United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
Nebraska Field Office
9325 South Alda Road
Wood River, Nebraska 68883

May 1, 2015

FWS-NE: 2014-224

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

RE: Transmittal of the U.S. Fish and Wildlife Service's Draft Biological Opinion to the Federal Energy Regulatory Commission on the Effects to Threatened and Endangered Species from Relicensing of the Loup River Hydroelectric Project, Federal Energy Regulatory Commission, Project No. P-1256-031, Nance and Platte Counties, Nebraska.

Dear Secretary Bose:

This document transmits the United States Fish and Wildlife Service's (Service) Draft Biological Opinion (Opinion) regarding potential impacts on federally listed threatened and endangered species resulting from the proposed relicensing of the Loup River Hydroelectric Project (Project) Project No. P-1256-031, by the Federal Energy Regulatory Commission (Commission). The Loup River Public Power District (District) is responsible for Project operations and maintenance. This Opinion addresses the following federally protected species that may be affected by operation and maintenance of the Project including the federally endangered pallid sturgeon *(Scaphirhynchus albus),* Interior least tern *(Sternula antillarum),* and whooping crane *(Grus americana);* and federally threatened piping plover *(Charadrius melodus)* and western prairie fringed orchid *(Platanthera praeclara).* This consultation document has been prepared pursuant to section 7 of the Endangered Species Act of 1973, as amended (Act) (16 United States Code [U.S.C.] § 1531 et seq.) and 50 Code of Federal Regulations [C.F.R] § 402 of our interagency regulations governing section 7 of the Act.

Section 7(a)(2) of the Act requires Federal agencies to consult with the Service to ensure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of any federally listed species nor destroy or adversely modify critical habitat. The direct and indirect effects, as well as the effects from any interrelated and interdependent actions, and cumulative effects, are considered in this Opinion to determine if the proposed project is likely to jeopardize the aforementioned federally listed species.

Once the Commission has had the opportunity to review the draft Opinion, the Service requests a consolidated set of Commission and District comments be provided for our review and subsequent discussion. Additionally, please make reference to the April 13, 2015, and April 14, 2015, letters from the Service to the Commission about the recently listed northern long-eared bat *(Myotis septentrionalis)* and red knot *(Calidris canutus rufa)*, determination of effect for the whooping crane, and modifications to License Articles 413 and 414. Please note that this Opinion was prepared based on the assumption that the Project may affect, but is not likely to adversely affect the whooping crane and the Commission's favorable response to our recommendations for modifications to License Articles 413 and 414. We have not, however, included any information about the red knot or northern long-eared bat in this Opinion. We look forward to further discussion of these items with the Commission over the next 45 days.

The Service appreciates the cooperation extended by the Commission and District in the preparation of this Opinion. If further assistance or information is required, or if you wish to discuss the contents of the Opinion in further detail, please contact the undersigned at eliza_hines@fws.gov (308-382-6468, extension 204) or Mr. Jeff Runge at jeff_runge@fws.gov; (308-382-6468, extension 209).

Sincerely,

Eliza Hines
Nebraska Field Supervisor

Enclosure

Cc: NGPC; Lincoln, NE (Attn: Frank Albrecht)

Biological Opinion

Endangered Species Act
Section 7 Consultation

90-Day Draft Document

U.S. Fish and Wildlife Service

Loup River Hydroelectric Project
Project No. P-1256-031

Agency: Federal Energy Regulatory Commission

Consultation Conducted By:
U.S. Fish and Wildlife Service
Nebraska Ecological Services Field Office

May 1, 2015

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Eliza Hines, Field Supervisor **Date**
Nebraska Field Office

TABLE OF CONTENTS

I. CONSULTATION HISTORY

The Service's Nebraska Field Office in Wood River, Nebraska conducted the consultation with the Commission on the relicensing of the Project. The following bulleted items provide a summary of meetings and pertinent agency correspondence regarding impacts from the Staff Alternative by Project stage as delineated by the Commission. Supporting meeting summaries, consultation letters, and other communications are on file at the Service's Nebraska Ecological Services Field Office in Wood River.

Pre-Application

<u>May 7, 2008:</u> An agency orientation meeting was held to provide the history, overview, and operations of the proposed Project; Commission relicensing process; and agency roles. The meeting was attended by representatives of District and HDR Inc. (consultant), Service, Nebraska Game and Parks Commission (NGPC), U.S. Geological Survey (USGS), National Park Service, Nebraska Department of Natural Resources (NDNR), Nebraska Department of Environmental Quality (NDEQ), Lower Loup Natural Resources District, Central Platte Natural Resources District, and local county and city municipalities.

<u>June 25, 2008:</u> A variety of agency issues were discussed and defined including Project impacts on recreation, fish and wildlife, and threatened and endangered species. Additional study needs were also discussed and identified.

<u>July 21, 2008:</u> A technical assistance letter was submitted by the Service to the Commission. The letter identified potential effects of the proposed Project on federally listed species and the section 7 consultation process pursuant to the Act. The letter also discussed potential effects of the proposed Project on State listed species, bald and golden eagles, and migratory birds.

<u>July 24, 2008:</u> Agency issues were further discussed and defined. Additional study needs were also further identified and discussed.

<u>August 19, 2008:</u> Agency issues with the Project were discussed and further study needs were defined for clarification.

<u>September 18, 2008:</u> A supplemental technical assistance letter was submitted by the Service to the Commission about potential effects of the proposed Project on federally listed species, bald eagles relating to water quality, ice flow, and Lost Creek.

<u>October 16, 2008:</u> A Pre-Application Document (PAD) was prepared by the District and distributed to the agencies.

February 9, 2009: The Service submitted a letter to the Commission about the PAD. Proposed Project effects to federal trust resources were identified by section with recommendations.

Scoping

December 12, 2008: An initial Scoping Document (SD1) was prepared by the District and submitted to interested agencies, including the Service, for input. The scoping document identified environmental issues, concerns, and alternatives; and identified issues and study requests.

December 16, 2008: A Notice of Intent was published by the Commission. The Notice signaled the District's intent to file a license application for a new license. The notice initiated informal section 7 consultation with the Service and designated the District as the Commission's nonfederal representative in carrying out that consultation.

January 12-13, 2009: A scoping meeting was held to identify environmental effects of the relicensing process. Service representatives attended and participated in the meeting.

March 27, 2009: A Scoping Document (SD2) was prepared based on input received at the scoping meeting and submitted to the interested agencies including the Service.

Study Plan

February 9, 2009: The Service submitted a letter to the Commission, which addressed the scope of its review and identified resource management objectives for the proposed study plan.

March 27, 2009: The District submitted a proposed study plan to the Commission, which included Service-advocated sedimentation, hydrocycling, water temperature, and flow depletion and diversion studies.

April 21, 2009: A study plan meeting was held to obtain agency feedback on study components and discuss the study plan process and criteria. Service representatives participated in the meeting.

May 27-28, 2009: A study plan discussion meeting occurred. Service representatives discussed flow depletion and diversion and sedimentation studies.

June 24, 2009: The Service submitted comments to the Commission about the proposed study plan having to do with the sedimentation, hydrocycling, and flow depletion and diversion studies. The Service proposed an additional sediment study on the Loup River Bypassed Reach and Platte River in accordance with the Commission's seven criteria for study plans.

July 27, 2009: A revised study plan was developed to address input provided by the agencies, including the Service.

August 10, 2009: The Service submitted comments to the Commission about its revised study plan. Comments that were submitted expressed concerns about the adequacy of information that may be gained in the revised study plan to support the section 7 consultation process.

August 26, 2009: The Commission submitted a study plan determination to the District based on a study plan meeting and discussions. Sedimentation, hydrocycling, water temperature, flow depletion and diversion studies were approved with modification.

Study Plan Implementation

January 5, 2010: A meeting was held about data collection for the sedimentation, hydrocycling, and flow diversion and depletions studies. The Service, NGPC, Commission, District, and HDR Inc. representatives participated in the meeting.

October 20, 2010: The Service submitted comments on the Initial Study Report (ISR) to the Commission. Service comments were in regards to the capacity of each study to assess potential affects to least terns, piping plovers, and pallid sturgeon.

September 9, 2010: A meeting was held to discuss the ISR. The ISR meeting presented a status of the sedimentation, hydrocycling, and flow diversion and depletion studies; preliminary results; and next steps. The ISR was prepared, filed with the Commission, and submitted to the agencies, including the Service for review.

February 23-24, 2011: A meeting was held to discuss the second ISR. Study results and modifications for the sedimentation, hydrocycling, and flow diversion and depletion studies were presented to the agencies, including the Service.

April 7, 2011: The Service submitted comments on the Second ISR to the Commission. Service comments were in regards to the study results demonstrating adverse effects to the least tern, piping plover, and pallid sturgeon.

September 8, 2011: An Updated Study Report meeting was held to present the results of the completed sediment and hydrocycling studies and implications to least terns, piping plovers, and pallid sturgeon.

Settlement Discussions

October 3, 2011: Conceptual discussions to achieve a settlement agreement occurred between the Service, District, and NGPC Representatives. Flow bypass, hydrocycling attenuation, North Sand Management Area (SMA) Memorandum of Understanding (MOU), and island clearing were discussed.

November 7, 2011: Conceptual discussions for settlement agreement occurred between the Service, District, and NGPC Representatives. Flow bypass, hydrocycling attenuation, North SMA MOU, and island clearing were discussed in further detail. Various alternatives to hydrocycling operations processes were discussed in detail to attenuate stage change.

March 5, 2012: A conference call about the MOU at the North SMA was discussed in detail between the Service, NGPC, and District representatives.

Draft License Application

November 18, 2011: The District filed a Draft License Application. The application described the Project proposal, existing and proposed Project operations, existing and proposed environmental measures, and the effects of the Project proposal on environmental resources.

February 16, 2012: The Service submitted comments on the Draft License Application to the Commission. The Service concluded that it could not concur with determinations that the proposed Project may affect but would not likely adversely affect the pallid sturgeon, least tern, and piping plover, and whooping crane. The Service made recommendations for avoidance and minimization measures to the Commission.

Final License Application

April 13, 2012: The District filed a Final License Application with the Commission. The application described the Project proposal, existing and proposed Project operations, existing and proposed environmental measures, and the effects of the Project proposal on environmental resources after taking into consideration comments provided on the draft document.

April 13, 2012: A draft biological assessment was submitted with the Final License Application

Environmental Document

August 23, 2012: The Commission issued a Notice of Application for the District to operate the Project. The notice solicited for motions to intervene and protests.

October 19, 2012: The Department of the Interior submitted a letter to the Commission in response to the Notice of Application. The Service submitted recommendations to avoid and minimize impacts to the least tern, piping plover, whooping crane, and pallid sturgeon and other riverine fish and wildlife species pursuant to section 10(j) of the Federal Power Act for inclusion in the license for the Project.

October 22, 2012: A Notice of Intervention was filed by the Department of the Interior.

Formal Consultation and Environmental Assessment

June 4, 2014: The Commission requested formal section 7 consultation and submitted the Assessment.

July 2, 2014: The Service submitted a letter to the Commission indicating that the formal section 7 consultation package for the relicensing was incomplete and requested additional information.

August 13, 2014: A conference call was held to discuss the environmental baseline and affects analysis. The Commission agreed to provide a matrix of species affects to the Service. The Service encouraged the Commission to conference on the northern long-eared bat, a species proposed to be listed as endangered and likely occurring in the Project Action area.

October 20, 2014: The Commission requested formal section 7 consultation and submitted the Endangered Species Matrix.

November 18, 2014: The Service acknowledged receipt of the request for formal consultation and the Assessment, and concluded that a complete formal consultation package had now been provided. The Service indicated that delivery of a final Opinion by March 4, 2015, was contingent on Commission validation of Service assumptions related to species effects resulting from the Staff alternative. The Service proceeded with preparation of its Opinion on the proposed Project.

December 5, 2014: The Service requested hydrology information to accurately characterize species affects that would be expected under the Staff Alternative in a letter to the Commission.

January 12, 2015: The Service requested extension of formal consultation given that hydrology information requested in a letter dated December 5, 2014, had not been provided by the Commission. The Service indicated that delivery of a final Opinion would now be on May 3, 2015.

January 16, 2015: The Commission hosted a conference call with Service representatives to discuss the Service's December 5, 2014 and January 12, 2015, letters.

January 23, 2015: The Commission stated that the agency does not object to the Service's requested extension of formal consultation.

January 30, 2015: The Commission provided the Service a description of methods used to develop Staff Alternative hydrology.

March 18, 2015: The Service requested extension of formal consultation given unexpected internal staff shortages. The Service indicated that formal consultation would conclude on May 1, 2015, and a final Opinion would be delivered to the Commission on June 15, 2015. The District provided verbal consent to the requested extension.

April 13, 2015: The Service requested modification of the License Article 414 to include Service approval of the North Sand Management Area Management Plan.

April 14, 2015: The Service recommended that the Commission consider Project effects on the recently listed red knot (threatened) and northern long-eared bat (threatened) and submit determination of affects for both species to supplement the Assessment. The Service also requested Commission reconsideration of the current determination of affect for the whooping crane and inclusion of a habitat monitoring component for that species under License Article 413.

Species Determinations

In its Assessment and in their October 20, 2015, request for formal consultation, the Commission has considered the effects of the Staff Alternative on federally listed species and designated critical habitat and has made determinations of effect as shown in Table 1. We concur with the Commission's determination that the Staff Alternative may affect and is likely to adversely affect the endangered Interior least tern, whooping crane <*note: Table 1 with effect determinations for the whooping crane, red knot and northern long-eared bat will be updated when the Commission provides an effects determination for these species*>, and pallid sturgeon; and the threatened piping plover. Therefore, this Opinion analyzes the effects of the Staff Alternative along with the effects of interrelated and interdependent actions on the Interior least tern, whooping crane, pallid sturgeon, and piping plover because the Project may affect and is likely to adversely affect these species. No critical habitat has been designated for any of the species with the Project action area.

The Service also concurs with the determination made by the Commission that the Staff Alternative will have no effect on the federally threatened western prairie fringed orchid. A detailed discussion of Commission's determination for the western prairie fringed orchid in addition to factors contributing to the "no effect" determination is on file at the Nebraska Ecological Services Field Office.

Table 1. Species considered in the Commission's 2014 analyses for the Staff Alternative and effect determinations.

Species	Scientific Name	Federal Status	Conclusion*
Pallid Sturgeon	*Scaphirhynchus albus*	Endangered	MALAA
Interior Least Tern	*Sternula antillarum*	Endangered	MALAA
Piping Plover	*Charadrius melodus*	Threatened	MALAA

Whooping Crane	*Grus americana*	Endangered	MALAA
Western Prairie Fringed Orchid	*Platanthera praeclara*	Threatened	NLAA

*NLAA – May affect, not likely to adversely affect
MALAA – May affect, likely to adversely affect.

II. DESCRIPTION OF THE FEDERAL ACTION

The Federal Action under consideration is the relicensing of the Project by the Commission for continued operation and maintenance. The license would be for 30 years. The Project is located on the Loup and Platte Rivers in Nance and Platte Counties in Nebraska (*Figure 1*). The most upstream portion of the Project is the diversion weir located about six (6) miles west of the community of Genoa, Nebraska. The diversion weir directs flow from the Loup River at river mile (RM) 34.2 into the 35.2-mile-long Loup Power Canal. The Loup Power Canal discharges into the Platte River at RM 101.5. The Project includes two powerhouses on the canal that are located near the communities of Monroe and Columbus, Nebraska. The Project has a combined installed capacity of 53.4 MW. The portion of the Loup River from the diversion weir to its confluence with the Platte River, which has a length of 34.2 miles, is referred to as the Loup River Bypassed Reach (*Figure 2*).

The segment of Platte River from the Loup River confluence to the mouth is commonly referred to as the lower Platte River. For purposes of this Opinion, the Service has divided the lower Platte River into two distinct segments. The portion of the Platte River from its confluence with the Loup River to its confluence with the Project tailrace return will be referred to as the Platte River Bypassed Reach and has a length of about 2.1 miles. The Platte River downstream of the Project tailrace return will be referred to as the Lower Platte River and has a length of about 101.5 miles (*Figure 3*).

All Project facilities (e.g., siphons. weirs, powerhouses) are located in or near the Loup Power Canal which is located north of, and parallel to, the Loup River Bypassed Reach. The locations of the various Project facilities and features are shown in *Figure 4*.

IIA. Project Description, Location, and Overview

<u>Diversion Weir:</u> The diversion weir, which is a concrete dam that spans the Loup River, directs water from the Loup River into the Loup Power Canal (*Figure 5*). The diversion weir has a length of 1,321 feet, a height of 6 feet and a fixed crest of 1,574 feet at mean sea level (msl). The diversion weir is furnished with 2-foot wooden flashboards that raise the crest of the dam to 1,576 feet msl. The flashboards, which are designed to fail under heavy ice loads or high water conditions, are not installed on about 77 feet of the southern portion of the diversion weir that has been buried by sediment. A 3,000-foot-long diversion dike, with a crest elevation of 1,585 feet msl, ties the diversion weir to high ground on the south side of the Loup River. From the right (south) bank, the diversion weir extends 1,051 feet across the Loup River where it turns 90 degrees to the east, in the downstream direct, where it connects to the right (south) side of the sluice gate structure.

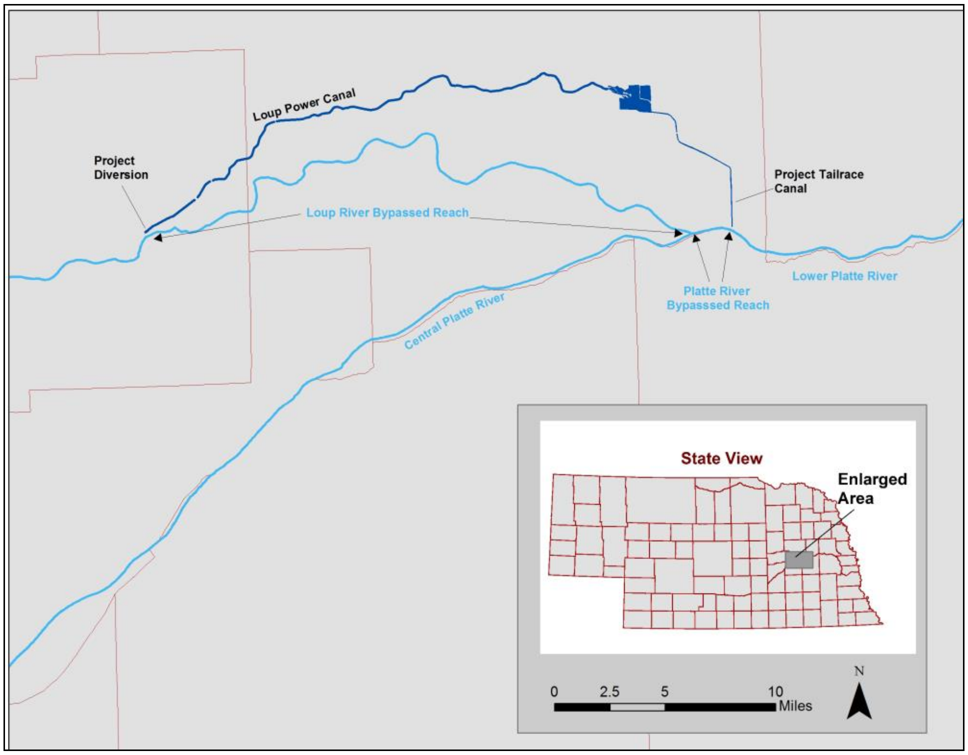

Figure 1. Action area depicting Loup River Bypassed reach, Platte River Bypassed Reach, and Lower Platte River.

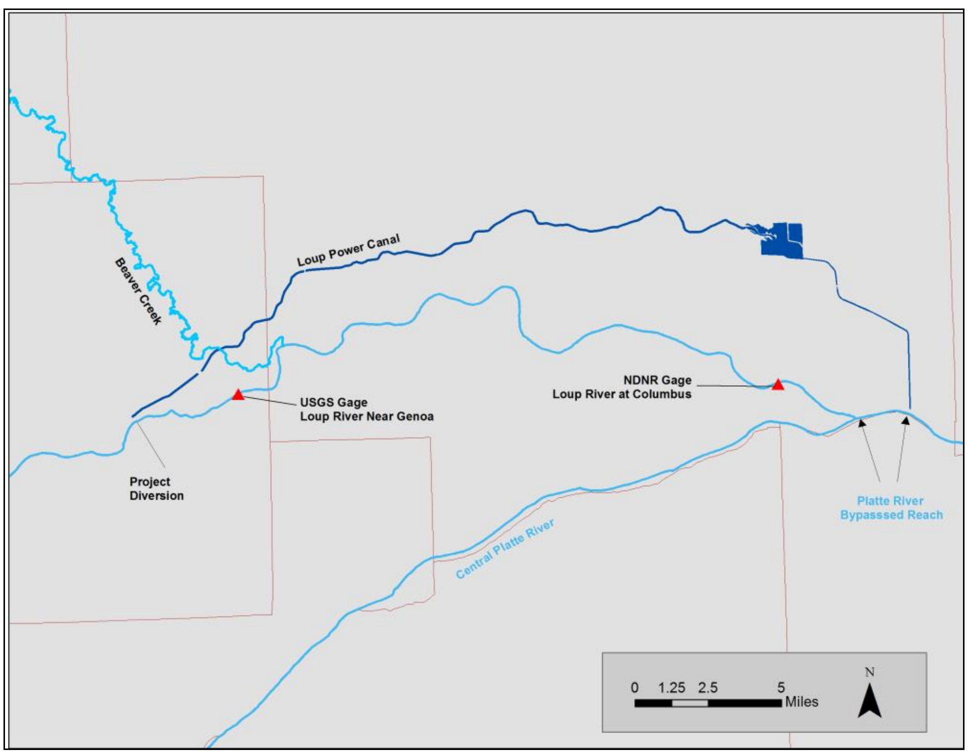

Figure 2. Expanded Loup River Bypassed Reach with important stream and gage locations.

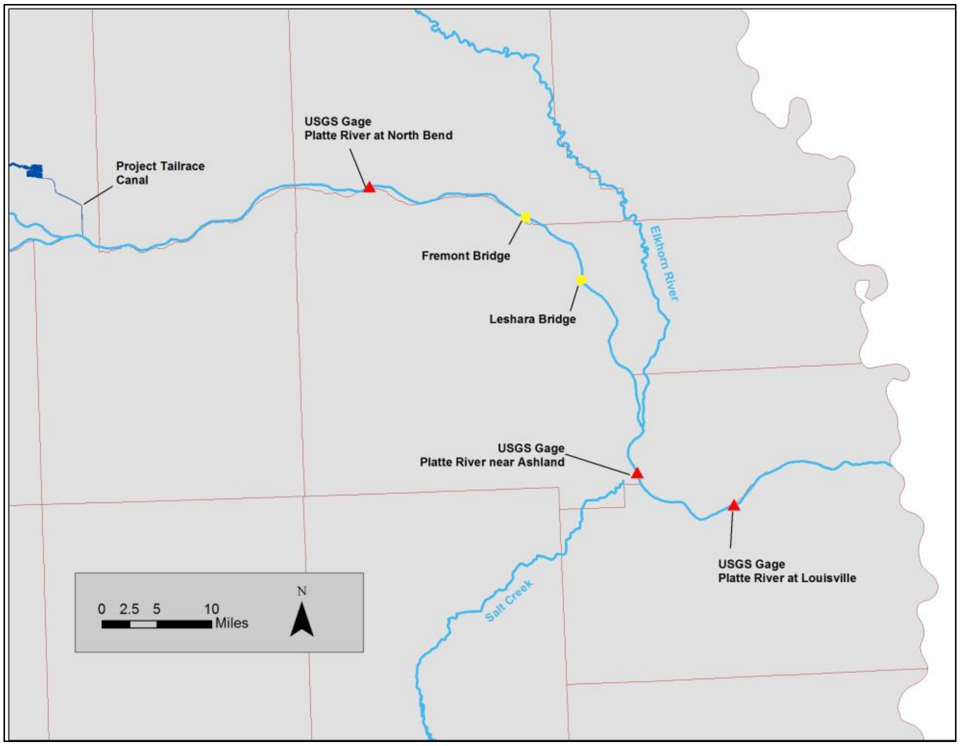

Figure 3. Expanded Lower Platte River with important river and gage locations.

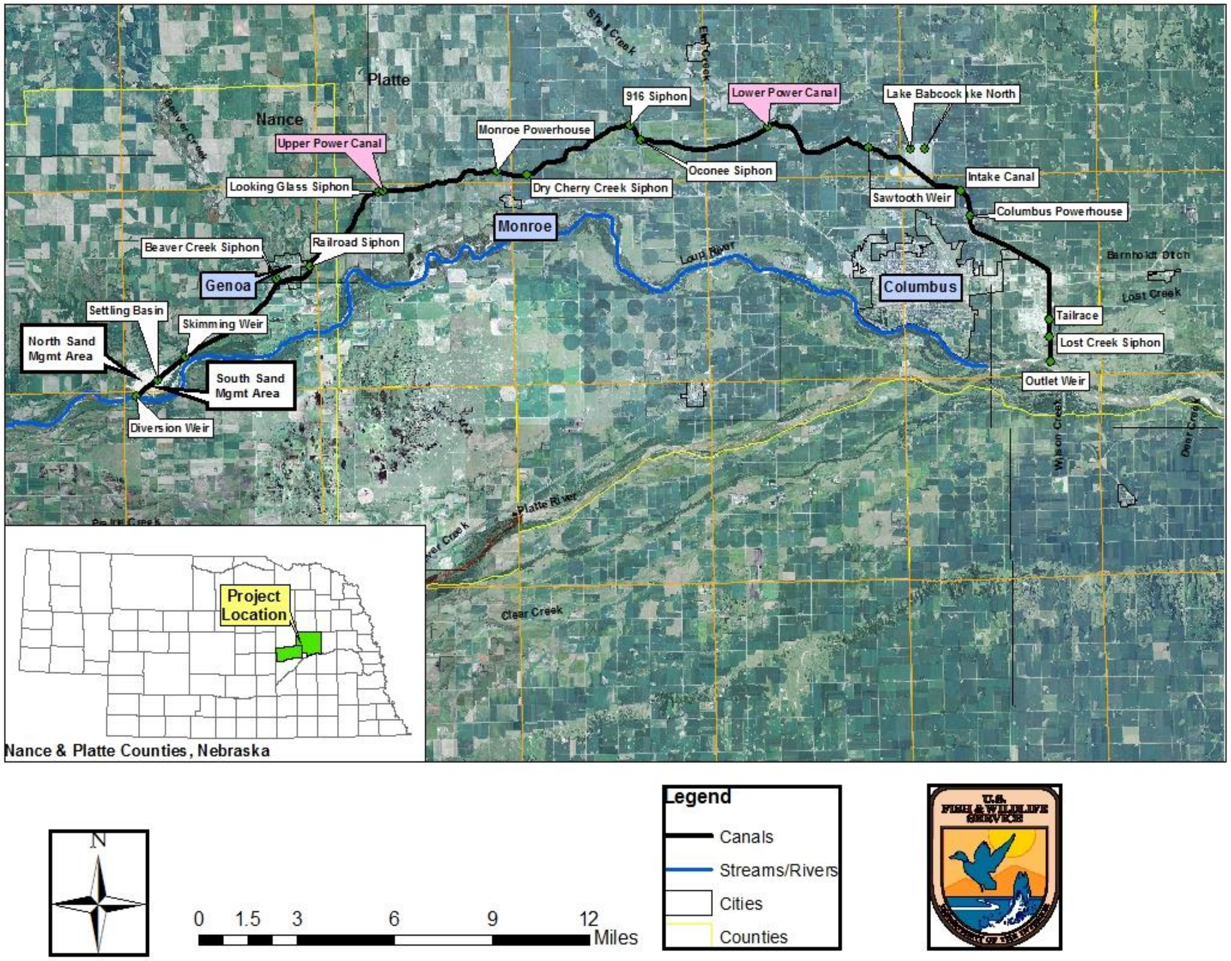

Figure 4. Project area.

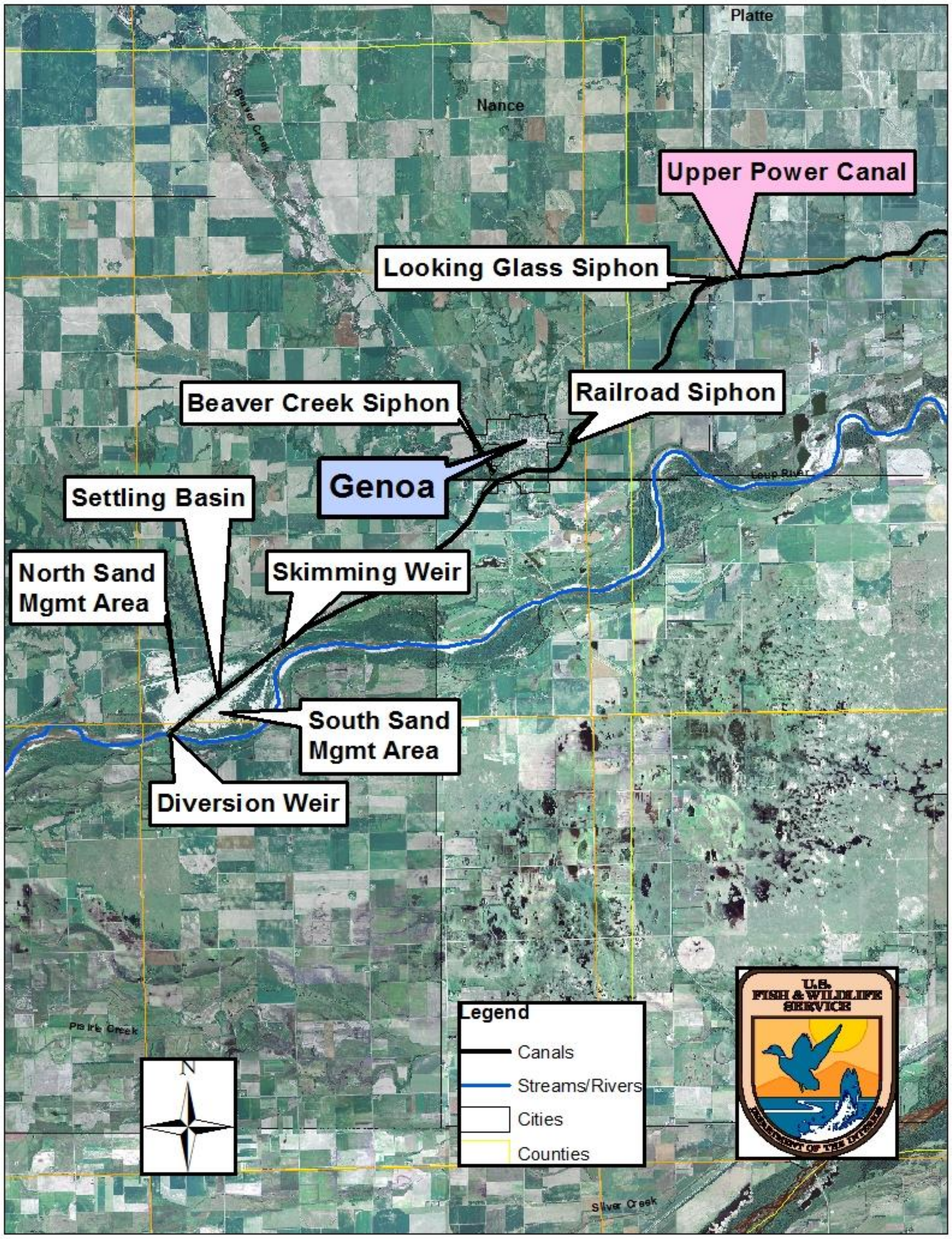

Figure 5. Portion of Project from the diversion to the Monroe Powerhouse.

Sluice Gate: A sluice gate structure, which has three 20-foot-long by 6-foot-high steel radial gates, and overall length of 64 feet, and a sill elevation of 1,568 msl is located on the north end of the diversion weir at the downstream end of the diversion structure (*Figure 5*). The sluice gate structure is operated to remove sediment from the upstream side of the intake structure and allow the sediment load in the Loup River to continue downstream, bypassing the Loup Power Canal. The left (north) side of the sluice gate structure connects to the southeast side of the intake gate structure.

Intake Gate Structure: The intake gate structure, which has eleven, 24-foot-long by 5-foot-high steel radial gates, on overall length of 284 feet, and a gate sill elevation of 1,569.5 msl, controls the amount of flow entering the Loup Power Canal. The intake gate structure can pass 3,500 cubic feet per second (cfs), which is the District's water right appropriation limit as well as the hydraulic capacity of the canal. A 7,200-foot-long earthen dike, with a crest elevation of 1,586 feet msl, ties the northwestern end of the intake gate structure to high ground to the north (Figure 5).

Settling Basin: Water diverted from the Loup River enters a 2-mile-long settling basin, the first component of the Loup Power Canal (*Figure 5*). The low velocity of the water flowing through the settling basin allows the heavier sediment to fall out of suspension and settle on the bottom. Sediment deposited in the settling basin is removed using a floating hydraulic dredge. The sediment and water mixture, referred to as slurry, is pumped to two the North and South SMA that have a combined area of approximately 720 acres.

North and South Sand Management Areas: The 400-acre South SMA is located between the settling basin and the Loup River Bypassed Reach. The 320-acres North SMA is adjacent to and north of the settling basin. Sand is mined at the North SMA by Preferred Sands, a commercial entity whose operations are wholly contained within the Commission's boundaries. There is no mining of the sand at the South SMA.

Skimming Weir: The skimming weir, which is located on the downstream end of the settling basin, has nine, 12-foot-long openings, an overall length of 133.5 feet and a fixed crest elevation of 1,568.2 feet msl (*Figure 5*). A 134-foot-wide, 5-foot-high trash rack, attached to the skimming weir crest, is used to collect trash and debris before it can enter the upper power canal. The trash rack is fabricated from 8-gage screen with 6-inch square openings.

Upper Power Canal: The skimming weir discharges water into a 10-mile-long power canal where it flows under one railroad and two creeks through three separate inverted siphons (*Figure 5*). The upper power canal terminates at the Monroe Powerhouse, which is located at a naturally-formed low terrace and functions as an energy-producing drop structure.

Monroe Powerhouse: The Monroe Powerhouse includes six trash racks that are each about 13 feet wide by 31.25 feet high with clear openings of 2.125inches (*Figure 6*). The rated net head of the Monroe Powerhouse is 28.6 feet. The Monroe Powerhouse contains three Francis-type, turbine generating units each with a rated capacity of 2.612 MW. Each of its three turbines has a maximum hydraulic capacity of 1,000 cfs for a powerhouse capacity of 3,000 cfs. The

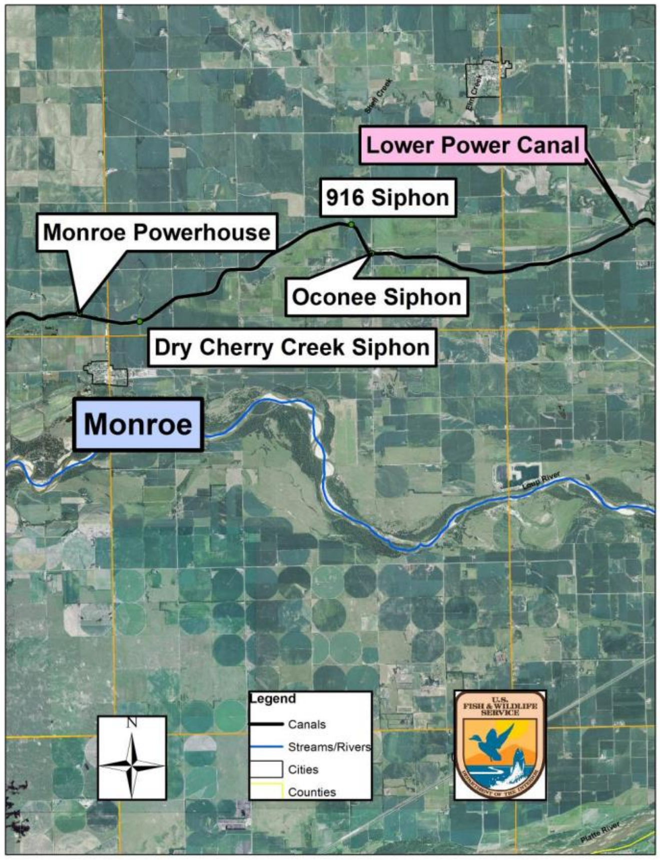

Figure 6. Portion of the Project between Monroe Powerhouse and Lake Babcock.

powerhouse includes a 16-foot-wide spillway used to pass flows exceeding the capacity of the on-line turbine generating units. The flow over the spillway, which has a crest elevation of 1,550 feet, is controlled using a radial gate. The Monroe Powerhouse operates as a "run of the canal" facility

<u>Lower Power Canal:</u> Water released downstream of the Monroe Powerhouse enters the 13-mile-long lower power canal where it flows under one railroad and two creeks through three separate inverted siphons and continues downstream where it flows over a sawtooth weir before entering Lake Babcock (*Figure 6* and *Figure 7*). The sawtooth weir maintains a minimum water level in the canal by eliminating the water level fluctuation that occurs in Lake Babcock resulting from the peaking activities at the Columbus Powerhouse. The sawtooth weir also prevents water from Lake Babcock from entering back into the lower power canal should a breach of the canal embankment occur.

<u>Lake Babcock:</u> Lake Babcock was created by constructing earthen embankments on the north, east, and south sides of a natural depression to store water for peaking operations at the Columbus Powerhouse (*Figure 7*). Although the settling basin was designed to capture sediment before reaching the Loup Power Canal, some sediment is transported into the canal. After 25 years of operations, sediment accumulation in Lake Babcock substantially reduced it storage capacity. To augment the storage needed for power production, in 1962 the District completed construction of

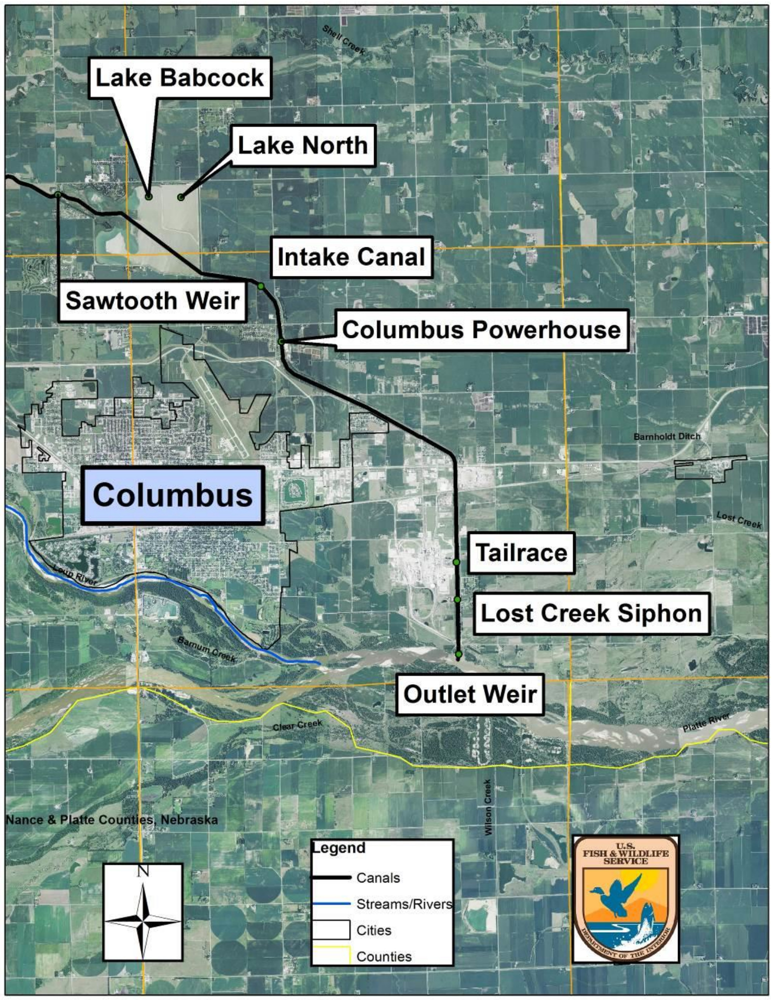

Figure 7. Portion of the Project from Lake Babcock to Platte River.

an off-channel reservoir called Lake North. Lake North is connected to Lake Babcock by a concrete control structure with a sill elevation of 1,520 feet msl, which is located in its south embankment. Currently, Lake Babcock has a surface area of 867-acres at its full pool elevation and an effective storage capacity of 2,449 acre-feet between a full pool elevation of 1,531 feet msl and a low pool elevation of 1,525 feet msl. Lake North has a surface area of 202 acres and an effective storage capacity of 1,187 acre-feet between full pool elevations of 1,531 feet msl and a low pool elevation of 1,525 feet msl. Water from Lake Babcock flows 1.5 miles through the intake canal to the Columbus Powerhouse. The intake canal terminates at the 60-foot-long by 104-foot-wide by 40-foot-high Columbus Powerhouse inlet structure. The inlet structure includes nine vertical steel trash rack panels that are each about 9 feet wide by 36.67 feet high with 2-inch clear openings and transitions the flow into three 20-foot-diameter, 385-foot-long, steel penstocks leading to the Columbus Powerhouse.

<u>Columbus Powerhouse</u>: The Columbus Powerhouse operates as a peaking facility and is located to use the natural land form and fall in elevation associated with the Shell Creek terrace (*Figure 7*).

The rated net head of the Columbus Powerhouse is 113.5 feet and the powerhouse contains three Francis-type, turbine-generating units each with a rated capacity of 15.2 MW. Each of the three turbines in the powerhouse has a maximum hydraulic capacity of 2,060 cfs for a total powerhouse capacity of 6,180 cfs. However, flow through the Columbus Powerhouse is limited by the capacity of the intake canal, which is 4,800 cfs.

