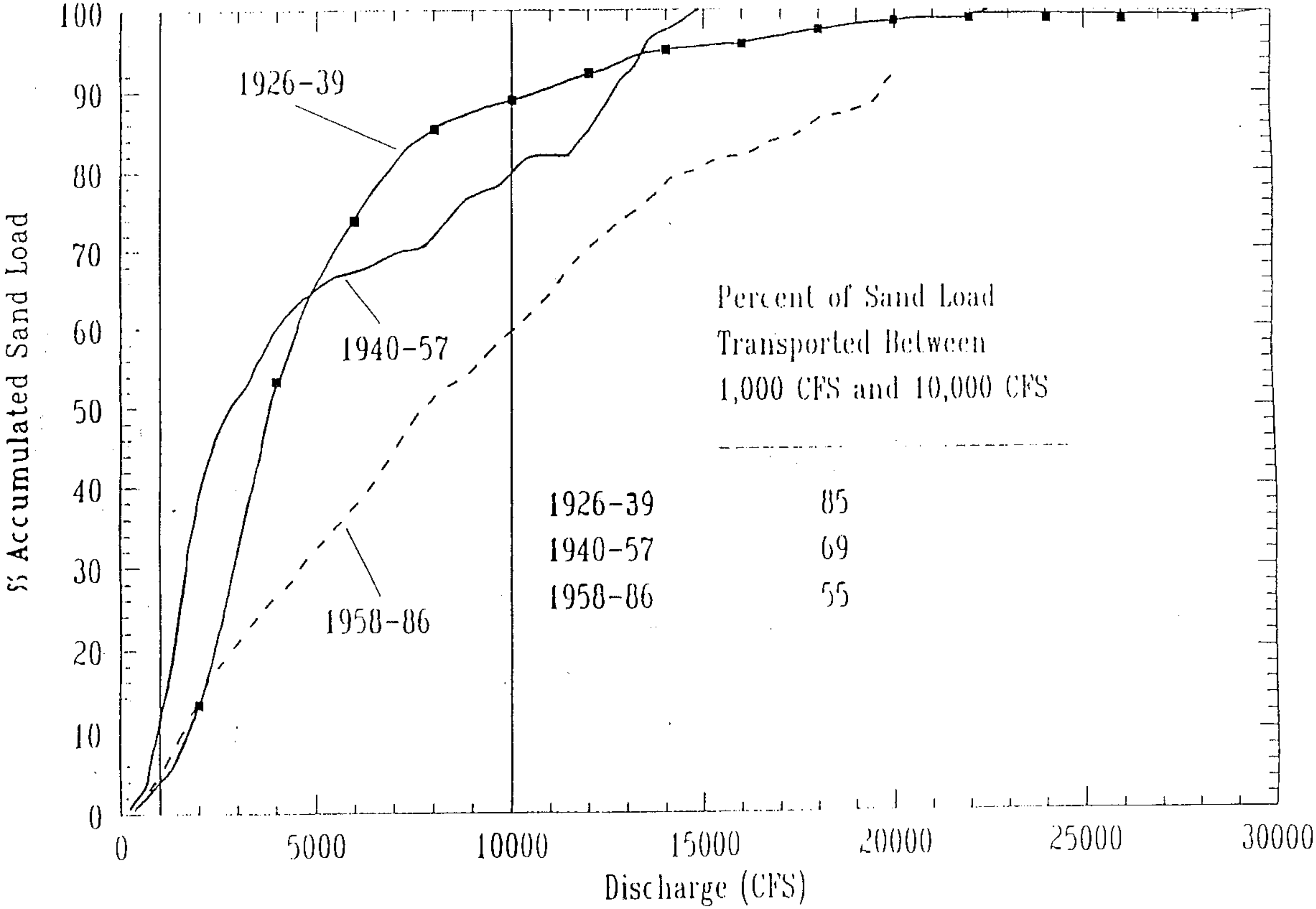
PLATTE RIVER NEAR GRAND ISLAND
DISCHARGE IN CFS
20000
10000
4000
2000
1000
400
200
100
40
20
10
PERCENT OF TIME DISCHARGE EQUALLED OR EXCEEDED
0.
10.
20.
30.
40.
50.
60.
70.
80.
90.
100.
1935-1939
1940-1957
1958-1986

Figure 19

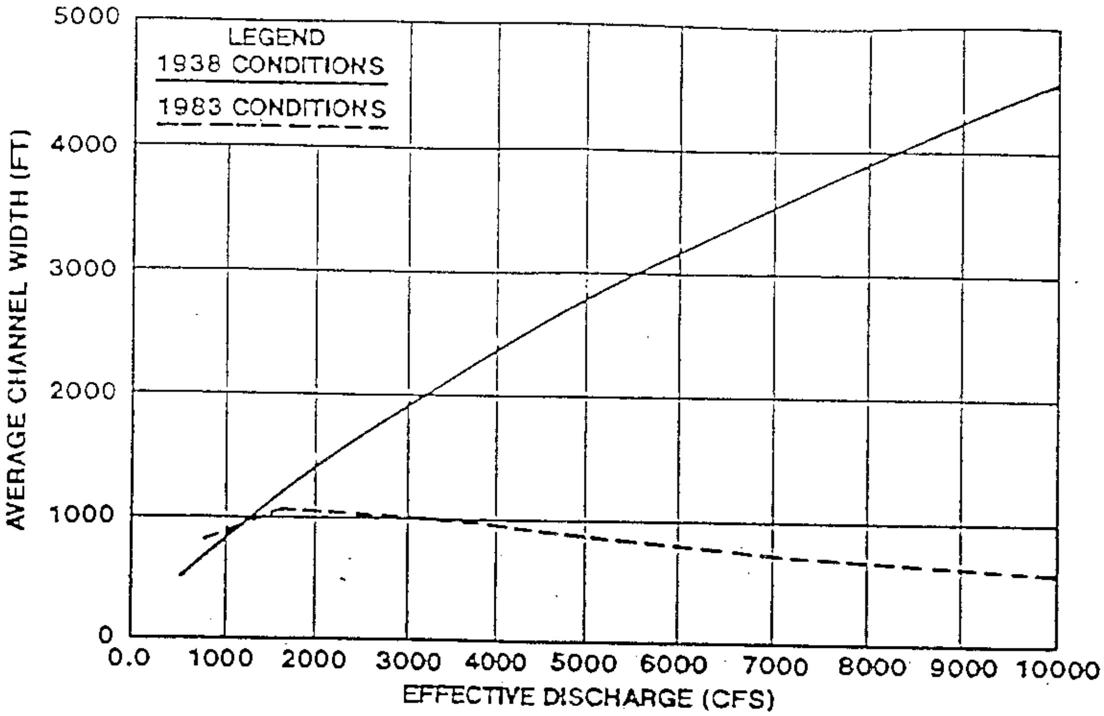


Effective Flow of the Platte River Near Overton

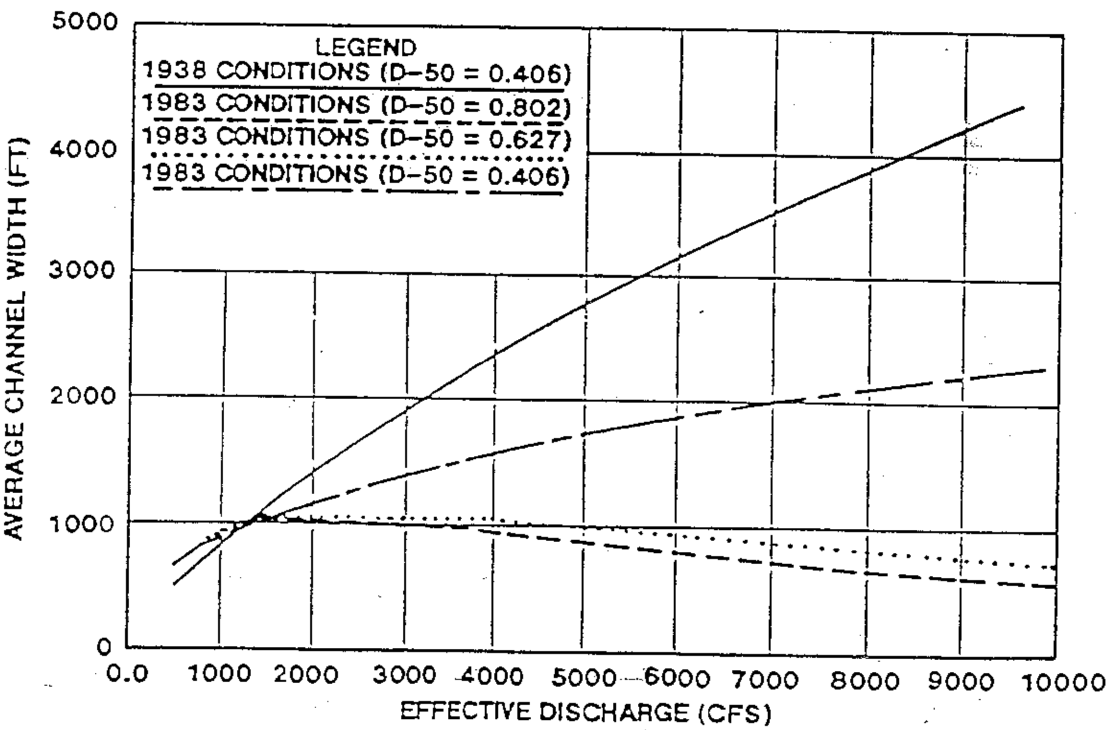