Tailrace Canal: The Columbus Powerhouse discharges into the 5.5-mile long tailrace canal that conveys the Project flow to the Platte River (*Figure 7*). Near the lower end of the tailrace canal, Lost Creek is conveyed under the tailrace canal in an inverted siphon where it joins the Lost Creek channel on the east side of the tailrace canal. At the confluence of the tailrace canal and the Platte River is the outlet weir.

Outlet Weir: The purpose of the outlet weir is to hold the tailrace canal water at an elevation that would maintain the water tight seal of the draft tubes located at the Columbus Powerhouse. The 700-foot-long outlet weir was originally constructed with a crest elevation of about 1,413 feet msl (*Figure 7*). In late 1952, the outlet weir crest was lowered about 18 inches to its present elevation of 1,411 feet msl. The height of the crest of the outlet weir was reduced to alleviate sediment build-up in the tailrace canal and subsequent increase in the velocity of flow. Modifying the outlet weir crest also lowered the height of the tailwater at the Columbus Powerhouse.

Transmission Lines: All power produced at the Monroe and Columbus Powerhouses flows to the grid via underground bus cable at the on-site substations. For this reason, no overhead transmission voltage lines are associated with the Project license.

At the Monroe Powerhouse, the three generators are connected to common 6.9 kilo-volt (kV) bus inside the powerhouse where power is metered and purchased by the Nebraska Public Power District (NPPD). The bus cable extends underground (approximately 300 feet) from the powerhouse to the adjacent substation, where the voltage is stepped up to 34.5 kV prior to interconnecting with the grid.

At the Columbus Powerhouse, power is generated at 13.8 kV. Each generator is directly connected via underground bus cable (approximately 275 feet long) to a separate District-owned transformer in the substation where the power is stepped up to 115 kV. At the substation, each of the three generator step-up transformers is connected to the grid.

Project Operation

During normal operation, the intake and sluice gates are jointly operated to divert the maximum practical amount of water (and the least amount of sediment) from the Loup River into the settling basin. The headgate operator adjusts flow diversion rates on a daily, or even hourly, basis to optimize the amount of water diverted into the Loup Power Canal. The Project can divert up to 3,500 cfs into the canal, the maximum hydraulic capacity. Based on USGS flow data at the Genoa gage, the long term average amount of water that is diverted out of the Loup River is 1,685 cfs, or 69 percent of the total Loup River flow.

Water then enters the settling basin where sediment falls out of suspension and is dredged to the nearby North and South SMAs. Water, now relatively free of sediment then flows down the canal to the run-of-canal Monroe Powerhouse then to two storage reservoirs: Lake Babcock and Lake North. The stored water is then released through the Columbus Powerhouse, which has a maximum hydraulic capacity of 6,180 cfs to produce energy during high-demand periods of the day. The Columbus Powerhouse generates about 80 percent of the total power produce by the Project.

Daily fluctuation of the reservoir surface in Lake North and Lake Babcock is approximately 2 feet. During periods of less electrical demand, the turbine units at the Columbus Powerhouse are shut down and Lakes Babcock and North refill to support peaking operations the next day. Typically, the Columbus Powerhouse generates electricity for one or sometimes two cycles during a 24-hour day; the amount and duration of power production varies each day according to electrical demand and available water. Except for brief ramp-up and ramp-down periods, operating discharges from the Columbus Powerhouse range from a minimum of about 1,000 cfs when one turbine is operational to a maximum of 4,800 cfs when all four turbines are operating. This range of discharge is conveyed via the Project tailrace to the Platte River.

Project Maintenance

Project maintenance involves periodic repair of diversion and dredging operations that might involve diversion of water to the Loup River Bypassed Reach. Occasional maintenance is required to stabilize canal banks and repair/replace siphon structures. Bank stabilization is occasionally required at Lakes Babcock and North and at the tailrace. Both Columbus and Monroe Powerhouses require occasional shut down for periodic maintenance.

IIB. Conservation Measures

Conservation measures are actions that benefit or promote the recovery of listed species that are included by the Commission as an integral part of the Staff Alternative. All of these conservation measures will be implemented by the District and/or Commission where specified and serve to avoid, minimize, or compensate for Project effects on the species under review.

<u>Pallid sturgeon</u>

The Commission and District have committed to incorporating the following conservation measures as part of the Staff Alternative to prevent potential direct or indirect impacts to the pallid sturgeon:

- <u>Article 405, Minimum Flow in the Lower Platte River:</u> The District shall maintain a continuous minimum flow of 4,400 cfs, or inflow, whichever is less, from May 1 through June 7 in the Lower Platte River, as measured at the North Bend USGS Gage no. 06796000, to facilitate longitudinal connectivity for pallid sturgeon movements in the Lower Platte River between the Project's outlet weir and North Bend, NE. Inflow as defined here, is the instantaneous flow at the North Bend Gage while the project is operating in a non-peaking mode or is not diverting flow into the power canal.

This flow may be temporarily modified if required by operating emergencies beyond the control of the licensee, and for short periods upon agreement between the licensee and the Nebraska Department of Environmental Quality, Nebraska Game and Parks Commission, and the U.S. Fish and Wildlife Service. If the flow is so modified, the Licensee shall notify the Secretary of the Commission as soon as possible, but no later than 10 days after each incident. Upon review, the Commission will determine if an additional report is necessary.

Interior Least Tern and Piping Plover

The Commission and District have committed to incorporating the following conservation measures as part of the Staff Alternative to prevent potential direct or indirect impacts to the Interior least tern and piping plover:

- Article 404, Seasonal Minimum Flows in the Loup River Bypassed Reach: The District shall maintain in the Loup River Bypassed Reach a continuous minimum flow of 275 cfs or inflow, whichever is less, from April 1 through September 30 and 100 cfs or inflow, whichever is less, from October 1 through March 31 to protect water quality and aquatic resources in the Loup River Bypassed Reach. These flows shall be measured at the Genoa USGS gage no. 06793000, located in the Loup River near Genoa Nebraska. Inflow, as defined here, is the instantaneous flow at the Genoa Gage while the project is not diverting flow into the power canal.

  These flows may be temporarily modified if required by operating emergencies beyond the control of the licensee, and for short periods upon agreement between the licensee and the Nebraska Department of Environmental Quality, Nebraska Game and Parks Commission, and the U.S. Fish and Wildlife Service. If the flow is so modified, the Licensee shall notify the Secretary of the Commission as soon as possible, but no later than 10 days after each incident. Upon review, the Commission will determine if an additional report is necessary.

- Article 406, Maximum Diversion of Flow into the Power Canal: The District shall ensure that the maximum flow diverted into the Loup Power Canal shall not exceed 2,000 cfs, from March 1 through June 30 to enhance habitat for threatened and endangered birds in the Loup River Bypassed Reach. These minimum flows shall be measured at the USGS gage no. 06792500, located at the power canal near Genoa, Nebraska.

  This flow may be temporarily modified if required by operating emergencies beyond the control of the licensee, and for short periods upon agreement between the licensee and the Nebraska Department of Environmental Quality, Nebraska Game and Parks Commission, and the U.S. Fish and Wildlife Service. If the flow is so modified, the Licensee shall notify the Secretary of the Commission as soon as possible, but no later than 10 days after each incident.

- Dredging Operations: The District shall cease dredging operations and discharge of sediment to the North and South SMA from early June through mid-August annually.

- Article 414 (3), North SMA Management Plan: The District shall prepare a North SMA Management Plan that includes: a) policies and procedures for ensuring that project dredging and sand removal operations will not adversely affect Interior least terns or piping plovers nesting in the North SMA; b) protection, mitigation, and enhancement measures to be implemented in the North SMA to ensure that it remains viable as a source of off-river nesting for least terns and piping plovers; and c) a schedule to periodically update the plan.

IIC. Analytical Framework for the Jeopardy and Adverse Modification Determination

Jeopardy Determination

In accordance with policy and regulation, the jeopardy analysis in this Opinion relies on four components: a) the *Status of the Species*, which evaluates the species name range-wide condition, the factors responsible for that condition, and its survival and recovery needs; b) the *Environmental Baseline*, which evaluates the condition of the species in the action area, the factors responsible for that condition ,and the relationship of the action area to the survival and recovery of the species; c) the *Effects of the Action*, which determines the direct and indirect effects of the proposed Federal action and the effects of any interrelated or interdependent activities on the species; and 4) *Cumulative Effects*, which evaluates the effects of future, nonfederal activities in the action area on the species.

Appendix B of this Opinion describes differences between the Service's and the Commission's definition of the environmental baseline. These differences and their relationships to the Staff Alternative made it difficult to evaluate how the proposed federal action may affect federally listed species.
To address this difference, the Service, in accordance with the Endangered Species Consultation Handbook, has developed the following approach for this Opinion.

1. The environmental baseline is defined as: a) no diversion into the Project canal for the purpose of hydropower production; b) existing Project infrastructure remains in place; and c) current habitat conditions that have been formed through past Project operations represent a starting condition for the environmental baseline.

2. The environmental baseline will also include the following assumptions: a) species habitat conditions are expected to change under a no diversion baseline; and b) species status in the action area is expected to be different under a no diversion baseline.

3. The effects of the Staff Alternative will include: a) diversion of water into the Project canal for the purpose of hydropower production; and b) Commission license articles serving as conservation measures to minimize adverse effects of Project diversion to federally listed species.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the species current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the species in the wild.

The jeopardy analysis in this Opinion emphasizes consideration of the range-wide survival and recovery needs of the species and the role of the action area in the survival and recovery of the species. It is within this context that we evaluate the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination,

Destruction or Adverse Modification Determination

No critical habitat has been designated for any of the species with the project action area.

III. PALLID STURGEON

IIIA. Pallid Sturgeon - Status of the Species/Critical Habitat

Species Description

Pallid sturgeon have a flattened shovel-shaped snout; a long, slender, and completely armored caudal peduncle (the tapered portion of the body which terminates at the tail); and lack a spiracle (small openings found on each side of the head) (Forbes and Richardson 1905). As with other sturgeon, the mouth is toothless, protrusible (capable of being extended and withdrawn from its natural position), and positioned under the head. The skeletal structure is primarily composed of cartilage rather than bone.

Pallid sturgeon are similar in appearance to the more common shovelnose sturgeon. Both species inhabit overlapping portions of the Missouri and Mississippi River basins. In their original description, Forbes and Richardson (1905) noted that pallid sturgeon differed from shovelnose sturgeon in size, color, head length, eye size, mouth width, barbel length ratios, ossification, gill raker morphology, number of ribs, and size of the air bladder. Additionally, pallid sturgeon have wider mouths and naked bellies generally lack the mosaic of embedded scutes that armor the ventral surface of the shovelnose sturgeon.

Life History

Pallid sturgeon can be long-lived, with females reaching sexual maturity later than males (Keenlyne and Jenkins 1993). Based on wild fish, estimated age at first reproduction was 15 to 20 years for females and approximately 5 years for males (Keenlyne and Jenkins 1993). Like most fish species, water temperatures influence growth and maturity. Female hatchery-reared pallid sturgeon maintained in an artificially controlled hatchery environment (i.e., near constant 61 to 68° Fahrenheit (F)) can attain sexual maturity at age 6, whereas female pallid sturgeon subject to colder winter water temperatures reached maturity around age 9 (U.S. Fish and Wildlife Service [USFWS] 2014). Hatchery-reared pallid sturgeon in the lower Missouri River reached sexual material at ages 9 and 7 for males and females, respectively (Steffensen 2012). However, as of 2012, no 1997 year-class hatchery-reared pallid sturgeon, released in the upper Missouri River between Fort Peck Dam and Lake Sakakawea, have been found to be sexually mature. Thus, age at first reproduction can vary between hatchery-reared and wild fish and is dependent on local conditions. Females do not spawn each year. Observations of wild pallid sturgeon collected as part of the Pallid Sturgeon Conservation Augmentation Program (Augmentation Program) in the northern part of the range indicates that females spawn at a 2-3 year frequency (USFWS 2014).

Fecundity is related to body size. The largest upper Missouri River fish can produce as many as 150,000-170,000 eggs (USFWS 2014), whereas smaller bodied females in the southern extent of the range may only produce 43,000-58,000 eggs (George et al. 2012). Spawning appears to occur between March and July, with lower latitude fish spawning earlier than those in the northern portion of the range.

Adult pallid sturgeon can move long distances upstream prior to spawning; a behavior that can be associated with spawning migrations (U.S. Geological Survey 2007; DeLonay et al. 2009). Females likely spawn at or near the apex of these movements (Bramblett and White 2001; DeLonay et al. 2009). Spawning appears to occur adjacent to or over coarse substrate (boulder, cobble, gravel) or bedrock, in deeper water, with relatively fast, converging flows, and is driven by several environmental stimuli including day length, water temperature, and flow (U.S. Geological Survey 2007; DeLonay et al. 2009).

Incubation rates are governed by and dependent upon water temperature. In a hatchery environment, fertilized eggs hatch in approximately 5-7 days (Keenlyne 1995). Incubation rates may deviate slightly from this in the wild. Newly hatched larvae are predominantly near the bottom, drifting in the currents for 11 to 13 days and likely dispersing several hundred miles downstream from spawn and hatch locations (Kynard et al. 2002, 2007; Braaten et al. 2008, 2010, 2012a; Phelps et al. 2012).

Diets: Juvenile and adult pallid sturgeon diets are generally composed of fish and aquatic insect larvae with a trend toward fish as they increase in size (USFWS 2014).

Data on food habits of age-0 pallid sturgeon is limited. Data available for wild age-0 *Scaphirhynchus* indicate mayflies (Ephemeroptera) and midge (Chironomidae) larvae are important food items (Sechler et al. 2012). In a hatchery environment, exogenously feeding fry (fry that have absorbed their yolk and are actively feeding) will readily consume brine shrimp, suggesting zooplankton and/or small invertebrates are likely the food base for this age group.

Pallid sturgeon will feed over a variety of substrates (Hoover et al. 2007; Keevin et al. 2007). However, the abundance of Trichoptera in the diet of fish studied in some reaches suggests that harder substrates like gravel and rock material may have become important feeding areas (Hoover et al. 2007), though it remains unknown if this was historically the case or a contemporary response to stabilization and channel maintenance activities increasing the abundance of localized rock material.

Distribution and Status

The Pallid Sturgeon was listed as endangered under the Act on September 6, 1990 (55 FR 36641-36647). Critical habitat was not designated for the pallid sturgeon. Floodplains, backwaters, chutes, sloughs, islands, sandbars, and main channel waters formed the large-river ecosystem that met the habitat and life history requirements of pallid sturgeon and other native large-river fishes. The species is a bottom-oriented, large river obligate fish inhabiting the Missouri and Mississippi rivers and some tributaries from Montana to Louisiana (Kallemeyn 1983) (*Figure 8*).

Since listing in 1990, the status of the species has improved and is currently stable. New information related to habitat extent and condition, abundance, and potential recruitment in the Mississippi and Atchafalaya rivers has improved our understanding of the species in these areas. While the numbers of wild Pallid Sturgeon collected in the Missouri, Mississippi and Atchafalaya rivers are higher than initially documented when listed and evidence for limited recruitment exists for the lower Missouri and Mississippi rivers, the population has not been fully quantified. This increase in observations is the result of increased monitoring efforts, improvements in sampling techniques, and greater emphasis on research in the impounded portion of the range (USFWS 2014). Despite increased efforts, data regarding recruitment, mortality, habitat use, and abundance remain limited. Population estimates for wild pallid sturgeon within some inter-reservoir reaches of the Missouri River indicate the extant wild populations are declining or extirpated. To prevent further extirpation, a conservation propagation program has been established. The Augmentation Program appears to be successful in maintaining the species' presence within the Missouri River basin. However, if supplementation efforts were to cease, the species would once again face local extirpation within several reaches.

Population Dynamics

Population Size: Approximately 50 wild adult pallid sturgeon are estimated to exist in the Missouri River upstream of Fort Peck Reservoir (USFWS 2007). An estimated 125 wild pallid sturgeon remain in the Missouri downstream of Fort Peck Dam to the headwaters of Lake Sakakawea as well as the lower Yellowstone River (Jaeger et al. 2009).

Figure 8: Current Range of the Pallid Sturgeon (Source: USFWS 2014)

Steffensen et al. (2013) estimated the wild, adult population size was approximately 6,000 fish for the lower Missouri River in 2012 with approximately 42,000 hatchery-reared pallid sturgeon. This estimate would include fish that inhabit the Lower Platte River. Garvey et al. (2009) generated an estimate of 1,600 to 4,900 pallid sturgeon for the middle Mississippi River (i.e., mouth of the Missouri River Downstream to the Ohio River confluence). No estimates are available for the remainder of the Mississippi River. Since 1994, supplementation with hatchery-reared pallid sturgeon has occurred throughout the Missouri River and sporadically in the Mississippi River.

Management Units: Originally, the Service established six recovery priority management areas to focus recovery efforts at locales believed to have the highest recovery potential in 1993 (USFWS 1993). Since then, our understanding of the species has improved and warrants redefining those management areas into four management units: 1) Great Plains; 2) Central Lowlands; 3) Interior Highlands; and 4) Coastal Plain (USFWS 2014). These management unit boundaries are based on: 1) genetic data; 2) morphological differences; 3) biogeography of other fish species and speciation associated with physiographic provinces; 4) common threats; and 5) the potential need and ability to implement differing management actions to address varying threats within a management unit. The Project is located upstream of the Central Lowlands Management Unit (CLMU) (*Figure 9*).

<u>Species Status for the Central Lowlands Management Unit:</u> The Platte River is a part of the Central Lowlands Management Unit (CLMU) whose extent represents the Missouri River from Fort Randall Dam, South Dakota to the Grand River confluence with the Missouri River in Missouri. Steffensen et al. (2013a) estimated 48,000 individuals (6,000 wild and 42,000 hatchery-reared) reside in the lower Missouri River recognizing slight differences in population boundaries between the CLMU and Steffensen et al. (2013a) study area. Extrapolating densities from Winders and Steffensen (2014) result in estimates ranging from 7,962 to 14,488 individuals for the Lower Missouri River. Totals provided by Steffensen et al. (2013a) and Winders and Steffensen (2014) provide a range in species densities within the CLMU.

Natural recruitment of pallid sturgeon within the CLMU is considered little to nonexistent (Winders and Steffensen 2014; Hamel et al. 2014a; Steffensen et al. 2013a) and not self-sustaining (i.e., population is not recruiting individuals through natural reproduction). Wildhaber et al. (2014) did not observe an increase in pallid sturgeon abundance in the Lower Missouri River, when compared to the 1996-1998 time period, even with stocking efforts in place. However, the CLMU is considered stable due to the high frequency of stocked pallid sturgeon maintained through the Augmentation Program (USFWS 2014). Because the CLMU population is not self-sustaining, it is recognized that hatchery-reared fish will need to supplement the adult population until natural reproduction can be maintained (Steffensen et al. 2013b; Winders and Steffensen 2014).

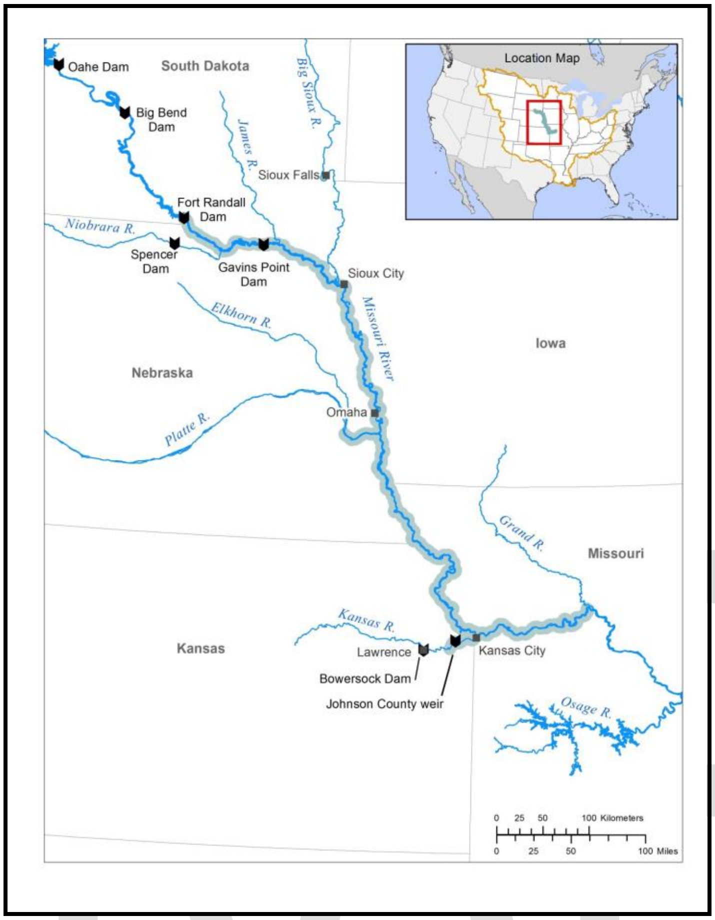

Figure 9: Central Lowlands Management Unit (Source: U.S. Fish and Wildlife Service 2014)

The Service has determined that a self-sustaining genetically diverse population of 5,000 adult pallid sturgeon are needed within each management unit for two generations (20-30 years) including the CLMU (USFWS 2014). In this context, a self-sustaining population is described as a spawning population that results in sufficient recruitment of naturally-produced pallid sturgeon into the adult population at levels necessary to maintain a genetically diverse wild adult population in the absence of artificial population augmentation.

Reasons for Decline

Pallid Sturgeon have been impacted in several ways through large river habitat alterations including: a) impoundment construction, altered flow regimes, river channelization, and bank stabilization; b) water quality; c) entrainment; d) energy development; e) hydridization; f) invasive species/aquatic nuisance species; and g) climate change. The following is a summarization of these impacts.

Impoundment Construction, Altered Flow Regimes, River Channelization, and Bank Stabilization: Pallid sturgeon were essentially extirpated from approximately 28 percent of their historical range due to the construction of dams and creation of large impoundments on major river systems. The remaining unimpounded range has been modified by channelization and bank stabilization, or is affected by upstream impoundments that alter flow regimes, turbidity, and water temperatures (Hesse et al. 1989; Keenlyne 1989; USFWS 2000). River channelization, bank stabilization, impoundments, altered flow regimes, and their effects are documented throughout the range of the pallid sturgeon and each can negatively affect the species' life history requirements.

The most obvious effects to riverine habitat and hydrology have occurred due to the operation of six main-stem Missouri River dams. These dams and their operations have: a) truncated drift distance of larval pallid sturgeon (Kynard et al. 2007; Braaten et al. 2008), b) created physical barriers that block normal migration patterns, c) degraded and altered physical habitat characteristics, d) greatly altered the natural hydrograph (Hesse et al. 1989), and e) produced subtle changes in river function that influence both the size and diversity of aquatic habitats, connectivity (Bowen et al. 2003), and benthos abundance and distribution (Morris et al. 1968). Moreover, these large impoundments have replaced large segments of riverine habitat with lake conditions. The mainstem Missouri River has been permanently altered by dams and channelization, creating a fairly homogenous system with uniform depths and velocities (Hesse and Sheets 1993).

Tributaries to the Missouri River, such as the Platte River may provide unique opportunities for restoration and conservation efforts aimed at preserving biodiversity of large riverine species (Pracheil et al. 2013), such as pallid sturgeon and other riverine fish species. However, the Platte River has also been influenced by altered flow regimes. The lower Platte River hydrograph from the confluence of the Missouri River to the Project tail race is influenced by Project hydrocycling. Hydrocycling affects are most exacerbated on the upper 68 miles of the lower Platte River from the confluence of the Elkhorn River to the Project tailrace (Hamel 2013). These oscillations in the hydrograph create drastic changes in river stage level, and many of the braided channels within the river are often stranded or completely dessicated during low flow periods (Hamel et al. 2014b). The effects of Project hydrocycling on the Lower Platte River are detectable in the hydrograph, however, water input from the Elkhorn River buffers the daily magnitude of change, reducing the likelihood of channel stranding and dessication (Hamel et al. 2014b).

Extreme daily fluctuations, such as Project hydrocycling events have no natural freshwater equivalent, but organisms in marine intertidal zones extremely harsh environment have adapted to frequent drying and wetting fluctuations (Poff et al. 1997). Because aquatic organisms have not adapted to the intraday fluctuations in hydrocycling, aquatic populations are negatively affected by hydrocycling (Nagrodski et al. 2012; Richards et al. 2013). In a study on the lower Platte River, Hamel et al. (2014) found that the local probability of encountering a pallid sturgeon declined longitudinally from the mouth of the Platte River to the Project tailrace and a negative relationship between high variability of daily flows caused by hydrocycling and pallid sturgeon occurrence in the spring and fall.

River channelization, and bank stabilization within the Missouri River basin has altered river features such as channel morphology, current velocity, seasonal flows, turbidity, temperature, nutrient supply, and paths within the food chain (USFWS 2014). In addition to the main-stem Missouri River dams, important tributaries like the Platte, Yellowstone, and Kansas rivers have experienced similar affects due to bank stabilization efforts within their respective watersheds.

<u>Water Quality</u>: Much of the available information regarding the likely effects to pallid sturgeon from contaminants originates from information obtained for shovelnose sturgeon, which can be used as a surrogate species to evaluate environmental contaminant exposure. Shovelnose sturgeon are considered a suitable surrogate species for pallid sturgeon in that they live for 20 years or longer, inhabit the same river basins, spawn at similar intervals and locations, and accumulate similar inorganic and organic contaminants (Ruelle and Keenlyne 1994; Buckler 2011). However, while inferences can be drawn from data related to shovelnose sturgeon, limitations of using this species as a surrogate for pallid sturgeon are based on life history differences between the two species. Pallid sturgeon have a longer life-span, attain a larger size, are more likely to eat fish, and contain a higher percentage of body fat (Ruelle and Keenlyne 1994). These differences may contribute to different contaminant effects or pathways; pallid sturgeon may be at greater risk than shovelnose sturgeon to contaminants that bioaccumulate and cause reproductive impairment because they are more likely to eat fish, have a greater maximum life-span, and a longer reproductive cycle than shovelnose sturgeon.

Shovelnose sturgeon collected from the Platte, lower Missouri, and Mississippi rivers have exhibited intersexual characteristics (having both male and female gonad tissue) (Harshbarger et al. 2000; Wildhaber et al. 2005; Koch et al. 2006; Schwarz et al. 2006). One pallid sturgeon exhibited both male and female reproductive organs (DeLonay et al. 2009). Although the effects of intersex on sturgeon reproduction are unknown, intersex in other fish species has been linked to decreased gamete production, lowered sperm motility, and decreased egg fertilization (Jobling et al. 2002). Koch et al. (2006) observed reduced numbers of spermatozoa in highly contaminated and intersexual shovelnose sturgeon that may suggest limited reproductive success.

To date, few studies have measured environmental contaminant concentrations in pallid sturgeon. Point-source discharges may adversely affect pallid sturgeon and their habitat. Effluent from wastewater treatment plants can contain hormonally active agents (USFWS 2014). In addition to wastewater treatment plants, drinking water treatment plants also are a concern. In April 2004, several radio-tagged pallid sturgeon were repelled from the mouth of the Platte River immediately following a milky discharge from a drinking water treatment facility located upstream (Parham et al. 2005). Further investigation found that the facility was not in compliance with its discharge permit which expired in 1993, and that the discharge likely contained several toxic irritants including ferric sulfate, calcium oxide, hydrofluosilicic acid, chlorine, and ammonia.

Because more information is needed to evaluate the exposure and effects of environmental contaminants to pallid sturgeon, a basin-wide contaminants review for pallid sturgeon was initiated in 2008. To date, this investigation has identified pesticides, metals, organochlorines, hormonally active agents, and nutrients as contaminants of concern throughout the species' range. Further assessments should be targeted in these areas to evaluate the exposure and effects of the impairing contaminants on pallid sturgeon and their reproductive physiology.

Little is known about pallid sturgeon tolerances of low dissolved oxygen concentrations and limits have not been quantified for all life stages. However, data from other sturgeon species are insightful. In general, sturgeon are not as tolerant of hypoxic conditions (very low dissolved oxygen levels) as are other fishes (Secor and Gunderson 1998; Niklitschek and Secor 2005). Temperature and dissolved oxygen levels can affect sturgeon survival, growth and respiration with early life stages being more sensitive than adults (Secor and Gunderson 1998).

Like many sturgeon species, pallid sturgeon are primarily benthic organisms within 10-12 days post hatch (Kallemeyn 1983; Kynard et al. 2007). This benthic life history strategy can result in sturgeon encountering hypoxic conditions. Like most organisms that encounter unsuitable habitats, juvenile and adult sturgeon have some ability to avoid unfavorable environmental conditions via migration (Auer 1996).

Anthropogenic changes within the range of pallid sturgeon that affect dissolved oxygen concentrations could be affecting survival and recruitment. Measurements on the lower Missouri River from 2006-2009 showed that large rises in the river during spring and summer may result in dissolved oxygen levels falling to < 2 milligrams per liter and remaining below 5 milligrams per liter for several days (Blevins 2011). In the upper Missouri River basin, larval pallid sturgeon are likely transported into or through reservoir transition areas. Because they are weak swimmers at this early life stage (Kynard et al. 2007), they are less able to migrate away from any encountered hypoxic conditions. Study efforts have been initiated to better evaluate the effects of riverine to reservoir transition areas on pallid sturgeon survival.

The pallid sturgeon is ectothermic, that is, its body temperature is dependent on water temperatures. As a result, water temperatures influence nearly every aspect of the pallid sturgeon's life history requirements. Anthropogenic changes within the range of pallid sturgeon that have substantially affected historical water temperatures are bottom release dams. Thus, altered temperature profiles of riverine habitats downstream from large bottom-release dams influence nearly every aspect of the life-history requirements and habitats of pallid sturgeon (USFWS 2014). While the magnitude of effects from altered temperature profiles vary by dam, they may be the most problematic in the inter-reservoir reservoir reaches of the impounded Missouri River.

<u>Impingement and Entrainment:</u> Another issue that can have negative consequences for pallid sturgeon range-wide is impingement and entrainment loss (USFWS 2014). The loss of pallid sturgeon associated with cooling intake structures for power facilities, towboat propellers, dredge operations, irrigation diversions, and flood control points of diversion has not been fully quantified, but impingement has been documented for both pallid and shovelnose sturgeon. Entrainment of juvenile and adult pallid sturgeon has been documented to occur in the few instances it has been studied. Thus, it is a greater threat than anticipated in the original version of this plan. The level of larval sturgeon entrainment is unknown. The overall effects from

entrainment are variable and depend on population demographics, exposure time, quantity of unscreened diversion points, and duration of diversion point usage (i.e., year-round versus seasonal or sporadic operation).

<u>Energy Development</u>: The federal authority for Gas and Oil pipeline safety is the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration. This agency reports that there were 2.3 million miles of pipelines in the U.S. carrying natural gas and hazardous liquids (primarily petroleum, refined petroleum products, and other chemicals). Many pipelines cross rivers within the range of pallid sturgeon; some of which are buried under the river bed. Depending on the timing, magnitude, and the material leaked, a ruptured pipeline could pose a threat to pallid sturgeon.

<u>Hybridization</u>: While we know that experimental mating of pallid sturgeon with shovelnose sturgeon can produce living offspring (Kuhajda et al. 2007), accurate assessment of hybridization in the evolution of *Scaphirhynchus* and its perceived threats to pallid sturgeon recovery will require statistically testing the hypothesis of hybridization against alternatives. Since hybridization is accepted as a process occurring in *Scaphirhynchus* and likely has been occurring for many decades (Schrey et al. 2011), it is important to determine the cause (i.e., historical/natural or contemporary) and extent of hybridization. Once these processes are elucidated, simulation/modeling exercises can address the actual risks associated with pallid/shovelnose hybridization. If it is determined that alteration of habitats has influenced temporal or spatial reproductive isolating mechanisms resulting in increased rates of hybridization, addressing this threat will likely rely on both site-specific and ecosystem improvement efforts; many of which are identified in the Recovery Outline/Narrative section below.

<u>Invasive Species/Aquatic Nuisance Species</u>: Several invasive species and aquatic nuisance species with the potential for impacting pallid sturgeon have become established in parts of the species' range. These include the Asian carps (common carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Hypophthalmichthys nobilis*) and black carp (*Mylopharyngodon piceus*)) as well as the zebra mussel (*Dreissena polymorpha*). Populations of Asian carp appear to be expanding exponentially in parts of the Mississippi River basin as the range of the zebra mussel continues to expand (Kolar et al. 2005). Asian carp is present in both the Platte River basin and the Missouri River adjacent to the Platte.

If food resources were limited from the presence of large populations of planktivores (e.g., Asian carps), early life-stage pallid sturgeon could face increased competition with native planktivorous fishes such as gizzard shad (*Dorosoma cepedianum*), bigmouth buffalo (*Ictiobus cyprinellus*) and paddlefish (*Polyodon spathula*) (Kolar et al. 2005). Several authors have expressed concern that, because nearly all fish feed on zooplankton as larvae and juveniles, Asian carps have high potential to impact native fishes of the Mississippi Basin. In addition to directly competing for food resources, Asian carps also could affect recruitment by predation on pallid sturgeon eggs or drifting larvae (USFWS 2014).

Zebra mussel colonization has occurred in areas occupied by pallid sturgeon but data are limited on direct effects. In juvenile lake sturgeon, data show that zebra mussel occupancy changes the nature of the bottom substrates and reduced foraging effectiveness of with mussel presence resulting in avoidance of those areas by study fish more than 90 percent of the time (McCabe et al. 2006).

Climate Change: Our recovery plan for the pallid sturgeon considers ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change. "Climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (Intergovernmental Panel on Climate Change 2007). The term "climate change" refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (Intergovernmental Panel on Climate Change 2007). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of climate interactions with other variables (e.g., habitat fragmentation) (Intergovernmental Panel on Climate Change 2007). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change. Both the Intergovernmental Panel on Climate Change and U.S. Global Change Research Program identify that the trend in global climate patterns is one of warming; average temperatures in the U.S. are at least 2°F (1.1°C) higher than they were 50 years ago (Intergovernmental Panel on Climate Change 2007; U.S. Global Change Research Program 2009).

Within the range of pallid sturgeon, predicted affects appear to be shifts in runoff patterns: discharge peaks are anticipated to occur earlier and potentially be larger, late season river flows may be reduced, and water temperatures may rise (Intergovernmental Panel on Climate Change 2007). These changes to the water cycle are anticipated to affect water use (U.S. Global Change Research Program 2009), which may alter existing reservoir operations. Broadly, these potential effects to pallid sturgeon could be altered spawning behavior (i.e., movement and timing), reduced survival of early life stages and young-of-year, and reduced late-season habitat suitability due to reduced flows and presumably warmer temperatures. Another predicted outcome is increased or prolonged periods of drought (Intergovernmental Panel on Climate Change 2007; U.S. Global Change Research Program 2009). Increased water demand coupled with reduced late-season flows could significantly affect in-channel habitats which in turn may affect other species that are food items for pallid sturgeon.

These effects would likely occur first, or be most pronounced, in the more northern portion of the pallid sturgeon range; the Intergovernmental Panel on Climate Change (2007) study suggests that in general, temperature increases correlate with latitude. Thus, higher northern latitudes appear to have relatively higher predicted warming trends.

<u>Analysis of the Species/Critical Habitat Likely to be Affected</u>

The species recovery plan discusses how pallid sturgeon have been impacted by: a) impoundment construction, altered flow regimes, river channelization, and bank stabilization; b) water quality; c) entrainment; d) energy development; e) hydridization; f) invasive species/aquatic nuisance species; and g) climate change. The Service has reviewed the recovery plan for the pallid sturgeon and identified the following recovery objectives that could be linked to effects of the proposed action.

<u>Recovery Objective 1.1.3 - Create Physical Habitat And Restore Riverine Function</u>

(1) Protect, enhance, and restore habitat diversity and connectivity

(b) Reconnect perched or disconnected side channels.

The Staff Alternative effects to sediment supply and transport in the Lower Platte River could result in either channel aggradation or degradation. Changes in gradation to Platte River channels could affect connectivity of side channels.

<u>Recovery Objective 1.1.4 - Provide And Protect Instream Flows</u>

(1) Develop an instream flow plan for riverine reaches important to pallid sturgeon recovery.

(a) Assess tributary water allocations to determine depletion effects on habitat formation and maintenance.

(b) Determine what flows are necessary to meet pallid sturgeon life history requirements.

(i) Consider precipitation pattern models and climate change forecasts when developing flow requirements.

(c) Implement flow protection strategies based on instream flow plan.

(2) Evaluate dam discharges during spring, summer, and fall (both main-stem and tributaries) to protect instream flows.

(a) Manipulate reservoir releases if needed to protect or restore flows for recovery of pallid sturgeon.

The Staff Alternative affects streamflow for the Platte River Bypassed Reach and the Lower Platte River, and therefore, the Staff Alternative has the potential to affect pallid sturgeon.

IIIB. Pallid Sturgeon - Environmental Baseline

<u>Status of the Species within the Action Area</u>

Summary

The Service will consider the effects of the Staff Alternative on the following life stages of the pallid sturgeon in this Opinion: 1) juvenile to non-reproductive adults; 2) non-reproductive adults to spawning adults; and 3) spawning adults to the production of larval pallid sturgeon. This is based on observed species presence and indirect information in published scientific literature. The Service will not consider aspects of the Staff Alternative that could affect the transition from larvae to free-swimming juvenile pallid sturgeon because the Service has determined that this transition period is not dependent on the Platte River.

Present Status of Pallid Sturgeon Population for the Platte River

The Platte River is a part of the Central Lowlands Management Unit (CLMU) whose extent represents the Missouri River from Fort Randall Dam, South Dakota to the Grand River confluence with the Missouri River in Missouri. Steffensen et al. (2013a) estimated 48,000 individuals (6,000 wild and 42,000 hatchery-reared) reside in the lower Missouri River recognizing slight differences in population boundaries between the CLMU and Steffensen et al. (2013a) study area. Extrapolating densities from Winders and Steffensen (2014) result in estimates ranging from 7,962 to 14,488 individuals for the Lower Missouri River. Totals provided by Steffensen et al. (2013a) and Winders and Steffensen (2014) provide a range in species densities within the CLMU.

Natural recruitment of pallid sturgeon within the CLMU is considered little to nonexistent (Winders and Steffensen 2014; Hamel et al. 2014a; Steffensen et al. 2013a) and not self-sustaining (i.e., population is not recruiting individuals through natural reproduction). However, the CLMU is considered stable due to the high frequency of stocked pallid sturgeon maintained through the Pallid Sturgeon Conservation Augmentation Program (USFWS 2014). Wildhaber et al. (2014) did not observe an increase in pallid sturgeon abundance in the Lower Missouri River, when compared to the 1996-1998 time period, even with stocking efforts in place. Because the CLMU population is not self-sustaining, it is recognized that hatchery-reared fish will need to supplement the adult population until natural reproduction can be maintained (Steffensen et al. 2013b; Winders and Steffensen 2014).

Hamel (2013) estimated that approximately 926 pallid sturgeon are present in the Lower Platte River during the study. This estimate provides a coarse estimate for a dynamic Platte River population with individuals from the CLMU migrating into and out of the Platte River (Chojnacki et al. 2014; Peters and Parham 2008). However, the Service has determined that 926 individuals represent a reasonable estimate given actual captures of 137 individuals with only four recaptures (Hamel et al. 2014a). The small number of recaptures indicates more individuals are present than what is being captured by researchers.

Pallid sturgeon have been captured throughout the entire lower Platte River, but are more abundant downstream of the Elkhorn River confluence. Of the 137 individuals collected by Hamel (2013), only 13 individuals were collected in the lower Platte River upstream of the Elkhorn River confluence. Individuals have been captured from March through November and are likely present year round; however, pallid sturgeon are more abundant during spring and fall seasons (*Table 2* and *Table 3*). Chojnacki et al. (2014) and Peters and Parham (2008) documented seasonal use of the Platte River by pallid sturgeons.

Table 2. Annual total number of pallid sturgeon captures in the Lower Platte River (Source Hamel 2014a).

	Year			
	2009	2010	2011	2012
Segment 1[a]	66	34	14	10
Segment 2[b]	3	5	3	2

[a] Lower Platte River from Elkhorn River confluence to mouth (approx. 32 miles)
[b] Lower Platte River from Project tailrace return to Elkhorn River confluence (approx. 66 miles)

Table 3. Pallid sturgeon captures by season and location in the Lower Platte River (Source Hamel 2014a).

	Average Number per Year		Range in Observed Numbers	
	Segment 1[a]	Segment 2[b]	Segment 1[a]	Segment 2[b]
Spring	9.8	1.8	5-21	1-3
Summer	6.5	1.0	1-16	0-2
Fall	14.8	0.5	1-42	0-1

[a] Lower Platte River from Elkhorn River confluence to mouth (approx. 32 miles)
[b] Lower Platte River from Project tailrace return to Elkhorn River confluence (approx. 66 miles)

The absence of natural recruitment limits species recovery in the CLMU. It is unknown to what degree the conditions on the Platte River may or may not limit natural recruitment. We evaluated existing information to assess if populations in the Lower Platte River are self-sustaining. We also reviewed information to determine if the Missouri River is essential for sustaining the Platte River population. If it is determined that the Platte River limits species recruitment, then the Service in this Opinion would determine if limits to recruitment is a condition of the Staff Alternative. The following describes the findings of our evaluation.