Figure 20



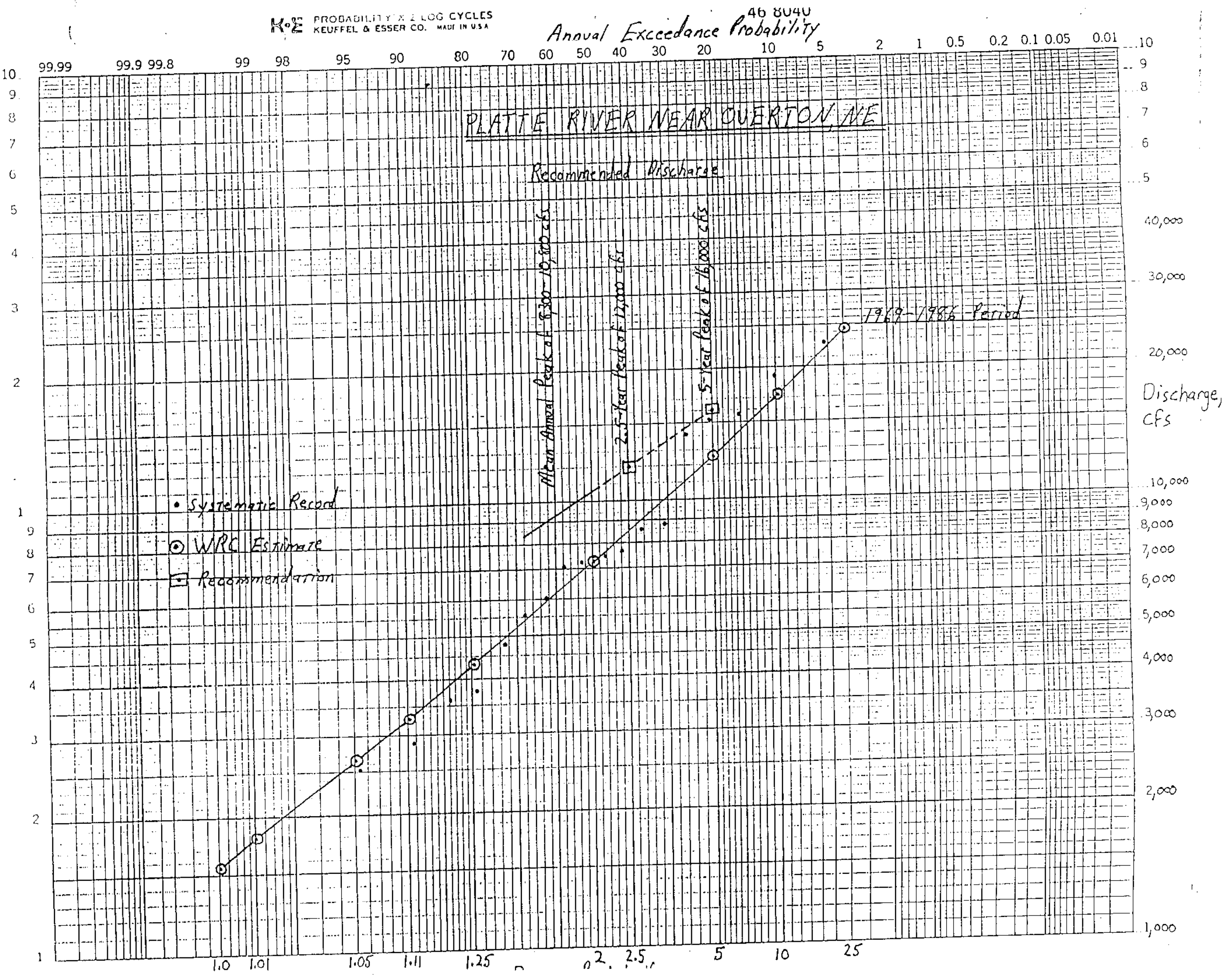
Accumulated Sand Load, Platte River near Overton.



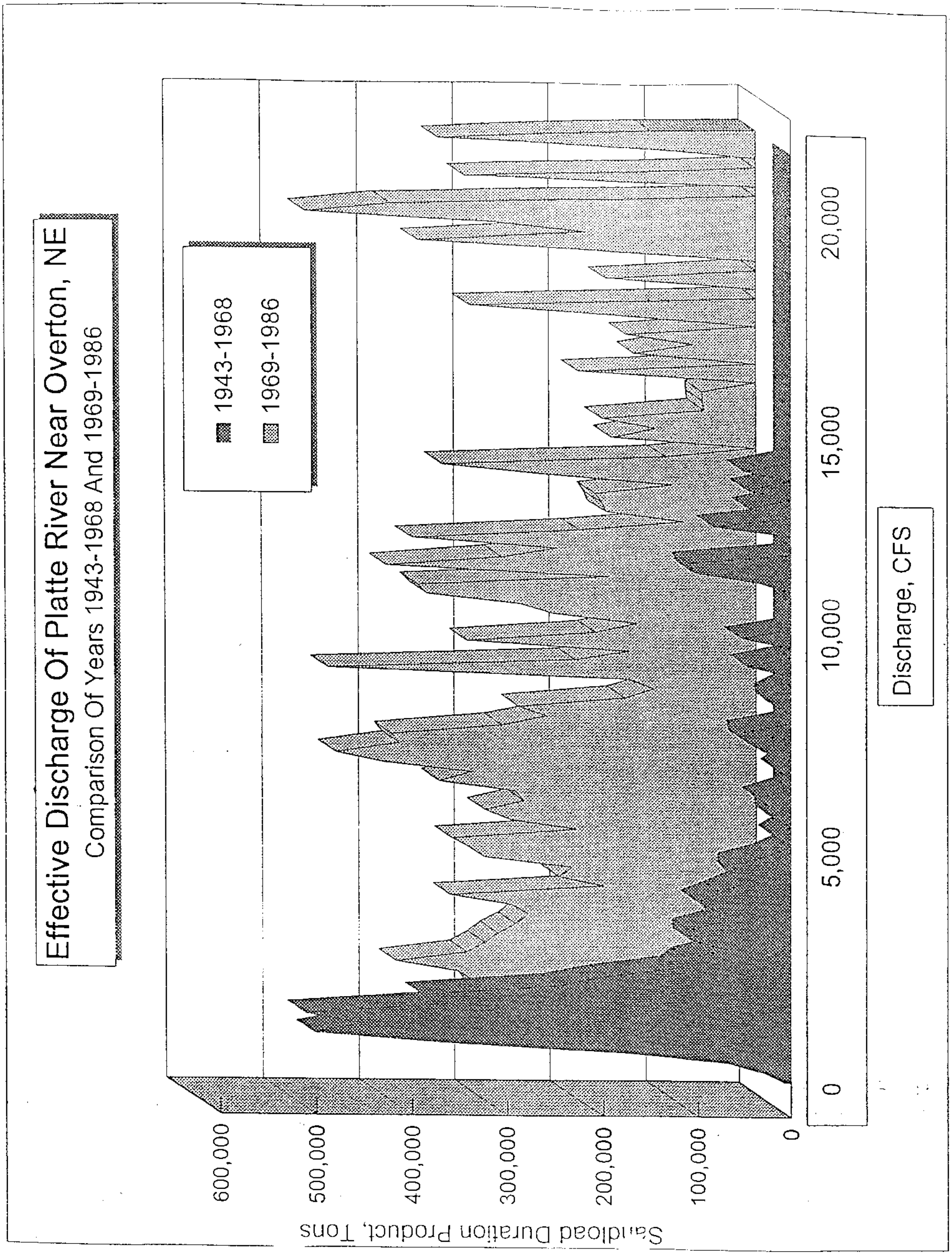
Platte River Width-Discharge Relationship Near Overton



Sensitivity of Bed Material Size Gradation



K&E PROBABILITY X 2 LOG CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 8040
Annual Exceedance Probability
PLATTE RIVER NEAR OVERTON, NE
Recommended Discharge
Mean Annual Peak of 8,300-10,800 cfs
2.5-Year Peak of 12,000 cfs
5-Year Peak of 16,000 cfs
1969-1986 Period
• Systematic Record
WRC Estimate
Recommendation
Discharge, cfs



Effective Discharge Of Platte River Near Overton, NE
Comparison Of Years 1943-1968 And 1969-1986
1943-1968
1969-1986
Sandload Duration Product, Tons
600,000
500,000
400,000
300,000
200,000
100,000
0
0
5,000
10,000
15,000
20,000
Discharge, CFS

Figure 24

Enclosure 3

REVISIONS TO THE DEPARTMENT OF THE INTERIOR'S PREVIOUS SECTION 10(J) RECOMMENDATIONS

August 10, 1994

REVISIONS TO THE DEPARTMENT'S SECTION 10(J) RECOMMENDATIONS

Project Nos. 1417 and No. 1835 have contributed and will continue to contribute to the loss of channel width and vegetative encroachment through sediment trapping, reduction of sediment transport flows, reduction of peak scouring flows, diversion of flows, and consumptive use of water. To address the past and continued deterioration of the North Platte River, Platte River, and Rainwater Basin habitats, the Department of the Interior (Department) provided section 10(j) recommendations for instream flow/water management, habitat restoration and maintenance, and water conservation/efficiency on November 15, 1990, and May 19, 1994.

The purpose of this amendment is to provided changes regarding the Department's previous license conditions recommended in its November 15, 1990, section 10(j) letter. These revisions are necessary because of the significant new information that was provided in the Revised Draft Environmental Impact Statement (RDEIS) for the subject projects and are based on information obtained subsequent to the Department's 1990 recommendations.