Several pallid sturgeon life stages have been documented in the Platte River. Peters and Parham (2008a) noted that adult and juvenile pallid sturgeon have been captured in the Lower Platte River which is a significant indicator that the habitats found in there are suitable for adults and juveniles. Both wild and hatchery-reared individuals have been observed, but the proportion of wild individuals is less than what is reported for the Missouri (Hamel et al. 2014a). The authors hypothesized that the reduced availability of deep-water habitats in the Lower Platte River may limit wild adults that are larger in size. Additionally, there is data to indicate that the Lower Platte River is likely used for spawning (Chojnacki et al. 2014; DeLonay 2012; Swigle 2003). Long-term telemetry monitoring of pallid sturgeon have documented several instances where male and female individuals have migrated into the Platte River in a likely attempt to spawn (Chojnacki et al. 2014). Pallid sturgeon larvae were documented within the lower Missouri River basin (USACE 2015), but the location or origin has not been confirmed. Additionally, larval *Scaphirhynchus* has been documented in the Lower Platte River, but captured larvae could not be identified to species (Hofpar 1997, Reade 2000). Given the information provided above, the Service concludes that pallid sturgeon spawn in the Platte River although actual spawning has not been confirmed.

In a review of existing information, the Service has found no documentation that would suggest pallid sturgeon larvae present in the CLMU (USACE 2015) are able to transition to free swimming juveniles. This transition period is frequently noted as a bottleneck in sturgeon recruitment (Steffensen et al. 2013b; DeLonay et al. 2009). To address this data limitation, the Service reviewed existing larval drift models from DeLonay et al. (2009) and Braaten et al. (2008) to predict when and where larvae are expected to transition from drifting individuals to those capable of swimming. DeLonay et al. (2009) stated that larval pallid sturgeon will drift in the water column for 11–17 days after hatching (Kynard et al. 2007; Braaten et al. 2008).

Larval pallid sturgeon tend to drift near the bottom of a channel, and drift rates were similar to or slightly less than that typically found in the water column (Braaten et al. 2008). The Service used ranges of velocities reported by Hamel et al. (2014a) and Peters and Parham (2008) to determine drift distances in the Lower Platte River. Hamel et al. (2014a) reported mean column velocities of 0.70 meters per second (0.02 standard error) at species use locations and 0.73 (standard 0.01) at nonuse locations which collectively represents an upper/lower range of velocities from 1.52 to 1.66 miles per hour. Peters and Parham (2008) reported a large range of mean column velocities (i.e., <0.2 to >1.1 meters per second). The Service used velocities of 0.2 and 1.1 meters per second (representing more than 85 percent of the measured velocities) to determine that current velocity ranges from 0.45 and 2.5 miles per hour.

Given the above velocities described in the published literature, the range of drift distances for 11–17 days represents a minimum distance drifted of 118.9 miles to a maximum of 1,020 miles. When considering that the combined length of the Platte River Bypassed Reach and the Lower Platte River is approximately 103.5 miles in length, it is likely pallid sturgeon larvae that have hatched in the Lower Platte River would drift into the Missouri River before they ever reach the free-swimming stage. We applied the slowest of current velocities measured in the Platte River to reach this conclusion. While drifting pallid sturgeon have been known to occupy areas of low velocity, occupation of these sites is usually a short-term condition with the individual eventually drifting to the main channel (Gosch et al. 2015; Ridenour et al. 2011; Kynard et al. 2007); therefore, it is unlikely that drifting larvae can be retained in habitats of low velocity areas reported on the Platte River. Drift distances was similarly described in the species recovery plan (USFWS 2014) and by Braaten et al. (2008) where, given velocities similarly similar to that on the Platte River, pallid sturgeon larvae would typically disperse several hundred miles downstream from spawn and hatch locations.

Thus, given the above analysis, we will not consider aspects of the Staff Alternative that could affect the transition from larvae to free-swimming juvenile pallid sturgeon because this transition period is not dependent on the Platte River. However, the Service will consider the effects of the Staff Alternative on the following life stages from: 1) juvenile to non-reproductive adults; 2) non-reproductive adults to spawning adults; and 3) spawning adults to the production of larval pallid sturgeon.

Factors Affecting the Species Environment within the Action Area

Summary

The Service identified a number of factors that could affect pallid sturgeon, and these factors were included in the species effect section. These include: a) pallid sturgeon habitat; b) pallid sturgeon food resources; and c) stream temperature. The Service has adopted a population size of 926 pallid sturgeon in the Lower Platte River that will serve as the baseline population for the 30 year evaluation period of this Opinion.

Lower Platte River

Pallid Sturgeon Habitat

Rosenfeld (2003) described three fundamental types of predictive models commonly used to define relationships between habitat and species use: 1) microhabitat models; 2) capacity models; and 3) distributional or macrohabitat models. The two habitat scales reported by Platte River research include macrohabitat models that predict the presence or absence of species at large spatial scales and microhabitat models that predict habitat associations at a fine spatial scale. Researchers have also developed mesohabitat models which represent an extension of microhabitat models. Mesohabitat models aggregate similar microhabitat features into discrete river features (Pardo and Armitage, 1997). Capacity models that predict species density or population size have not been conducted in Platte River research and will not be addressed further in this Opinion.

Present Condition of Microhabitat/Mesohabitat: Hamel et al. (2014a) and Peters and Parham (2008) evaluated pallid sturgeon habitat at the microhabitat level. Hamel et al. (2014a) reported pallid sturgeon were disproportionately captured in portions of the river that were relatively deeper, cooler, and lower in turbidity. Other variables investigated by Hamel et al. (2014a) that were not significant at a microhabitat level include: conductivity, dissolved oxygen, mean daily discharge, and mean column velocity. Hamel et al. (2014a) reported depths at pallid sturgeon capture sites were approximately 3 feet in depth (SE ±0.1 feet) compared to depths where the species was absent (2.3 feet, SE ±0.03 feet). The selection of deeper water (i.e., depths of 2 to 5.9 feet) was similarly described from research on the Platte River (Peters and Parham 2008) and is commonly reported in the scientific literature (USFWS 2014).

At a mesohabitat level, Hamel et al. (2014a) and Snook (2001) stated that pallid sturgeon typically occurred in slower velocity pools created by high velocities resulting from the thalweg flowing into mid-channel sandbars. Individuals were also observed using secondary and braided channels when suitable depth was available. Creation and maintenance of these mesohabitat features are important because loss of these habitats have significantly affected the species status on the Missouri River navigation channel (USFWS 2014). The effects of the sediment deficit were noted by the Commission (Page 35 of the Assessment) and Elliott et al. (2009) where relatively deeper water extends about two miles downstream from the Project tailrace return. The presence of deep water is an indicator of channel incision described further in this Opinion, and channel incision could affect pallid sturgeon mesohabitat described by Hamel et al. (2014a).

Present Condition of Macrohabitat: Two publications evaluated pallid sturgeon at a macrohabitat level (Hamel 2014a; Peters and Parham 2008). Hamel et al. (2014b) evaluated a number of variables and related these variables to pallid sturgeon captures. Of these variables, sampling season (i.e., spring, summer, or fall), mean daily discharge, coefficient of diel variation (CV), and location in the Lower Platte River were linked to probability of pallid sturgeon occurrence. Of the aforementioned variables, only mean daily discharge and the CV represent flow-related variables described within the Environmental Baseline, and therefore evaluated further in this Opinion. Mean daily discharge represents the average streamflow throughout a 24-hour day and CV is a measure of variability of streamflow within a day (i.e., index for within day variability in streamflow). The CV is described in greater detail in the Appendix E.

Prior to Hamel et al. (2014b), Peters and Parham (2008) developed the first macrohabitat model by applying results from their microhabitat assessment into a spatial Geographic Information System model. The model output described the percentage of the total 101 miles of the Lower Platte River that provided connected deep water habitats. The Peters and Parham (2008) study results showed connectivity of pallid sturgeon habitats rapidly declined as flows were reduced from 5,600 cfs to 3,200 cfs, and habitat was nearly fully connected at a flow of 8,000 cfs (Assessment Page 216-221). Disconnection of habitat reported by Peters and Parham (2008) was similarly described by HDR Inc. et al. (2009) where pallid sturgeon habitats (i.e., run and plunge) at a single study site were mostly connected at 6,000 cfs, and habitat connectivity declined as flows dropped below 6,000 cfs. The utility of the Peters and Parham (2008) macrohabitat model is different from that of Hamel et al. (2014b) in that the latter links modeled results to species use which enhances the utility of Hamel et al. (2014b).

The relationship between microhabitat and macrohabitat are closely linked. At the microhabitat level, deep water is important to the species, but studies in the macrohabitat section demonstrate that the amount of deep water and the connectivity of deep water habitats are important for species use. Access to deep water is important for spawning adults that have a relatively large body size and have been observed migrating several miles in search of spawning habitats. Maintaining connectivity high connectivity also allows for individuals to easily move between Platte and Missouri Rivers. High river connectivity allows for the movement of individuals to avoid adverse conditions such as times when Platte River water temperatures reach lethal levels. The Commission in their Assessment provides a good example showing how changes in streamflow affect the connectivity of deepwater habitats (Figures 25 through 27 of the Assessment).

Microhabitat/Mesohabitat Baseline: The No Diversion condition would convey more water through the Platte River Bypassed Reach and on to the Lower Platte River. The effects of hydrocycling would be eliminated under the No Diversion condition. The Environmental Baseline describes an 82 to 477 cfs decline expected within 25 years as a result of water development not associated with the Project. The No Diversion condition is expected to increase evaporation resulting in a minor decrease in Lower Platte River streamflow of up to 9.3 cfs which is additive to the aforementioned declines.

The pallid sturgeon is a large bodied fish that requires deep water habitats. Under a No Diversion scenario, the within day variability in stream flow downstream of the Project tailrace return (i.e., North Bend streamgage) would vary from 600 to 1,130 cfs. The variability in river stage at the North Bend streamgage would range from 0.17 to 0.21 feet. The within day variability is significantly reduced compared to Current Operations whose variability ranges from 2,750 to 4,150 cfs and 0.94 to 1.09 feet.

Variability in streamflow and stage at the Louisville streamgage is 630 to 1,400 cfs and 0.15 to 0.19 feet, respectively. The within day variability is significantly reduced compared to Current Operations whose variability ranges from 2,800 to 4,320 cfs and 0.69 to 0.79 feet. Appendix E discusses in greater detail how within day variability in streamflow is lower under the Environmental Baseline when compared to Present Conditions. The reduction in variability of depths under the Environmental Baseline is expected to improve species microhabitat when considering selected depths of 3 feet (SE ±0.1 feet) (Hamel et al. 2014a) and 2 to 5.9 feet (Peters and Parham 2008). Low within day flow variability under the Environmental Baseline maintains stable depths for the species.

The effects of the sediment deficit extend approximately two miles downstream from the Project tailrace return. As further described in this section, the No Diversion condition will eliminate the sediment deficit occurring at the Project tailrace return, and is therefore likely to eliminate the local channel incision resulting in limited increases in channel width. The elimination of the sediment deficit would halt the degradation of mid-channel sandbars and braided channels that represent mesohabitat features important for species downstream form the tailrace. Since channel incision has been only reported to within approximately two miles of the Project tailrace return. The Service recognizes that benefits of the restored habitat features represent a relatively short section of the Platte River in the action area.

<u>Macrohabitat Baseline:</u> Total streamflow and within day variability in streamflow are associated with pallid sturgeon occurrence (Hamel et al. 2014b). The minor declines in streamflow of up to 9.3 cfs due to evaporative losses may decrease species occurrence in the Lower Platte River. Because the projected declines in streamflow are greatest downstream of the Elkhorn River confluence, species occurrence would be most affected in this area. The high use of the Platte River downstream of the Elkhorn River confluence described by Hamel et al. (2014a) would be most affected by the reduction in streamflow.

A decline in streamflow would reduce habitat connectivity described by Peters and Parham (2008). However, the reduction in within day variability under the Environmental Baseline would improve connectivity. Appendix E in this Opinion describes the reduction in the within day variability in streamflow under the No Diversion conditions. The CV under the No Diversion hydrology would be reduced from 24 to approximately 10 at North Bend and from 17 to 4 at Louisville. Appendix E discusses in greater detail how CV was calculated for Environmental Baseline and Present Conditions. These reductions in within day variability under the No Diversion condition will improve connectivity and increase species use.

Pallid Sturgeon Food Resources

No studies currently exist that directly assess food resources for pallid sturgeon in the Platte River, so the establishment of a baseline requires indirect assessment. Scientific literature indicates food resources differ by life stage. Hamel et al. (2013) documented that the majority of individuals captured over 500 mm, and the diet of these individuals are primarily fish while individuals less than 500 mm have food diets that consist primarily of invertebrates (French et al. 2013).

Service review of scientific literature identifies how current hydrocycling could affect pallid sturgeon food resources. Hydrocycling affects benthic invertebrate abundances (Gisalson 1985), causes stranding of burrowing invertebrates (Braaten and Guy 1997), and decreased feeding and growth of fish (Weisberg and Burton 1993). Cabaltica et al. (2013) concluded that high within day variability in streamflow results in the greatest reduction in suitable habitat for the macrozoobenthos population. Jones (2013) found that invertebrate taxa are particularly affected by hydrocycling flows because they often have preferences for a distinct range of water velocity, depth, substrate, and temperature conditions.

<u>Present Condition of Food Resources:</u> Indicators of invertebrate diversity such as the Invertebrate Community Index Metrics (ICI) developed for ecoregions in Nebraska (Bazata 2005) serve as a surrogate for pallid sturgeon invertebrate resources. The ICI is a composite of species diversity indices where good quality streams in Nebraska set a benchmark for the highest ICI scores. Perennial streams and good quality benchmark streams in Nebraska are rated at 16.5 and 20.8, respectively. A side channel of the Platte River in Platte County rated “Good” at 14 from Bazata (2005) was used to assess the ICI index for the action area.

The Fish Index of Biotic Integrity Metrics (IBI) (Bazata 2005) was used to determine the availability of fish for pallid sturgeons. The IBI is a composite of species diversity indices from which good quality streams in Nebraska set the benchmark for the highest IBI scores. The IBI score for the Platte River site in Platte County was rated as “Excellent” with a 72.6 which is higher than the average for Nebraska perennial streams (56.9) and for good quality reference streams (61.1). Andersen (2010) found no significant difference in fish diversity or abundance between upstream and downstream segments of the Lower Platte River for the majority of indices. Andersen (2010) did find fish abundance was lower from the project tailrace to the Elkhorn River confluence compared to downstream of the Elkhorn River confluence.

However, data provided by Bazata (2005) and Anderson (2010) demonstrate that aquatic invertebrate and fish communities are not severely impacted by Project hydrocycling. While Anderson (2010) hypothesized that Project hydrocycling and water development is likely to impact shovelnose sturgeon food base, these differences are not reflected in the relative condition of pallid sturgeon found in Hamel et al. (2014a). Relative condition for pallid sturgeon captured by Hamel et al. (2014a) in the Platte River was considered excellent (i.e., relative condition ranging from 0.95 to 0.99). Relative condition values from the Lower Platte River met or exceeded values reported from the Missouri River. The relative condition for the lower Missouri River ranged from 0.86 to 0.97 (Steffensen et al. 2013a) of which of which the overall relative condition of the population is 0.9 when non-reproductively ready individuals. Shuman et al. (2011) stated that a relative condition of greater than 0.94 indicates suitable conditions for growth. The higher relative condition for Platte River individuals indicate these individuals are heavier compared to other river systems, and this improved health is likely due to environmental factors such as food resources (Shuman et al. 2011).

<u>Food Resources Under Environmental Baseline Hydrology:</u> The No Diversion baseline would provide flows that have less daily variability compared to hydrocycling operations under Current Operations (see *Appendix E*). Less daily variability would improve base flows for the Lower Platte River when compared to Current Operations. The No Diversion condition would improve availability of food resources including macroinvertebrates and fish. However, the food resources under Current Operating conditions were of good quality and pallid sturgeon in the Platte River are in excellent condition. Therefore, it would be reasonable to expect limited improvement in the condition for the species under the when comparing a No Diversion condition with Current Operations.

<u>Stream Temperature</u>

The importance of stream temperature to the pallid sturgeon is demonstrated in three ways: 1) temperature is a recognized factor that influences species use at the macro/micro habitat level; 2) temperature can affect food resources; 3) high stream temperatures lead to a reduction in dissolved oxygen; and 4) high temperatures can harm individuals and lead to direct mortality. Hamel et al. (2014a) found that pallid sturgeon were disproportionately captured in portions of the river that were relatively cooler when compared to total available habitat. While pallid sturgeon may select for areas that are relatively cooler, water temperatures were not considered a factor that limited species use on the Lower Platte River (Hamel et al. 2014b).

As discussed in the Hydrology and Geomorphology section, reducing the anthropogenic effect (i.e., Project operation) to a river's temperature regime is important for the ecological integrity of biotic systems. It is reasonable to suggest that reducing lethal temperatures are likely to improve food resources for pallid sturgeon. As stated previously, the relative condition for pallid sturgeon captured by Hamel (2014a) in the Platte River was considered excellent; therefore, present stream temperatures have not significantly impacted food resources where it would be reflected by low relative conditions.

Temperatures higher than 86° F have been shown to be stressful and detrimental to pallid sturgeon (Blevins 2011). During the summer of 2012 (July 2012), water temperatures exceeded the 86° F threshold for most of the month of July (data from USGS 06805500 station at Louisville) stressing and causing mortality of many fish in the Lower Platte River, including pallid sturgeon. A major fish kill was first observed on July 19, 2012. Fish kill response teams from the University of Nebraska at Lincoln and the Service documented two dead pallid sturgeon. One of the deceased individuals was documented near the Salt Creek and Platte River confluence (river mile 26). This individual was approximately 13 years old and considered at (or near) sexual maturity (USFWS 2014). Additionally, over 150 dead individuals were attributed to the *Scapyrhynchus* genus, but the decomposed condition of the fish prevented identification to species for the majority of the individuals. Peak temperature the day of the fish kill was 97° F.

In 2013, a fish kill was reported in the Lower Platte River on July 9 between the Loup River confluence and Elkhorn River confluence (KPTM News 2013). This fish kill was not reported to resource agencies in time to conduct a field survey. Stream temperatures were not recorded near the site of the fish kill; however, the peak stream temperature at the downstream Louisville gage was over 96° F.

<u>Present Conditions of Stream Temperature:</u> Stream temperatures in the Lower Platte River were recorded at the Louisville stream gage from November 1974 to September 1981, and then were restarted on a seasonal basis from May 2007 to present. In that time, stream temperatures reached an average daily maximum of 97.5° F on July 19, 2012, which exceeded the previous maximum of 96.8° F on July 24, 1977 (USGS 2014; USGS 2012).

It is reasonable to assume that Lower Platte River exceedances of high stream temperatures are likely to increase over the life of the Project license (30 to 50 years). A large volume of water takes longer to be heated or cooled than a small one, and low discharge leads to more pronounced daily temperature fluctuations. Lag effects from current development through 2014 in the Lower Platte Basin would result in a 64 cfs reduction in streamflow upstream of the North Bend stream gage and a 398 cfs upstream of Louisville stream gage by the year 2039 (NDNR 2014). Lower Platte River streamflow, even under the No Diversion condition, will be subject to future declines as a result of water development not associated with the Project. Additionally, air temperatures in the Lower Platte River basin are likely to increase. The University of Nebraska (2014) projects a substantial increase in air temperatures of 100°F in Nebraska and the Great Plains region. By midcentury (2041-2070), this increase would equate to experiencing typical summer temperatures equivalent to those experienced during the 2012 drought. Thus, it is reasonable to conclude that pallid sturgeon mortalities in the Lower Platte River would increase as a result of projected increased high temperature events and lower streamflow.

<u>Stream Temperature Under the Environmental Baseline Hydrology:</u> The No Diversion condition is expected to increase evaporation resulting in a decrease in Lower Platte River streamflow of up to 9.3 cfs. The 9.3 cfs decline is additive to the declines described earlier.

Platte River Bypassed Reach

<u>Pallid Sturgeon Habitat</u>

The No Diversion condition would increase flows in the Platte River Bypassed Reach (*Figure 1; Appendix D*). The increase in flow would increase flow widths from an average of 871 feet to an average range of 990 to 1,079 feet. From a microhabitat perspective, the increase in flow widths in the Platte River Bypassed Reach would increase the total area of habitat available to the species. Additionally, the increase in streamflow would increase deep water habitats used by the species as described by Hamel et al. (2014a) and Peters and Parham (2008). However, the increase in flow width, while significant, only applies to a 2.1 mile-long segment of the Platte River which represents a relatively short river segment in the action area.

From a macrohabitat perspective, increased flows under the No Diversion condition would improve habitat connectivity. The increase in river discharge through the Platte River Bypassed Reach is also likely to increase pallid sturgeon occurrence there (Hamel et al. 2014b). However, any improvements under the No Diversion Baseline would apply to only the 2.1 miles river segment within the Platte River action area.

Pallid Sturgeon Food Resources

The Commission concluded in their Assessment that fisheries habitat in the Platte River Bypassed Reach would likely benefit from any additional flows released into the Loup River Bypassed Reach as these flows would help to reduce the potential for fish kills associated with temperature exceedances caused by thermal heating of shallow water. The Commission also noted that increased flows provided from the Loup River Bypassed Reach would augment the flows received by the central Platte River and would act to ensure that the fish community was sustained in the Loup River Bypassed Reach. An additional benefit would be to improve the composition and diversity of fish species occurring there because increase water volume and depth (Assessment, Page 140). Given the increases in streamflow and the potential benefits projected by the Commission, the Service concludes that the similar benefits to the fish community in the Platte River Bypassed Reach are likely to improve food resources for the pallid sturgeon under the Environmental Baseline.

Stream Temperature

On July 19, 2012, Service biologists observed a fish kill on the Platte River between the Loup River confluence and the Loup Power District tailrace return. Fish observed in the kill included freshwater drum, common carp, silver carp, carpsuckers, and one shovelnose sturgeon. The No Diversion condition would improve streamflow and would reduce the likelihood of high stream temperatures. The Commission determined that fisheries habitat in the Platte River Bypassed Reach would benefit from any additional flows released into the Loup River Bypassed Reach as these flows would help to reduce the potential for fish kills associated with temperature exceedances caused by thermal heating of shallow water in the bypassed reach. Figure 1 in Appendix D shows that flows delivered to the Platte River via the Loup River Bypassed Reach represents a substantial improvement over Current Operations. Given the increases in streamflow under the Environmental Baseline, it reasonable for the Service to conclude that the aforementioned increases in bypass flows would decrease the likelihood of temperature exceedances that could harm pallid sturgeon.

Pallid Sturgeon Population in the Action Area

Present Status of Pallid Sturgeon Population

Hamel et al. (2013) estimated 926 pallid sturgeon were present in the Lower Platte River throughout the duration of the study, but also recognized that the population size presented a coarse estimate given movement of fish between the Platte and Missouri Rivers. Estimated pallid sturgeon use of the Platte River, however, represents a small portion of the total CLMU population (approximately 48,000 individuals) (Winders and Steffensen 2014; Steffensen et al.

2013); but a large portion of the total number of individuals needed for downlisting (i.e., 5,000 individuals) if the CLMU can maintain a self-sustaining status.

Pallid Sturgeon Population Under Environmental Baseline

Steffensen et al. (2013) found that the pallid sturgeon population for the Missouri River, from Gavins Point Dam at Yankton, South Dakota to the confluence with the Mississippi River at St. Louis, Missouri, represents a stable population as a result of Augmentation Program (USFWS 2014). Projected pallid sturgeon demographics for the Project's Environmental Baseline are difficult to predict because of the heavy influence of artificial propagation on the population size. Since the pallid sturgeon propagation and stocking program represents a high priority objective in the species recovery plan (USFWS 2014), it is expected that the CLMU population will remain stable or increase throughout the Project's 30 to 50 year license duration. Alternatively, natural recruitment is currently minimal to nonexistent across the lower reach of the Missouri River (Hrabik et al., 2007; U.S. Fish and Wildlife Service, 2007; Steffensen, 2013a), and there is no indication that corrective actions are in place that would change this trend.

While the Service expects the CLMU will continue to remain stable under the Environmental Baseline, there are a number of factors that could change the proportion of pallid sturgeons (estimated at 926 individuals) from the CLMU that use the Platte River. The following factors under the Environmental Baseline are likely to increase species use throughout the Lower Platte River compared to Current Operations.

1. Within day fluctuations in streamflow is reduced (i.e., reduced coefficient of diel variation)
2. Increase in total streamflow for the Platte River Bypassed Reach
3. Elimination of the sediment deficit at the Project tailrace return
4. Improved food resources in the Platte River Bypassed Reach and Lower Platte River

However, these are factors under the Environmental Baseline that would decrease species use throughout the Lower Platte River compared to Current Operations.

1. Reduction in total streamflow in Lower Platte River
2. Increase in stream temperatures that affect pallid sturgeon mortalities and food resources

In summary, predicting the population size for the Environmental Baseline is difficult because of multiple factors that affect population size. There certain factors, described above, support a Lower Platte River population under the Environmental Baseline would be higher than what is presently observed. Additionally, there were factors that would support a population that is lower than what is presently observed. Given the conflicting factors that affect the Service's ability to determine future trends in population size, the Service has adopted, under the Environmental Baseline, a population size of 926 pallid sturgeon in the Lower Platte River that would remain constant throughout the 30-year evaluation period of this Opinion.

IIIC. Pallid Sturgeon - Effects of the Action

Pallid Sturgeon Effects Summary

As described in the environmental baseline, the Service considered the effects of the Staff Alternative on the following life stages.

1. juvenile to non-reproductive adults
2. non-reproductive adults to spawning adults
3. spawning adults to the production of larval pallid sturgeon

The Service did not consider aspects of the Staff Alternative that could affect the transition from larvae to free-swimming juvenile pallid sturgeon. Additionally, the Service adopted a population size of 926 pallid sturgeon in the Lower Platte River that will serve as the baseline population for the 30-year evaluation period of this Opinion.

The Service described the following effects of the Staff Alternative within the Lower Platte River.

1. Project hydrocycling under the Staff Alternative juvenile and non-reproductive adults because operations would limit habitat connectivity at low flow/high stream temperatures resulting in the harm of two individuals via fish kill mortality.
2. Project hydrocycling effects to juvenile and non-reproductive would affect the species' habitat, but adopted license articles reduce the Staff Alternative's effect to habitat. The Staff Alternative does not meaningfully reduce hydrocycling effects in the summar and fall time periods, and thus, would reduce the condition of 926 individuals by affecting species' feeding and sheltering.
3. Project hydrocycling under the Staff Alternative would not affect spawning adults or larval pallid sturgeon because of adopted license articles reduce the Project's effect to habitat connectivity during the spawning time period.
4. The Staff Alternative would not affect pallid sturgeon food resources in the Lower Platte River.

The Service described the following effects of the Staff Alternative within the Platte River Bypassed Reach.

1. Project effects to juvenile and non-reproductive adults as a result of diversions into the Loup Power Canal would increase the likelihood of high temperature events and harm of one individual as a result of fish kill mortality.
2. Project effects to juvenile and non-reproductive adults as a result of diversions into the Loup Power Canal would affect species habitat, but adopted license articles reduce the Staff Alternative's effect to habitat.
3. The Staff Alternative would not affect pallid sturgeon food resources in the Platte River Bypassed Reach.

The Service described the following effects of species monitoring under Article 408.

1. Mortality associated with monitoring activities under Article 408 is anticipated to be no more than four fish.

Subsequent sections describe in detail: 1) the conservation measures under the Staff Alternative, 2) indirect species effects of the Staff Alternative within the Lower Platte River and Platte River Bypassed Reach; 3) how indirect effects of the Staff Alternative would affect the population in the Platte River; and 4) effects of species monitoring under Article 408.

Description of Conservation Measures under the Staff Alternative

The following summarizes conservation measures adopted by the Commission for the Staff Alternative. Under the Staff Alternative, a portion of Loup River streamflow would be diverted into the Loup Power Canal and the remaining flow would be diverted into the Loup River Bypassed Reach (see *Figure 1; Appendix D*). The water diverted to the Loup River Bypassed Reach would increase total flow in the Platte River Bypassed Reach where effects to pallid sturgeon are first described in the Assessment. The Commission's License Articles 404 and 406, which will serve as conservation measures in this Opinion, would improve the quantity of flow in the Loup River Bypassed Reach and Platte River Bypassed Reach.

License Article 405 was adopted by the Commission as a conservation measure to minimize Project hydrocycling impacts on the pallid sturgeon. License Article 405 requires a minimum base flow of 4,400 cfs at the North Bend Streamgage from May 1 through June 7. Because of the minimum base flow of 4,400 cfs, Project hydrocycling cannot occur from May 1 through June 7 when flows are below the minimum. Figure 9 shows the different levels of streamflows at the North Bend streamgage in addition to the minimum streamflow that must be maintained under License Article 405.

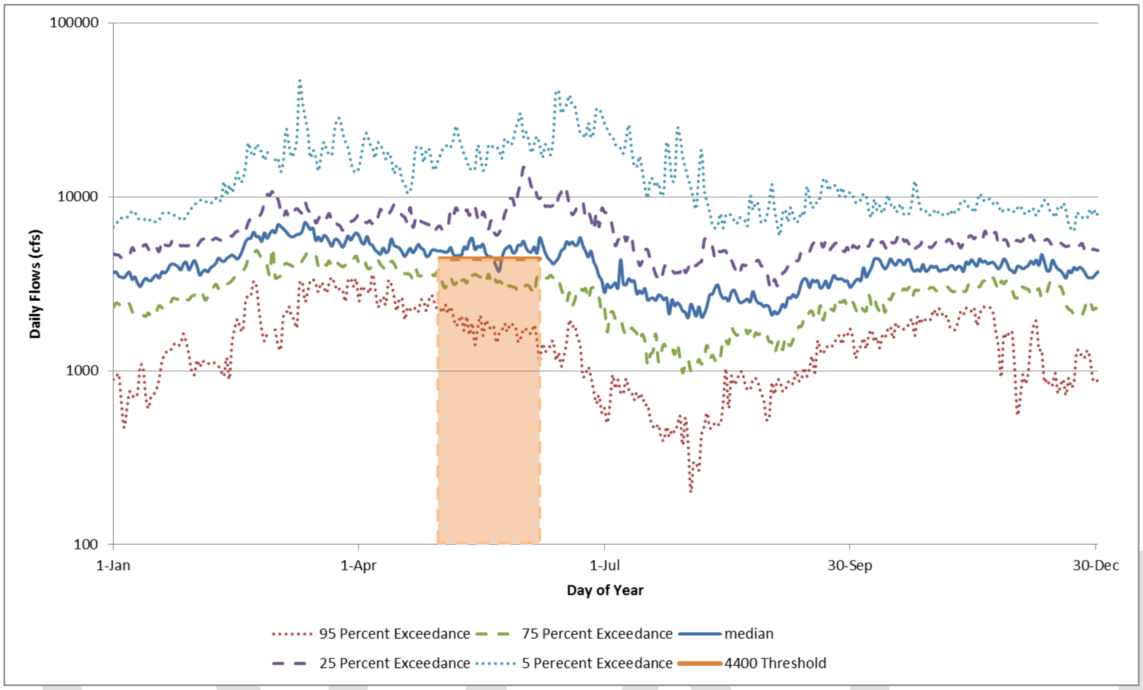

Figure 9. Streamflow variables for the Platte River at North Bend. Red box identifies time period when a 4,400 cfs minimum streamflow is to be maintained at North Bend streamgage from May 1 through June 7.

Lower Platte River

Pallid Sturgeon Habitat

The Service set in place the following assumptions for Project hydrocycling to evaluate the effects of the Staff Alternative to pallid sturgeon habitat and effectiveness of the license articles. These assumptions include: 1) Project hydrocycling is expected to occur year round provided minimum flows are maintained under Articles 404 and 405; 2) Project hydrocycling is expected to occur in excess of the base flows maintained by license articles; and 3) reduced inflows in the Loup Power Canal are expected to reduce the duration of a hydrocycle but would not affect the maximum capacity of a release. Appendix E describes these assumptions in greater detail.

Under the Staff Alternative, there is no time period when hydrocycling is prohibited as long as minimum flow is maintained from May 1 to June 7. However, the Service recognizes that license articles 404, 405, and 406 serve as conservation measures that minimize Project hydrocycling under the Staff Alternative in two ways: 1) the measures improve the minimum combined flow upstream of the Project tailrace return, and 2) the measures reduce the volume available for power production and thus, reduces the duration of a hydrocycle. License articles 404 and 406 increase flows in the Loup and Platte River Bypassed Reaches. These higher flows in the bypassed reaches provide an improved base flow for the Lower Platte River. Project releases at the tailrace return are additive to these base flows. These improved base flows would improve conditions that support the pallid sturgeon.

Improved base flows also reduce the quantity of flow available for power production. Figure 10 in the Hydrology and Geomorphology effect section depicts how these license articles would reduce the quantity of water diverted in the Loup Power Canal. The reduced inflows in the Loup Power Canal are expected to reduce the duration of a hydrocycle, but would not affect the maximum capacity of a release. This reduction volume of water would result in greater attenuation of the hydrocycle wave as it travels down the Lower Platte River, when compared to Current Operations with relatively higher volumes within a hydrocycle.

The majority of license articles benefit the spring pallid sturgeon use period as described by Hamel et al. (2014b) (Figure 10). Levels of flow protection in Figure 10 represent maximum flow protection that could be attained under each license article. The purpose of Figure 10 is to illustrate the relationship between timing of conservation measures and pallid sturgeon use time frames.

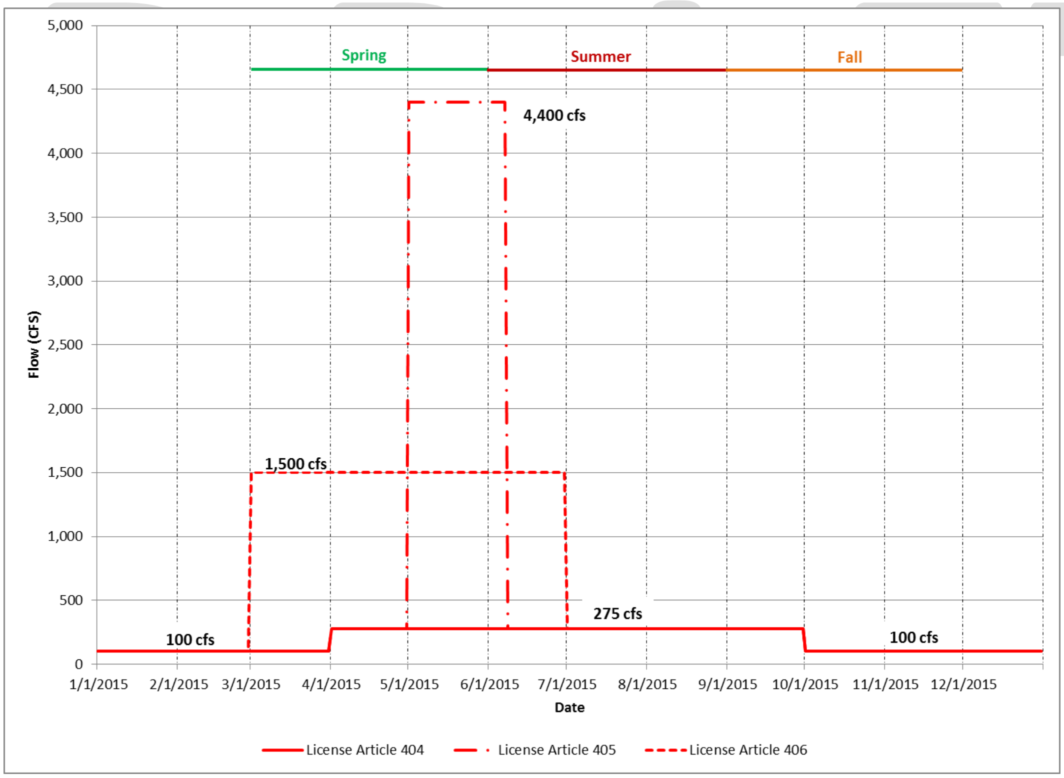

Figure 10. Flow-related conservation measures proposed by the Commission for the Loup River Bypassed Reach and the Lower Platte River. Also displayed is the spring, summer, and fall time periods described in Hamel et al. (2014a).

<u>Factors to be Considered - Microhabitat/Mesohabitat:</u> Water depth represents a microhabitat variable that is important to the pallid sturgeon and is a variable that could be affected by Project operations under the Staff Alternative. As described in the Environmental Baseline section, total streamflow and within day variability in streamflow affect the amount of deep water used by the species. Under the Environmental Baseline, the within day variability in stream flow

downstream of the Project tailrace return (i.e., North Bend streamgage) varies from 600 to 1,130 cfs. The variability in river stage at the North Bend streamgage ranges from 0.17 to 0.21 feet. Variability in streamflow and stage at the Louisville streamgage is 630 to 1,400 cfs and 0.15 to 0.19 feet, respectively. Appendix E provides within day variability in streamflow and stage for additional sites in the Lower Platte River.

At a mesohabitat level, Hamel et al. (2014a) stated that pallid sturgeon typically occurred in slower velocity pools created by high velocities resulting from the thalweg flowing into mid-channel sandbars. Individuals were also observed using secondary and braided channels when available depth was suitable. Sustainability of certain pallid sturgeon mesohabitats, such as sandbars and braided channels, require functioning sediment transport processes. The No Diversion condition will eliminate the sediment deficit occurring at the Project tailrace return, and is therefore likely to eliminate the local channel incision allowing for a limited increase in channel width increase (i.e., from 1,060.6 feet to 1,072.4 feet; Assessment, Table 26). The elimination of the sediment deficit at the Project tailrace return is also expected to improve maintenance of pallid sturgeon mesohabitats (e.g., sandbars and braided channels) especially those within two miles of the Project tailrace return.

Factors to be Considered – Macrohabitat: The pallid sturgeon selects for relatively deeper water compared to available depths in the Platte River. Peters and Parham (2008) showed that the connectivity of deep water habitats rapidly declined as flows were reduced from 5,600 cfs to 3,200 cfs, and habitat was nearly fully connected at a flow of 8,000 cfs (Assessment Page 216-221).

Hamel et al. (2014) evaluated the mean daily discharge, coefficient of sampling season (i.e. spring, summer, and fall), CV (i.e., within day variability in flows), location in the Lower Platte River, temperature, turbidity, and mean water column velocity. Of these variables, sampling season, mean daily discharge, CV, location in the Lower Platte River were important variables related to species occurrence. Of these variables, river discharge and CV represented flow-related variables that could be affected by Staff Alternative operations. The relationship between Project hydrocycling and habitat variables is described in greater detail in the Appendix E.

Habitat Under Staff Alternative Hydrology

Staff Alternative Effects to Microhabitat: The pallid sturgeon is a large bodied fish that requires deep water habitats. The expected increase in total streamflow of less than 9.3 percent (Appendix D) is expected to have little effect on the pallid sturgeon microhabitat described by Peters and Parham (2008).

Under the No Diversion condition, the within day variability in stream flow downstream of the Project tailrace return (i.e., North Bend streamgage) varies from 600 to 1,130 cfs. From June 8 through April 30, Project hydrocycling is expected to increase within day variability by a magnitude of 2,150 to 3,020 cfs. Within day variability in stage at the North Bend streamgage is expected to increase by 0.73 to 0.92 feet which is additive to the 0.17 to 0.21-foot variability described in the Environmental Baseline. For approximately half of the days from May 1 through June 7 under the Staff Alternative, no hydrocycling is expected to occur (see Hydrology and Geomorphology effects section), so within day variability in streamflow is no different from the Environmental Baseline under those days. For the remaining days within May 1 through June 7, hydrocycling is expected to occur above the 4,400 cfs minimum. Under these days, the 4,400 cfs minimum flow is expected to maintain stable deep water habitats described by Peters and Parham (2008), but hydrocycling occurring above 4,400 cfs would affect availability of deep water habitats.

Channel incision that is presently observed downstream of the Project tailrace return would also be present under the Staff Alternative and would affect pallid sturgeon mesohabitat. As described in Appendix D, the channel incision is a result of the Project's effect to sediment supply in the Lower Platte River. Staff Alternative effects to mesohabitat would not extend beyond two miles downstream of the Project tailrace return.

<u>Staff Alternative Effects to Macrohabitat:</u> As discussed previously, mean daily discharge and intraday variability in streamflow represent flow-related variables that could be affected by the Staff Alternative. As described in the Lower Platte River hydrology, the Staff Alternative will divert a portion of Loup River streamflow into the Project canal. The increase in streamflow under the Staff Alternative is not expected to exceed 9.3 cfs. The improvements in streamflow under the Staff Alternative would also result in very small change in percent connectivity described by Peters and Parham (2008) and a very small change in species occurrence described by Hamel et al. (2014b).

The within day variability is expected to increase under the Staff Alternative when compared to the No Diversion Baseline. Project hydrocycling is expected to occur throughout the year with the exception of half of the days within the May 1 through June 7 time period. Because hydrocycling is expected to occur for the majority of the year, the CV values under the Staff Alternative would be higher than that of the Environmental Baseline. License articles serving as conservation measures would reduce the CV values below that of Current Operations (see Appendix E). Based on information from Hamel et al. (2014b), Project hydrocycling affects species occurrence regardless of season (i.e., spring, summer and fall) and regardless hydrologic condition (i.e., wet, normal, or dry); therefore, it is reasonable to conclude that hydrocycling operations under the Staff Alternative will reduce overall use of action area by the species when compared to Environmental Baseline.

Pallid Sturgeon Food Resources

<u>Factors to be Considered - Food Resources:</u> The No Diversion condition is expected to provide flows that have less intraday variability when compared to hydrocycling operations under Current Operations (see *Appendix E*). Research in the Lower Platte River concluded that macroinvertebrates and fish communities were of good quality and pallid sturgeon captured in the Platte River were in excellent condition. A review of published hydrocycling-related studies provides indication that reduced intraday variability in streamflow would improve the quality of pallid sturgeon food resources in the Lower Platte River. However, improvement in the relative

condition for the species under the Environmental Baseline is expected to be limited because of the present condition of individuals was already considered excellent.

Food Resources Under Staff Alternative Hydrology: A review of published hydrocycling-related studies provides indication that increased intraday variability in streamflow would reduce the quality of pallid sturgeon food resources in the Lower Platte River. However, the Service has determined that the reduction in the quality of pallid sturgeon food resources would not significantly affect the species because available food resources in the Platte River would not limit the transition from juvenile to spawning adults.

Stream Temperature

Factors to be Considered - Stream Temperature: The importance of stream temperature to the pallid sturgeon is demonstrated in three ways: 1) temperature is recognized as an important factor at the macro/micro habitat level; 2) temperature can affect food resources; and 3) high stream temperatures can harm individuals and possibly lead to direct mortality. Large volumes of water take longer to be heated or cooled compared to relatively smaller volumes, and thus, relatively lower stream discharges leads to more pronounced daily temperature fluctuations.

Stream temperatures in the Lower Platte River were recorded at the Louisville streamgage from November 1974 to September 1981, and then were restarted on a seasonal basis from May 2007 to present. In that time stream temperatures reached an average daily maximum of 97.5°F on July 19, 2012, which exceeded the previous maximum of 96.8°F on July 24, 1977 (USGS 2013; USGS 2011).

Stream Temperature Under the Staff Alternative: As discussed in the environmental baseline, a large volume of water takes longer to be heated or cooled than a small one, and low discharge leads to more pronounced daily temperature fluctuations. Given the 30-50 year evaluation time frame for this Opinion, the increased probability in Lower Platte River streamflow temperatures is primarily driven by the large quantities of streamflow losses due to water development in the Lower Platte River. At present the expected 9.3 cfs increases in streamflow due to the Staff Alternative would when comparing the streamflow values to temperature exceedences in Figure 13 of the Assessment, it appears reasonable that the increases in streamflow of less than 9.3 cfs would provide limited benefit in minimizing stream temperatures exceedences in the Lower Platte River.

Additionally, Project hydrocycling operations under the Staff Alternative are likely to restrict the movement of individuals under low flow conditions which increasingly makes them susceptible to fish kill events. The relationship between streamflow, Project hydrocycling, and habitat connectivity was discussed in the macrohabitat section in this Opinion. The fish kill event in 2012 is an example of how fish migration is likely to be inhibited. One deceased individual was documented near the Salt Creek confluence (river mile 26) and was approximately 13 years old which was considered at (or near) sexual maturity. *Figure 11* shows the hydrograph at the steamgage nearest to the site of mortality. It is clear that Project hydrocycling was present as the Lower Platte River streamflow started its decline prior to the July 19 event. As described in the macrohabitat section, variable streamflow under hydrocycling reduces streamflow connectivity. Reduced connectivity during high water temperatures increases the likelihood of pallid sturgeon mortality which is especially the case in low flow events when individuals could become stranded in isolated pools.

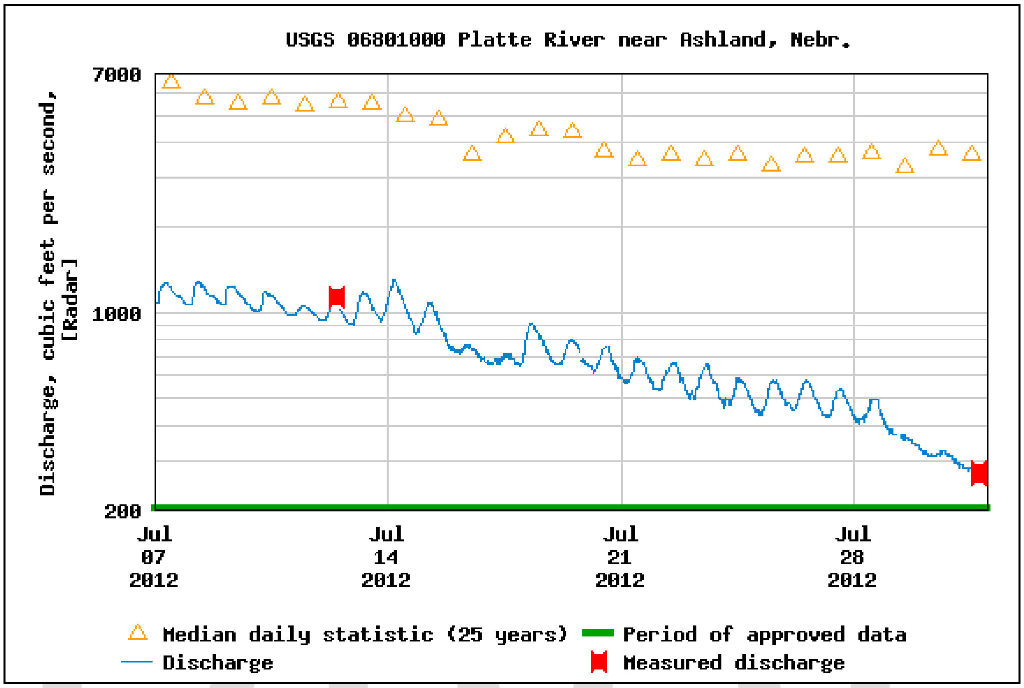

Figure 11. Hydrograph of the Ashland stream gage located near the pallid sturgeon fish kill that occurred on July 19, 2012.

Platte River Bypassed Reach

Pallid Sturgeon Habitat

<u>Factors to be Considered - Microhabitat/Mesohabitat:</u> The No Diversion condition would increase flows in the Platte River Bypassed Reach (*Figure 1*). The increased in flow would improve flow widths from 871 feet compared to a range of 990 to 1,079 feet. From a microhabitat perspective, the increase in flow widths in the Platte River Bypassed Reach would increase the total area of habitat available to the species. Additionally, the increase in streamflow under the Environmental Baseline is likely to increase deep water habitats used by the species as described by Hamel (2014a) and Peters and Parham (2008). The Service notes that the increase in flow width, while significant, is applied to 2.1 miles which represents a relatively short section of the Platte River in the action area.

<u>Factors to be Considered – Macrohabitat:</u> From a macrohabitat perspective, increased flows under the No Diversion condition would improve habitat connectivity. The increase in river discharge through the Platte River Bypassed Reach is also likely to increase pallid sturgeon

occurrence (Hamel et al. 2014b). As with microhabitat, the Service notes that any improvements under the Environmental Baseline would apply only to 2.1 miles within the Platte River action area.

Habitat Under Staff Alternative Hydrology: The Commission's Assessment did not include a quantitative description of how Loup River Bypassed Reach flows under the Staff Alternative would affect flows in the Platte River Bypassed Reach. In absence of this information, the Service is only able to qualitatively assess how the Staff Alternative would affect pallid sturgeon in the Platte River Bypassed Reach. Figure 1 in Appendix D shows significant reductions in Platte River Bypass Reach streamflow that is evident throughout the year but is most prominent from July through February. Total flow diverted in the Loup Power Canal is expected to range from 280 to 2,500+ cfs (Figure 2; Appendix D), and these diversions are expected to reduce streamflow in the Platte River Bypassed Reach by similar quantities. The reduction in streamflow in the Platte River Bypassed Reach is expected to reduce the quantity of deep water habitat, connectivity of deep water habitat, and species occurrence for the 2.1 miles in the Platte River Bypassed Reach. Commission license articles 404, 405, and 406 are expected to improve flows from March through June which minimize effects of the Staff Alternative within this time period (Figure 2; Appendix D).

Pallid Sturgeon Food Resources

Factors to be Considered - Food Resources: As identified in the Lower Platte River section, research studies in the Lower Platte River identified macroinvertebrates and fish communities were of good quality and pallid sturgeon captured in the Platte River were in excellent condition. Similarly, the Service concludes that food resources in the Platte River Bypassed Reach would also be of good quality in the Environmental Baseline.

Food Resources Under Staff Alternative: The Service supports the Commission's determination that decreases in streamflow under the Staff Alternative would reduce the quality of pallid sturgeon food resources in the Platte River Bypassed Reach. However, the Service has determined that the reduction in the quality of pallid sturgeon food resources would not significantly affect the species in the bypassed reach, and available food resources in the Platte River would not limit the transition from juvenile to spawning adults.

Stream Temperature

Because the total flow volume is expected to decrease under the Staff Alternative, there is an expected increase in probability high stream temperatures. However, this relationship between streamflow and temperature exceedance was not evaluated in the Assessment which, in turn, limits the Service's ability to quantify this relationship within the Environmental Baseline.

Pallid Sturgeon Population Response to the Staff Alternative

Hamel et al. (2013) estimated 926 pallid sturgeon were present in the Lower Platte River throughout the duration of the study, but also recognized that the population size presented a coarse estimate given movement of fish between the Platte and Missouri Rivers. According to Table 2, Hamel et al. (2014a) captured 124 individuals (90.5 percent of total) downstream of the Elkhorn River confluence and 13 upstream (9.5 percent of total). Of the 926 individuals estimated by Hamel et al. (2013), approximately 838 individuals is likely to occur downstream of the Elkhorn River confluence and 88 individuals upstream assuming the proportionate use is similar to that described by Hamel et al. (2014a). Because a number of individuals have been observed migrating into and out the Platte River, it is likely that the proportionate use downstream of the Elkhorn River confluence is higher than 838 individuals. Therefore, the 88 individuals represent an upper limit in species occurrence for the Lower Platte River above the Elkhorn River confluence.

Pallid Sturgeon Population Under Staff Alternative Hydrology

Lower Platte River

Under the Staff Alternative, Project hydrocycling increases the within day variability of streamflow, and there is no time period when hydrocycling is prohibited as long as minimum flows are maintained under Articles 404 and 405. Based on information from Hamel et al. (2014b), Project hydrocycling affects species occurrence regardless of season (i.e., spring, summer and fall) and regardless hydrologic condition (i.e., wet, normal, or dry). Therefore, the Service finds it reasonable to suggest that Staff Alternative would affect all of the 926 pallid sturgeon in the Lower Platte River at some point in the 30-50 years of Project operations under the Staff Alternative. This determination is based on the: 1) wide range in flow variability; 2) the expected decrease in streamflow due to non-Project operations; 3) increase in the likelihood in high temperature events; 4) hydrocycling impacts to habitat connectivity; 5) the frequency of at which hydrocycling is expected to occur under the Staff Alternative; and 6) universal effect that hydrocycling has on species occurrence.

When considering the combined effects of Articles 404, 405, and 406 serving a conservation measures to minimize hydrocycling effects, the least affected time period due to hydrocycling is the spring time period. In Table 3, 33.6 percent of individuals were captured in the spring, 21.9 percent in the summer, and 44.5 percent in the fall (Hamel et al. 2014a). The spring time period represent a period of high species use and represents an important period for pallid sturgeon spawning. Maintenance of a 4,400 cfs minimum flow would improve habitat connectivity in the Lower Platte River from May 1 through June 7, and this level of connectivity under the Staff Alternative would eliminate adverse effects of the Staff Alternative to spawning individuals.

The effects of Project hydrocycling under the Staff Alternative is most pronounced in the summer and fall time periods where flows in the Platte River Bypassed Reach was the least, and thus, the effects of hydrocycling is greatest (*Figure 10*).

Project hydrocycling, under the Staff Alternative, would create an adverse environmental condition where individuals would leave the Platte River that would have otherwise have remained under Environmental Baseline conditions. Affected life stages include juvenile and adult pallid sturgeon. The early departures into the Missouri River would as a direct result of Project releases would represent the harassment of individuals by affecting species feeding and sheltering. The effects of Project hydrocycling is expected to be more pronounced and departures into the Missouri River are expected to become more frequent because of the declines in Lower Platte River streamflow from non-Project operations. Compared to individuals using the Platte River, pallid sturgeon captured in the Missouri River have reduced fitness (i.e., lower relative condition) because the quality of habitat and food resources are less than what is available in the Platte River (USFWS 2014; Steffensen et al. 2013b).

Early and more frequent departures into the Missouri River will reduce the relative condition of affected individuals from what is presently observed on the Platte River. The relative condition for the Platte River ranges from 0.95 to 0.99 and the lower Missouri River ranges from 0.86 to 0.97 (Hamel et al. 2014a; Steffensen et al. 2013b). Early and more frequent departures into the Missouri River would reduce relative condition of individuals in the Platte River basin. However, combined effects of Articles 404, 405, and 406 serving a conservation measures is expecting to minimize effects of Project hydrocycling under the Staff Alternative, so relative condition of individuals are not expected decrease to levels reported for the Lower Missouri River (i.e., 0.86 to 0.97). The relative condition for the lower Missouri River ranged from 0.86 to 0.97 (Steffensen et al. 2013a), of which the overall relative condition of the population is 0.9 for non-reproductively ready individuals. For this Opinion, the Service has determined that the relative condition of individuals in the Lower Platte River will remain above 0.9 which represents a midpoint between lowest values observed on the Platte and Missouri Rivers (i.e., 0.95 and 0.86, respectively).

In extreme cases, Project hydrocycling would limit habitat connectivity and pallid sturgeon movement at times of low flow conditions and high stream temperatures resulting in the stranding and eventual mortality of individuals. As described in the environmental baseline section, fish kill mortality in the Lower Platte River is infrequent with only two pallid sturgeon mortalities documented. Given the low incidence of pallid sturgeon mortalities in the Lower Platte River, the Service has determined that two pallid sturgeon would be harmed (i.e., fish kill mortality) by Project operations within the 30-year operational period of the license.

Platte River Bypassed Reach

The reduction in streamflow in the Platte River Bypassed Reach under the Staff Alternative is likely to reduce species use. The total number individuals affected by the Staff Alternative is expected to be relatively low based on: 1) the 2.1 miles of Platte River affected by Project diversions; 2) low species use in the Lower Platte River upstream of the Elkhorn River confluence; 3) license articles serving to increase streamflow in the bypass from March through June; and 4) prominent adverse effects limited from July through February.

Table 2 in the Environmental Baseline identified pallid sturgeon use is relatively low for the Lower Platte River upstream of the Elkhorn River confluence. The maximum number of individuals is 88 for Lower Platte River upstream of the Elkhorn River confluence (approximately 66 miles). Commission license articles 404, 405, and 406 are expected to improve flows from March through June which minimizes effects of the Staff Alternative within this time period.

However, the Project significant reduces streamflow in the Platte River Bypass Reach from July through February. The reduced streamflow in Platte River Bypassed Reach, under the Staff Alternative, will increase the likelihood lethal stream temperatures which could harm individuals. The Service has determined that Project diversions affecting individuals in the Platte River Bypassed Reach is small given the expected low species use in the reach and the infrequent occurrence of kill reported for the Platte River Bypassed Reach. Because of the low species use and infrequent fish kill observations in the Platte River Bypassed Reach, the Service expects one individual will be harmed (i.e., fish kill mortality) by Project operations within the 30 duration of the Project license.

Pallid Sturgeon Monitoring Plan Under Staff Alternative

License Article 408 was adopted by the Commission as means for monitoring the effectiveness of the 4,400 cfs minimum flow. Under Article 408, the Commission stated that the plan shall include:

1. Provision to monitor annually, for a minimum of five years, between May 1 and June 7
2. Identification of sampling sites between the project's outlet weir and North Bend, Nebraska (i.e., the Target Reach)
3. Sampling equipment to be used and the frequency of sampling
4. Data collection protocols (e.g., fish numbers, length, weight, sex, gravid/ripe, general health, and identification of fish to wild or hatchery origin)
5. Methodology for monitoring the effectiveness of the minimum flow required by Draft Article 405
6. Provision to prepare and file annual reports of monitoring results
7. Implementation schedule

The Commission in the Assessment stated monitoring activities could result in take of pallid sturgeon. Take from monitoring activities could represent harass and/or harm to individuals. Monitoring activities described under Article 408 are similar to monitoring activities conducted across the species range. Incidental take for range-wide monitoring activities are permitted under a programmatic biological opinion entitled *Intra-Service Programmatic Section 7 Consultation on Region 6's section 10(a)(1)(A) Permitting Program and Fish and Wildlife Service Initiated Recovery Actions*. Since monitoring described under Article 408 are similar to that covered by the programmatic biological opinion, the Service in this Opinion has determined that take under Article 408 would not exceed the take permitted under the programmatic biological opinion; specifically, mortality associated with monitoring activities under Article 408 is anticipated to be no more than four fish.

IIID. Pallid Sturgeon - Cumulative Effects

Cumulative effects include the effects of future State, local, or private (non-federal) actions that are reasonably certain to occur in the action area considered in this biological opinion. A nonfederal action is "reasonably certain" to occur if the action requires the approval of a State or local resource or land-control agency, such agencies have approved the action, and the project is ready to proceed. Other indicators which may also support such a “reasonably certain to occur” determination include whether: a) the project sponsors provide assurance that the action will proceed; b) contracting has been initiated; c) State or local planning agencies indicate that grant of authority for the action is imminent; or d) where historic data have demonstrated an established trend, that trend may be forecast into the future as reasonably certain to occur. These indicators must show more than the possibility that the non-federal project will occur; they must demonstrate with reasonable certainty that it will occur. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act and would be consulted on at a later time.

Future Water Development in the Lower Platte River Basin

Cumulative effects to the Lower Platte River hydrology were derived using a report titled, 2014 Annual Evaluation of Availability of Hydrologically Connected Water Supplies (NDNR 2014). The report projects the streamflow losses in the Lower Platte River at the North Bend and Louisville gages for a 25-year time period starting in 2014. Estimated streamflow losses due to lag effects from existing groundwater development in the Lower Platte River basin are described in detail in the Environmental Baseline section while this section describes expected effects to streamflow resulting from future water development.

NDNR (2014) projects that future water development in the basin would result in an additional reduction in streamflows of 76 cfs at the North Bend streamgage and 173 cfs at the Louisville streamgage by 2039. Streamflow losses from future water development is in addition to the lag effects from current development reported as a 64 cfs reduction at the North Bend streamgage and a 398 cfs reduction at the Louisville streamgage by the year 2039 (NDNR 2014). Project hydrocycling is expected to be more pronounced and departures into the Missouri River are expected to become more frequent as a result of declines in Lower Platte River streamflow described under cumulative effects.

IIIE. Pallid Sturgeon - Conclusion

After reviewing the current status of the pallid sturgeon, the environmental baseline for the action area, the effects of the Staff Alternative, and the cumulative effects, it is the Service’s Opinion that the Staff Alternative is not likely to jeopardize the continued existence of pallid sturgeon. To “jeopardize the continued existence means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species” (50 CFR §402.02). No critical habitat has been designated for this species; therefore, none would be affected. Our determination is based on the following primary factors.

- The Service has determined that the harm of seven (7) pallid sturgeon individuals (i.e., three from fish kills and four from monitoring) would not affect the status of the species throughout its range, which the status is currently stable. The recovery plan states that, since listing in 1990, the status of the species has improved and is currently stable. While there is no range-wide estimate for the species, estimates for the lower Missouri River, which contains the Platte River, vary from approximately 7,000 to 48,000 individuals. The mortality of seven individuals would result in a small reduction in population size, and would not have a substantial effect on the range wide population.

- The mortality of seven individuals would not affect the self-sustaining status of the species. The pallid sturgeon recovery plan identifies the need to maintain a self-sustaining population throughout the range of the species. The mortality of seven individuals would result in a small reduction in population size, but these losses are not expected to limit the self-sustaining status of the species (i.e., limit species production).

- The Service has determined that the Staff Alternative would affect the feeding and sheltering of 926 pallid sturgeon in the Lower Platte River at some time during the 30 years of Project operations under the Staff Alternative; this effect would reduce the condition of affected individuals. The fish affected by the Staff Alternative in the Lower Platte River are expected to maintain an excellent condition, higher than that described for individuals in the adjacent Missouri River. Therefore, the Service has concluded that the expected condition of individuals under the Staff Alternative, would not limit the self-sustaining status of the species (i.e., limit species recruitment).

- In conclusion, we anticipate that the effects of the Staff Alternative and the cumulative effects associated with future State, tribal, local, and private actions will not appreciably reduce the likelihood of survival and recovery of the pallid sturgeon. The anticipated direct and indirect effects of the Staff Alternative will not affect the present status of the species, which is described as stable, and the Staff Alternative does not restrict the transition of important species' life stages necessary to maintain a self-sustaining status.

IV. INTERIOR LEAST TERN

IVA. Interior Least Tern - Status of the Species/Critical Habitat

Species Description

The Interior least tern grows to a length of 8 to 9 inches (in) with a wingspan of 10 to 21 in. Plumage and coloration is similar for both sexes and all ages. Banding records indicate Interior least terns may live up to 20 years; however, the average life span is probably less. Most begin breeding at 2 or 3 years of age, and breed annually throughout their lives. Least terns migrate as far as 2,000 miles between their summer nesting habitats and wintering habitats in South America (Thompson et al. 1997). Least terns are the inland reproductive population of the least tern that nests on or adjacent to the major rivers of the Great Plains and the Lower Mississippi Valley (*Figure 12*). Least terns are strong fliers, migrating as far as 2,000 miles between their summer nesting habitats and wintering habitats in South America.

Life History

Nesting Habitat and Behavior: Least terns are ground-nesters, preferring open areas with minimal vegetation near feeding habitat. Nests are simple scrapes in the sand. Typical least tern clutch size is reported as 2 to 3 eggs but may vary in response to varying availability of prey (Massey et al. 1992).

Vegetation-free sand or gravel islands are preferred for nesting, although, sand banks, point bars, and beaches may also be utilized. Natural nesting habitat features are maintained and influenced by magnitude and timing of riverine flood events (Sidle et al. 1992; Renken and Smith 1995; Pavelka in litt. 2012). However, flooding was historically, and remains a primary cause of nest failure in both unregulated and regulated river channels (e.g., Szell and Woodrey 2003, Sidle et al. 1992). The species prefers areas that are unobstructed by trees or other vegetation that may hide or support predators (Lott et al. 2013). Least terns will also nest on anthropogenic sites near water bodies with appropriate fish species and abundance, including industrial sites, dredged-material deposition sites; sand pits, created habitats, and rooftops.

Lott and Wiley (2012) described physical and biological conditions that are necessary for nest initiation and successful reproduction. For successful reproduction, nest sites must not be inundated during egg laying, incubation or until chicks can fly; nesting sites must be minimally vegetated (<30% ground vegetation, greater than 250 feet from large trees); and prey fishes must be available to support chick growth until fledging.

Least terns are colonial nesters. Colony size may vary from a few to over 1,200 breeding birds (e.g., Jones 2012). Some populations may be limited by annual availability of nesting habitat (e.g., Missouri River; Stucker 2012) while potential nesting habitat is generally abundant and underutilized in others (e.g., Mississippi River; USACE 2008). Nesting site conditions (e.g., habitat suitability, flood cycles, forage fish abundance, predation pressure) can vary significantly from year to year in all drainages, resulting in wide fluctuations in bird numbers and/or nesting success. Least terns may re-nest, or relocate and re-nest if nests or chicks are destroyed early in the season (Massey and Fancher 1989; Thompson et al. 1997). Least tern chicks leave their nests within a few days of hatching (semiprecocial), but remain near the nests and are fed by their parents until fledging.

Food and Foraging Habitat: Least terns are opportunistic and feed on small fish species including shad, minnows, and shiners, or fingerlings of larger species including sunfish and bass. The species will also occasionally feed on aquatic or marine invertebrates (Thompson et al. 1997). Riverine foraging habitats and fish abundance may be influenced by stochastic hydrological conditions and events (i.e., flow, and flood timing and magnitude), and geomorphic modification (Schramm 2004).

Migration and Winter Habitat: Fall migrants are believed to generally follow major river basins to their confluence with the Mississippi River and then south to the Gulf of Mexico. However, late summer observations of least terns greater than 93 mi from major river drainages suggest that some birds migrate cross-country (Thompson et al. 1997). Once least terns reach the Gulf Coast, they cannot be distinguished from other least tern populations en route to, or within their winter habitats (i.e., Gulf of Mexico, Caribbean islands, Central and South America), therefore the limited information on migration and winter habitat is inclusive of other populations (i.e., Caribbean, Gulf Coast, East Coast). Least tern winter habitats are primarily observed along marine coasts, in bays and estuaries, and at the mouths of rivers.

Predation: Interior least tern eggs, chicks, and adults are prey for a variety of mammal and avian predators. Reported predators found within Nebraska include crows, gulls, herons, owls, falcons, kestrels, harriers, shrikes, foxes, coyotes, raccoons, skunks, opossums, bass, catfish, and domesticated and feral dogs and cats (Thompson et al. 1997). Cryptic coloration of eggs and chicks, and secretive behavior of chicks, and mobbing behavior by adult birds protect eggs and chicks from predators (Thompson et al. 1997).

Location and size of nesting colonies also has a significant influence on the degree of predation. In several studies, reproductive success has been higher on island colonies when compared with sandbar colonies that are connected to land (e.g., point bars) and when water levels maintain isolation of islands and nesting bars from mammal predators (e.g., Smith and Renken 1993; Szell and Woodrey 2003). Burger (1984) found significantly higher rates of predation in larger colonies compared to smaller least tern colonies in New Jersey.

Status and Distribution

The Service published a Final Rule (50 FR 21784) listing the Interior population of the least tern as endangered on May 28, 1985. The listed population includes only those least terns that breed and nest within the boundary of the continental U.S. on interior rivers and other water bodies including breeding populations in large river habitats from Montana southward through North Dakota, South Dakota, Nebraska, Colorado, Iowa, Kansas, Missouri, Illinois, Indiana and Kentucky to eastern New Mexico, Oklahoma, Arkansas, Tennessee, central Texas, central Louisiana, and central Mississippi (*Figure 12*).

Other breeding populations of least terns are found along coastal and estuarine habitats in the U.S. from Texas to Maine. The Interior least tern is separated from coastal populations by a combination of physical and ecological factors unique to their nesting habitats. For example, coastal habitats are created and maintained by daily and seasonal tidal and storm surges, while inland habitats used by the Interior least tern are primarily created and maintained by fluctuating riverine hydrologic conditions. Foraging habitats and species differ markedly as well, with coastal least terns foraging on fish and invertebrate prey species associated with brackish and salt water habitats (e.g., anchovy, silversides), while Interior least terns forage on freshwater prey species (e.g., shad, minnows). The Interior least tern and Eastern least tern are geographically separated from the California least tern (*S. antillarum brownii*), which nests and forages in brackish and marine habitats along the Pacific coast of U.S. and Mexico.

In 1991 (56 FR 56882) the Service conducted a 5-year review for Interior least tern, including a 5 factor threats assessment and recommended no change in the species listing classification. The Service (2014) completed a 5-year review in 2014 for the Interior least tern. This 5-year review concluded that the species had been recovered because range-wide numerical recovery criteria had been met and exceeded for more than a decade because the species is resilient, has been able colonize areas that were previously not used, and threats to the species have declined. The 5-year review further recommended delisting of the species once a metapopulation model, conservation agreements for monitoring and management, and a post-delisting monitoring plan were completed. The Service has not initiated a rule–making process to delist the species to date.

Distribution: *Figure 12* shows the current documented east to west distribution of summer nesting Interior least terns. The species currently nests along greater than 2,858 mi of river channels across the Great Plains and the Lower Mississippi Valley (Lott et al. 2013). Coordinated surveys indicate a minimum adult population size of approximately 17,500 individuals, with nesting occurring in greater than 480 colonies spread across 18 states (Lott 2006). Lott (2006) also provided counts for 21 populations or population segments unknown at the time of listing, which collectively supported over 2,000 individuals.

Productivity and Population Trends

Productivity: Productivity (generally measured as fledgling success per breeding adult pair) considered necessary to maintain stable or increasing populations of the Interior least tern has been estimated at 0.51 fledglings/pair or higher (Kirsch and Sidle 1999). However, estimates of productivity have been highly variable within and between drainage populations (Kirsch and Sidle 1999; Dugger et al. 2000), and do not appear sufficient to support observed increases in local or range-wide populations (Kirsch and Sidle 1999).

Discrepancies between productivity and population trends have also been observed for California least terns. The California Least Tern Recovery Plan identified productivity levels averaging at least 1.0 fledglings/pair as necessary to maintain a stable or growing population of terns (USFWS 1985b). However, California least terns have experienced an overall positive population trend even when productivity levels have been substantially lower (e.g., 0.23 to 0.36 fledglings/pair; USFWS 2006a).

There is strong evidence that Interior least tern productivity naturally varies dramatically by year, and among sites within years (e.g., Sidle et al. 1992; Dugger et al. 2000). Factors other than fledgling success affecting long-term productivity include post-fledging juvenile survival, adult annual survival, longevity, and/or emigration and immigration (Kirsch and Sidle 1999), all of which are poorly documented for least terns.

Dispersal of individuals between populations is an important factor in the persistence of unstable peripheral populations (e.g., Taylor 1990). In such cases, immigration of individuals into the population can reduce the magnitude of population fluctuations and even prevent extirpation of the population (Taylor 1990). Dispersal between Interior least tern populations has been poorly documented, but appears to be an important factor in the maintenance of peripheral populations such as the upper Missouri River (Lott et al. 2013).

<u>Population Trends:</u> The listed population of the Interior least tern has demonstrated a positive population trend, increasing by almost an order of magnitude since listing. As both the geographical extent and effort of species surveys increased after listing, sufficient count data became available to analyze population trends for several river reaches supporting persistent breeding colonies. Kirsch and Sidle (1999) reported a range-wide population increase to over 8,800 adults in 1995 and found that 29 of 31 Interior least tern locations with multi-year monitoring data were either increasing or stable. Lott (2006) reported an increase to greater than 17,500 adult birds in 2005, forming 489 colonies in 68 distinct geographic sites.

Lott (2006) conceptualized the Interior least tern as having a large meta-population (a group of spatially separated populations of the same species which interact at some level), which might also include least terns on the Gulf Coast. Using available information on dispersal, Lott (2013) defined 16 discrete breeding populations, with four major geographical breeding populations (population complexes) accounting for more than 95 percent of all adult birds and nesting sites throughout the range (*Figure 12*). Portions of these four population complexes have experienced multi-year monitoring to different degrees.

Population trends (i.e., decreasing, stable, increasing number of terns/year) can also be used to quantify the success of habitat management and protection over time. While available monitoring data are highly variable between, and even within subpopulations and colonies, an extensive monitoring record (25+ years in some areas) provides inferences to population trends.

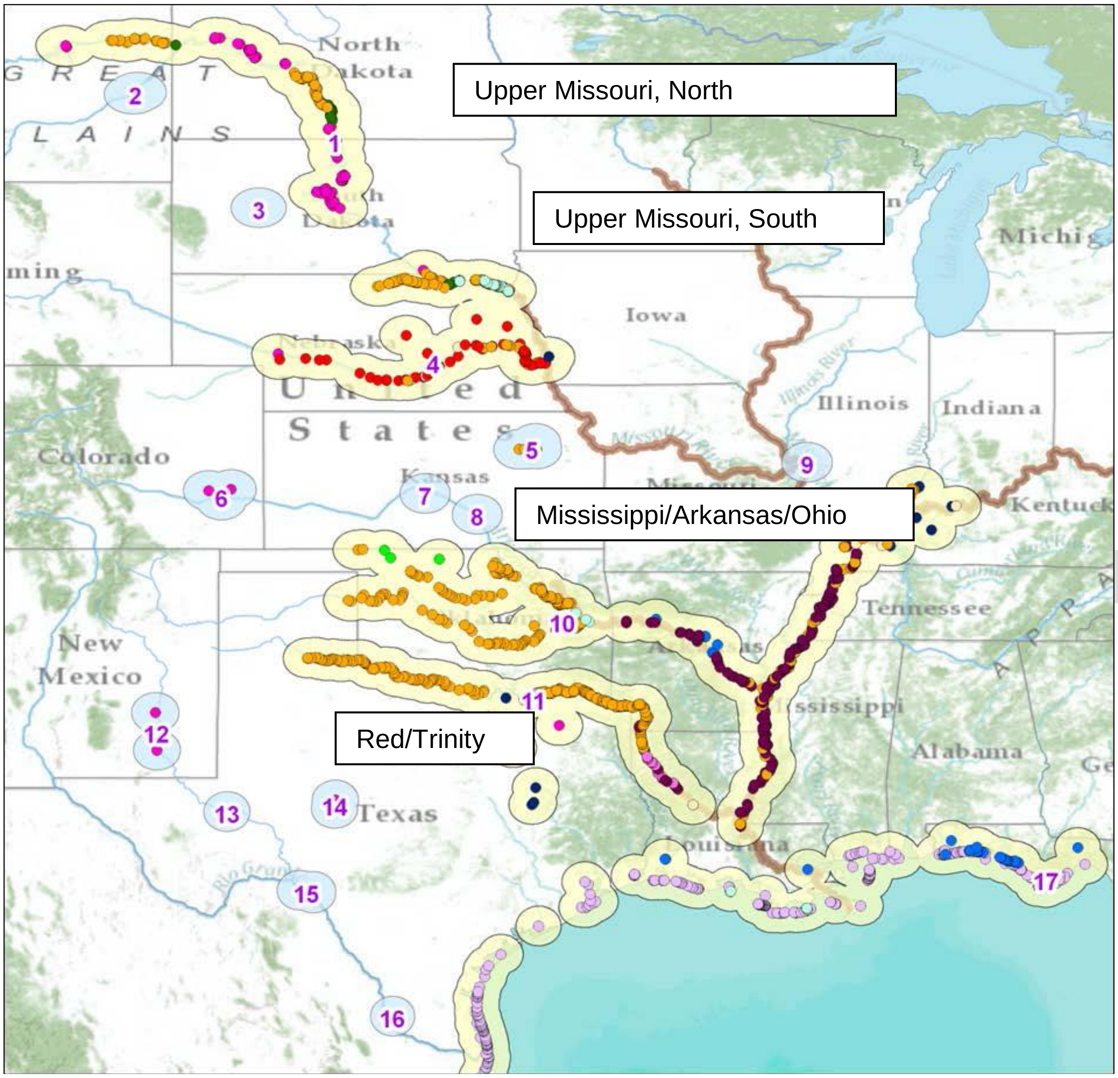

Figure 12. Current range of Interior and coastal populations of the least tern including the 4 major geographical breeding populations of the Interior least tern. Numbers represent discrete breeding subpopulations, based upon dispersal distances. Reproduced from *Service* Interior least tern 5-year review, 2014, originally in Lott (2012b).

<u>Upper Missouri River South</u>: The recovery plan identified population benchmarks and targets for 5 rivers, 3 river segments, and 5 States in the Missouri River system (USFWS 1990). These combined are higher (State targets), or lower (river segment targets) than the overall Missouri River system recovery target of 2,100 Interior least terns. For the purposes of this analysis, we are focusing on protection and management of four major rivers within the Upper Missouri River South identified in the recovery plan (Missouri, Niobrara, Loup, and Platte Rivers) which encompasses both State and river segment targets. These rivers collectively are ecologically and geographic similar and are the most directly related to the Loup River.

The following is a description of persistence and population trends within the Upper Missouri River South segment which was identified in the recovery plan as essential (USFWS1990). This analysis was done for the period of record, with the corresponding population data benchmark provided in the recovery plan (1985-1988, USFWS1990).

Conservation and management of the Interior least tern and its habitat throughout much of the Missouri River are based upon a Jeopardy Biological Opinion (USFWS2000) and its amendment (USFWS2003). Conservation efforts to implement the Biological Opinion have been funded under the Missouri River Recovery Program, a collaborative Federal/State/Tribal initiative, authorized and funded under the Water Resources Development Act of 2007, which also extends into some of the tributaries.

Management actions for the Interior least tern in the Missouri River include habitat management and creation, flow modification, population and habitat monitoring, predator and vegetation control, applied scientific studies, and public education (USFWS2003). Combined data for the Upper Missouri River South population indicate a stable, possibly increasing overall trend over the period of record (*Figure 13*), and that habitat and population size in the Missouri River are primarily influenced by periodic events of large habitat forming floods and intervening years of comparatively low flows (*Figure 14*). Interior least tern persistence and population stability for more than two decades indicate successful protection and management of essential habitat in the Missouri River.

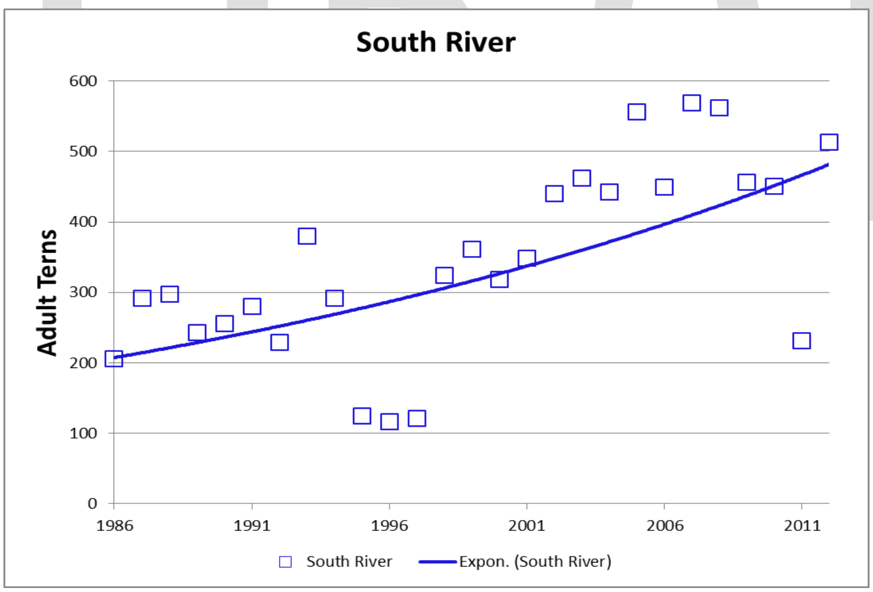

Figure 13: Annual Interior least tern counts and trend line, 1986 - 2012, Upper Missouri River, South (Pavelka in litt. 2012). Reproduced from Service Interior least tern 5-year review.

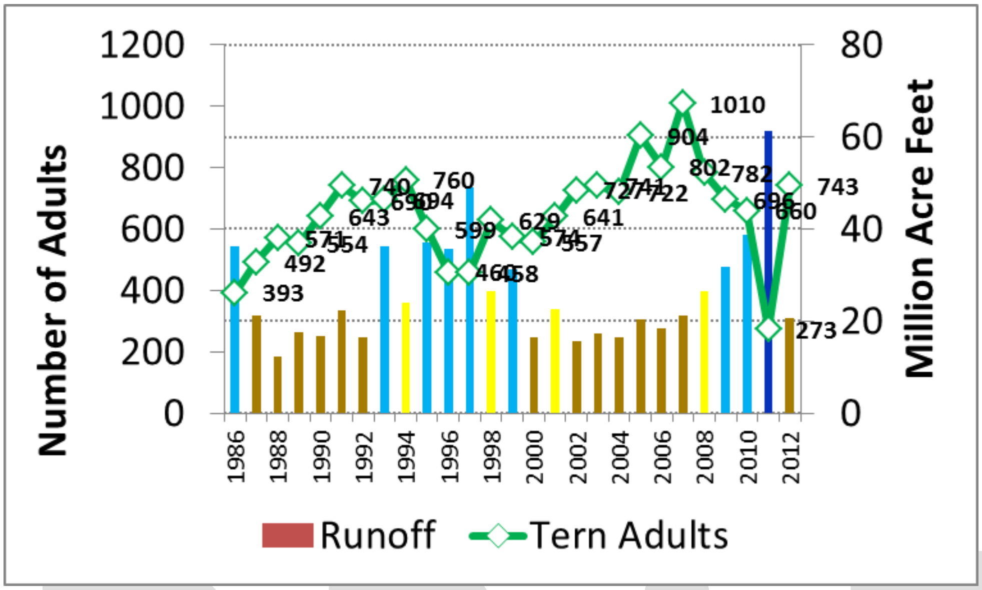

Figure 14: Interior least tern annual adult counts and runoff in the Missouri River above Sioux City, Iowa, 1986 - 2012 (Pavelka in litt. 2012). Reproduced from Service Interior least tern 5-year review.

There is no active management for the Interior least tern on the Niobrara River, and agencies involved in monitoring the river have identified no immediate management needs due to that river's natural hydrograph, which maintains habitat conditions for the species (Yager in litt. 2012a). Long term management may need to consider offsetting increases in consumptive use of water that could ultimately alter the natural hydrograph. Data from the Niobrara River shows persistence of the species, with annual variation in counts, attributed to annual flow and resultant habitat condition, and relatively stable numbers for the period of record in comparison to the recovery plan benchmark (~200 birds) (*Figure 15*).

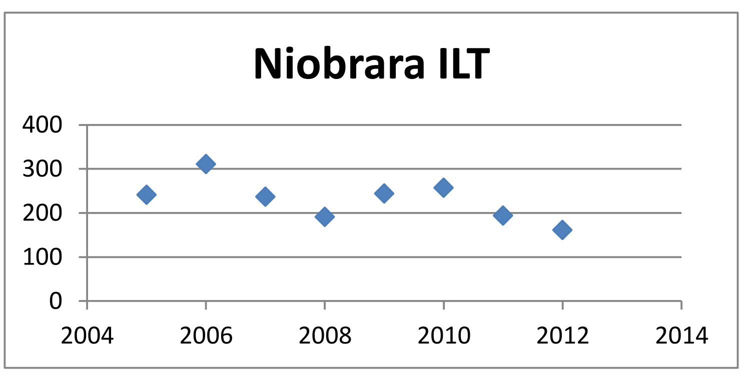

Figure 15: Interior least tern counts on the Niobrara River, 2000 - 2012 (compiled from Yager in litt. 2012b, Hicks et al. 2012, Jenniges in litt. 2012, Lott 2006). Reproduced from Service Interior least tern 5-year review.