The Department's modifications to the November 15, 1990, section 10(j) recommendations and prioritization of those recommendations are discussed in the Department's August 1994 comments on the RDEIS (specific comments section entitled "Prioritization of Supplemental Measures"). These recommendations are summarized below and amend the Department's earlier section 10(j) recommendations (i.e, November 15, 1990, and May 18, 1994).

The greatest impact of these projects has been to the riverine ecosystem upon which many fish, plant, and wildlife species depend, including federally listed threatened and endangered species. The Department's prioritization of its recommendations emphasize restoring and maintaining the structure and function, patterns and processes, and habitat of the Platte River ecosystem.

Recommendations that contribute to the recovery of the Platte River ecosystem and also contribute to the survival and recovery of threatened and endangered species received a priority 1 rating. Recommendations which would result in the restoration of riverine habitat and/or Rainwater Basin habitat for nonlisted species (e.g., sandhill cranes, shorebirds, waterfowl, etc.) received a priority 2 rating. Recommendations which do not contribute to restoring the riverine ecosystem are a lower priority (i.e., priority 3 or 4) and should not be funded at the expense of those areas most affected by the projects (Platte River, North Platte River, and Rainwater Basins). Recommendations which will result in benefits to other fish and wildlife resources at no cost to priority 1 or 2 measures also received a priority 1 or 2 rating.

Using the same economic analysis as presented in the RDEIS, the estimated direct cost of implementing the Department's priority 1 and 2 measures with the Department's suggested revised cost estimates is approximately $37,298,000 (see Department's comments on RDEIS, Appendix C, Tables C-1 and C-2). This value favorably compares with the Federal Energy Regulatory Commission's (FERC) estimated present value for implementing the priority 1 and 2 supplemental measures for the RDEIS preferred alternative (i.e., $36,754,000). Over the period of the new licenses, the annual additional cost will be minimal.

Based on this analysis the Department believes that its priority 1 and 2 recommended license conditions can be implemented without appreciably affecting current project purposes and, thus, are not inconsistent with the requirements of the Federal Power Act. Rather, implementation of these measures are consistent with FERC's obligations under section 7(a)(1) of the Endangered Species Act. The Department believes that ample justification for inclusion of these recommendations as terms and conditions in the licenses has been provided to FERC in past correspondence (e.g., Department's section 10(j) comments and recommendations, dated November 15, 1990; Department's comments on the DEIS, dated June 10, 1992; Department's revised section 10(j) flow recommendations, dated May 19, 1994; and the Department's comments on the RDEIS, dated August 1994; etc.) in addition to this letter.

Water Management

Recommended measures that have the potential to result in water savings, which could be used to augment instream flows and increase the frequency of the Department's flow recommendations, received a priority 1 rating.

1. Reregulating Reservoir in Lower Project Reach--The Department had previously recommended (Department's 10(j) recommendations, November 15, 1990, page 18) that the Nebraska Public Power District and Central Nebraska Public Power and Irrigation District (Districts) fund and complete an independent study, within 3 years of issuance of the license, that addresses the feasibility and cost of constructing a reregulating reservoir that could be used to store excess flows and better manage instream flows in the central Platte River. **The Department assigns this recommendation a priority 4 rating.**

2. North Platte State Fish Hatchery Flows--The Department recommended that the licensees maintain the current water supply and appropriations to the hatchery (Department's 10(j) recommendations, November 15, 1990, page 8). **The Department supports this measure because the cost is minimal but recommends a priority 2 ranking.**

3. Water Conservation Program--The Department recommended that the Districts fund an independent study to investigate, develop, and implement a plan to conserve water for instream flows through improved water delivery and on-farm efficiency and conjunctive use of stored ground water in the ground water mound area. The Department also recommended that the plan address the use of mounded ground water during drought periods to conserve water in Lake McConaughy for instream flow purposes and that the plan should be implemented within 3 years after issuance of the license (Department's 10(j) recommendations, November 15, 1990, page 16). **The Department assigns this recommendation a priority 1 rating.**

   In addition, the Department recommends the following be added to the Department's Water Conservation recommendation:

a. The Department recommends that FERC set target levels of net conserved water which the success of the conservation plan will be weighed against, based on information currently available and the success achieved in other midwestern irrigation areas.

b. The Department recommends that within 6 months of license issuance that the Districts submit a detailed plan and schedule concerning water delivery and ground water monitoring programs.

c. The Department requests that it and the other parties be provided an adequate opportunity to comment to FERC regarding the adequacy of the monitoring plan and to participate in the monitoring process.

d. Water measuring devices needed to implement the monitoring plan should be operational within 1 year of license issuance.

e. The Department recommends that the water conservation plan be developed and filed with FERC and implemented within 3 years of license issuance.

f. The license should be conditioned to require the licensees to provide a copy of the filed conservation plan simultaneously with the Department, including the Service's Grand Island Field Office.

g. The Department requests that it be provided an opportunity to comment to FERC regarding the adequacy of the conservation plan.