Annual monitoring on the Loup River has been done by the Least Tern and Piping Plover Partnership (TPCP), NGPC, and the Service. There are no habitat creation or restoration efforts being done on the Loup River for the benefit of the Interior least tern. The recovery plan quantified the Loup River population as 155 birds based on 1988 NGPC data (USFWS 1990). Lott (2006) reported 87 Interior least terns from the Loup River in 2005. Survey data compiled by NGPC from 1986 to present are considerably lower for both of these years (61 in 1988; 35 in 2005; Loup Power District 2012). Recent surveys reported maximum counts ranging from 46 to 60 (USFWS Nebraska Field Office 2010-2012, 2014) during annual monitoring conducted on the river (monitoring was not conducted for off-channel mining sites where additional Interior least tern may have been present). Loup River nesting areas include those found in some river reaches, as well as multiple off-channel mining sites. Surveys conducted by the Service and NGPC for Interior least tern on the Loup have and continue to be inconsistent, infrequent, or only partial during some years over the period of record (Loup Power District 2012), and are likely the cause of count discrepancies. Using the NGPC annual count data in combination with recent Service data, however, indicates a small, relatively stable Interior least tern population, with years of low abundance offset by years of higher abundance during the period of record (Figure 16).

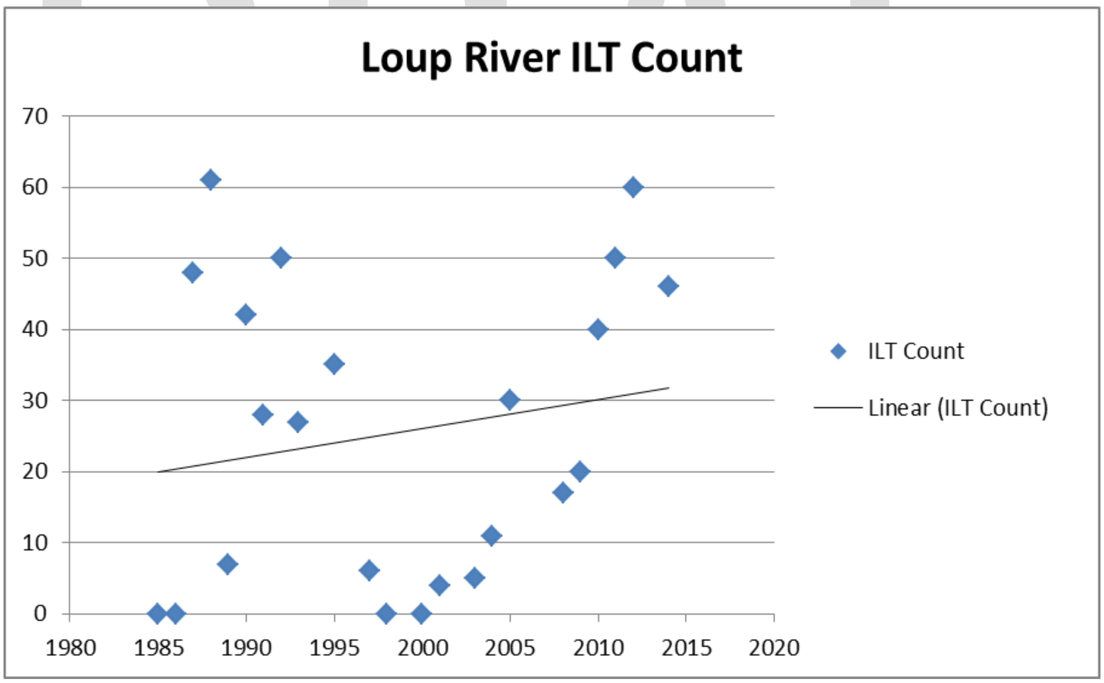

Figure 16: Interior least tern counts on the Loup River, 1985-2015 (NGPC data from: Loup Power District 2012, USFWS Nebraska Field Office data 2010-2012, 2014).

Management actions on the lower Platte River include clearing of some nesting sandbars to increase flow conveyance and reduce the potential for ice jam flooding. A benefit of these efforts has been the restoration of nesting habitat for the Interior least tern. The TPCP has been instrumental in the protection of Interior least terns through their work with off-channel commercial sand and gravel operations and housing developments along the Platte River where bare sand attracts nesting birds. These efforts include development of MOUs, which prescribe management actions with several sand and gravel mines and housing developments, annual monitoring of river and off-river nesting sites, and public education (e.g., Brown et al. 2012).

On the central Platte River, a cooperative effort between the states of Colorado, Nebraska, and Wyoming, the U.S. Department of Interior, water users from the states, and environmental groups resulted in the development of the Platte River Recovery Implementation Program (PRRIP). The PRRIP was developed to offset historic and ongoing affects to endangered species (including Interior least tern) on the central Platte River (USFWS 2006b). Actions undertaken by the PRRIP to benefit the Interior least tern include increasing stream flows in the central Platte River during relevant times as well as enhancing, restoring and protecting habitat for Interior least tern (PRRIP 2006). The PRRIP is actively engaged in creating and managing on and off channel habitat in addition to undertaking directed research and monitoring (including annual Interior least tern reproductive monitoring) intended to answer key uncertainties related to management decisions. Recent nesting by Interior least tern has occurred almost entirely on land owned, managed or protected by the PRRIP and other non-governmental organizations. The PRRIP provides Act compliance for the duration of the first increment (through 2019).

The Platte River population size was estimated at 635 birds in 1990. Lott (2006) reported the existence of many sources of historical data for the Platte River system, but noted a large number of inconsistencies in count totals that could not be reconciled. Partial count data was reported for the central and lower Platte River from 2010 through 2012 (Table 1: Baasch in litt. 2012, Brown in litt. 2012) in the Interior least tern5-year review (USFWS, 2014). Additional available data show high annual variability in Interior least tern use of on river and off-river nesting sites (*Figure 17*). However, the species has persisted in the Platte River drainage since listing, and the 2012 count (665 birds) exceeded the 1988 recovery plan benchmark (635 birds) (USFWS 2014). Therefore, we conclude that the Platte River Interior least tern habitat has been successfully managed and protected since listing.

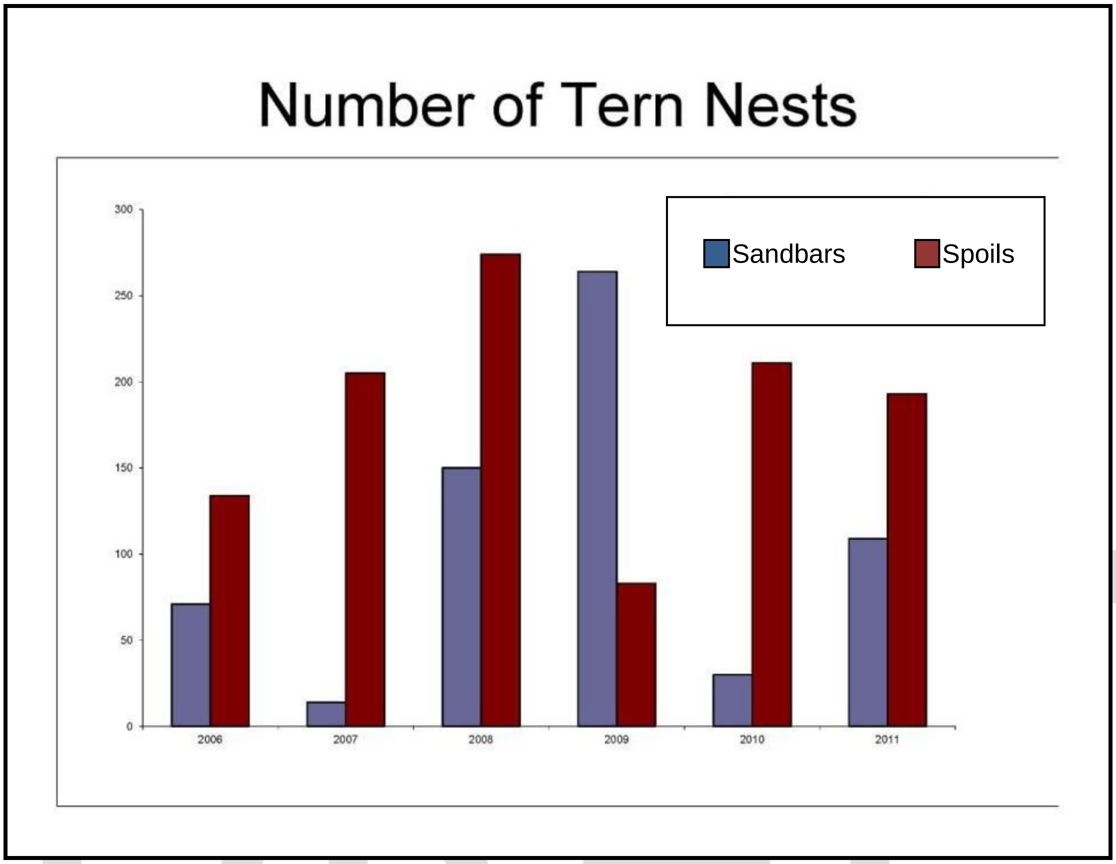

Figure 17: Number of Interior least tern nests on sandbars v. sand mine spoil on the lower Platte River, 2006 – 2011 (Jorgensen and Brown 2012).

In summary, management has been successfully implemented within the Upper Missouri River South population (Platte, Loup, Niobrara, Missouri Rivers). There are currently fewer habitat management issues in the Niobrara River, due to its natural hydrograph (Yager 2012a). However, increasing consumptive uses on the Niobrara may pose a future threat. The species has persisted in these four rivers at population levels at, or above, those reported in the 1990 recovery plan. Collectively, the Missouri, Platte, Loup, and Niobrara rivers contain habitats supporting approximately 90 percent of Missouri River drainage summer residents, and approximately 10 percent of Interior least tern range-wide (Table 1; Lott 2006).

<u>**Threats, Conservation Measures and Regulatory Mechanisms**</u>

The present or threatened destruction, modification, or curtailment of its habitat or range.

The primary threats identified for the Interior least tern in the listing rule and the recovery plan were the destruction of habitat and curtailment of range due to channel engineering practices on large rivers of the Interior Basin (i.e., damming, channelization, and channel stabilization), and low numbers of surviving birds throughout the range (USFWS1985a; USFWS1990). The species' threat analysis found that reservoirs had inundated hundreds of miles of historical or potential riverine habitat in many drainages of the Mississippi River Basin. Reduced sediment input into channels below dams had resulted in channel constriction and loss of nesting islands for the species. Channel training structures (dikes) and bank stabilization measures in numerous rivers including the Missouri, Mississippi, and Ohio rivers had prevented natural geomorphic response to loss of sediments, resulting in deepened and narrowed channels, and loss or terrestrialization (vegetation encroachment) of nesting sandbars and islands. Reservoir releases for hydropower, navigation, and flood control also were found to adversely affect Interior least tern populations surviving below these same dams (USFWS1990, pp. 22-23).

These threats were identified and considered in context with the known historical range and abundance of the species at that time (i.e., Hardy 1957, Downing 1980, and Ducey 1981), and a lack of evidence of the bird in potential historical range, including most of the lower Mississippi, lower Missouri, and lower Red, Ouachita, and White rivers, as well as on significant portions of the Ohio, Platte, and Arkansas rivers. Trends of habitat degradation were expected to continue throughout most of the birds fragmented range (e.g., Smith and Stuckey 1988).

Since listing, reported numbers of nesting Interior least terns have expanded by almost an order of magnitude from greater than 2,000 to approximately 18,000 individuals, and the range has increased significantly. Currently, multiple colonies are known to occur in all major drainages where the species historically nested, and available monitoring data indicate most of these drainage populations are stable or increasing.

<u>Habitat Management:</u> At least some proportion of range-wide improvement of the species is due to increased awareness, survey efforts, management, and protection. Interior least terns have colonized numerous anthropogenic sites (approximately 15 percent of sites throughout their range, such as sand pits, rooftops, reservoirs, industrial sites), and the persistence of some of these are reliant upon aggressive management (e.g., predator or vegetation control) and protection (e.g., seasonal avoidance). However, the species has also expanded significantly in range and numbers in flowing portions of the Mississippi, Red, and Arkansas river channels over the past three decades (Lott 2006), even in the absence of aggressive management in many of these areas.

Nesting habitat availability and quality for the Interior least tern are primarily controlled by stochastic events (droughts and floods) affecting river flow and habitat quantity and quality (e.g., Sidle et al. 1992; Renken and Smith 1995; Lott et al. 2013). Productivity peaks may also be influenced by stochastic drought events or cycles in some drainages (e.g., Pavelka in litt. 2012). For example, despite severely altered flow regimes and aggressive habitat management in the Missouri River drainage, the species' distribution and population size have remained relatively stable over the period of record. Evidence suggests that habitat condition in this drainage, as well as annual Interior least tern numbers and productivity, are more strongly influenced by hydrologic patterns than by direct management (see Figure 14, above).

Anthropogenic changes in some river drainages supporting the species may also have benefited the birds in ways that have partially compensated for habitat losses. For example, sandpits created as a result of sand and gravel mining operations occur in some reaches of the Platte, Loup, and Missouri River where the species persists (e.g., Jorgensen 2009).

Summary of threats and management: Although loss of Interior least tern summer nesting habitat may have occurred on a local scale (e.g., lower Missouri River), we have found no evidence that nesting habitat loss is limiting populations on a range-wide scale. The listed population is currently abundant, wide-spread, self-sustaining, and with no evidence of decline or extirpation in the period of record (Lott et al. 2013). Interior least terns are well adapted to annual variability in local habitat availability, quality, and quantity due to their long lives, ability to renest, and dispersal capability (e.g., Thompson et al. 1997, Lott et al. 2013). With minimal management requirements the species has been capable of adapting to and exploiting a variety of anthropogenic habitats such as navigation systems, reservoirs, sand mines, etc., allowing the species not only to survive, but to thrive in some drainages, and even expand its range into areas where it did not historically occur (Lott et al. 2013).

While future conditions within some portion of the species range may deteriorate due to natural changes (e.g., climate change), or human demands (e.g., water needs in the western plains), the wide range of the inland population of least terns, and the bird's ability to emigrate to areas with better conditions reduces the unknown degree of threat. Management practices conducive to maintaining nesting habitats and protecting breeding colonies have also been developed and implemented in a substantial portion of the range. Therefore, based upon the Interior least tern's representation throughout its historical range, its resilience to anthropogenic changes in its habitat, and the redundancy provided by hundreds of breeding colonies in multiple drainages, we conclude that the present or threatened destruction, modification, or curtailment of habitat or range is not a significant factor affecting the species throughout all of its range, both now and for the foreseeable future.

Overutilization for commercial, recreational, scientific, or educational purposes.

Least terns were exploited by egg collectors and for feathers for the millinery trade during the late 19th century (Thompson et al. 1997, p. 18; Draheim et al. 2012, p. 146); however, overutilization on U.S. nesting habitats is not currently a threat.

Least terns may be killed for sport or food on their wintering ground (Thompson et al. 1997, p. 18); however, the three decade increase in abundance on the interior U.S. nesting grounds suggests overutilization on winter grounds, while unknown, may not be significant.

Human disturbance by recreational activities unrelated to utilization of Interior least tern is discussed below under "*Other natural or manmade factors affecting its continued existence"*. We do not have any information to indicate that overutilization for commercial, recreational, scientific, or educational uses is occurring now or will occur in the future. Therefore, we do not believe overutilization is a significant factor affecting the Interior least tern throughout all of its range, either now or in the foreseeable future.

Disease or Predation.

Little is known about diseases in least tern. Infection with paramyxovirus (Jackson and Jackson 1985, p. 59), mallophagan ectoparasites (Thompson et al. 1997, p. 15) and West Nile virus (USGS in litt. 2012) have been previously reported.

Interior least tern eggs, chicks, and adults are susceptible to a wide variety of avian and terrestrial predators (see *Predation*, under 2.3.1, above). Predation is a high natural source of mortality, specifically to eggs and chicks (Aron in litt. 2012, Smith and Renken, 1993).

Location of nesting colonies also has a significant influence on degree of predation. Reproductive success has been higher on island colonies versus land-connected sandbar colonies on the Mississippi River (e.g., Smith and Renken 1993; Szell and Woodrey 2003), and in river colonies versus terrestrial sand pit colonies in the Platte River (Jorgensen and Brown 2012).

While diseases in the Interior least tern have been documented, they are not known to be a significant cause of mortality on nesting areas. The level and effect of predation can be locally high and significant in some colonies and in some years, however, the exponential growth of the species' breeding numbers since listing indicates locally high levels of predation is not currently a factor in the range-wide survival of the species. Interior least terns are long-lived, and current population trends indicate that sporadic local breeding failures caused by disease, predation, or parasites are unlikely to be having a significant effect on long-term stability of the listed population. The species is also adapted to predation by their ability to relocate and re-nest when nests are depredated. Therefore, evidence indicates that disease, parasites, and predation are not significant factors to the Interior least tern throughout its range, either now or in the foreseeable future.

The inadequacy of existing regulatory measures

Interior least terns are found on private, State, and Federal lands throughout their range. The species is listed as endangered by the States of South Dakota, Nebraska, Colorado, Iowa, Illinois, Missouri, Kansas, Mississippi, Arkansas, Louisiana, Kentucky, Tennessee, Illinois, Indiana, New Mexico, and Texas. Most State laws protect native wildlife (including the Interior least tern) from take, and require State permits, in addition to Federal permits to collect, harm, or harass migratory bird species. Many of the States listed above actively manage the Interior least tern, facilitating cooperative partnerships to research, protect and manage the bird (e.g., Nebraska), by participating in multi-agency planning, management, and monitoring programs (e.g., Missouri River Recovery Implementation **C**ommittee, Platte River Recovery Implementation Program) or developing MOU's with housing or sand and gravel companies to avoid take.

Contamination of water or the fish prey species of the Interior least tern could have a deleterious effect on the species. Under the Clean Water Act, States establish and maintain water-use classifications through issuance of National Pollutant Discharge Elimination System permits to industries, municipalities, and others that set maximum limits on certain pollutants or pollutant parameters. Current State and Federal regulations regarding pollutants are considered to be protective of shorebird species, and contamination of water and fish is not currently known to be a threat to the Interior least tern.

The Interior least tern is protected by The Migratory Bird Treaty Act (MBTA) (16 USC. 703 et seq.), which protects the bird and its parts, nests, and eggs from taking and trade. Federal permits are required to collect, harm or harass birds listed under the MTBA. The 1985 listing rule identified the inadequacy of existing regulatory mechanisms to prevent habitat loss, as the main threat and cause of decline to the species (USFWS1985), noting that while the species was protected from harm or harassment by the MBTA, it did not provide a mechanism to address habitat threats.

At the time of listing and recovery plan development, nesting colonies of the Interior least tern were primarily known from jurisdictional waters with a strong Federal nexus, i.e., navigation systems, reservoirs, NWRs, national scenic river reaches, etc. Since listing, these habitats have to various degrees been considered, managed, protected, and/or monitored under the conservation (section 7(a)(1)) and/or consultation (section 7(a)(2)) requirements of the Act. For example, management guidelines, monitoring and conservation strategies, and operating plans in the Missouri, Platte, Arkansas, and Red rivers have been developed and implemented following formal consultation under section 7(a)(2) of the Act. Management actions in other drainages (e.g., Mississippi, Ohio rivers) have developed through informal consultation under section 7(a)(1) of the Act.

There is concern that absent the protection of the Act, Federal habitat management actions will cease, or decline.   However, Executive Order (EO) 13186 (66 FR 3853-3856), enacted in 2001 (entitled Responsibilities of Federal Agencies to Protect Migratory Birds), requires all Federal agencies to use their authorities and conduct their actions to promote the conservation of migratory bird populations. Actions authorized under the MBTA by EO 13186 include: avoiding and minimizing adverse impacts to migratory birds; habitat restoration and enhancement, and preventing pollution or detrimental alteration of migratory bird environments; designing habitat and population conservation principles, measures, and practices into agency plans and planning processes; promoting research and information exchange, including inventorying and monitoring; and ensuring full environmental consideration of migratory birds such as the Interior least tern under the National Environmental Policy Act.

Implementation of some management actions authorized under EO 13186 are discretionary, contingent upon opportunity, as well as annual appropriations and other budgetary constraints (as are the conservation requirements of section 7(a)(1) of the Act). However, many Federal action agencies now have a 25 year history of managing Interior least tern in compliance with both the Act and EO 13186. Many conservation activities have become standard operating practices (e.g., monitoring, avoidance, and channel construction design in the LMR, USACE 2008; dredge material disposal in the Ohio River, (Fischer 2012)), while some actions developed and conducted under formal consultations are adaptable to becoming standard operation practices (e.g., reservoir control and dredge practices in the Red and Arkansas rivers, (USACE 2003, 2012)). It is also in the interest of Federal agencies, and conservation partnerships (e.g., Platte

River Conservation Partnership) to continue management for the species to remain in compliance of the EO, as well as to avoid future decline of the species. Additionally, water and habitat management actions in some portions of the range that are beneficial will continue to be non-discretionary due to Biological Opinions for other endangered species (e.g., piping plover and pallid sturgeon in the Missouri River, USFWS2003).

The Interior least tern is protected under State laws and by the MBTA throughout their range. Activities that may adversely affect the species are currently subject to numerous regulatory mechanisms, including the MBTA, Clean Water Act, Fish and Wildlife Coordination Act, and National Environmental Policy Act. Federal actions to conserve habitat are now authorized by EO 13186 under the MBTA, addressing the inadequacy of this regulatory mechanism identified in the listing rule. Therefore, we determine these protections, considered together and with the increase in range and abundance of the species, provide adequate regulatory mechanisms to prevent significant decline of the Interior least tern throughout all of its range in the foreseeable future.

Other natural or manmade factors affecting its continued existence

<u>Climate Change Effects:</u> Our analysis under the Act includes consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the IPCC. "Climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2012). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2012). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

The distributions of many terrestrial organisms, including birds, are shifting in latitude in response to climate warming (Chen et al. 2011). Population declines, apparently in response to climate change, have been reported for long distance migrant bird species in both Europe and North America (Knudson et al. 2011). However, negative effects of climate change at one life or migratory stage may be compensated at another stage, e.g., by increased survival or reproduction on winter or breeding grounds (Knudson et al. 2011).

The ability of migratory birds to cope with rapid climate change depends upon the rate of adaptive response to the changes (Knudson et al. 2011). Phenotypic plasticity (i.e., the ability to shift dates of migration, breeding, fledgling, etc.) may allow rapid adaptation to climate change in some species (Charmantier et al. 2008). While there is little information on Interior least tern phenology (i.e., life cycle events and how they are influenced by climate variation), their adaptations to habitats controlled by stochastic events, including high mobility and utilization of anthropogenic habitats, indicates that they will be resilient to predicted climate changes.

Most climate change models predict increased extreme weather events (i.e., floods and droughts) throughout the species' breeding range (e.g., Lubchenco and Karl 2012). In the absence of clear knowledge of least tern wintering distributions, potential impacts of climate change on the species when it is away from its breeding range are unknown. The species is well adapted to cope with extreme hydrologic changes, and its habitat and productivity are closely tied with stochastic weather events. For example, while extreme high flow events may result in annual recruitment loss, such events are also the primary factor in creating and maintaining high quality nesting habitats (Sidle et al. 1992). Genetic studies have demonstrated gene flow within populations and between other least tern populations (USFWS 5-year review, 2014). Additionally, the dispersal of the Interior least tern over a wide geographical area encompassing a variety of latitudinal and longitudinal gradients, its long life, and its ability to move long distances make the species less vulnerable to future patterns of predicted climate change. Potential localized or regional reduction in habitat quantity or quality will likely be offset by new opportunities in other portions of the range and the Interior least terns ability to emigrate to new areas.

Decline of Fish Prey: California least tern chick starvation has been reported due to El Nino effects on fish abundance (Massey and Fancher 1989; Massey et al. 1992). Decreased fish prey availability has been linked to reduced egg weights, clutch size, and chick weights, and may influence chick survival and fledgling rates (Dugger 1997). Declines in fish prey have been noted on the Missouri River (Stucker 2012) and in some years on the Mississippi River (Dugger 1997). Fish prey abundance has also been linked to cyclic river conditions (e.g., river stage during nesting season; Dugger 1997). In 2012 and 2013, portions of the Platte and Loup Rivers experienced fish kills resulting from low or no flow conditions. Interior least terns, however, are strong flyers, capable of exploiting a large variety of aquatic habitats and fish species, including exotic species that may invade river systems (e.g., see *Food and Foraging Habitat*, under 2.3, above). These characteristics, coupled with the birds long life, its ability to re-nest, and its ability to relocate to more productive areas, likely enable it to cope with local periodic cycles of fish prey abundance.

Other Factors: Thompson et al. (1997) documented the mortality of eggs, chicks, and/or adults due to a number of factors. These included flooding of nesting areas during heavy summer rains and high water events, exposure to pesticides (Jackson and Jackson 1985) and other contaminants, burial of eggs by sand, hailstorms, heat, cold, sandspurs, fire ants, fireworks, airboats, off-road vehicles (ORV), and human recreationists. Cattle trampling has been documented in the Red (Hervey 2001) and Niobrara rivers (Yager in litt. 2012). Nupp (2012) has documented mortality of eggs and chicks from heat exposure in rooftop colonies.

As noted previously, Interior least terns are adapted to effects of potential flooding of nesting areas. Other threats (i.e., sandstorms, hailstorms, heat, cold, sandspurs, fire ants, fireworks, airboats, etc.) are site-specific and sporadic, or otherwise limited in scope; however, sandstorms, hailstorms, and temperature extremes may increase in frequency and severity in some portion of the range. ORV access to nesting areas is usually limited to flow conditions which provide access to nesting areas. In some areas, ORV access is managed by posting and/or fencing, while in more remote areas such as the Loup River, it is uncontrolled. In recent years, disturbance and other impacts from ORV use have occurred at a local scale (Loup River) to breeding terns. ORV use increases with increased access during low water conditions (USFWS Nebraska Field Office 2010-2012). These disturbances may impact the likelihood of Interior least tern successfully nesting within the Loup River. Disturbance by foot traffic and recreational vehicles for California, coastal, and Interior least terns has been well documented historically (Massey and Atwood 1979, Goodrich 1982, Burger 1984, Kirsch 1987-90, Lingle 1989, and Smith and Renken 1990 in USFWS recovery plan 1990). Losses incurred can be direct (destroying eggs and chicks) and indirect (inhibit feeding, breeding, and other reproductive behavior). There has not been any comprehensive data collected to indicate the degree of threat recreational vehicles and off-road traffic poses to Interior least tern and their recovery or the effect on local/regional counts. Impacts caused by recreational vehicles have a high degree of annual variability based on the amount and timing of easily accessible sand. There does appear to be a direct correlation on the local scale that indicates as flow declines, exposing more sand, ORV use on the Loup River increases.

Summary of Factors Affecting Continued Existence

Mortality of the Interior least tern has been documented to occur locally throughout the range of the species due to a variety of natural or man-made factors. However, the wide distribution of the species, currently high numbers, its long life span, and its ability to emigrate and re-nest (see above) make the species resilient to occasional or periodic sources of mortality, and possible effects due to climate change. The increase in range and population size over the past three decades indicates that sources of mortality on localized colonies are compensated by these traits of resiliency, and the potential of high recruitment rates in other Interior least tern colonies or populations. Therefore, we have no evidence that other natural or man-made factors are detrimentally affecting the Interior least tern throughout all of its range, both now and for the foreseeable future.

IVB. Interior Least Tern - Environmental Baseline

Status of the Species within the Action Area

The “action area” means all areas to be affected directly or indirectly by the Federal Action and not merely the immediate area involved in the action. Within that action area, the Service analyzed species effects within the following river segments: the Loup River Bypassed Reach, North SMA, Platte River Bypassed Reach, and the Lower Platte River.

Recently, the Service completed the 5-year review for the Interior least tern. The Platte River population (which includes the river segments in the action area) was characterized as relatively small (4.4% of the entire Interior least tern population). The Loup River contains only 0.42% of the range-wide population. The Platte River population is on the outside edge (western) of their overall range. Range wide, the species was recommended for delisting and numbers have met overall recovery number objectives. The Lower Platte River population is considered to be stable but highly variable. The analyses pointed toward episodic periods of relatively large numbers of nests and colonies during low to moderate flow years immediately following habitat forming peak flow events. These peak flow events in combination with the subsequent lower flows are believed to be the single greatest driver in habitat availability and number of Interior least tern nests. Surveys documenting nesting were conducted on the Loup River upstream and downstream of the diversion, the Platte River from the Loup confluence to the Missouri confluence, and at off-channel sandpits. Methods used to survey for Interior least tern nests were inconsistent over time. We considered data primarily since 2008 which provides the most recent and best available nesting data compared to historic surveys conducted since between 1987 and 2007 for varying years and river segments. Overall nesting numbers collected in that time period seem to support the species status in the action area relative to the overall Interior least tern range wide population (*Table 4*). *Table 4* provides nest totals for the respective river segments in the action area from 2008 to 2014, but is not all inclusive and at times data was collected inconsistently. However, the Service has concluded that this data set represents the best available scientific data about nesting by Interior least terns within this region.

Table 4. Total Interior least tern nests from 2008 through 2014*

Location	**# Nests 2008-2014**
North SMA	112
Loup River Bypassed Reach*	32
Platte River Bypassed Reach*	0
Lower Platte River	709

*Data is unavailable for the Loup River Bypassed Reach and Platte River Bypassed Reach in 2008. Data is available for 2013 and 2014 and will be included once compiled in the final Opinion.

Factors Affecting the Species Environment within the Action Area

The primary causes of decline for the Interior least tern are anthropogenic alterations to hydrology and sediment within rivers from large dams and water diversions, which leads to habitat loss and degradation and a corresponding reduction in nesting habitat. As described in greater detail within the Hydrology and River Geomorphology baseline, the PRRIP has committed to provide managed flows for central Platte River species by the end of calendar year 2019. The PRRIP also manages both on and off-river (sandpit) habitat for the benefit of the Interior least tern and since implementation has seen an increase in the total number of Interior least tern nests. The majority of Interior least tern nesting within the central Platte River occurs on off-river habitat resembling or associated with sand and gravel mining. Under this baseline, the PRRIP is expected to continue providing these contributions through 2019. The PRRIP flows will contribute to the amount, timing, and duration of flows within action area, resulting in an average annual increase of 130,000-150,000 af of water during relevant time periods.

Sand and gravel mining in the Platte River basin has increased over time. A byproduct of mining through dredging operations has been the creation of large areas of barren sand (i.e., spoil piles). These areas often provide temporary Interior least tern nesting habitat. However, these large areas of bare sand can become quickly vegetated and make nesting habitat unsuitable. This habitat can be managed to persist over time. There are numerous examples of this occurring throughout the action area on the Loup and Platte Rivers. The TPCP works with sand mining operators and housing developments to avoid impacts to nesting Interior least terns and their habitats. Maintenance of suitable habitat has been used as a mechanism to dissuade Interior least terns from using other areas under active mining operations and housing construction. However, there are no assurances that these habitats would persist without active maintenance of nesting substrates—a period lasting 15-20 years (in most cases) from the start of a sand and gravel mining to the construction of a housing development. Existing off-channel habitats within the Platte River basin are included within the Environmental Baseline but we acknowledge their persistence and contribution into the future is uncertain. We also anticipate development of new sand and gravel mines will continue while persistence of existing mines will end. Within the Upper Missouri River South breeding population, nesting distribution shifts annually among riverine and off-channel habitats as local variability affects the amount and location of habitat (See *Figure 17*).

Other factors affecting the Interior least tern environment within the action area are continued recreation and human interaction within or in close proximity to Interior least tern nesting habitat. Adverse effects from ORVs occur throughout the Loup River when low water conditions allow. Airboats in the action area may cause adverse effects as they can disturb nesting adults and chicks and traverse important nesting habitat. Housing developments occur following the completion of sand and gravel mining operations. Human development in close proximity has the potential to increase predation from pets, disturbance, and destruction of nesting habitat or individuals.

IVC. Interior Least Tern - Effects of the Action

Factors to be Considered

Within the action area, we considered adverse effects related to: a) reproduction (breeding); b) forage or fitness (feeding); and c) sheltering. Adverse effects to breeding, feeding, and sheltering for the Interior least tern were analyzed for the Staff Alternative within each sub-action area (Loup River Bypassed Reach, North SMA, Platte River Bypassed Reach, lower Platte River from the tailrace to the confluence of the Missouri River) previously described and compared with the environmental baseline.

1. Loup River Bypassed Reach

We assessed the present conditions upstream and downstream of the diversion to determine habitat conditions for the Loup River Bypassed Reach under the environmental baseline. We compared those conditions for the period of the license (30 years) to help inform what changes we would expect to see under the Staff Alternative. The Loup River upstream of the diversion provides a reference for conditions that could be expected under the environmental baseline.

The Loup River upstream of the diversion has wider channel widths and wetted widths than does the Loup River downstream of the diversion. Additionally mid-channel sandbars which are used by Interior least terns for nesting can be found upstream of the diversion whereas they are uncommon downstream from the diversion. The Loup River upstream of the diversion provides a useful reference condition and serves as an analogous river for the environmental baseline.

Under the environmental baseline, flow and sediment transport and channel morphology approximates the characteristics of the Loup River located upstream of the diversion. However, channel morphology would take time to evolve. Initially, higher flows under the environmental baseline would result in a decrease in exposed sand (bare sand would be inundated by increased river stage) and an increase in water depth (see Hydrology and Geomorphology section). In the absence of abnormal climate and hydrologic conditions (flooding) creating higher sandbars, we expect an initial reduction in the amount of Interior least tern nesting habitat for an unknown period of time. However, within the period of the license (30 years), we anticipate a gradual improvement in habitat conditions under the environmental baseline, but those improvements may not completely replicate the Loup River upstream of the diversion due to the persistence of permanent mature riparian forest encroachment which will restrict the maximum channel width and unobstructed width on the Loup River below the diversion. Within this period of the 30-year license, channel widths below the diversion would likely increase, but only to the point where widening becomes restricted by a mature riparian forest that for the last 80-90 years has grown under reduced and less frequent discharge conditions. Areas that are now large, elevated point bars would erode and become part of the active channel and mid-channel sandbars would be expected to develop and occur more frequently. Once channel widths reach the mature riparian forest, widening would slow down and be largely dependent upon peak flows. Thus, it is likely that widening would occur over time and reasonable to assume that habitat availability and nesting occurrence on the Loup River Bypassed Reach would begin to approximate the Loup River upstream of the diversion (reference condition).

Under the Staff Alternative, conditions on the Loup River Bypassed Reach would improve when compared to existing conditions. Article 406 requires that the maximum flow diverted into the Loup Power Canal will not exceed 2,000 cfs from March 1 through June 30. This time period coincides with the majority of habitat-forming peak flows that occur on the Loup River. This article would allow for an additional 1,500 cfs to be bypassed down the Loup River Bypassed Reach instead of being diverted into the canal as is it currently. We expect this increased water and sediment to contribute to both higher and larger nesting sandbars and thus, more nesting than is currently occurring under existing operations.

Reproduction
Interior least tern nesting data was previously collected on the Loup River upstream of the diversion to the confluence of the Middle and North Loup Rivers. This segment is approximately the same length as the Loup River Bypassed Reach. This data was used to establish an environmental baseline for reproduction by the Interior least tern. Habitat conditions under the Staff Alternative and thus, reproduction are expected to improve on the Loup River Bypassed Reach when compared to current conditions. This analysis (which compares nesting

under Current Operations to the environmental baseline) reasonably estimates the maximum reduction to nesting we expect under the Staff Alternative within this segment.

We analyzed data from 2009-2012 that was collected by the Service, NPPD, and NGPC and compared it with data reported within the Assessment for the period of 1985-2005. While the reported data from 1985 to 2005 indicated fewer nests overall, the data showed the same relationship and did not affect our conclusions.

During the time period 2009-2012, a total of 57 nests were documented (FWS 2010-2012; NPPD 2009-as cited within EA/BA) on the Loup River from the diversion to the confluence of the Middle and North Loup Rivers (approximately 14 nests/year). During that same period, a total of 32 nests were documented on the Loup River Bypassed Reach (8 nests/year; Table 5). In comparing nesting on the Loup River below the diversion under Current Operations with the environmental baseline, we estimated that implementation of the Staff Alternative will result in a reduction of 6 nests/year (14-6=8) when compared to the environmental baseline. As previously mentioned, this represents the maximum reduction of nests (maximum adverse effect) given that, we expect nesting to improve under the Staff Alternative when compared to the Current Operations for the Loup River Bypassed Reach. As mentioned above, we have no way of estimating how many more nests might occur in the Staff Alternative than under Current Operations. We compared these data to that reported within the Assessment (Table 37, p.159) for the period 1985-2005 (District 2012a) and the results were not meaningfully different. During that time period, nesting averaged 10 nests/year on the Loup River upstream of the diversion compared to 5 nests/year on the Loup River Bypassed Reach. Numbers for both segments were reduced by a similar proportion (ratio of birds using each segment was similar for both periods of record). We believe this difference is attributed to an increase in the overall Interior least tern population (e.g. 1985 vs. 2009) or reduced survey frequency/intensity.

More recently, nesting on the Loup River Bypassed Reach has been largely confined to a single location - a large sandpit adjacent to the river, which became part of the river when high flows converted it into an island separated from the adjacent bank. This manmade sandpit is now being vegetated and it is unknown what level of production it will maintain into the future. However, given consistent nesting over the longer period of record, we anticipate some level of nesting would continue under existing conditions; nesting would increase under the Staff Alternative but would still be less than what we would eventually expect to see under the environmental baseline. For this reason, using data under current conditions and selecting the 2009-2012 period (which corresponds to a higher reduction of annual nesting numbers [6] than the 1985-2005 period) reasonably estimates the maximum reduction in nesting on the Loup River below the diversion we would expect when comparing the environmental baseline to the Staff Alternative over the 30 year period of the license.

Table 5. Number of Nests found Upstream and Downstream of the Diversion				
Location	**2009**	**2010**	**2011**	**2012**
Loup Upstream diversion	4	10	27	16
Loup Below Diversion	2	7	20	3

We also considered the effect that daily stage variation associated with hydrocycling could have on reproduction. However, because hydrocycling does not occur on the Loup River Bypassed Reach, we conclude that lethal nest loss from inundation resulting from hydrocycling is not occurring within this sub-action area.

Feeding/Fitness

We considered the reduction of flow under the Staff Alternative compared to the environmental baseline to evaluate the impacts to foraging for Interior least terns. We also used current conditions as the maximum likelihood of effect for the availability of forage fish because we have no way to estimate how many forage fish may be lost under the Staff Alternative. Low water conditions can result in elevated temperatures in the summer and cause fish kills. Fish kills reduce the availability of forage fish for Interior least terns if kills occur to their potential prey species. Fish kills have been documented during low water conditions on the Loup River Bypassed Reach (FWS Nebraska Field Office, 2012); these conditions have the potential to reduce the abundance of forage fish. Forage fish sampling has not been conducted on the Loup River. Productivity monitoring (chick survival) was not conducted frequently enough to determine chick fate or fledgling success; therefore, documentation of a reduction in foraging, fitness, or chick/adult survival is not possible given existing information on the Loup River. In the central Platte River, NPPD and Central Nebraska Public Power and Irrigation District have monitored forage fish abundance since 1999. Additionally, the PRRIP analyzed this data in combination with a USGS foraging habits study undertaken to answer key questions related to least tern foraging. The results of the analyses indicated forage fish are likely not limiting least tern production so long as there is flow present (while they did not indicate how much) in the river and that a relationship between flow and forage fish abundance could not be established despite several years of data collection (PRRIP, 2014). Sherfy (USGS, 2012) found that least terns on the central Platte River routinely traveled six miles or more while foraging. The study also found that total fish abundance was variable at different flows but demonstrated that forage fish are present in high numbers and capable of quickly re-inhabiting areas with little or no flow once flow returns. The PRRIP concluded that forage availability did not limit least tern productivity on the central Platte River.

We have no data to suggest that conditions (flow and sediment) under the Staff Alternative for the Loup River Bypassed Reach will result in adverse effects to the Interior least tern adult's/young's fitness or ability to forage. However, given that water levels would be higher and water temperatures would be lower under the Staff Alternative (compared to the present conditions), we would expect a greater availability of forage fish to ensure Interior least tern production, when comparing the Staff Alternative with the environmental baseline.

Shelter

The Staff Alternative provides for much lower water levels during the Interior least tern nesting season when compared to the environmental baseline. This has the potential to increase the ability of predators to more easily access nesting islands, though no research directly verifies this cause and effect relationship. High predation rates for birds using sandbars attached to the riverbank were observed on the Missouri River and the need for a predator moat is believed to be important (USACE 2011). Under no/low flow conditions, islands would become attached to the riverbank and create a land connection which may facilitate access by predators. Additionally, narrow channels with nearby mature woody vegetation expected under the Staff Alternative could increase avian predation. Surveys and monitoring for Interior least tern nest/chick survival have been done on an opportunistic basis at best on the Loup River and thus, are unable to provide conclusive nest/chick fate or cause of death in nearly all cases. At most, nesting colonies were revisited once or not at all after initial discovery. Nest chick fates were reported in some cases on the Lower Platte River but do not distinguish between avian and land-based predators. Additionally, numerous nests had an undetermined fate. An unknown amount of predation is expected to occur in absence of the Staff Alternative being implemented. These factors, when considered together, make any useful comparison between flow and an increase in the ability of land-based predators to access and depredate nests difficult.