h. The Department requests that the conservation plan (a) identify methods used to determine the "net savings", (b) identify the amount and intended use of the net conserved water, and (c) identify a detailed accounting and monitoring procedure for the delivery of the conserved water.

i. The Department recommends that the majority of the net water saved be made available to supplement instream flows and to increase the frequency of meeting the Department's flow recommendations.

j. The Department recommends that in no instances should the net water that is conserved be used to (a) expand the number of surface irrigated acres or (b) significantly increase the consumptive use or delivery of water through the improved system.

k. The Department recommends that a mandated priority be given to conserving water that is currently being lost to the Republican River Basin, especially by the E-65 and E-67 laterals. Net conserved water from those improvements should be dedicated 100 percent to instream flows.

1. The Department also recommends that FERC retain authority to reopen new licenses for Project Nos. 1417 and 1835 as necessary to comply with Federal laws and to change license conditions based on: (a) new scientific information regarding water conservation, (b) results of the water conservation study, and (c) results from the water conservation monitoring program.

4. Limitations on New Commitments to Deliver Irrigation Water--The Department recommended that the licensees not contract for delivery of any additional water for irrigation over that required for contracts existing as of July 31, 1987 (Department's section 10(j) recommendations, November 15, 1990, page 8).

   The Department believes that additional depletions of any significance will encourage additional vegetative encroachment and will reduce the volume and frequency of instream flows, thus further reducing riverine habitat for certain migratory birds, fish, and other species of concern. The Department assigns this recommendation a priority 1 rating.

5. Water Right Application for Instream Flow Purposes--The Department recommended that the licensees apply for and diligently pursue a reservoir storage permit so that the storage released for fish and wildlife purposes could be protected to the points of delivery (Department's 10(j) recommendations, November 15, 1990, page 8). The Department assigns this recommendation a priority 1 rating.

   In addition, the Department recommends that all water specifically released for fish and wildlife purposes not be diverted below the J-2 Hydro Powerplant Return (J-2 Return) and that it remain in the Platte River, subject to carriage losses.

   The Department also recommends that the terminus of the required storage use permit be extended downstream at least to Grand Island for the whooping crane and sandhill crane flows and to the Loup River Power Return Canal near Columbus, Nebraska, for the forage fish flows.

   The Department recommends that water conserved and dedicated for instream flow purposes, as a result of implementing the conservation plan, also be legally protected under Nebraska State law.

6. Passthrough of Upstream Releases for Fish and Wildlife--The Department recommended that the licensees shall pass (not consumptively use) any water from sources upstream of the projects specifically for instream flow purposes (Department's 10(j) recommendations, November 15, 1990, page 9). The Department assigns this recommendation a priority 1 rating.

   The Department also recommends that passthrough water be separately accounted for and that water made available from upstream sources for instream flow purposes remain in the river and bypass the Districts' diversions (e.g., Korty, Keystone, and Tri-County) and not be routed through the Districts' canals.

Sediment and Channel Morphology

1. Structural and Operational Changes to Pass Sediment--The Department recommended that the licensees shall implement structural and operational changes at the Korty (Project 1835) and North Platte (Project 1417) Diversion to avoid intake of sediment (bedload) into the respective supply canals and to facilitate movement of bedload past the structures (Department's 10(j) recommendations, November 15, 1990, page 15). The Department assigns this recommendation a priority 1 rating.

Aquatic Resources

1. Prevention of Aquatic Vegetation Flushing Downstream of Keystone Diversion Dam--The Department recommended that the licensees shall not flush aquatic vegetation from Lake Ogallala into the rock weir area below Keystone Diversion Dam unless the 50 cfs bypass flow was in effect. (Department's 10(j) recommendations, November 15, 1990, page 14). Any flushing of aquatic vegetation should ensure State water quality standards are not violated due to decomposition of flushed material. The Department assigns this recommendation a priority 1 rating.

2. Protection of Sutherland Canal Trout Habitat--The Department had previously recommended that the licensees develop and implement means to protect the Sutherland Canal fishery (Department's 10(j) recommendations, November 15, 1990, page 15). The Department amends its original 10(j) recommendation regarding the Sutherland Canal Trout Fishery by substituting the following:

   The Department requests that the Districts assist Game and Parks in salvaging trout from the canal system when it is dewatered for maintenance purposes, which occurs approximately every 5 years. The Department assigns this recommendation a priority 4 rating.

Wildlife and Botanical Resources

1. Management of District Lands for Wildlife--The Department recommended that the licensees shall prepare and implement a plan to develop and manage fish and wildlife habitat associated with the canyon lakes of the Central Nebraska Public Power and Irrigation District's (Central) main supply canal (Department's 10(j) recommendations, November 15, 1990, page 13). The Department assigns this recommendation a priority 4 rating.

2. Habitat Restoration, Keystone to North Platte--The Department recommended that the licensees shall develop and implement a plan to restore, protect, and manage, where possible, through fee title purchase, easements, leases, or other means a 2-mile long, 510-feet wide channel free of woody vegetation on the North Platte River from Sutherland Bridge approximately 14 miles downstream to the city of North Platte for sandhill crane habitat (Department's 10(j) recommendations, November 15, 1990, page 10).

The Department also recommended that the licensees shall restore, protect, and manage, through fee title purchase, easements, leases or other means, 1,200 acres of nonwooded semipermanent, temporary, and wet meadows/wetlands in the North Platte River valley for the benefit of sandhill cranes, waterfowl, and other species (Department's 10(j) recommendations, November 15, 1990, page 11).

Both of these recommended measures would result in the restoration of riverine habitat primarily for nonlisted, but nonetheless very important, migratory bird species (e.g., sandhill cranes, shorebirds, waterfowl, wading birds, etc.) which Congress has protected under the Migratory Bird Treaty Act. Therefore, the Department assigns this recommendation a priority 2 rating.

In addition, the Department recommends that the 0.5-mile buffer that was previously recommended by the Department (Department's section 10(j) recommendations, November 15, 1990, page 14) be changed to a 0.25-mile buffer for this habitat complex. The Department recommends that all commercial and industrial development be prohibited within the buffer zone to protect cranes from disturbances, including the construction of access roads leading to commercial and industrial development and sand and gravel mining operations.

3. Habitat Restoration, North Platte to J-2 Return--The Department recommended that "The licensees shall develop and implement a plan to restore, protect, and manage for the life of the licenses, through fee title purchase, easements, leases, or other means, riverine and non-wooded wet meadow/wetland habitat primarily for sandhill cranes, bald eagles, waterfowl, and other migratory birds in the four (emphasis added) habitat segments located between different bridges on the upper Platte reach between the J-2 Return and Gothenburg bridge." "The major management objective for each segment should include a 2-mile long channel free of woody vegetation with a width of a least 510 feet. Adjacent to this channel should be a contiguous 640-acre tract of wet meadow/wetland habitat" (Department's 10(j) recommendations, November 15, 1990, page 10).

   This supplemental measure would result in the restoration of riverine habitat primarily for nonlisted, but nonetheless very important, migratory bird species (e.g., sandhill cranes, shorebirds, waterfowl, wading birds, etc.) which Congress has protected under the Migratory Bird Treaty Act. Therefore, the Department assigns all four of the habitat complexes in this reach of the river a priority 2 rating.

   In addition, the Department recommends that the 0.5-mile buffer that was previously recommended by the Department (Department's section 10(j) recommendations, November 15, 1990, page 14) be changed to a 0.25-mile buffer for these four habitat complexes. The Department recommends that all commercial and industrial development be prohibited within the buffer zone to protect cranes from disturbances, including the construction of access roads leading to commercial and industrial development and sand and gravel mining operations.

4. Habitat Restoration, J-2 Return to Chapman--The Department recommended that "The licensees shall develop and implement a plan to restore, protect, and manage for the life of the licenses, through fee title purchase, easements, leases, or other means, suitable riverine and adjacent nonwooded wet meadow/wetland habitat for whooping cranes, sandhill cranes, bald eagles, waterfowl, and bald eagles, in four (emphasis added) habitat segments located between different bridges on the central Platte reach between the Kearney Bridge and the Johnson 2 Power Plant (J-2) Return." "Major management objective should include a habitat complex within each segment containing a 510-foot wide, 1-mile long channel free of any woody vegetation encroachment and a 1,150-foot wide channel, 1-mile long, also free of any woody vegetation encroachment. Adjacent to this channel in each habitat segment should be a contiguous 640-acre tract of wet meadows" (Department's 10(j) recommendations, November 15, 1990, page 9).

   This recommended measure would contribute to (a) the maintenance and recovery of the Platte River ecosystem; (b) the survival and recovery of threatened and endangered species (i.e., whooping crane, western prairie fringed orchid, least tern, piping plover, etc.); (c) the maintenance and restoration of critical habitat; and (d) the restoration of riverine habitat for nonlisted species (i.e., sandhill cranes, shorebirds, waterfowl, other migratory birds, etc.). Therefore, the Department assigns <u>all four</u> habitat complexes in this reach of the river a priority 1 rating.

   The Department also recommends that the 0.5-mile buffer that was previously recommended by the Department (Department's 10(j) recommendations, November 15, 1990, page 14) <u>remain unchanged for these four habitat complexes</u>.

5. Tern and Plover Nesting Habitat

   a. Permanent Riverine Sites--The Department recommended that "Beginning immediately after issuance of the licenses, the licensees shall prepare and maintain for the life of the licenses eight permanent sites for interior least tern and piping plover nesting habitat safe from inundation during the nesting season in the central Platte River. These sites should be developed within the same habitat complexes recommended for cranes and waterfowl . . ." (Department's 10(j) recommendations, November 15, 1990, page 12).