The Staff Alternative provides for additional base flows when compared to present conditions. Given that we have no nest/chick fate data for nesting on the Loup River or evidence that flows under the Staff Alternative increase or decrease predation compared to the environmental baseline, we believe it is reasonable to describe the expected relationship qualitatively. Jorgenson et al. (2012) found that Interior least tern nesting incidence was positively correlated with channel width and that least terns avoid nesting in narrow channels and anabranches. The authors suggested a possible explanation for selection of wider channels is predator avoidance and pointed out numerous studies that demonstrated that shorebird site use and behavior is affected by the presence of avian predators (Cresswell 1994; Cresswell and Whitfield 1994). Avoidance of narrower channels may be a behavioral or adaptive response to reduce predation of nests and chicks. Therefore, we anticipate that narrower channels with mature forest along the banks increase the potential for both avian and land-based predators to access and prey on shorebirds, nests or chicks such as the least tern.

Based on the above information, knowledge that natural predation occurs (not resulting from Staff Alternative), and a lack of documentation that predation has occurred on the Loup River under Current Operations, we expect the following: a) the Staff Alternative will result in decreased predator access when compared to the existing conditions due to increased baseflows and the potential for higher flows capable of widening the river and creating water barrier to nesting islands; b) the Staff Alternative will result in increased predator access when compared to the environmental baseline, which would have even higher flows and wider widths. We also acknowledge that some level of natural predation will continue under all three scenarios (Staff alternative, current conditions, environmental baseline).

2. Platte River Bypassed Reach

The Loup River joins the Platte River near Columbus. At this location on the Platte River, there is no hydrocycling because this reach is located upstream from the Project tailrace. The Platte River is in sediment balance here, but flow and sediment are reduced when compared to the environmental baseline (*Appendix D*). The 1.8 million tons of sediment/year and 67 percent of the annual flows contained in the Loup River, that would enter the Platte River, are absent from this segment (*Appendix D*). Under the environmental baseline, we expect this segment to resemble the Lower Platte River downstream of North Bend where sediment is in balance and effects on channel geomorphology of hydrocycling are considered negligible. While channel widths would be unlikely to change given the presence of mature riparian forest on islands and banks, we expect an improvement in nesting habitat conditions for the Interior least tern under the Staff Alternative when compared to existing conditions. A large permanently forested island occurs throughout most of the first mile below the confluence causing a flow split that may inhibit island development capable of supporting nesting or significant channel widening. However, we expect improved Interior least tern nesting habitat conditions for the remaining 1.25 miles downstream from this forest island. Habitat conditions downstream of North Bend (sediment imbalance absent, hydrocycling reduced) are useful in approximating conditions that might be present under the environmental baseline (see further description under the following segments of Lower Platte River). Under the Staff Alternative, we expect the increase in flows from Article 406 (discussed in Loup River analyses) during the nesting season to result in improved island/bar development when compared to Current Operations, but to be less than that expected under the environmental baseline.

<u>Reproduction</u>
Interior least tern nesting data on the Platte River Bypassed Reach was compared to nesting data on the Lower Platte River from North Bend to the Highway 64 bridge crossing near Leshara to evaluate the reproduction we expect might occur under the environmental baseline conditions.

The Lower Platte River from North Bend to Leshara has averaged 0.56-0.63 nests/mile from 2008-2014 (Brown and Jorgensen, 2008-2010, Brown et. al 2011-2014). We multiplied 0.63 nests/mile * 2.1 (# miles in the segment) to estimate the maximum number of nests that might be expected under the environmental baseline (1.3) and compared this to nesting data under current conditions (representative of Staff Alternative). We used current conditions because we have no way to estimate how many more nest might occur under the Staff Alternative. However, improvement of habitat conditions under the Staff Alternative would be reasonably expected to result in additional nests. Since 2008, zero nests were documented on the Platte River Bypassed Reach (Table 6). Using the maximum likelihood of effect, the largest difference in nesting between the Staff Alternative and environmental baseline is estimated to be 1.3 nests/year.

Given that hydrocycling does not affect the Platte River Bypassed Reach upstream of the tailrace, we conclude no nests are lost as a result of hydrocycling related to the Staff Alternative.

Feeding and Fitness

The Platte River Bypass Reach is bound by the Platte and Loup Rivers confluence and the tailrace and is 2.1 miles in length. Given the lack of nesting, ability of Interior least terns to fly long distances (over 6 miles) to forage, and lack of data to indicate forage is limiting, the Staff Alternative is unlikely to affect foraging or fitness of Interior least tern adults or chicks within this segment.

Shelter

Given that the Staff Alternative for the Lower Platte River from the Loup River confluence to the tailrace is not expected to result in nesting, adverse effects to active nests (increased potential for flooding, erosion, nest loss, predation) are not addressed.

3. Lower Platte River

River Reach - Tailrace to North Bend

Approximately 2.1 miles downstream of the Platte and Loup Rivers confluence, the Project tailrace returns the water diverted through the Loup Power Canal and creates a sediment deficit. Under the environmental baseline, there would be no diversion into the Loup Power Canal, so there would likewise be no sediment deficit at the Project tailrace return. The Lower Platte River below the tailrace would transition from an incised sediment-deprived channel to a wide channel with large and high-elevation sandbars. Daily fluctuation from hydrocycling would be absent under the environmental baseline. Under the Staff Alternative, we expect a lower volume of water returned at the tailrace but the magnitude of daily variation from hydrocycling would be similar to existing conditions for the majority of the year (see *Appendix E*). The Staff Alternative would result in higher base flows entering the Lower Platte River from the Loup River Bypasses Reach that would combine with water entering the Lower Platte River from the tailrace. We expect hydrocycling to attenuate faster (due to decreased volume of water from the tailrace and length of each cycle) and degradation to slow when compared to existing conditions. Based on these changes, we expect nesting conditions to improve from existing conditions but still remain less than what we would expect under the environmental baseline.

As mentioned previously under Current Operations, the Project removes 1.8 million tons of sediment from the Loup and Platte Rivers of which a sediment deficit is created at the project tailrace return. Adverse effects of a sediment deficit can include reduced bar building capacity, channel narrowing, channel deepening, and increased scour of potential Interior least tern nesting islands/bars. Similar conditions exist below the J-2 hydropower return (operated by CNPPID), which contains sediment free water returned to the river on the central Platte River. The sediment deficit on the central Platte River is in sediment balance at or near the Kearney bridge (HDR 2011; The Flatwater Group 2010; PRRIP, 2013), which is approximately 32 miles downstream of the J-2 return. Given that there are no major tributaries or other sediment inputs, the sediment deficit is likely offset by erosion of the bed, banks, or sandbars. This process is described within the Assessment (FERC 2014). We believe this may provide a useful reference because similar conditions occur at both locations (J-2 return and Project tailrace return). On the Lower Platte River, channel narrowing and deepening are observed immediately downstream of the tailrace but detailed modeling investigating exactly how far the sediment deficit extends has not been undertaken. However, studies have confirmed that at the North Bend gauge, approximately 29 miles downstream of the tailrace, no channel incision is observed [Assessment, pp.108 Sedimentation Study 1.0]. Conditions on the central Platte River below the J-2 return (sediment free water return, hydrocycling operations present) appear similar to conditions observed at the Project tailrace return. Therefore, given the distance of observed sediment deficits below the J-2 return (32 miles) and evidence that channel gradation for the Lower Platte River is in dynamic equilibrium at North Bend (29 miles downstream of the tailrace), we conclude that the effects of the sediment deficit exist throughout much of the reach (decreasing gradually downstream) from the tailrace to North Bend, but sediment deficit effects to channel degradation is minimal below this point. This indicates that effects on island and bar formation below North Bend appear to be minimal. We believe this is consistent with observed nesting island characteristics and occurrence as documented within Figure 41 of the 2009 least tern and piping plover annual monitoring report for the Lower Platte River (Figure 41; Jorgensen and Brown, 2009a). While the sediment deficit observed downstream of the tailrace has not changed the overall planform (geomorphic classification) of the Lower Platte River (Elliot et. al, 2009), it is inappropriate to equate this to measurable Project effects (Assessment, p. 108).

While the Staff Alternative will improve hydrology/sediment conditions compared to the Current Operations, hydrologic and geomorphic effects discussed previously will reduce habitat availability when compared to the environmental baseline. In considering the effects described above, we attempted to examine a river that approximates the Lower Platte River from the tailrace to North Bend under the environmental baseline with the goal of comparing Interior least tern use to the Staff Alternative. Under the environmental baseline, degradation would be absent, sediment transport supplied to the Lower Platte River from upstream would increase and flow volumes would remain similar (but without hydrocycling). We selected the segment of the Lower Platte River from North Bend to the Highway 64 bridge crossing near Leshara, Nebraska because it appears to represent habitat conditions we would expect to see under the environmental baseline, given that we determined sediment deficits and degradation seen upstream are believed to be insignificant downstream of North Bend. See below for additional information relating similar characteristics of this reach to the environmental baseline.

<u>Tailrace to North Bend - Reproduction</u>

We considered the hydrologic, geomorphic, and physical effects of the Staff Alternative described previously and attempted to compare them with a river reach that would closely approximate the Lower Platte River from the tailrace to North Bend, under the environmental baseline. A search for an analogous river with matching hydrology, geomorphology, and physical characteristics that contained least tern nesting was unsuccessful (pers. communication, Casey Lott, Joel Jorgensen and Mary Brown, 2014). This focused our attention on other segments of the Lower Platte River (i.e., the Lower Platte River downstream from North Bend). Given that the sediment deficit is eliminated and effects of hydrocycling will be largely reduced by North Bend, we concluded that a comparison between Interior least tern nesting data upstream and downstream of North Bend may useful. Adverse effects to nesting habitat from the sediment deficit and erosional effects of hydrocycling are expected to be largest from the tailrace to North Bend. Hydrocycling may continue to have an adverse effect (to nest and chick success) downstream of North Bend but it is unlikely to adversely affect nest initiation. Within any given year, we believe it is unlikely that the erosional effect contributed solely from hydrocycling downstream of North Bend would reduce the habitat acreage of any nesting island appreciably enough to cause a reduction in the number of nests that were initiated. Under the Staff Alternative, the within-day stage variation due to hydrocycling would be reduced by 0.67(annual)-0.96(seasonal) feet from the tailrace to North Bend during dry years and 0.31(annual)-0.27(seasonal) feet for wet years (Final License Application, *Appendix B*). The resulting erosional effect would be expected to be incrementally reduced, further from the tailrace. Thus, the effect from hydrocycling is likely diminished where a majority of the annual nesting occurs (downstream of Leshara, NE).

The amount of sandbar nesting habitat available to Interior least terns is highly variable from year to year. As seen over the period from 2008-2014, daily and seasonal fluctuations in discharge and stage, annual rainfall, ice and snow conditions, ground water levels, and river channel morphology all play important roles in habitat creation and persistence. While individual peak flow events are the primary driver in habitat creation (nesting islands) as documented by peak flows in the Lower Platte River in 2008, 2010 and 2011, persistence of habitat is also dependent upon both short-term events and long-term interactions between other variables described above.

Hydrocycling and sediment deficits at the tailrace may play a role in long-term formation and persistence of islands but detailed studies quantifying their amount or extent of effect and interaction with other natural processes have not been completed. Sediment deficits may contribute to systemic bar degradation (Horn et al. 2012b). This degradation is likely occurring between the tailrace and North Bend on the Lower Platte River. The reduction in bar size documented in the Lower Platte River (Horn et al. 2012) further supports this given that streamflow at the site of local sediment deficits would maintain sediment transport capacity by removing the local sediment supply from the bars. However, we do not have any evidence that reduction in bar size below North Bend is specifically due to Project operations.

We do know that many of the nesting islands are used and persist for multiple years. We recognize some degree of sandbar/island erosion is a natural process and a dominant factor in the evolution of sandbars and islands within the Platte River. Predictably, decreases in island size were reported from year-to-year for many nesting islands (Brown and Jorgensen, 2008-2010, Brown et. al 2011-2014). Islands created from peak flows one year may have been overtopped and reworked by flows of significantly less magnitude the following year, often resulting in a reduction of bar height and size. The persistence of islands on the central Platte River supports our assertion. Mechanically-created and managed islands persisted throughout the entire 2009 nesting season and into the start of the 2010 nesting season with relatively low reductions in size on the central Platte River. However, peak flow events occurred during the 2010 and 2011 nesting season. During and immediately following these high flow events, substantial erosion and reduction in size of these nesting islands were documented and largely attributed to the high flows (PRRIP 2010, 2011). By the end of the 2011 nesting season, many of these bars were completely eroded and redistributed throughout the channel. Similarly, we expect seasonal high flow events such as these may be the dominant factor for sandbar and island persistence on the Lower Platte River as well.

For these reasons, including the lack of channel incision at North Bend (FERC 2014), we believe that the majority of bar erosion that occurs downstream of North Bend is a phenomenon that is related to naturally occurring factors and less on hydrocycling operations. Hydrocycling may have some influence, but we are unable to meaningfully measure its effects on Interior least tern nesting habitat creation or persistence within the Lower Platte River downstream of North Bend. Hydrocycling effects would be more likely to affect nests after initiation due to inundation (see discussion under segment: North Bend to confluence of Missouri River).

We used survey data from 2008-2014 (Jorgenson and Brown2008-2014) to compare the Staff Alternative to the environmental baseline from the tailrace to North Bend. This nesting data collected from the tailrace to North Bend was used to represent the minimum expected nest production under the Staff Alternative. This data was compared to survey data collected on the Lower Platte River from North Bend to Leshara, which is the river segment that we believe represents the environmental baseline (*Table 6*).

Table 6. Nesting survey data, Lower Platte River, Loup confluence to Leshara, NE

Location	2008	2009	2010	2011	2012	2013	2014
Platte River Bypassed Reach	NA	NA	0	0	0	0	0
LPR tailrace to North Bend	16	15*	7	0	12	NA	8
LPR North Bend to Leshara	20	50	0	10	6	*0	5

*Entire segment not surveyed
NA- Not applicable, no survey done

As mentioned above we discontinued our analyses at Leshara because significant geomorphic differences begin to effect key nesting characteristics such as channel width, sediment supply, bare sand area, valley width, etc. These geomorphic changes affect the amount of nesting habitat and are likely responsible for increased least tern colony size and number of nests. The two segments (tailrace to North Bend and North Bend to Leshara) are similar in length (28 and 23 miles, respectively) and characteristics (i.e., few large forested islands, no major tributaries, similar valley width, similar channel form, and similar flow).

We performed two comparisons using data from Jorgensen and Brown (2008-2014). Both comparisons had limitations and potential biases that affect the results. Due to multiple constraints and factors (resources limited, access limited, hydrologic conditions preventing surveys, etc.), the two segments were not equally or consistently surveyed. In some years, portions of each segment were not surveyed. In other years, portions or entire segments were surveyed multiple times while others were not. In 2013, no surveys were conducted upstream of

Fremont (see Table 7) while surveys were conducted from Fremont to Leshara, NE. In 2009, only a portion (tailrace to Schuyler) was surveyed for the upstream segment. We did not analyze nest or chick fate as the data was more limited and unavailable in most instances for this dataset. Where nest/chick fate data was available, the cause of fate (in the event of failure or loss) was often speculative or unknown due to a limited number of return surveys. Despite these limitations, the data from 2008-2014 surveys still represents the best scientific data available. As with previous analyses, we focused on the number of nests, which provides the best metric of habitat availability and precludes additional biases that might result from adult counts and nest fate counts.

Our first analyses looked strictly at the total number of nests related to the overall total of miles surveyed over five years for both segments. From 2008-2014, 58 nests were located after surveying 154 miles of the river from Columbus to North Bend. This equated to an average of 0.38 nests/mile (58/154) from Columbus to North Bend using data collected during that period of record. From North Bend to Leshara, an average of 0.62 nests/mile (91 nests/146 miles) was located during the period of record (*Table 7*).

Table 7: Results of Nest Surveys from 2008-2014. Source: Jorgensen and Brown, 2008-2014

	LPR tailrace at Columbus to N. Bend		**North Bend to Leshara**	
Year	**# Nests**	**Miles surveyed w/i segment**	**# Nests**	**Miles surveyed w/i segment**
2008	16	28	20	23
2009	15	14	50	23
2010	7	28	0	23
2011	0	28	10	23
2012	12	28	6	23
2013	N/A	0	0	8
2014	8	28	5	23
TOTAL	58	154	91	146

Our analysis was heavily impacted and biased by two factors. First, the segment from North Bend to Leshara was often surveyed multiple times in many years while the upstream segment was rarely surveyed more than once in a given year. In some instances, it was unclear exactly how many times each segment was surveyed. Therefore, we expect the data may have been strongly biased by capturing additional nesting during additional surveys on the lower segment. This was not accounted for in the miles surveyed. If only a portion of a segment was surveyed in a specific year, we did account for the reduction in miles surveyed. We recorded the maximum miles surveyed (within one survey for any given year) and combined the total for all years. Mileage from multiple surveys was not additive within any year due to insufficient information on the number of surveys.

Secondly, the data is strongly influenced by data from one location and year which was not equally represented among other locations. In 2009, peak habitat conditions coincided with the highest nesting incidences recorded throughout the entire Lower Platte River. Fifty nests were observed on the segment from North Bend to Leshara. This same year, only half (14 miles) of the upper segment was surveyed. While that data still represented the highest number of nests (15) located per mile for the upper segment, its magnitude was not weighted equally to the lower segment, which was surveyed in its entirety. Therefore, the increase in nest production on the upstream segment did not affect the data nearly as much as the downstream segment due to the relatively lower amount of nests and miles surveyed. Had the entire stretch from North Bend to Columbus been surveyed and had nesting similar to the upstream segment that was surveyed, the analyses may not have demonstrated as much variation in number of nests/mile between segments. Furthermore, this analysis considers nesting under existing conditions.

We anticipate the Staff Alternative to result in improved nesting conditions within the segment from the tailrace to North Bend. For these reasons, the nesting potential for the Lower Platte River upstream segment is likely biased lower while the downstream segment is biased higher. However, this is useful in obtaining a maximum difference in nesting when comparing the Staff Alternative and the environmental baseline. In this analysis, we believe the difference in estimated nesting depicts the maximum likelihood of effect for a reduction in nesting resulting from the Staff Alternative.

Our second analysis used the same data but weighed the data individually within the years surveyed and averaged them. We calculated the nests per mile for each segment for each year. We took each of these values, added them together, and divided by the number of years they were surveyed (to account for sections that were not surveyed some years). This provided a second estimate for average nests/mile for each segment (above and below North Bend). This resulted in an average of 0.43 nests/mile for the tailrace to North Bend and 0.56 nests/mile for North Bend to Leshara, when weighted by the number of years surveyed between 2008 and 2014. While this uses the same data and its inherent limitations discussed above, it reduces the significance of any one data point when weighted by the number of years surveyed (*Table 8*).

Table 8. Weighted Averages for Nesting Data

	Tailrace to North Bend	**North Bend to Leshara**
2008	0.57 nests/mile	0.86 nests/mile
2009	1.07 nests/mile	2.17 nests/mile
2010	0.25 nests/mile	0 nests/mile
2011	0 nests/mile	0.43 nests/mile
2012	0.42 nests/mile	0.26 nests/mile
2013	NA- Was not surveyed	0 nests/mile
2014	0.29 nests/mile	0.22 nests/mile
	AVE. 0.43 nests/mile	**AVE. 0.56 nests/mile**

Results from both analyses were compared and a larger difference in nests/mile between the Staff Alternative and environmental baseline were noted from the first analysis. In an effort to obtain the maximum difference in nesting between the segments (thereby analyzing the maximum likelihood of effect), we multiplied 0.38 (analysis #1 nests/mile, tailrace to North Bend) * 28 (# miles, tailrace to North Bend) and compared it to 0.62 (analysis #2 nests/mile, North Bend to Leshara) * 28. This gave us a difference of approximately 7 nests/year (10.6 vs. 17.4), which we believe is the maximum average difference in nesting we would expect when the Staff Alternative is compared to the environmental baseline. Given data limitations that potentially bias the data and the fact that the Staff Alternative will be an improvement from existing conditions, this difference is likely overestimated.

We conducted an evaluation to determine if hydrocycling was adversely affecting nest success. Data that quantitatively describes the amount of adverse effects or take of least tern resulting from differences in daily stage variation related to hydrocycling would be helpful but this data is unavailable. In the absence of this data, we calculated the number of nests that would be lost due to inundation specifically resulting from hydrocycling. We used data from the same source as was used for our nesting number analyses (Brown and Jorgensen 2008-2010, Brown et. al 2011-2014). However, given the lack of nest fate information for the previously discussed segments (e.g., the Lower Platte River from Columbus to Leshara was often surveyed only once or twice and lacked nest fate data), we used additional data from the Lower Platte River at Fremont to the confluence of the Missouri River which was the most often and consistently surveyed over the same time period (2008-2014). Reporting nest loss (due to inundation events) often required making numerous assumptions. In most instances, nests and chicks were not directly observed as being lost and assumptions regarding the cause of a lost nest or chick were made given circumstances surrounding each nest or chick. Accuracy is dependent on the length of time between surveys. Data reporting nest loss downstream of Fremont was more reliable and more often reported due to increased survey efforts. Nest loss due to inundation above Fremont was speculative or not reported at all because of the absence of data collected after the initial nest observations to determine nest fate. Factors affecting natural inundation events (due to natural hydrology, climate, etc.) are expected to be similar between the different reaches. Therefore, our analysis assumes nest loss due to inundation and natural events would occur in similar proportions (relative to the number of nests occurring) from the tailrace to North Bend as from North Bend to the confluence of the Missouri River.

Out of seven years of data collected from Fremont to the confluence of the Missouri River from 2008-2014, the data showed three years with failed nesting attempts specifically due to inundation. We calculated the total proportion of nests lost to inundation over the 7 years of data to develop the average amount of nest loss occurring solely due to inundation. A significant number of nests failed with a cause “unknown” and those reported as inundated were almost always not physically observed actually being flooded. Even with these limitations, this is the only data set for the Platte River that provides any reasonable estimate of the number of nests lost to inundation. Out of 592 total nests, 101 were lost due to inundation (17.1%) (*Table 9*).

Table 9. Number of nests and nests inundated- Fremont to confluence of Missouri River.

Year	Total number of nests	Total number of nests inundated	% inundated
2008	124	0	
2009	228	50	
2010	22	5	
2011	96	46	
2012	56	0	
2013	53	0	
2014	13	0	
Total	***592***	***101***	***17.1%***

We used the total number of nests recorded for 2008-2014 for the Lower Platte River at North Bend to predict the number of nests inundated from the tailrace to North Bend. A total of 58 nests (see *Table 7*) occurred over the seven year period but surveys did not occur during 2013. Therefore, we multiplied 58 (# nests) * 0.17 (ave. of 17 percent of nests inundated on Lower Platte River) to obtain the estimated number of nests lost over the entire 6 years when data was collected; this equates to 9.9 nests. We divided 9.9 by 6 (the number of years) to get 1.66 which we estimate is the number of nests/year that are lost to inundation for the lower Platte River from the tailrace to North Bend.

Using predicted inundation probabilities from the NGPC (NGPC 2011) we applied the modeled increase in the probability of inundation from Current Operations (hydrocycling) relative to run of river (no hydrocycling). Probabilities were reported for different representative benchmark flows at North Bend. We used the highest probability increase reported to calculate the maximum amount of inundation resulting from hydrocycling. The highest increase (difference between hydrocycling and normal run-of-river) in probability of inundation (0.068) occurred at a 10,000 cfs benchmark flow. The inundation probability increase (percent occurrence) was used as a surrogate for the proportion of inundated nests caused by hydrocycling. In relating the probability of inundation increase to existing estimated nests lost, we calculated the amount of the inundated nests that might be specifically related to hydrocycling as a result of Current Operations (1.66*0.068). Using this method, an estimated 0.11 nests/year would be lost from inundation as a result of hydrocycling under Current Operations.

For this Opinion, the Service expects that within day variability in streamflow under the Staff Alternative will be similar to that under Current Operations at the Project tailrace return, but the within day variability in streamflow under the Staff Alternative will experience greater attenuation rates at downstream locations in the Lower Platte River because of the reduced volumes available for power production under the Staff Alternative. In particular, Articles 405 and 406 have the greatest reductions water available for power production which is in effect for the March 1 through July 1 timeframe (see *Appendix E* for additional information). After July 1, the Service considers effects of hydrocycling under the Staff Alternative to be similar to these effects described for Current Operations.

We recognize there are numerous limitations for this analysis. As mentioned previously, the nest fate data used required assumptions to be made in order to determine nest fate as failed due to inundation. Accurate and reliable nest fate data can only be obtained by repeatedly following up on nests daily or multiple times/week. Obtaining chick survival often times requires marking or banding to measure survival until fledging. Given the inability to consistently monitor all the colonies daily throughout the nesting season, we acknowledge that the data makes assumptions and that these assumptions may limit accuracy. While the data may be best served for analyzing baseline trends as opposed to rigorous scientific analyses, it serves as the only and best available data.

We acknowledge that a study was undertaken by District to analyze this relationship between Project hydrocycling and nest inundation. The NGPC (2011) specifically pointed out the following assumptions that may limit the study and the Service concurs: 1) the study did not appropriately set benchmark flows; 2) the study used a single point value for nesting distribution in place of multiple values; 3) the period of time needed for successful nesting was not appropriately applied for least terns and piping plovers. NGPC described an alternative study in which the above nest inundation probabilities were developed. We selected and used the NGPC Inundation probability analyses and believe it constitutes as the best available scientific and commercial data available.

Tailrace to North Bend - Feeding and Fitness

Daily releases from the tailrace likely provide for sufficient flow within the river under nearly all conditions. Forage fish would be expected to have some flow or pools where they could survive between hydrocycles. Considering that the majority of the flow volume diverted from the Loup River is returned and present throughout this reach, we do not expect foraging or fitness throughout this segment to adversely affect the Interior least tern's ability to forage or its fitness.

Tailrace to North Bend - Sheltering

See previous discussion on shelter within the Loup River segment. Based on the previously described information, knowledge that natural predation occurs (not resulting from Current Operations) and a lack of documentation that predation has occurred on the Lower Platte River specifically due to Current Operations, we expect the following: 1) the Staff Alternative will result in decreased predator access when compared to the existing conditions due to increased base flows and the potential for higher flows capable of widening the river; 2) the Staff Alternative will result in increased predator access when compared to the environmental baseline, which would have even higher flows and wider widths. We also acknowledge that some level of natural predation will continue under all three scenarios (Staff Alternative, current conditions, and environmental baseline).

River Reach - North Bend to the Confluence of the Missouri River

From North Bend to the confluence of the Missouri River, hydrocycling would continue to have a potential adverse effect related to inundation of nests/chicks but this effect would attenuate as the water moves downstream. However, we do not expect measurable differences in the amount of nesting habitat throughout this segment when comparing the Staff Alternative to the environmental baseline. At the Highway 64 Bridge near Leshara, geomorphic changes begin to affect key habitat characteristics including island height and size, channel width, and presence of large wooded islands within the Lower Platte River. Changing valley widths, increasing annual rainfall further to the east, and tributary inputs from the Elkhorn River and Salt Creek contribute to higher flows and sediment loads. These changes play critical roles in the characteristics of nesting habitat found below Leshara. Larger and more frequent sandbars with larger Interior least tern colonies are observed. The observed increase in Interior least tern nesting may be explained by the changes in key habitat characteristics. These morphologic characteristics are likely to remain similar under both the environmental baseline (no hydrocycling) and the Staff Alternative (hydrocycling present) for this segment.

North Bend to the Confluence of the Missouri River - Reproduction

As mentioned previously, we determined adverse effects to the amount of nesting habitat below North Bend, resulting from the Staff Alternative were minimal when compared to the environmental baseline. Therefore, we do not expect a reduction in least tern nesting habitat or nesting numbers from North Bend to the Missouri and Platte Rivers confluence.

Hydrocycling continues to persist downstream of North Bend to the Missouri and Platte Rivers confluence. We applied this same methodology using NGPC inundation probabilities (NGPC (2011) to predict the amount of inundation from hydrocycling that would be expected. We added the nests documented from North Bend to Fremont (*Table 10* - 59 nests in 7 years) to the existing 592 nests (see Table 9) from the same 7 years of surveys that were conducted from Fremont to the Missouri River to obtain the total number of nests downstream of North Bend. This resulted in a total of 651 nests. The same inundation factor used upstream of North Bend was applied (17 percent) to estimate 111 nests (0.17 x 651) would be flooded over 7 years or 15.9 nests/year. Using the same predicted inundation probability factor of 0.068, we estimate an average of 1.08 nests/year would be lost due to hydrocycling operations under existing conditions.

We recognize that the effect of hydrocycling is attenuated as it proceeds downstream and would have less impact on habitat. Specifically, the mean difference between the daily maximum and minimum stage is reduced 2-6 inches (range 0.18 ft. for wet year to 0.53 ft. for dry year) moving from North Bend to Louisville (FERC 2014). Given that the inundation probabilities were calculated for North Bend hydrograph, we expect that this calculation represents the maximum likelihood of effect relative to the amount of take that is likely to occur due to inundation resulting from the Staff Alternative.

In considering this information related to the Staff Alternative, we expect adverse effects through inundation of Interior least tern nests will occur as a result of hydrocycling and over the course of the 30 year license. Inundation would result in loss of nests, eggs, and/or chicks. However, based on this analyses and a lack of direct observation or evidence of inundation directly resulting from hydrocycling, we expect these adverse effects to be very infrequent and low in number.

Table 10. Lower Platte River Nests - North Bend to Fremont

Year	Total number of nests
2008	20
2009	18
2010	0
2011	10
2012	6
2013	0
2014	5

North Bend to the Confluence of the Missouri River - Feeding and Fitness
The Lower Platte River has sufficient flow to support forage fish under all conditions within this reach. Interior least tern foraging and fitness would not be adversely affected within this segment. See previous discussions.

North Bend to the Confluence of the Missouri River - Sheltering
The Staff Alternative will have no effect on shelter throughout this segment. Daily fluctuation in flows due to hydrocycling is attenuated more throughout this segment and effects on habitat conditions specific to shelter (channel width, water depth) are unlikely to be effected by the Staff Alternative throughout this reach. Natural predation will continue. See previous discussions on shelter throughout other segments for further information.

4. North Sand Management Area

The persistence and characteristics of the North SMA are heavily dependent upon the District's operations and operations of its tenant, Preferred Sands of Genoa, LLC (Preferred Sands). The District diverts Loup River water into the settling basin where sediment accumulates. After sediment has been removed, the District moves water back through its system and returns it to the Lower Platte River at the tailrace. Every spring and fall, sediment is dredged from the settling basin and pumped through pipes uphill to a large network of sand piles (Brown, personal communication, 2015). Dredging and pumping sand has been occurring over the last 80-90 years and as a result large sand piles have developed. Dredging has not only kept the canal open but has resulted in the generation and regeneration of Interior least tern nesting habitat through the creation of these sand piles. Preferred Sands sorts and mines these sand piles for select material sizes that are sold to commercial interests. Waste sands are discarded by Preferred Sands back on the property at a different location. The District stops dredging when piping plovers first arrive in the spring while Preferred Sands continues operations throughout the nesting season.

Under the environmental baseline, the District would no longer divert water from the Loup River into the power canal and settling basin. Dredging and deposition of sand onto the North SMA would no longer be necessary and thus, this action would cease to exist. We predict that

Preferred Sands would continue mining for some indefinite period of time until they have mined and sorted through existing sand and removed preferred sediment sizes. The North SMA would initially continue providing habitat and nesting production. However, without the District's dredging operations, nesting habitat would no longer be generated and regenerated as Preferred Sands continues mining it. We expect this to begin decreasing the amount and quality of nesting habitat as vegetation encroaches into areas currently providing nesting habitat. Within 3-5 years, we expect the North SMA will no longer provide Interior least tern nesting habitat or production. Under the Staff Alternative, the District will continue its dredging operations and nesting habitat will continue to be generated and regenerated. Additionally, Article 414 states:

Tern and Plover Monitoring Plan

> *…(3) a management plan for the North Sand Management Area (SMA), that includes (a) policies and procedures for ensuring that project dredging and sand removal operations will not adversely affect interior least terns or piping plovers nesting in the 20140522-3059 FERC PDF (Unofficial) 05/22/2014 North SMA; (b) protection, mitigation, and enhancement measures to be implemented in the North SMA to ensure that it remains viable as a source of off-river nesting for least terns and piping plovers; and (c) a schedule to periodically update the plan.*
>
> *The licensee shall prepare the plan after consultation with the U.S. Fish and Wildlife Service and Nebraska Games and Parks Commission. The licensee shall include with the plan documentation of consultation, copies of comments and recommendations on the completed plan after it has been prepared and provided to the agencies, and specific descriptions of how the agencies' comments are accommodated by the plan. The licensee shall allow a minimum of 30 days for the agencies to comment and to make recommendations before filing the plan with the Commission. If the licensee does not adopt a recommendation, the filing shall include the licensee's reasons, based on project specific information.*
>
> *The Commission reserves the right to require changes to the plan. Implementation of the plan shall not begin until the licensee is notified by the Commission that the plan is approved. Upon Commission approval, the licensee shall implement the plan, including any changes required by the Commission.*

These long term protective measures are included within the Staff Alternative to protect, maintain and enhance (where appropriate) the nesting habitat free from the threat of anthropogenic disturbances, under the Staff Alternative; therefore, the North SMA is expected to continue increasing Interior least tern nest production over what would be occurring at the North SMA under the environmental baseline. The proximity of disturbance and potential for lethal loss of eggs/chicks as well as the non-lethal loss to adult reproduction is not completely eliminated but unlikely to occur. Protective measures at the North SMA contained within draft Article 414 will reduce adverse effects, making take less likely to occur. Memoranda of understanding (MOUs) between gravel mining operators, the Service, and NGPC have been used at many locations to demonstrate that the mining activities themselves, when operating using a set of best management practices, can avoid adverse effects. The Service is a signatory on these

MOUs and our written approval ensures adequate considerations are given to terns and plovers, further reducing and eliminating the risk of take. Therefore, we anticipate production at the North SMA under the Staff Alternative to remain similar or consistent with Current Operations which are substantially improved when compared to the environmental baseline, given that habitat would eventually diminish under the environmental baseline.

North Sand Management Area - Reproduction

For consistency, we analyzed nesting data collected during the same period of record as the analysis on the Lower Platte River (2008-2014). This is the most recent available data and also corresponded to the time when an MOU was developed to aid in protecting and maintaining the area to consistently provide habitat and monitoring while avoiding adverse effects from mining operations. Given the terms of Commission Article 414 provided above, and information regarding the MOU, this period appears to be the most appropriate in estimating the habitat conditions and number of nests we expect under the Staff Alternative going forward. From 2008-2014, 112 Interior least tern nests were documented at the North SMA, averaging 16 nests/year.

We also looked specifically at data collected for 2009-2012 since that coincided with our data collection period for the Loup River. During this period, the North SMA averaged 14 tern nests/year. Under the environmental baseline zero nests would be expected.

We compared these to the average for the North SMA over all years where data exists (Assessment, Table 38). Since 1987, the North SMA averaged approximately 12 nests/year (*Table 11*). It is unknown what level of effort was undertaken in nest monitoring from 1987-1992 and monitoring did not occur from 1992-2008. Nesting has been occurring at this location every year since monitoring has occurred. Data from the overall period indicates that the data from 2008-2014 is not outside of the range expected or observed within historic period of record.

Table 11. **Interior Least Tern Nests at the North SMA**

Year	NSMA nest count
1987	23
1988	13
1989	4
1990	3
1991	0
1992	3
2008	17
2009	14
2010	22
2011	13
2012	6
2013	18
2014	22

North Sand Management Area - Feeding/Fitness
The Staff Alternative for the North SMA is unlikely to have any effect on foraging or fitness. Interior least terns routinely select and use riverine habitats in close proximity over sandpits. We anticipate Interior least terns would forage on the Loup River. See previous discussion of effects on foraging for the Interior least tern on the Loup River.

North Sand Management Area - Sheltering
Predation has likely been occurring and mammalian and avian predator presence has been detected at or near the North SMA. Nest success is not believed to be limiting production at the North SMA, however, improvements to existing habitat conditions could lead to improved Interior least tern productivity. Specifically, a limited amount of shade, cover and access to a fresh water source in close proximity to chicks are factors that may affect Interior least tern chick survival at the North SMA, though we do not have direct evidence that this is currently limiting survival.

Summary of Effects
When comparing effects of the Staff Alternative to the Environmental Baseline for all areas within the Project action area, we combined the estimated reduction in nesting at the Loup River Bypassed Reach, Platte River Bypassed Reach and Lower Platte River (tailrace to North Bend), and compared it with the estimated increase in nesting under the Staff Alternative at the North SMA. Below North Bend, we do not anticipate the Staff Alternative will adversely affect the number of Interior least tern nests. Under the Staff Alternative, we anticipate that the Loup River Bypassed Reach will result in a maximum average *decrease* of approximately 6 nests/year, the Platte River Bypassed Reach to result in a maximum average *decrease* of approximately 1 nest/year, and the Lower Platte River (tailrace to North Bend) to result in a maximum average *decrease* of approximately 7 nests/year. Likewise, under the Staff Alternative, we estimate the North SMA will continue resulting in an average *increase* of 16 nests/year. Therefore, we anticipate the combined effect of the Staff Alternative on all reaches will result in an increase of 2 nests/year when compared to the Environmental Baseline. Given that a maximum likelihood of effect was most often used in calculating the difference in nesting between the Staff Alternative and the Environmental baseline, we do not expect the Staff Alternative to result in a reduction in the number of Interior least tern nests.

The reported reduction in the number of nests on the Loup and Platte Rivers within the Project action area is not indicative of an actual reduction in nests, chicks or young at the local or regional population level. These reductions to on-river nesting habitat (and the coincident reduction of nests) within the Project action area affect individuals within the breeding population (Upper Missouri River South), thus requiring them to shift their breeding to another location. Within the Project action area, other available habitat has been created at the North SMA under the Staff Alternative. The net effect to breeding habitat and nesting numbers for the regional population (Upper Missouri River South) under the Staff Alternative is neutral as it results in similar quantities of nesting habitat and corresponding nests within the action area and within the region. The adverse effects (inconvenience of flying to a nearby location to breed) at the individual level are considered minor and inconsequential. This adverse effect does not rise to the level of "take" as defined under the Act; to be considered take, this habitat modification must result in harm to Interior least terns by *significantly impairing* essential behavioral patterns such as breeding, feeding, or sheltering. Interior least terns are strong flyers and there is ample evidence of regional population redistribution to exploit high-quality nesting habitat (Lott et al. 2013). Lott et al. (2013) furthers explains that the ability of Interior least terns to respond rapidly to changing environmental conditions allows for recolonization of former breeding areas or range expansion when habitat restoration and other anthropogenic activities (such as that which occurs at the North SMA) create suitable habitat in new areas.

We expect hydrocycling to adversely affect nest success and chick survival. The effect is more pronounced close to the tailrace but significantly more nesting occurs downstream from Fremont to the confluence with the Missouri River. We estimate a small amount of harm in the form of egg or chick death is expected from inundation resulting from Project hydrocycling operations. This is expected to be infrequent and low in numbers. Under the Staff Alternative, we estimate 1.19 nests/year would be lost to inundation. This estimate accounts for inundation above that expected to occur naturally under the Environmental Baseline. The species is adapted to re-nest to offset nest and chick failure resulting from inundation; available evidence indicates the Platte River population of Interior least tern is relatively stable, further supporting the assertion that the proposed Project is not likely to appreciably reduce survival and recovery of the species in the wild.

IVD. Interior Least Tern - Cumulative Effects

Cumulative effects include the effects of future State, local, or private (non-federal) actions that are reasonably certain to occur in the action area considered in this biological opinion. A nonfederal action is "reasonably certain" to occur if the action requires the approval of a State or local resource or land-control agency, such agencies have approved the action, and the project is ready to proceed. Other indicators which may also support such a “reasonably certain to occur” determination include whether: a) the project sponsors provide assurance that the action will proceed; b) contracting has been initiated; c) State or local planning agencies indicate that grant of authority for the action is imminent; or d) where historic data have demonstrated an established trend, that trend may be forecast into the future as reasonably certain to occur. These indicators must show more than the possibility that the non-federal project will occur; they must demonstrate with reasonable certainty that it will occur. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act and would be consulted on at a later time.

Off-Road Vehicles and Airboats

The use of ORVs at nesting sites can harass and/or harm Interior least tern chicks and adults (Brown et al. 2011). Nest loss and destruction of eggs can also be caused by ORV use. Primary use of ORV’s on Nebraska rivers is for recreation (Brown et al. 2011). High ORV use in the Loup River Bypassed Reach was documented on islands where least tern nests were present (FWS 2012). Local and/or private ORV use is reasonably certain to occur in the action area. Additionally, frequent airboat use occurs on the Loup River and to a lesser extent within the lower Platte River. On the Loup River, annual races are held and large numbers of airboats and recreational visitors congregate on specific segments of the river (http://thunderontheloup.com/). Nest, chicks and adults can be exposed to a variety of effects ranging from lethal loss to non-lethal harassment. Given historic use, we believe airboat use is reasonably certain to occur in the action area.

Under the Staff Alternative, Project diversions into the Loup Power Canal would reduce flows within the Loup River Bypassed Reach during the nesting season (compared to the environmental baseline). Lower streamflow increases ORV access to sandbars which may contain nesting sites. Increased ORV access can result in increased harm and/or harassment of adults, chicks, and eggs. The Staff Alternative will increase the amount of flow relative to Current Operations and is expected to decrease the number of years where ORV access is possible (compared to present condition). However, given past incidences of ORV use, it is likely that ORV use will continue under the Staff Alternative.

Sand and Gravel Mining Operations
Sand mining occurs frequently throughout Nebraska and is expected to continue within the foreseeable future (Brown et al. 2011). Nebraska contains aggregate material along the Loup River and Platte River. We anticipate sand mining to continue expanding and new locations and sites will be developed. Additional sand mines, if actively managed for least tern and piping plover could supplement existing populations (Brown et al. 2011). If not managed and protected, these areas can also act as a source of disturbance and lethal take. Abandoned sand mining sites are often converted into housing developments which maintain bare sand for recreational beaches. These too can positively or negatively affect Interior least tern's depending upon management and protective measures (Brown et al. 2011). We expect both positive and negative impacts to Interior least tern will occur in the future resulting from new or expanded sand and gravel mining or housing developments. MOU's have been developed and used with many gravel mines or housing locations to avoid take of Interior least tern nests, chicks and adults. We anticipate existing and similar agreements to continue to exist.