      This recommended measure would contribute to (a) the recovery of the Platte River ecosystem; (b) the recovery of threatened and endangered species (e.g., least tern, piping plover, and whooping crane); and (c) the restoration of riverine habitat for nonlisted species (i.e., sandhill cranes, shorebirds, waterfowl, other migratory birds, etc.). Therefore, the Department assigns this recommended measure a priority 1 rating.

b. Lake McConaughy Protection--The Department recommended that "The licensees shall, in coordination with the Nebraska Game and Parks Commission and Service, contribute 50 percent of the cost of protecting least terns and piping plovers on beach habitats at Lake McConaughy." (Department's 10(j) recommendations, November 15, 1990, page 15). The Department assigns this recommended measure a priority 3 rating.

6. Rainwater Basin Habitat Restoration, Habitat Restoration--The Department recommended that "The licensees develop and implement a plan to acquire, protect, and maintain through fee title purchase, easement, leases, or other means 945 acres of wetland in the western section of the Rainwater Basin. To optimize the functional value of the wetland and to provide nesting cover, 4 acres of upland grassland (3,780 acres) is required for every 1 acre of wetland (945 acres) for a total of 4,725 acres." (Department's 10(j) recommendations, November 15, 1990, page 11).

   The Department is revising its original section 10(j) recommendation regarding the number of upland acres required for every acre of wetland. To optimize the functional value of the wetland and to provide nesting cover, the Department recommends that the Districts provide an acre of upland grassland (945 acres) for every acre of wetland (945 acres) for a total of 1,890 acres. The Department assigns this recommended measure a priority 2 rating.

   The Department also recommended that "The licensees develop a plan subject to review by the Service and the Nebraska Game and Parks Commission, prior to license issuance, to route Central District supply canal flows in excess of irrigation needs and instream flows requirements at Grand Island (emphasis added) during the interior least tern and piping plover summer breeding season through the central District irrigation delivery system for delivery to Rainwater Basin (RWB) wetlands managed by the Service, the Nebraska Game and Parks Commission, or the licensees." (Department's 10(j) recommendations, November 15, 1990, page 8). The Department assigns this recommended measure a priority 2 rating.

7. Bald Eagle Protection--The Department recommended that "The licensees shall protect and maintain trees used by bald eagles as perching and roosting habitat along project canals and reservoirs." The Department also recommended that "Protection of existing bald eagle perching and roosting habitat be integrated into riverine sandbar/wetland habitat restoration work along the North Platte and Platte River." (Department's 10(j) recommendations, November 15, 1990, page 13). The Department supports the intent of its original section 10(j) recommendation to protect existing roosting habitat and assigns this recommended measure a priority 1 ranking. The Department does not consider the planting of trees and the placement of artificial structures for roosting to be necessary and recommends those items be eliminated or given a priority 4 rating.

8. Monitoring Program and Modification to License Conditions--The Department recommended that "The licensees, in consultation with the Service and the Nebraska Game and Parks Commission, shall develop and implement ongoing monitoring plans to determine the effectiveness of the fish and wildlife measures ordered by FERC and the need for new measures to existing measures." (Department's 10(j) recommendations, November 15, 1990, page 15). The Department assigns this recommended measure a priority 1 rating.

Other Measures

1. Dedication of Project Lands to Recreational Use--The Department recommended that the "licensees shall provide access for public fishing and hunting at all project facilities (lakes, canals, and diversion dams) consistent with the safety and the operational requirements of the facilities." (Department's 10(j) recommendations, November 15, 1990, page 15). The Department assigns this recommended measure a priority 4 rating.

2. Reopener Clause--The Department recommended that "FERC retain authority to reopen the Project 1417 and Project 1835 new licenses as necessary to comply with Federal laws and to change license conditions based on new scientific information, including information resulting from monitoring the effectiveness of fish and wildlife license conditions." (Department's 10(j) recommendations, November 15, 1990, page 15). The Department assigns this recommended measure a priority 1 rating.

3. Filing for Amendments--The Department recommended that "At the time of filing, the license shall serve the Regional Solicitor, Rocky Mountain Region, Department of the Interior, and the Field Supervisor, a copy of any request the licensees may file for amendment of any fish and wildlife related article in any new licenses." The Department amends its original recommendation to read: "At the time of filing, the licensees shall serve the Regional Solicitor, Rocky Mountain Region, Department of the Interior, and the Service's Ecological Services Field Supervisor in Grand Island, Nebraska, a copy of any request the licensees may file for amendment of any article in the new licenses." The Department assigns this recommended measure a priority 1 rating.

CERTIFICATE OF SERVICE

I hereby certify that I have this day served the foregoing document upon each person designated on the official service list compiled by the Secretary in this proceeding.

Dated at Denver, CO this 11th day of August, 1994.

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