IVE. Interior Least Tern - Conclusion

After reviewing the current status of the Interior least tern, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects, it is the Service's opinion that the proposed Project is not likely to jeopardize the continued existence of the Interior least tern. To "jeopardize the continued existence means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR §402.02). No critical habitat has been designated for this species; therefore, none would be affected. Our determination is based on the following primary factors.

- Since listing in 1985, reported numbers of nesting Interior least terns have expanded from greater than 2,000 to approximately 18,000 individuals, and the documented range has increased. This overall population estimate from 2012 (~18,000) is more than double the objective outlined within the Interior least tern recovery plan. Currently, nesting colonies are known to occur in all major drainages where the species historically nested, and available monitoring data indicates most of these drainage populations are stable or increasing. Species' range and numbers have expanded over the past three decades.

- The Project action area is entirely contained within the Platte River basin. The species has persisted in the Platte River drainage since listing, and the 2012 count (665 birds) exceeded the 1988 recovery plan benchmark (635 birds). Recently, the Service concluded in its 5-year Review of the Interior least tern that the Platte River habitat has been successfully managed and protected (USFWS 2014). Within the Project action area, Interior least terns represent a subset of the population using the Platte River basin, which contains 4 percent of the overall population.

- A small amount of take in the form of harm causing egg or chick death is expected from inundation resulting from hydrocycling operations (an average of 1.19 tern nests per year). Interior least tern nests typically contain 3 eggs or chicks. Therefore, this equates to 107 eggs or chicks over the life of the 30 year license (1.19 * 3 * 30). Adult interior least terns are excluded from the take estimate because flying birds can escape the rising water. This amount of egg and chick loss is considered to be of low magnitude and occurring infrequently (compared to natural egg and chick loss for the species); about six nests containing 3 eggs every 5 years. We conclude that the small reduction of eggs or chicks within the action area due to Project hydrocycling under the Staff Alternative, is not likely to meaningfully change the reproduction, numbers and distribution range-wide for the interior least tern population for the following reasons: 1) the Loup River and Lower Platte River populations are relatively stable; 2) the overall population of least terns is increasing or stable with population levels far exceeding the overall recovery objectives; and 3) the species is well adapted to offset nest loss from inundation. Therefore, the staff alternative is not likely to appreciably reduce survival and recovery of the species in the wild.

- When compared to the Environmental Baseline, nesting numbers and habitat conditions under the Staff Alternative will likely equal or exceed the average number of Interior least tern nests within the action area; this is due to the contribution of nests resulting from the North SMA as well as an expected increase in nesting on the Loup and Platte Rivers due to proposed flow modifications under the Staff Alternative. Within the action area, populations appear to be stable but highly variable between years. Specifically, Under the Staff Alternative, there will be a reduction in the total number of nests occurring in the following river reaches: a) reduction of 6 nests/year on the Loup River Bypassed Reach; b) reduction in 1 nest/year on the Platte River Bypassed Reach; and c) reduction in 7 nests/year on the Lower Platte River. Conversely, there will be an increase in the number of nest (16 nests/year) in the North SMA. This reduction of the number of nests in specific river reaches within the action area is not indicative of an actual reduction in nests, chicks or young at the local or regional population level. Alternatively, these reductions to on-river nesting habitat (and the coincident reduction of nests) within the action area affect individuals within the breeding population (Upper Missouri River South) by requiring them to shift their breeding to another location. This affect does not rise to the level of take as it does not significantly impair breeding, feeding or sheltering. Instead, it results in a redistribution of reproduction to nearby locations (e.g. North SMA). Within the action area, habitat quantity is expected to be similar or increased under the Staff Alternative. While the habitat redistribution will affect the location of breeding, this change within the action area in not likely to meaningfully change the reproduction, numbers, and distribution range-wide for the interior least tern.

- The cumulative effect of disturbance or lethal loss of Interior least terns due to housing developments, ORVs, airboats and sand/gravel mining operations may reduce Interior least tern production within any given year. Given the species ability to adapt and use a variety of different habitats where disturbance is frequently encountered, we do not expect this level of disturbance to have a significant effect on survival and recovery of the species at the local or range-wide population level.
- Commission license articles or conservation measures are included as part of the proposed Project and are a factor that is used by the Service to inform its jeopardy/non-jeopardy opinion. Commission draft articles or conservation measures under the Staff Alternative included as part of the proposed Project, would likely result in a net increase in Interior least tern habitat and reproduction. Thus, these conservation measures will contribute to the likelihood of survival and recovery of the Interior least tern.

In summary, within the context of a stable or increasing populations in this portion of the species range and an overall population exceeding recovery objectives, we conclude that implementation of commission articles combined with an increase in the amount and shift in the location of Interior least tern habitat and nesting, and a small amount of egg or chick death due to inundation caused by hydrocycling, will not reduce appreciably the likelihood of survival and recovery of the species.

V. PIPING PLOVER

VA. Piping Plover – Status of the Species/Critical Habitat

<u>Species Description</u>

The piping plover is a migratory shorebird of the family Charadriidae. Adult birds weigh between 1.5 to 2.2 ounces (43 and 63 grams), are 6.7 to 7.1 in long (17-18 cm), and have a wingspan 4.3 to 5 in long (11.0-12.7 cm). Both sexes are sand-colored with white undersides, and the legs are orange. During the breeding season, adults develop an orange bill, and a single black forehead band and breast band. In general, males have more complete bands than females, and inland birds have more complete bands than Atlantic coast birds (Prater et al. 1977, Haig and Oring 1988a). Breeding birds lose the orange bill and bands after the breeding season, but are easily distinguished from related plover species by their slightly larger size and orange legs (Prater et al. 1977). Juvenile plumage is similar to adult nonbreeding plumage (USFWS 1988a). Juveniles acquire adult plumage the spring after they fledge (Prater et al. 1977) (USFWS 2000).

<u>Life History</u>

<u>Reproductive Biology:</u> Piping plovers are territorial shorebirds that spend three to four months at breeding sites in the northern U.S. and southern Canada. Piping plovers begin arriving on the breeding grounds in late April and early May. Adults may return to the same nest areas in succeeding years (Wilcox 1959, Cairns 1982, Haig and Oring 1988b, Wiens and Cuthbert 1988). Courtship behavior includes aerial flights, digging of several nest scrapes, and ritualized stone-tossing (Cairns 1977, 1982; Haig and Plissner 1993). Piping plovers exhibit a predominantly monogamous mating system, although mate switching may occur during the breeding season (Haig and Oring 1988a) or between years (Wilcox 1959, Wiens 1986, Haig and Oring 1988a) (USFWS 2000). Haig and Oring (1988a) found that new pair-bonds are established from year-to-year regardless of previous nesting success.

Nest initiation may begin by late April and continue until early July (USACE 1998). Finished nest scrapes or bowls are shallow depressions approximately 0.8 in deep (2 cm) and 2.4 in in diameter (6 cm) and frequently lined with small pebbles or shell fragments (USFWS 1988a). Both adults actively defend the nesting territory. Egg laying typically begins the second or third week of May. Females lay an egg every other day until a four-egg clutch is complete. Both sexes share incubation responsibilities, which can last for 25 to 31 days (Wilcox 1959; Cairns 1977; Wiens 1986; Haig and Oring 1988a; USFWS 2000).

Eggs within a clutch typically hatch within four to eight hours of one another, but the hatching period may be delayed up to 48 hours (USFWS 1988a). Piping plover chicks are precocial, leave the nest almost immediately, and are able to feed themselves within a few hours. Males and females both defend and brood the chicks until they fledge. Adults will accompany the chicks and lead them to and from foraging locations, provide shelter during inclement weather, and attempt to protect them from predators (Wilcox 1959; Cairns 1982). Most adults raise only one brood of up to four chicks per nesting season, although one pair in Nebraska raised two broods (Lingle 1990). Upon the loss of eggs or newly hatched chicks, a pair may renest up to four times. Renesting efforts characteristically result in fewer than the typical four eggs being produced (Lingle 1988; USFWS 1988a). Reproductive maturity is reached the year following fledging, but little information indicating reproduction by first-year birds on the Great Plains is available (Kruse DATE, pers. comm.).

By July and August, piping plovers begin fall migration (Cairns 1982; Prindiville-Gaines and Ryan 1988). Breeding adults in Minnesota were observed departing the nesting grounds as early as mid-July and the majority had left by early August (Wiens 1986). Juveniles departed a few weeks later and had largely disappeared by late August (Wiens 1986). Adult males in Manitoba were observed to remain with broods until after fledging and were frequently seen moving into nonbreeding flocks with their chicks (Haig 1987; USFWS 2000).

Growth and Longevity: Time from hatching to fledging is estimated to be approximately 21 days in Nebraska (Wilson DATE, pers. comm.). Current estimates of piping plover survival rates are limited, although a mean annual survival rate of 0.664 was estimated for the northern Great Plains population (NGP) (Root et al. 1992). Recent studies indicate that overwinter survival can be very high (Drake 1999). In New York, in the 1930s through 1950s, 13 percent of 149 females and 28 percent of 139 males lived to at least age 5; twelve of those lived at least 8 to 11 years (Wilcox 1959; USFWS 2000).

Movement and Dispersal Patterns: Several banding efforts of NGP piping plovers have occurred along the Missouri and Platte rivers in Nebraska. Lingle (1993) banded least terns and piping plovers between Lexington and Grand Island, Nebraska, from 1984 to 1989. He found distances of nesting birds from their banding origin extended from 0 to 200 km for piping plovers (based on 71 sightings of 57 individuals). Lingle (1988) confirmed the movement of piping plovers upstream and downstream in the Platte River valley. Along the lower Platte River, 426 piping plovers nesting at off-channel sand and gravel mines have been individually color-banded since 2008 by the NGPC and TPCP; 5 chicks were marked with aluminum tags only on lower Platte River sandbars in 2009 (Brown et al. 2014). Of the 332 plovers banded along the lower Platte River prior to 2014, 111 (33 percent) have been re-sighted during the breeding season at least one year after they were banded; 93 (28 percent) returned to nest along the lower Platte River, 15 (5 percent) were observed nesting on the Missouri River, and 3 (1 percent) were observed nesting on the Niobrara River. A majority (62 percent) of the lower Platte River plovers that returned to the lower Platte River to nest were originally banded as adults; a majority (94 percent) of the lower Platte River plovers reported nesting outside the lower Platte River study area were originally banded as chicks (Brown et al. 2014).

Piping plovers winter along the Gulf and southern Atlantic Coasts, as well as in eastern Mexico and some Caribbean Islands. Banded piping plovers from the NGP and Canada Prairie have been observed in virtually all the southern states, most have been reported along the Gulf Coast (Haig and Oring 1988b). Piping plovers color-marked along the lower Platte River have be re-sighted during the non-breeding season from the southern tip of Texas to the Florida Keys and north along the Atlantic Coast to South Carolina (Brown et al. 2013). Four of the re-sighted plovers were the first piping plovers from the lower Platte River to be documented along the Atlantic Coast during the winter.

Nesting Habitat Characteristics: Piping plovers are semi-colonial and nest on sparsely vegetated sandbars, aggregate mining spoil piles, and reservoir shorelines. Nesting habitats on the Platte, Niobrara, Loup and Missouri rivers typically are dry sandbars located midstream in wide, open channels, with less than 25 percent vegetative cover (Faanes 1983; Schwalbach 1988; Ziewitz et al. 1992). The optimum range for vegetative cover on nesting habitat has been estimated at 0 to 10 percent (Armbruster 1986), and Ziewitz et al. (1992) noted vegetated cover on nesting islands was usually less than 25 percent. Schwalbach (1988) and Ziewitz et al. (1992) suggest that birds select a higher nest site when available and sites located away from the water's edge. Those conditions provide the essential requirements of wide, horizontal visibility; protection from terrestrial predators; isolation from human disturbance; and (when sandbars are of sufficient height) sufficient protection from rises in river levels (USFWS 2000 and 2003a).

Much of the natural river sandbar habitat has been lost due to human-caused, broad-scale changes to natural river systems on the Great Plains. The amount of suitable river sandbar habitat has been reduced by construction of dams and reservoirs, the presence of invasive plant species, river channelization, bank stabilization projects, hydropower generation, and water diversions. Along the Platte, Loup, and Elkhorn rivers in Nebraska, piping plovers also nest on human-created habitats outside the river channel, such as sand and gravel mines, dredge spoil piles, and construction sites (Brown et al. 2014). The decrease of suitable river sandbar habitat and the increase in man-made off-channel habitat has resulted in the piping plover nesting on both habitat types in Nebraska. Although off-channel habitats offer alternative nesting sites during years when river sandbars are limited, they are unlikely to serve as long-term substitutes for riverine nesting habitat (Brown et al. 2014).

Currently, along the Platte and Loup rivers in Nebraska, the majority of piping plovers nest on these off-channel habitats. Additionally, during the prolonged drought in the early 2000's, and consequent low water levels, up to 236 pairs of piping plovers nested on the newly exposed sandy beaches at Lake McConaughy on the North Platte River (Central Nebraska Public Power and Irrigation District 2007), although nesting piping plovers and their chicks were adversely affected by recreational activities at the lake. As with other off-channel habitats, the non-vegetated expanse of dry sand at Lake McConaughy was temporary, and disappeared through a combination of re-vegetation and rebounding water levels in 2010.

Food and Foraging: Diet and foraging behavior are not well studied, largely because the species' status and sensitivity to disturbance have precluded the collection of birds for stomach contents analysis (USFWS 2000). Open, wet, sandy areas provide feeding habitat for plovers on river systems and throughout most of the bird's nesting range. Piping plovers forage visually for invertebrates in shallow water and associated moist substrates (Cairns 1977; Cuthbert et al. 1999; Whyte 1985). Along the central Platte River, prey consists primarily of beetles and small soft-bodied invertebrates from the waterline and opportunistically-taken prey from dryer sites at sandpits (Lingle 1988).

Corn and Armbruster (1993a and 1993b) identified several patterns of invertebrate distribution and abundance of significance to piping plover foraging and breeding success. Although the food base is similar taxonomically between sandbars and spoil piles, invertebrate catch rates and densities are higher on river channel sites. Invertebrates are distributed more or less uniformly across riverine foraging habitat, but decline with increasing distance from the water's edge at sand pit locations. Invertebrate catch rates increased more dramatically over the course of the summer on riverine sites than on sand pit sites. These patterns of invertebrate occurrence translated into greater foraging activity on river channel sites even when birds nested off the river (Corn and Armbruster 1993b). Their research emphasizes the importance of river channel habitat for foraging. Lingle (1988) observed banded piping plovers known to be nesting at sandpits foraging 0.5-mile away in riverine habitat.

Substrate moisture most likely explains the differences in invertebrate catch rates between the river and spoil pile sites. The dominant invertebrate taxa collected from both sites were shore-inhabiting and semi-aquatic species associated with moist, sandy environments. Piping plover foraging activity correlates with moisture of the foraging substrate. Piping plovers using aggregate mining locations concentrated their foraging effort along sand pit shorelines, where substrate moisture was highest. Piping plovers foraging on river channel sites, where substrate moisture did not vary as much with distances from the water's edge, tended to forage at all distances from the water's edge. Aggregate mining locations likely had lower invertebrate abundance of dominant taxa because of reduced area of moist sand on sand pit shorelines relative to river channel shorelines (Corn and Armbruster 1993b).

Food availability can be critical to the survival and reproduction of piping plovers. Chick mortality is correlated with reduced growth rates (Cairns 1982), potentially a result of reduced prey availability. Piping plover chicks studied on the Atlantic coast typically tripled their weight during the first two weeks after hatching; and chicks that failed to achieve at least 60 percent of this weight gain by day 12 were unlikely to survive (USFWS 1996a). During the breeding season, energy demands on shorebirds are typically higher than intake rates (Ashkenazie and Safriel 1979), and even on the best of foraging habitats, breeding shorebirds may not be able to forage efficiently enough to meet those demands (Evans 1976). In areas where invertebrate densities are not high, lowered feeding efficiency (Goss-Custard 1977a and 1977b, Connors et al. 1981) exacerbates the energy deficit during the breeding season.

Sightings of color-banded piping plovers (N=19) by Lingle (1988) revealed movement and dispersal patterns; in about 80 percent of the observations, birds moved from sand pit to riverine sites. Post-fledging chick movements were generally to the river from sand and gravel sites. The exception was when high flows forced the birds off the river to the spoil piles. Once chicks attain flight, they accompany adults to the river (Lingle 1988).

Population Dynamics

<u>Population size:</u> The 1988 recovery plan listed a recovery criterion based on maintaining 1,300 pairs for the NGP. Although recent annual survey numbers suggest that the NGP population has been at or close to 1,300 pairs since 2004, this number is likely a high estimate (USFWS 2009). Along the Missouri River (with up to 70 percent of the NGP), the U.S. Army Corps of Engineers (USACE) counts adult birds and divides by two instead of counting pairs. The USACE does not track pairs because of the vast area being surveyed and the difficulty in differentiating pairs

where there are a large number of densely nesting birds. This method likely overestimates pairs, as it does not take into account nonbreeding birds. Studies have estimated that the percent of nonbreeding birds ranges from 10 to 34 percent (Prindiville 1986; F. Cuthbert, University of Minnesota, in litt. 2009). Thus, by incorporating the low correction factor of only 10 percent nonbreeders, USFWS (2009) identified the population goal was met only once, in 2005. If we assume that 34 percent of the birds did not breed, the goal of 1,300 pairs has not yet been achieved. Ongoing studies are expected to help clarify and account for this apparent discrepancy.

The International Piping Plover Census (IPPC), conducted every five years, also estimates the number of piping plover pairs in the NGP. The IPPC provides more complete coverage of breeding habitat than the annual surveys, but the five-year window does not allow for rapid trend evaluation. As illustrated in Table 12, none of the IPPC estimates of the number of pairs in the U.S. suggest that the NGP population has yet satisfied the recovery criterion ideintified in the recovery plan for the species (Plissner and Haig 1997, Ferland and Haig 2002, Elliot-Smith et al. 2009). Collectively, this suggests the numeric portion of the recovery goal remains unmet.

<u>Population variability:</u> Piping plover breeding population levels likely vary from year to year due to differences in water regimes in different areas of the breeding range. When large areas of the Distinct Population Segment (DPS) range experienced exceptionally dry years, an abundance of exposed dry sand may result in increased breeding opportunities. Conversely, when large areas of the DPS range experiences wet summers, river sandbars and the beaches of alkali lakes are inundated. When exceptionally wet summers result in repeated high river flows, as they did on the Missouri River in 1997 and in 2010, nests are likely flooded and reproduction is lower, depending on timing of the high flows. Under very wet conditions, plover nests on the beaches of alkali lakes or reservoirs may also be inundated. Piping plovers will re-nest if high flows occur early enough in the breeding season, and may be successful if inundating flows don't recur. However, when sediment is available, near record river flows build tall sandbars that provide bare sandbar habitat for a couple of years until the sandbars become too vegetated to support breeding plovers. Subsequent erosion of such sandbars may create tall (up to 6 feet), nearly vertical sandbar edges; whether such sandbar morphology complicates or prevents plover chicks' access to water is unknown.

There is little coordination of breeding piping plover surveys across the NGP piping plover range, except during the IPPC surveys at five year intervals. Therefore, it is difficult to determine fine-scale population variability. The base overall NGP piping plover population level necessary to withstand repeated years of low reproduction is not known.

<u>Population stability</u>: The geographic extent of the NGP piping plover range likely ameliorates significant swings in the DPS population to some degree. If heavy rains and high water occur in one or more parts of the range, there may still be suitable nesting areas available in other parts of the range. Under such circumstances, the overall population may remain relatively stable, even though reproduction varies considerably between different portions of the range.

In certain parts of the range, species reproduction may exhibit relative stability at a smaller geographic scale. As discussed above, off-channel nesting habitat along the Loup, Platte, and Elkhorn river systems in Nebraska can, at least temporarily, provide alternate nesting opportunities for piping plovers. The species is known to nest at many off-channel sites and monitoring by the TPCP affords some protection against accidental nest destruction. In 2014, 31 off-channel nesting areas were surveyed for nesting and piping plover and Interior least terns; nesting occurred at 21 of these sites, including the NSMA at the head of the Loup Power Canal. These off-channel nesting sites can help stabilize piping plover reproduction in Nebraska when river nesting habitat is limited.

Status and Distribution

The final listing rule (50 FR 50726), effective January 10, 1986, listed the piping plover as an endangered for states in the Great Lakes watershed (IL, IN, MI, MN, NY, OH, PA, and WI and Province of Ontario) and threatened throughout the remainder of its range. The rule's preamble acknowledged the continuing recognition of two subspecies, *Charadrius melodus melodus* (Atlantic Coast of North America) and *Charadrius melodus circumcinctus* (Northern Great Plains of North America) in the American Ornithologists' Union's treatment of subspecies (AOU 1957). However, the rule also noted that allozyme studies with implications for the validity of the subspecies were in progress. The final rule determined that the species was endangered in the Great Lakes watershed of both the U.S. and Canada and as threatened in the remainder of its range in the U.S. (Northern Great Plains, Atlantic and Gulf Coasts, Puerto Rico, Virgin Islands), Canada, Mexico, Bahamas, and the West Indies (USFWS 1985).

Subsequent Act actions have consistently recognized three separate breeding populations of piping plovers, on the Atlantic Coast (threatened), Great Lakes (endangered), and NGP (threatened). Two successive recovery plans established delisting criteria for the threatened Atlantic Coast breeding population (USFWS 1988a, 1996). A joint recovery plan specified separate criteria for the endangered Great Lakes and threatened NGP (USFWS 1988b), and the Service later approved a recovery plan exclusive to the Great Lakes population (USFWS 2003).

Section 3 of the Act defines "species" to include subspecies and "any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." The best available scientific information, described in USFWS (2009), supports recognition of three separate entities consistent with the Act definition of "species" (*Figure 18*). Piping plovers that breed on the Atlantic Coast of the U.S. and Canada belong to the subspecies *C. m. melodus*. The second subspecies, *C. m. circumcinctus*, comprises two DPSs. One DPS breeds on the NGP of the U.S. and Canada, while the other breeds on the Great Lakes. Each of these three entities is demographically independent. Furthermore, the conservation status of each of the three entities reflects factors affecting it throughout its entire life cycle. Recovery planning and implementation continue to respect the biological integrity of each entity. Because the NGP DPS is consistent with the Act definition of "species", subsequent sections of this Opinion will focus on NGP DPS.

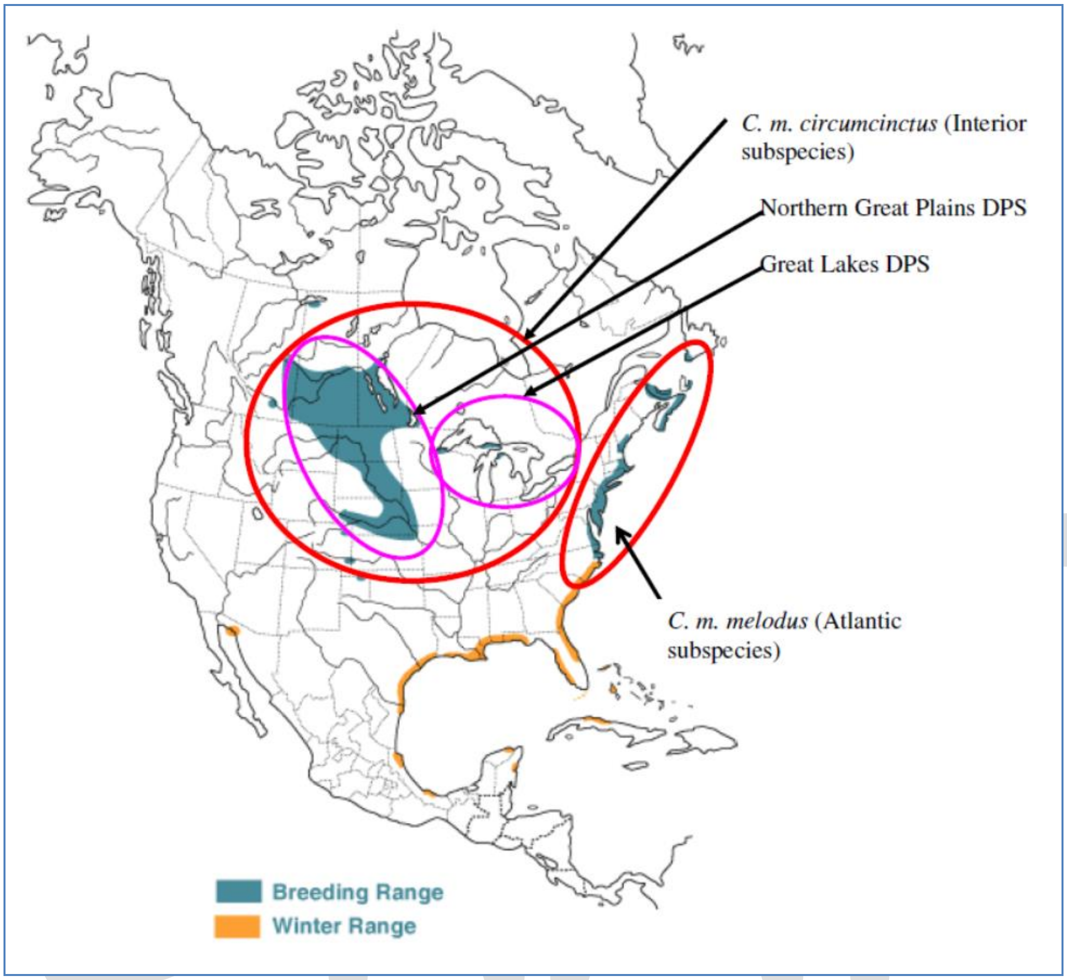

Figure 18. Range of piping plover

<u>Critical habitat for the NGP breeding population:</u> Critical habitat was federally designated for the NGP population on September 11, 2002, (67 FR 57638). Nineteen critical habitat units originally contained approximately 183,422 acres of prairie alkali wetlands, inland and reservoir lakes, and portions of four rivers totaling approximately 1,207.5 RM in Montana, Nebraska, South Dakota, North Dakota, and Minnesota. In October 2005, the critical habitat designation for the piping plover was vacated and remanded for redesignation by the U.S. District Court for the District of Nebraska. Since that time, there has been no effort to redesignate the vacated portion of critical habitat in Nebraska by the Service. All other critical habitat designated for the NGP population of piping plovers remains intact.

Piping plovers nest on off-river habitats in Nebraska, especially along the Platte, Loup and Elkhorn rivers. These alternative habitats include sand and gravel mines, construction sites around lakes created during aggregate mining, and dredge spoil piles.

<u>Rangewide trend:</u> Table 12 shows the approximate number of adult plovers in the NGP (U.S. and Canada) as estimated by the four IPPC surveys. The IPPC indicates that the U.S. population decreased between 1991 and 1996, then increased in 2001 and 2006. The Canadian population showed the opposite trend for the first three censuses, increasing slightly as the U.S. population decreased, and then decreasing in 2001. Combined, the IPPC numbers suggest that the population declined from 1991 through 2001, then increased almost 58 percent between 2001 and 2006 (*Table 12*).

Table 12. The number of adult piping plovers and breeding pairs reported in the U.S. Northern Great Plains by the IPPC efforts. Canadian values and totals are for adult piping plovers only.

	United States NGP		**# Adults in Canada NGP**				**Canada Adults**	**NGP Adults**
Year	**# of Adults**	**# of Pairs**	Alberta	Saskatchewan	Manitoba	Ontario	**Total**	**Total**
1991	2,023	891	180	1,172	80	5	**1,437**	**3,460**
1996	1,599	586	276	1,348	60	3	**1,687**	**3,286**
2001	1,981	899	150	805	16	1	**972**	**2,953**
2006	2,959	1,212	274	1,420	8	1	**1,703**	**4,662**

Source: Plissner and Haig (1997), Ferland and Haig (2002), Elliot-Smith et al. (2009); in USFWS (2009).

The USFWS (2009) concluded that such a large increase in population reported in 2006 may indeed indicate a positive population trend, but with the limited data available, it is impossible to determine by how much. Additional review by USFWS (2009) suggests that despite the likelihood of some population increase between 2001 and 2006, it is unlikely that the population has actually grown to the extent indicated by the IPPC (even with good habitat conditions in the last five years). Rather, a number of other factors may explain the apparent increase. The breeding population may have been under-counted in 2001 and/or over-counted in 2006 (e.g., the tight survey window and large survey area result in participation by less experienced plover surveyors). The IPPC was implemented in 2011 as scheduled, but the results have not yet been published.

<u>Distribution:</u> The 1988 recovery plan listed a recovery criterion based on maintaining 1,300 pairs will be maintained in the following distribution for 15 years (assuming at least three major censuses will have been conducted during this time): 60 pairs in Montana, 650 pairs in North Dakota (including 550 pairs in the Missouri Coteau and 100 pairs along the Missouri River), 350 pairs in South Dakota (including 250 pairs along the Missouri River below Gavins Point (shared with Nebraska), 75 pairs at other Missouri River sites, 25 pairs at other sites), 465 pairs in Nebraska (including 140 pairs along the Platte River, 50 pairs along the Niobrara River, 250 pairs along the Missouri River (shared with South Dakota), and 25 pairs in Minnesota (Lake of the Woods). Overall, the NGP seems to be trending upwards in recent years, but collectively the population targets have not been met. The following state summaries from USFWS (2009) describe the population variability for the NGP DPS.

Montana: The number of pairs in Montana has been near the goal of 60 pairs since 2005 (not less than 56 pairs). Although the goal has been exceeded in a number of years, the target has not been consistently achieved.

North Dakota: The overall North Dakota goal of 650 pairs has been exceeded annually since 2004. This is mostly due to birds on the Missouri River, which has been much greater than the North Dakota goal of 100 pairs since 1998. The North Dakota alkali lakes population is well below the goal of 550 pairs.

South Dakota: The number of pairs surveyed in South Dakota overall has fallen well short of the goal of 350 pairs. The reach below Gavins Point Dam (shared with Nebraska) has been about 100 pairs or more short of the goal of 250 pairs. On other Missouri River sites in South Dakota where piping plovers nest (i.e., Lake Oahe, Fort Randall River reach downstream of Lake Francis Case, and Lewis and Clark Lake), the number of pairs has exceeded the goal of 75 pairs since 2000. Off-river sites in South Dakota have only been checked during the IPPC, or reported by birders on occasion (R. Olson, South Dakota Ornithologists' Union, in litt. 2008). The numbers have fallen well short of the goal of 25 pairs.

Minnesota: Minnesota DNR monitors plovers at Lake of the Woods annually. They attempt to estimate both the number of breeding pairs and non-breeding plovers in the area. The number of pairs has never approached the recovery goal of 25 pairs and has dwindled to one or two pairs since 2002.

Colorado, Kansas, and Iowa (areas not discussed in the recovery plan): Although the recovery plan has no population goals for Colorado, Kansas, or Iowa, a few nesting piping plovers have been documented in these states. Colorado and Kansas have been surveyed annually since 1990 and 1998 respectively. The number of pairs in Colorado has ranged between 2 and 18 pairs. The numbers in Kansas have been very low, with only two to four pairs counted annually, and none reported in 2007-2008. We only have reports of surveys from Iowa during the IPPC years. The number of pairs has ranged from four to seven (Haig and Plissner 1993, Plissner and Haig 1997, Ferland and Haig 2002, Elliott-Smith et al. 2009).

Nebraska: The Nebraska Game and Parks Commission (NGPC), with help from the USFWS, USACE, TPCP, the Platte River Recovery Implementation Program, and the National Park Service, monitor the major rivers in Nebraska for nesting piping plovers. Despite creation of hundreds of acres of new emergent sandbar habitat, the number of pairs in the Missouri River reach shared with South Dakota, and below Gavins Point dam has been about 100 pairs or more below the goal of 250 pairs (USFWS 2014). In addition to the Missouri River, plovers in Nebraska nest on and along the Platte, Elkhorn, Loup, and Niobrara rivers. Habitat conditions on these systems fluctuate widely depending on flows (Brown and Jorgensen 2008; Wilson 2009, pers. comm.). Plovers in Nebraska also nest along the edges of lakes created by the sand and gravel mining industry, or by lakes created directly for housing development. Although this habitat is transitory, it has supported from 0 to 200 adult plovers since monitoring began in 1987. Piping plover pairs on the Niobrara River have only reached about half of the 50 pairs called for in the recovery plan. The Loup River has never approached the Loup River recovery goal of 25 pairs (*Figure 19*; *Table 13*).

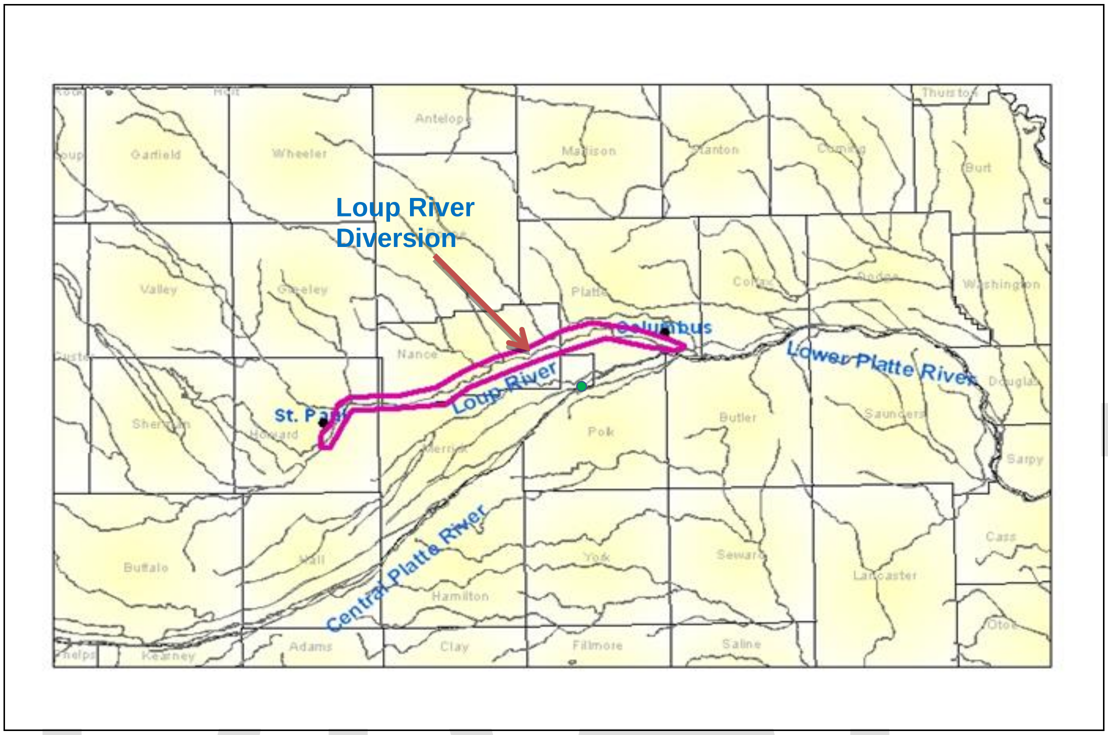

Figure 19. Areas of the Loup River surveyed in 2010 to 2012. (Modified from Figure 1, USFWS (2010). The Lower Platte River has been surveyed annually since 2008.

Table 13. Number of piping plover nests in various Loup River and lower Platte River segments.

Survey Year	Loup River Above Diversion	Loup River Below Diversion	North SMA[1,2]	Lower Platte River Sand Bars[1]	Off-channel Nest Sites[1,3]
2008			8	3	60
2009	2	1	5	46	33
2010	3	0	7	8	42
2011	4	1	3	10	49
2012	1	0	3	4	64
2013			1	11	55
2014			7	0	58

[1] Data sources: Brown and Jorgensen (2008, 2009, 2010), and Brown et al. (2011, 2012, 2013, 2014)

[2] Only off-river nesting site that is part of the action area (not included in footnote [3]).

[3] Off-river nesting sites are not part of the action area, including sand and gravel mines, and housing subsequently built at these mines.

Reasons for Decline

Habitat Loss and Degradation: Reservoir construction, river channelization, and modification of river flows have and continue to be a major threat to the piping plover due to the resulting reduction in sandbar riverine habitat, the flooding of remaining breeding habitat during the nesting season, and vegetation growth on sandbars that are rarely scoured by high flows.

Prior to colonization, river systems in the Northern Great Plains generally had large rises in the spring as water melted off of the prairie and then the mountains. These spring rises carried sediment down the system, creating sandbar islands as the water slowed and deposited the material. The water levels would then drop throughout the summer, exposing more acres of sandbar as the season progressed (USFWS 2003). After European settlement, attempts were made to make rivers more predictable and suitable for navigation, minimize seasonal flooding, and to use impoundments to generate electricity. River channels were straightened and channelized, and a number of dams were constructed. These dams greatly reduced sediment inflow into the system, reducing the amount of sand available for sandbar creation (National Research Council 2002).

The hydrology of rivers has been drastically altered. For example, on the Missouri River, flows used to generally decline over the summer as tributary flows decreased. Today, they generally increase during the nesting season to provide for downstream needs related to navigation (USFWS 2003). This means that less sandbar habitat is available over the course of the summer, rather than more, as would have been the case prior to dam construction. By contrast, due to the large number of water users on the Platte River, flows are variable and the river often runs dry in the summer, leading to a reduction in piping plovers on the river (National Research Council 2004).

Conditions on rivers and reservoirs depend on a combination of local and regional weather conditions and water management of the dams. On the Missouri River, a drought from 2001 through 2008 led to low water levels on the largest of the reservoirs (Lake Oahe and Lake Sakakawea) and generally lower releases out of the dams, providing habitat for a relatively large number of birds. However, reservoir levels can rise very quickly due to inflows from weather events or snow-melt. This rise often occurs in the middle of the season, flooding nests. Below dams, flows change according to downstream needs, inundating nests or chicks directly or covering foraging habitat.

The lack of sufficient suitable habitat due to modification of river flows continues to be a major threat to the piping plover. Depending on the year, up to 45 percent of the birds in the NGP population may nest on river systems (Haig and Plissner 1993; Plissner and Haig 1997; Ferland and Haig 2002; USACE 2006; USACE 2007; Brown and Jorgensen 2008; USACE 2008).

Other threats to the availability of suitable piping plover habitat include commercial sand and gravel mining, collisions with power lines, oil and gas development, and invasive species.

<u>Climate change:</u> IPCC (2007) predicts that changes in the global climate system during the 21st century are very likely to be larger than those observed during the 20th century. For the next two decades a warming of about 0.4° F per decade is projected globally; after this, temperature projections increasingly depend on specific emission scenarios (IPCC 2007). Various emissions scenarios suggest that by the end of the 21st century, average global temperatures are expected to increase 1.1 to 7.2° F0with the greatest warming expected over land. Finally, IPCC (2007) projects a high likelihood that hot extremes, heat waves, and heavy precipitation will increase in frequency. The average temperature in the Great Plains already has increased roughly 1.5° F relative to a 1960s and 1970s baseline (U.S. Global Change Research Program 2009). By the end of the century, temperatures are projected to continue to increase by 2.5° F (and up to more than 13° F) compared to the 1960–1979 baseline, depending on future emissions of heat-trapping gases (USGS 2009). Across the U.S. range of the NGP piping plover, summer temperatures are projected to increase 5° F to 9° F by the end of the century, depending on future emissions (USGS 2009). Northern areas of the Great Plains are projected (with high confidence) to experience a wetter climate by the end of this century (USGS 2009). Across the U.S. range of the NGP piping plover, spring precipitation is expected to increase between zero and 15 percent under a lower emissions scenario and between zero and 40 percent under a higher emissions scenario. This shift in temperature and moisture could have profound effects on piping plover habitat, which is dependent on wet-dry cycles to keep habitat clear of vegetation. Additionally, changing precipitation patterns in the Rockies would likely have profound effects on the amount of inflow into the Missouri River system also affecting the amount of habitat available there.

VB. Piping Plover - Environmental Baseline

Piping plovers (and Interior least terns) nest at many off-channel nesting sites adjacent to the Loup and Platte Rivers, including sand and gravel mining operations and sandy areas in residential developments built around lakes from former mining operations. These off-channel nesting areas are not part of the Project action area, because Project operations do not affect habitat conditions at off-channel sites. The only exception is the North SMA, the off-channel sand pile adjacent to the Loup Power Canal, used by nesting plovers. The North SMA receives the sediment dredged from the settling basin at the upstream end of the power canal, is a direct result of Project operation, and occurs within the Project footprint. Therefore, the sand pile is a component of the Project and included in the action area. However, the North SMA is not part of the environmental baseline; the plover nesting habitat would cease to exist in the absence of Project operations due to the area quickly becoming vegetated and unsuitable for nesting plovers.

Species Status in the Action Area

As discussed in the plover status section, piping plovers nest on sandbars in the channels of the Loup and Platte Rivers, including the Lower Platte River. The Project action area includes a small percentage the range of the NGP piping plover population (see Figure 18). Additionally, the maximum number of piping plovers nesting in the action area from 2009 to 2012 (which includes 2009, with the highest number of nests) ranged from 14 to 108 piping plovers, averaging 45.5 adults per year (Table 14). The maximum annual number of nesting piping plovers in the action area from 2009 to 2012 constitutes 3.6 percent of the lowest survey tally from the NGP range-wide population censuses (2,953 in 2001), and 2.3 percent of the highest estimated tally from the range-wide population censuses (4,662 in 2006). The average annual number of nesting pair in the action area constitutes 1.5 percent of the lowest range-wide survey result, and 0.98 of the highest range-wide census tally.

Table 14. Number of piping plover nests and maximum number of individuals represented by those nests during Current Operations (re-nesting attempts are included in number of nests). The origin and status of floaters observed on the river is unknown, so they are excluded (e.g., birds nesting on off-channel sites commonly forage in the river channels; some floaters likely non-breeding plovers).

Survey Year	Loup R Below Diversion	NSMA	L. Platte R. Sand Bars	Total Nests	Max # Nesting PIPL
2009	1	5	48	54	108
2010	0	7	8	15	30
2011	1	3	11	15	30
2012	0	3	4	7	14
Total (mean)	**2 (0.5)**	**18 (4.5)**	**71 (17.8)**	**91 (22.8)**	**182 (45.5)**

Source of data: Brown and Jorgensen (2008, 2009, 2010), and Brown et al. (2011, 2012, 2013, 2014), and M. Brown, pers. comm. 12/18/14.

Another way to evaluate the contribution of the piping plovers in the action area to the recovery of the NGP is to compare the number of plover pairs in the action area to the U.S. recovery goal from the recovery plan (i.e., the number of pair to be maintained in the U.S. to support recovery (USFWS, 1988). In *Table 14,* the highest number of nesting pairs in the action during the four years when all areas were surveyed is 54, or 4.2 percent of the 1,300 pair goal. The average number of pairs in the action area during these four years is approximately 23 pairs, or 1.8 percent of the United States recovery goal.

Factors Affecting Species Environment in the Action Area

These factors are the same as discussed in the environmental baseline for the Interior least tern. See section IVB, above.

Generally, the effects of the Staff Alternative on piping plovers are analyzed using the same methods as the analysis of effects in the interior least tern section.

Factors to be Considered

We divide the action area into the following three river reaches, based on the different effects of the Project Staff Alternative (compared to the environmental baseline) on river flow, sediment supply and transport, and hydrocycling: 1) Loup River Bypassed Reach; 2) Platte River Bypassed Reach; and, 3) Lower Platte River. The third river reach was subdivided into additional river sections, depending on the species or habitat parameter being analyzed. Under each reach, we discuss Project effects in relation to species requirements for survival; including habitat conditions required for reproduction, food and foraging, and shelter.

In order to compare the effects of the Staff Alternative to the Lower Platte River under the environmental baseline conditions, we subdivided the 101.5 miles of the Lower Platte River on the basis of differences in characteristics between the reaches related to geomorphology, sediment load and hydrology. The Lower Platte River subdivisions include: 1) Project tailrace return to North Bend (at RM 72.5); 2) from the North Bend to Leshara (at RM 48.5); and 3) Fremont (at RM 57) to the confluence with the Missouri River. The characteristics of these river reaches and the rationale behind their use in the analyses of effects of the Staff Alternative are described in the Effects of the Action section for the Interior least tern (Section IVC).

The effects analyses are grouped according to Project effects under Current Operations (compared to river conditions under the environmental baseline) where we describe how those effects influence survival of the least tern and piping plover. We then describe how Commission adopted license articles, under the Staff Alternative, would avoid and/or minimize adverse effects to the piping plover. Conservation measures evaluated in this section include: 1). Article 404, Seasonal Minimum Flows in the Loup River Bypassed Reach; 2) Article 406, Maximum Diversion of Flow into the Power Canal; and 3) Article 414, North SMA Management Plan.

VC. Piping Plover - Effects of the Action and Species Response

1. Loup River Bypassed Reach

Habitat conditions (under the Staff Alternative, compared to the environmental baseline) in the Loup River downstream of the diversion are the same for the piping plover as for the Interior least tern. See Appendix D for a description of the effects of the Staff Alternative to habitat in this river reach.

Loup River Bypassed Reach -Reproduction
Methods used to evaluate Project effects to piping plover reproduction in this river reach are similar to those used to evaluate Interior least tern reproduction

The Loup River upstream of the project diversion serves as the environmental baseline for the evaluation of piping plover reproduction in the Loup River below the diversion. From 2009 to 2012, a total of 10 piping plover nests were documented on the Loup River above the diversion (USFWS 2010-2012, NPPD 2009), for an average of 2.5 piping plover nests per year (*Table 15*). Below the diversion, two piping plover nests were documented during the same time period, averaging 0.5 per year from 2009 to 2012. Therefore, we estimate that Current Operations result in an average loss of 2.0 piping plover nests per year. Given that we expect nesting habitat to improve under the Staff Alternative compared to Current Operations, we consider the loss of 2.0 piping plover nests to represent the maximum loss from the Staff Alternative (i.e., a maximum likelihood of effect).

Table 15. Number of piping plover nests documented on the Loup River, above and below the Loup River diversion. Both reaches of the Loup River are approximately 34 miles long.

	Loup River	
Survey Year	**Above Diversion** Environmental Baseline	**Below Diversion** Current Conditions
2009	2	1
2010	3	0
2011	4	1
2012	1	0
Total (average per year)	10 (2.5)	2 (0.5)
Nests per mile surveyed	2.5/34 = 0.074 nests/mi.	0.5/34 = 0.015 nests/mi.

Source: USFWS 2009, 2010, 2011, 2012

Given that hydrocycling does not affect the Loup River downstream of the diversion, we conclude no piping plover nests are lost in this river reach due to hydrocycling operations under the Staff Alternative.

Loup River Bypassed Reach - Feeding and Fitness

As described in the Piping Plover Status section (Section VA), foraging habitat for piping plovers consists of open, wet, sandy areas on river systems, mud flats and shallow water areas along the shores of saline wetlands throughout most of the plovers' nesting range. The plovers forage visually for invertebrates in shallow water and associated moist substrates (Cairns 1977, Cuthbert et al. 1999, Whyte 1985). Along the Platte River, their diet includes small beetles and soft-bodied invertebrates, among others (Lingle 1988).

Corn and Armbruster (1993) identified several patterns of invertebrate distribution and abundance of significance to piping plover foraging and breeding success. The food base is similar taxonomically between sandbars and spoil piles, but invertebrate catch rates and densities are higher on river channel sites. It is worth noting, however, that the North SMA is substantially larger than spoil piles at typical sand and gravel mines, and there is less water available. The dominant invertebrate taxa collected from river foraging areas were shore-inhabiting and semi-aquatic species associated with moist, sandy environments; the invertebrates are distributed more or less uniformly across riverine channel areas (Corn and Armbruster 1993). Piping plover foraging activity correlates with moisture of the foraging substrate.

In the Loup River upstream from the Project diversion, median annual flows that represent the environmental baseline range from 2,000 cfs at the beginning of the calendar year, to peak flows of approximately 4,100 cfs in March (Figure 1, *Appendix D*). These flows form the elevated sandbars suitable for breeding piping plovers. From this peak flow, the discharge gradually decreases to about 2,100 cfs in early May and varies between 2,000 cfs and 2,700 cfs during the primary piping plover nesting period (May and June), before it decreases to about 1,300 cfs by the end of July. Under the environmental baseline, the Loup River bypassed reach would contain a similar natural hydrograph which would widen the channel and build higher sandbars for nesting. Current conditions observed upstream from the project diversion (representing the environmental baseline) are nearly ideal in terms of providing an abundance of foraging habitat for plovers nesting on quality sand bars in this river reach, and for migrating piping plovers.

Compared to the environmental baseline, the Staff Alternative does not provide flow and sediment sufficient to build elevated sandbars in the Loup River Bypassed Reach. However, the Staff Alternative improves summer flows when compared to Current Operations by ensuring a 275 cfs discharge into the Loup River Bypassed Reach throughout the summer. These additional flows would provide a greater amount of wet sand and shallow water to support piping plover foraging, compared to the current operating conditions.

Loup River Bypassed Reach - Sheltering

Adequate shelter is necessary for piping plover egg and chick survival to flight stage. Shelter provides safety from exposure to a variety of hazardous conditions. For piping plovers, shelter from extreme temperatures (too high or too low) is provided for eggs and young chicks by the nesting adults and, for older chicks, by sparse vegetation, driftwood, or any other component of the environment that provides shade. Eggs and chicks also require safety from exposure to mammalian and avian predators. While their cryptic coloration can provide some safety, additional protection (at least from mammalian predators) can be gained from the presence of deep water surrounding the nesting sandbars. However, river flows that are high enough to inundate nests or wash chicks downstream obviously preclude survival.

Compared to the environmental baseline, the Staff Alternative provides much lower water levels during the piping plover nesting season. Shallow water increases accessibility of plover eggs and chicks to mammalian predators; raccoons, foxes, coyotes and other potential predators can wade to nesting islands, as opposed to swimming through moving, deep water. Alternatively, when compared to Current Operations, the Staff Alternative provides somewhat higher flows during the piping plover nesting season. We do not have any quantitative evidence that flows under the Staff Alternative or Current Operations would increase nest predation compared to the environment baseline. Definitive nest fate, nest productivity and chick survival data are absent for nesting plovers on the Loup River Bypassed Reach. Therefore, no quantitative analysis of the effect of the Staff Alternative on exposure of piping plover nests to predation can be made for this river reach. However, a qualitative comparison is presented in the Interior least tern section, above, that also applies to nesting piping plovers in this reach.

2. Platte River Bypassed Reach

Platte River Bypassed Reach - Reproduction

This river segment is only 2.1 miles long and no plover nests were documented in the reach from 2008 until present. To estimate the number of piping plover nests in this segment of the bypassed reach under environmental baseline conditions, we used the number of plover nests documented in adjacent reaches and compared the largest of these from river reaches considered analogous to environmental baseline with conditions on the Loup River Bypassed Reach.

For the Loup River, the environmental baseline reach extends from the Loup diversion upstream approximately 34 miles to the Middle Loup and North Loup Rivers confluence; an average of 2.5 plover nests/year (0.074 nests/mile) were documented on this reach (*Table 15*, above). For the Lower Platte River, the analogous baseline river reach extends from North Bend about 23 miles downstream to Leshara; an average of 1 piping plover nest/year (0.048 nests/mile) was documented on this reach). Under the environmental baseline scenario, the Platte River Bypassed Reach would receive the entire Loup River flow and corresponding sediment load, as would the environmental baseline reach used for the Lower Platte River from North Bend to Leshara. Over time the increased flow would likely improve habitat conditions within the 2.1 mile-long bypassed reach (*Appendix D*).

To characterize baseline conditions for the Platte River Bypassed Reach, we applied 0.074 nests/mile as a means of projecting use of the bypassed reach by piping plovers. At 0.074 nests per mile, we expect an average of 0.16 nests to occur annually under the environmental baseline in the Platte River Bypassed Reach. Because no nests were documented in this reach during the period of record used for these analyses, then all of the nests expected to occur here under the environmental baseline (i.e., an average of 0.16 plover nests/year) are lost under Current Operations. The Staff Alternative is expected to improve habitat conditions in the target reach relative to the Current Operations, so the average of 0.16 plover nests annually would represent the maximum adverse effect for this reach. Given that hydrocycling does not affect the Platte River Bypassed reach, we conclude no nests are lost due to hydrocycling under the Staff Alternative.

Platte River Bypassed Reach - Feeding and Fitness

The Platte River Bypassed Reach is only 2.1 miles long and does not experience the effects of hydrocycling. Given the lack of nesting in this segment, the ability of piping plovers to fly long distances to forage, and no data to indicate forage is limiting to piping plovers nesting on the river, the Staff Alternative is unlikely to affect foraging or fitness of piping plover adults or chicks within this segment.

Platte River Bypassed Reach - Sheltering

Given that the Staff Alternative for the Platte River Bypassed Reach is not expected to result in nesting, adverse effects to nests once initiated (increased potential for flooding, erosion, nest loss, predation) are not addressed.

3. Lower Platte River

River Reach - Project Tailrace to North Bend

The greatest adverse effects to piping plover nesting habitat are caused in this reach by two characteristics of the Staff Alternative. First, the sediment deficit results in channel incision downstream of the tailrace (see *Appendix D*). This channel incision from sediment deficit is not detected at North Bend; therefore, we don't expect the sediment supply downstream of North Bend to diminish the suitability of sand bar nesting habitat downstream of that location (See detailed description in Interior least tern, *Section IVC*). Second, there are substantial erosional effects to nesting habitat caused by Project hydrocycling at the Project tailrace.

Project Tailrace to North Bend - Reproduction

Given channel incision is not detected at North Bend and effects of hydrocycling are reduced downstream of North Bend, we selected this location to compare nesting data upstream and downstream of North Bend to try and detect differences in piping plover nesting. In other words, to determine the effect of the Staff Alternative on piping plover nesting in this segment of the Lower Platte River from the Project Tailrace to North Bend, we compared the number of piping plover nests in this segment to those in the river segment that serves as the environmental baseline for the Lower Platte River (i.e., the segment from North Bend to Leshara). *Table 16* presents the difference between these two Lower Platte River reaches in frequency and density of piping plover nesting.

Table 16. Frequency and density of piping plover nesting between two river reaches downstream of the Power Canal tailrace.

Survey Year	Tailrace to North Bend	# Miles Surveyed	North Bend to Leshara*	# Miles Surveyed
2008	0	28	0	23
2009	3	14	7	23
2010	0	28	0	23
2011	0	28	0	23
2012	1	28	0	23
2013	Not surveyed	Not surveyed	0	8
2014	0	28	0	23
Total # of Plover Nests	**4**		**7**	
Average Nests/Year	**0.67**		**1**	
Total Miles Surveyed		**154**		**146**
Average Nests/Mile		**0.026**		**0.048**

*Serves as the environmental baseline for the lower Platte River when determining the effects of the Staff Alternative on nesting.
Source: Brown and Jorgensen (2008, 2009, 2010), and Brown et al. (2011, 2012, 2013, 2014); and M. Brown, pers. comm. 12/18/14.

As noted previously, few piping plovers have been documented nesting in these two reaches of the Lower Platte River. Nevertheless, fewer piping plover nests occurred in the tailrace to North Bend segment than in the North Bend to Leshara segment. Although the tailrace to North Bend segment was longer than the environmental baseline (28 miles vs. 23 miles), 3 fewer nests were located in the target segment than the baseline over the same period of time. Likewise, the frequency (average # of nests per year) was 0.33 nests/year less in the target segment than in the environmental baseline. Although the incidence of plover nests (nests/mile) in these two Lower Platte River reaches is very small, the nest density is still 54 percent lower in the tailrace return to North Bend segment than in the environmental baseline when the nesting is adjusted to consider unequal river segment length (i.e., 0.026 nests/mile in the target segment upstream of North Bend versus 0.048 nests/mile in the baseline reach downstream of North Bend).

Our piping plover nesting analysis did not include Lower Platte River nesting records below Leshara. We stopped our analyses at Leshara because geomorphic differences downstream from there begin to effect key nesting characteristics such as channel width, channel sinuosity, bare sand area, valley width, etc. which in turn affects piping plover nesting (See Interior least tern section IVC for more information). This effectively splits the two segments into similar size (28 vs. 23 miles) and precludes data from river reaches that that are strongly affected by the presence of large forested islands, tributary inputs (Elkhorn River), changing valley widths, channel form, and higher flows.

This piping plover nesting analysis considers nesting under Current Operations. We expect the Staff Alternative to result in improved nesting conditions within the tailrace to North Bend segment. For these reasons, the nesting potential for the segment upstream of North Bend underestimates production under the Staff Alternative. We believe the difference in nesting estimated within this analysis depicts the maximum likelihood of adverse effect for a reduced in nesting as a result of the Staff Alternative.

The dataset used in these calculations to evaluate piping plover nesting in this Lower Platte River has similar limitations as was discussed in the Interior least tern effects section above (*Section IVC*). Nevertheless, as with the Interior least tern data, the piping plover dataset for these reaches is considered the best data currently available.

The effects of hydrocycling on creation and persistence of tern and plover sand bar nesting habitat is discussed in greater detail in the Interior least tern effects section (Section IVC).

Hydrocycling may continue having an adverse effect downstream of North Bend but this effect is unlikely to affect nest initiation. Within any given year, it is unlikely that the erosional effect attributed solely to hydrocycling downstream of North Bend reduces the habitat acreage of any nesting island enough that it causes a reduction in the number of nests initiated. We lacked data that quantitatively described the amount of piping plover mortality resulting from differences in daily stage variation due to Project hydrocycling. Therefore, in the absence of better information, we sought to calculate the number of nests we would expect to be lost due to inundation specifically resulting from hydrocycling. We used data from the same source as our nest analysis. Nest data from the tailrace to Leshara was often surveyed only once or twice and lacked sufficient nest fate data; therefore, we evaluated additional data from Lower Platte River from Fremont to the confluence of the Missouri River in our analysis because this segment was more frequently and consistently surveyed during the 2008-2014 time period. This evaluation was then extrapolated to assess nest abundance, fate data, and incidence of nest inundation in the entire Lower Platte River.

Estimating nest loss due to inundation events requires several assumptions. Information on nest inundation was limited for the Lower Platte River upstream of Fremont due to the absence of data collected after the initial nest observations. Therefore, our analysis assumes nest loss due to inundation occurs in similar proportions from the tailrace to North Bend as it does from North Bend to the confluence of the Missouri River.

From Fremont to the Missouri River, inundated nests were reported in three out of the seven years of surveys (2008-2014). We calculated the total proportion of nests lost to inundation over the 7 years of data to develop the average proportion of nest loss due to inundation. A substantial number of nests failed due to "unknown" causes. Additionally, nests reported as inundated were almost never observed being flooded. Despite these limitations, this is the only dataset for the Lower Platte River that provides a reasonable estimate of the number of nests lost to inundation.

Table 17. Number of piping plover nests in various reaches of the Lower Platte River and the number of nests inundated from Fremont to confluence of the Missouri River.

Survey Year	Tailrace to North Bend	North Bend to Fremont	Fremont to MO River	Total # Nests Lower Platte	# Nests Inundated
2008	0	0	3	3	1
2009	3	2	43	48	14
2010	0	0	8	8	8
2011	0	0	11	11	7
2012	1	0	3	4	0
2013	NA	NA	11	11	0
2014	0	0	0	0	0
Total Nests	**4**	**2**	**79**	**85**	**30**
Average Nests/Yr.	**0.67**	**0.33**	**11.3**	**12.1**	
Average Nests Inundated/Year	**0.25**	**0.13**	**4.3**	**4.6**	
Ave. Nests/Year Inundated Due to Hydrocycling	**0.017**	**0.009**	**0.29**	**0.31**	**Total due to hydrocycling 0.62**

Of the 79 nests documented from Fremont to the Missouri River (the river segment where colonies were visited multiple times) between 2008 and 2014, 30 nests total were lost due to inundation (38.0 percent) (*Table 17*). This proportion of nests inundated can be applied to plover nesting in any reach to estimate the average number of nests/year that would be inundated in that reach. For example, the average number of plover nests/year in the tailrace to North Bend segment is 0.67 nests/year (4 nests/6 years of surveys). By applying the proportion of nests inundated (0.38) we expect that an average of 0.25 plover nests/year would be inundated in the tailrace to North Bend segment, or approximately 1 nest every 4 years, on average.

Using predicted inundation probabilities from (Table 2 in NGPC letter to Commission, dated April 11, 2011), we sought to apply the modeled increase in probability of inundation from Project hydrocycling under Current Operations to conditions that reflect a no hydrocycling baseline (i.e., Run-of-River). Nest inundation probabilities were identified for different representative benchmark flows at North Bend. To estimate the maximum amount of nest inundation resulting from hydrocycling, we used the highest probability increase reported; the highest increase (difference between Current Operations and Run-of-River) in probability of inundation (0.068) occurred at a 10,000 cfs benchmark flow. Having no other mechanism to apply to the estimated nests lost to inundation, we used the inundation probability increase (% occurrence) as a surrogate for the number of nests inundated by hydrocycling. In relating the probability of inundation increase to existing estimated nests lost, we calculated the number of the inundated nests we predict might be specifically related to hydrocycling as a result of Current Operations (average nests/year inundated*0.068). Therefore, in the tailrace to North Bend reach, we expect an average of 0.017 nests per year to be inundated due to hydrocycling under Current Operations.

For this Opinion, the Service expects that within day variability in streamflow under the Staff Alternative will be similar to that under Current Operations at the Project tailrace return, but the within day variability in streamflow under the Staff Alternative will experience greater attenuation rates at downstream locations in the Lower Platte River because of the reduced volumes available for power production under the Staff Alternative. In particular, Articles 405 and 406 have the greatest reductions water available for power production which is in effect for the March 1 through July 1 timeframe (see *Appendix E* for additional information). After July 1, the Service considers effects of hydrocycling under the Staff Alternative to be similar to these effects described for Current Operations.

We recognize limitations of this calculation and methodology. As mentioned previously, the nest fate data within these analyses used many assumptions in determining nest fate as lost to inundation. Accurate and reliable nest fate data can only be obtained by repeatedly following up on nests daily or multiple times/week. Obtaining chick survival often times requires marking or banding to measure survival until fledging. Given the inability to consistently monitor all the colonies daily throughout the nesting season, we acknowledge that the data makes assumptions and that these assumptions may limit accuracy. While the data may be best served for analyzing baseline trends as opposed to rigorous scientific analyses, it serves as the only and best available data.

We acknowledge that a study was undertaken by District to analyze this relationship between Project hydrocycling and nest inundation. However, assumptions related to: 1) how and when the benchmark flow was set, 2) using a single point value for nesting distribution, and 3) the period of time needed for successful nesting; were pointed out within the same letter (NGPC, 2011) describing an alternative study in which the above nest inundation probabilities were developed. For this reason, we believe the NGPC inundation probability analysis constitutes the best available scientific and commercial data available.

Project Tailrace to North Bend; Feeding and Fitness
Daily releases from the Project tailrace return provide sufficient flow for the presence of wet sand in this reach under nearly all conditions. Sand bar habitat and piping plover nesting have been documented in this segment, although we have no information on nesting success in this reach. The amount of wet sand available to foraging adults and chicks is not expected to be limiting.

Project Tailrace to North Bend; Shelter
The Service acknowledges that some level of natural predation will continue under the environmental baseline and the Staff Alternative, but there is a lack of documentation that predation has occurred on the Lower Platte River specifically due to the Staff Alternative. We believe the Staff Alternative will have no effect on shelter throughout this segment.

North Bend to Confluence of Missouri River

North Bend to Confluence of Missouri River – Reproduction

As mentioned previously, we determined that the sediment-related effects to nesting habitat under the Staff Alternative were would not extend beyond North Bend. Therefore, we do not expect a reduction in piping plover nesting habitat or nesting numbers of plovers throughout this segment of the river.

However, hydrocycling continues to persist downstream of North Bend. To estimate the number of nests in this reach that would be inundated due to hydrocycling under the Staff Alternative, we applied the same information from Table 17. First we added the average number of plover nests per year in the North Bend to Fremont reach to the average number of nests/year in the Fremont to the Missouri River reach (i.e., 0.33 + 11.3, respectively)We then estimated the number of nests in the Lower Platte river from North Bend to Missouri River confluence affected by Project hydrocycling: [(11.6 nest/year * 0.38)*.068] = an average of 0.33 nests/year inundated in the North Bend to Missouri River segment due to hydrocycling under the Staff Alternative.

As stated previously, the within day variability in Lower Platte River streamflow under the Staff Alternative has greater downstream attenuation compared to the Current Operations. Specifically, the mean difference between the daily maximum and minimum stage is reduced 2-6 inches (range 0.18 ft. for wet year to 0.53 ft. for dry year) going from North Bend to Louisville (Assessment). Given that the inundation probabilities were calculated using the hydrograph at North Bend, we expect that this calculation represents the maximum likelihood of effect relative to the number of plover nests lost due to hydrocycling under the Staff Alternative for the Lower Platte River from North Bend to the confluence with the Missouri River.

In considering this information related to the Staff Alternative, we expect adverse effects to piping plover will occur as a result of Project hydrocycling and over the course of the 30 year license, we expect those adverse effects to result in nest failure and/or chick mortality. However, based on this analyses and a lack of direct observation or evidence of inundation directly resulting from hydrocycling, we expect these adverse effects to be very infrequent and low in number.

North Bend to Confluence of Missouri River - Feeding and Fitness

Sand bars built in this reach of the river during the record river flows of 2010, especially those in the portion downstream of the Elkhorn, were more than 6 feet tall in parts of this river segment and exhibited the near-vertical sides described above. Sand bars of this shape are suitable for piping plover stopover migrants but not for brood rearing due to restricted access to food. Additionally, sandbars with steep or vertical sides are problematic for chicks trying to return to the surface of the sandbar. According to our analysis, above, we expect nests to be inundated approximately once in 3 years. Reshaping of tall sand bars will lower the slope of the edges and provide foraging sites.

North Bend to confluence of Missouri River - Sheltering
The Service acknowledges that some level of natural predation will continue under the environmental baseline and the Staff Alternative, but there is a lack of documentation that predation has occurred on the Lower Platte River specifically due to the Staff Alternative. We believe the Staff Alternative will have no effect on shelter throughout this segment.

4. North Sand Management Area

The persistence and characteristics of the North SMA are heavily dependent upon the District's operations and operations of its tenant, Preferred Sands of Genoa, LLC (Preferred Sands). See Interior least tern North SMA, *Section IVC* for a detailed description of operations at the North SMA.

Under the environmental baseline, the District would no longer divert water from the Loup River into the power canal and settling basin. Dredging and deposition of sand onto the North SMA would no longer be necessary and thus, this action would cease to exist. We predict that Preferred Sands would continue mining for some indefinite period of time until they have mined and sorted through existing sand and removed preferred sediment sizes. The North SMA would initially continue providing habitat and nesting production. However, without the Districts' dredging operations, nesting habitat would no longer be generated and regenerated as Preferred Sands continues mining it. We expect this to begin decreasing the amount and quality of nesting habitat as vegetation encroaches into areas currently providing nesting habitat. Within 3-5 years, we expect the North SMA will no longer provide Interior least tern nesting habitat or production. Under the Staff Alternative, the District will continue its dredging operations and nesting habitat will continue to be generated and regenerated. See Commission Article 414, North SMA section of Interior least tern, *Section IVC*)

These long term protective measures are included within the Staff Alternative to protect, maintain and enhance (where appropriate) the nesting habitat free from the threat of anthropogenic disturbances, under the Staff Alternative; therefore the North SMA is expected to continue increasing Interior least tern nest production over what would be occurring at the North SMA under the environmental baseline. The proximity of disturbance and potential for lethal loss of eggs/chicks as well as the non-lethal loss to adult reproduction is not completely eliminated but unlikely to occur. Protective measures at the North SMA contained within draft Article 414 will reduce adverse effects, making take less likely to occur. MOU's between gravel mining operators, the Service, and NGPC have been used at many locations to demonstrate that the mining activities themselves, when operating using a set of best management practices, can avoid adverse effects. The Service is a signatory on these MOU's and our written approval ensures adequate considerations are given to terns and plovers, further reducing and eliminating the risk of take. Therefore, we anticipate production at the North SMA under the Staff Alternative to remain similar or consistent with Current Operations which are substantially improved when compared to the environmental baseline, given that habitat would eventually diminish under the environmental baseline.

North Sand Management Area - Reproduction
For consistency, we analyzed nesting data collected during the same period of record as the analysis on the Lower Platte River (2008-2014). This is the most recent available data and also corresponded to the time when an MOA was developed to aid in protecting and maintaining the area to consistently provide habitat and monitoring while avoiding adverse effects from mining operations. Given the terms of Commission Article 414 provided above, and information regarding the MOA, this period appears to be the most appropriate in estimating the habitat conditions and number of nests we expect under the Staff Alternative going forward. From 2008-2014, a total of 34 piping plover nests were documented on the North SMA averaging about 5 nests/year.

We also looked specifically at data collected for 2009-2012 since that coincided with our data collection period for the Loup River. During this period, the North SMA averaged 4.5 plover nests/year. Under the environmental baseline zero nests would be expected.

North Sand Management Area - Feeding/Fitness
The North SMA is analogous to other off channel plover nesting sites such as sand and gravel mines and housing developments. Corn and Armbruster (1993) compared foraging success and food availability between river channels and sand and gravel mines. They concluded that food availability on mining areas decreased with distance from the water's edge. Therefore, large areas of relatively permanent wet sand or moist areas with organic material need to be provided on the North SMA to ensure adequate food availability.

Assuming Article 414 is implemented in a way that provides access to a sufficient, high quality foraging sites for nesting plovers, Staff Alternative for the North SMA would not adversely affect piping plover adults and chicks compared to the environmental baseline where no foraging sites would be available due to the ceasing of dredging operations.

North Sand Management Area - Sheltering
Assuming Article 414 is implemented in a way that provides shelter and/or reduced predation, Staff Alternative for the North SMA would not adversely affect piping plover adults and chicks compared to the environmental baseline where no foraging sites would be available due to the ceasing of dredging operations.

Summary of Effects
When comparing effects of the Staff Alternative to the Environmental Baseline for all areas within the Project action area, we combined the estimated reduction in nesting at the Loup River Bypassed Reach, Platte River Bypassed Reach and Lower Platte River (tailrace to North Bend), and compared it with the estimated increase in nesting under the Staff Alternative at the North SMA. Below North Bend, we do not anticipate the Staff Alternative will adversely affect the number of piping plover nests. Under the Staff Alternative, we anticipate that the Loup River Bypassed Reach will result in a maximum average *decrease* of approximately 2.0 nests/year, the Platte River Bypassed Reach to result in a maximum average *decrease* of approximately 0.16 nest/year, and the Lower Platte River (tailrace to North Bend) to result in a maximum average *decrease* of approximately 0.33 nests/year. Likewise, under the Staff Alternative, we estimate

the North SMA will continue resulting in an average *increase* of 5 nests/year. Therefore, we anticipate the combined effect of the Staff Alternative on all reaches will result in an increase of 2.5 nests/year when compared to the Environmental Baseline. Given that a maximum likelihood of effect was most often used in calculating the difference in nesting between the Staff Alternative and the Environmental baseline, we do not expect the Staff Alternative to result in a reduction in the number of piping plover nests.

The reported reduction in the number of nests on the Loup and Platte Rivers within the Project action area is not indicative of an actual reduction in nests, chicks or young at the local or regional population level. These reductions to on-river nesting habitat (and the coincident reduction of nests) within the Project action area affect individuals within the breeding population (Northern Great Plains), thus requiring them to shift their breeding to another location. Within the Project action area, other available habitat has been created at the North SMA under the Staff Alternative. The net effect to breeding habitat and nesting numbers for the regional population under the Staff Alternative is neutral as it results in similar quantities of nesting habitat and corresponding nests within the action area and within the region. The adverse effects (inconvenience of flying to a nearby location to breed) at the individual level are considered minor and inconsequential. This adverse effect does not rise to the level of “take” as defined under the Act; to be considered take, this habitat modification must result in harm to piping plovers by *significantly impairing* essential behavioral patterns such as breeding, feeding, or sheltering. Within Nebraska, there is ample evidence of local population redistribution between riverine and anthropogenic off-channel habitats (such North SMA) to exploit changing habitat availabilities.

We expect hydrocycling to adversely affect nest success and chick survival. The effect is more pronounced close to the tailrace but significantly more nesting occurs downstream from Fremont to the confluence with the Missouri River. We estimate a small amount of harm in the form of egg or chick death is expected from inundation resulting from Project hydrocycling operations. This is expected to be infrequent and low in numbers. Under the Staff Alternative, we estimate 0.63 nests/year would be lost to inundation. This estimate accounts for inundation above that expected to occur naturally under the Environmental Baseline. The species is adapted to re-nest to offset nest and chick failure resulting from inundation; available evidence indicates that the regional and overall population of piping plovers is relatively stable, further supporting the assertion that the proposed Project is not likely to appreciably reduce survival and recovery of the species in the wild.

VD. Piping Plover - Cumulative Effects

Cumulative effects include the effects of future State, local, or private (non-federal) actions that are reasonably certain to occur in the action area considered in this biological opinion. A nonfederal action is "reasonably certain" to occur if the action requires the approval of a State or local resource or land-control agency, such agencies have approved the action, and the project is ready to proceed. Other indicators which may also support such a “reasonably certain to occur” determination include whether: a) the project sponsors provide assurance that the action will proceed; b) contracting has been initiated; c) State or local planning agencies indicate that grant of authority for the action is imminent; or d) where historic data have demonstrated an established trend, that trend may be forecast into the future as reasonably certain to occur. These indicators must show more than the possibility that the non-federal project will occur; they must demonstrate with reasonable certainty that it will occur. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act and would be consulted on at a later time.

Off-Road Vehicles and Airboats

The use of ORVs and airboats at nesting sites can harass and/or harm Interior least tern chicks and adults (Brown et al. 2011, FWS 2012). Given historic use, we believe ORV and airboat use is reasonably certain to occur in the action area. See Interior least tern, Section IVC discussion on ORV's and airboats.

Sand and Gravel Mining Operations

Sand mining occurs frequently throughout Nebraska and is expected to continue within the foreseeable future (Brown et al. 2011). Nebraska contains aggregate material along the Loup River and Platte River. We anticipate sand mining to continue expanding and new locations and sites will be developed. Additional sand mines, if actively managed for least tern and piping plover could supplement existing populations (Brown et al. 2011). If not managed and protected, these areas can also act as a source of disturbance and lethal take. Abandoned sand mining sites are often converted into housing developments which maintain bare sand for recreational beaches. These too can positively or negatively affect the piping plover depending upon management and protective measures (Brown et al. 2011). We expect both positive and negative impacts to Interior least tern will occur in the future resulting from new or expanded sand and gravel mining or housing developments.

VE. Piping Plover - Conclusion

After reviewing, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects in the action area, all within the context of the status of the piping plover, it is the Service's opinion that the proposed Project is not likely to jeopardize the continued existence of the piping plover. To "jeopardize the continued existence means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR §402.02). No critical habitat has been designated for this species; therefore, none would be affected. Our determination is based on the following primary factors.

- Within the overall Northern Great Plains Population of piping plovers, the USFWS (2009) concluded that the large increase in population reported in 2006 may indeed indicate a positive population trend though it is difficult to determine by how much. Census data from 2006 indicates reported numbers of piping plover pairs are at or above the 1988 recovery goal of 1,300 breeding pairs. Within the U.S. alone, 1,212 pairs were reported in 2006 with an additional 1,703 adults reported in Canada (Canada does not count pairs, only adults). Data from the 2011 IPPC has not been made publically available. However, available data through 2006 indicates the species may be maintaining populations at or above recovery goals.
- The Project action area is entirely contained within the Platte River basin and contains only a portion of the population using the Platte River Basin. The most recent population census indicates piping plovers in the action area comprise 2.6 to 3.2 percent of the Northern Great Plains piping plover overall population. The species has persisted in the Platte River drainage since listing.

- A small amount of take in the form of harm causing egg or chick death is expected from inundation resulting from hydrocycling operations (an average of 0.62 plover nests per year). Piping plover nests typically contain 4 eggs or chicks. Therefore, this equates to 72 eggs or chicks over the life of the 30 year license (0.62 * 4 * 30). Adult piping plovers are excluded from the take estimate because flying birds can escape the rising water. This amount of egg and chick loss is considered to be of low magnitude (compared to natural egg and chick loss for the species) and occurring infrequently; about three nests containing 4 eggs every 5 years. We conclude that the small reduction of eggs or chicks within the action area due to Project hydrocycling under the Staff Alternative, is not likely to meaningfully change the reproduction, numbers and distribution range-wide for the interior least tern population for the following reasons: 1) the Loup River and Lower Platte River populations are relatively stable; 2) the overall population of piping plovers are increasing or stable with population levels near or exceeding the overall recovery objectives; and 3) the species is well adapted to offset nest loss from inundation. Therefore, the staff alternative is not likely to appreciably reduce survival and recovery of the species in the wild.
- When compared to the Environmental Baseline, nesting numbers and habitat conditions under the Staff Alternative will likely exceed the average number of piping plover nests within the action area; this is due to the contribution of nests resulting from the North SMA as well as an expected increase in nesting on the Loup and Platte Rivers due to proposed flow modifications under the Staff Alternative. Within the action area, populations appear to be stable but highly variable between years. Specifically, Under the Staff Alternative, there will be a reduction in the total number of nests occurring in the following river reaches: a) reduction of 2 nests/year on the Loup River Bypassed Reach; b) reduction in 0.16 nest/year on the Platte River Bypassed Reach; and c) reduction in 0.33 nests/year on the Lower Platte River. Conversely, there will be an increase in the number of nests (5 nests/year) in the North SMA. Cumulatively, this results in an increase in 2.5 nests per year. The reduction of the number of nests in specific river reaches within the action area is not indicative of an actual reduction in nests, chicks or young at the local or regional population level. Alternatively, these reductions to on river nesting habitat (and coincident reduction of nests) within the action area affect individuals within the breeding population (Northern Great Plains Population) by requiring them to shift their breeding to another location (e.g. North SMA). This affect does not rise to the level of take as it does not significantly impair breeding, feeding or sheltering. Instead, it results in a redistribution of reproduction to nearby available locations. Within the action area, habitat quantity is expected to be similar or increased under the staff alternative. While the habitat redistribution will affect the location of breeding, this change within the action area in not likely to meaningfully change the reproduction, numbers, and distribution range-wide for the interior least tern.
- The cumulative effect of disturbance or lethal loss of piping plovers due to housing developments, ORVs, airboats and sand/gravel mining operations may reduce Interior least tern production within any given year. Given the species ability to adapt and use a variety of different habitats where disturbance is frequently encountered, we do not

expect this level of disturbance to have a significant effect on survival and recovery of the species at the local or range-wide population level.

- Commission license articles or conservation measures are included as part of the proposed Project, and are a factor that is used by the Service to inform its jeopardy/non-jeopardy opinion. Commission license articles or conservation measures under the Staff Alternative included as part of the proposed Project would likely result in a net increase in piping plover habitat and reproduction. Thus, these conservation measures will contribute to the likelihood of survival and recovery of the Piping Plover.

In summary, within the context of a stable or increasing populations in this portion of the species range and an overall population near or exceeding recovery objectives, we conclude that implementation of commission articles combined with an increase in the amount and shift in the location of piping plover habitat and nesting, and a small amount of egg or chick death due to inundation caused by hydrocycling, will not reduce appreciably the likelihood of survival and recovery of the species.

VI. INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service as an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not for the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Commission so that they become binding conditions of any grant or permit issued to the District, as appropriate, for the exemption in section 7(o)(2) to apply. The Commission has a continuing duty to regulate the activity covered by this incidental take statement. If the Commission: a) fails to assume and implement the terms and conditions; or b) fails to require the District to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Commission must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement. [50 CFR §402.14(i)(3)]

VIA. AMOUNT OR EXTENT OF TAKE (Pallid Sturgeon)

The Service has determined that Project hydrocycling under the Staff Alternative will result in the harm of two individuals in the Lower Platte River via fish kill mortality. One pallid sturgeon in the Platte River Bypassed Reach will be harmed as a result of death due to lethal water temperatures from reduced flows under the Staff Alternative. These totals are for the 30-year license period.

The Service has determined that Project hydrocycling operations affecting pallid sturgeon will impair feeding and sheltering and reduce the condition of 926 individuals within the 30-year license period. For this Opinion, the Service has determined that the impairment will harm 926 individuals, but relative condition will remain above levels reported for the Missouri River (i.e., relative condition of 0.9 or higher).

The Service has determined that mortality associated with monitoring activities under Article 408 would not exceed four fish. This total is for the 30-year license period.

EFFECT OF THE TAKE

In the accompanying Opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the pallid sturgeon or result in the destruction or adverse modification of habitat.

REASONABLE AND PRUDENT MEASURES TO MINIMIZE INCIDENTAL TAKE, AND CORRESPONDING TERMS AND CONDITIONS

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of the pallid sturgeon. In order to be exempt from the prohibitions of section 9 of the Act, the Commission must comply with the terms and conditions, which implement the reasonable and prudent measures, which outline required reporting requirements. These terms and conditions are non-discretionary.

RPM 1. Minimize the likelihood of pallid sturgeon mortalities (i.e., fish kills) due to Project dewatering in the Platte River Bypassed Reach and Project hydrocycling affecting pallid sturgeon habitat connectivity during high water temperature events (i.e., fish kills).

Terms and Conditions of RPM 1:

The following terms and conditions are required for the implementation of RPM 1:

1(a). The Commission will reinstate real-time stream temperature monitoring at the Louisville Bridge (i.e., U.S. Highway 50 Bridge) if temperature monitoring is discontinued by USGS. Real-time temperature monitoring is presently available at the USGS stream gage at Louisville (USGS 06805500).

1(b). The Commission will cease all hydrocycling operations once real-time temperatures have met or exceeded 93° F (33.9° Celsius as reported by the USGS gage) based on real-time temperature readings at the Louisville stream gage. The cessation of hydrocycling shall continue until the daily maximum temperature at the Louisville stream gage falls below 93° F for three consecutive days. The cessation of hydrocycling represents no Project diversion of water into the Loup Power Canal or implementation of run-of-canal operations.

1(c): The Commission will develop an annual summary for years when temperatures have met or exceeded 93° F. The report must describe: 1) daily minimum and maximum discharge and gage height for operational Lower Platte River stream gages for 14 days prior to cessation of hydrocycling; 2) daily minimum and maximum discharge and gage height for days when hydrocycling has ceased; 3) daily minimum and maximum discharge and gage height for operational Lower Platte River stream gages for 14 days after the cessation of hydrocycling; and 4) daily maximum temperatures for operational Lower Platte River stream gages for the aforementioned days encompassing the cessation of hydrocycling. The annual summary must include both provisional and final approved data for the aforementioned time period when both data sets are available. Final report must be submitted to the Service by March 1 following the cessation of hydrocycling.

1(d): The Commission shall notify the Service of any reported fish kills in the Platte River Bypassed Reach or Lower Platte River. Contact the U.S. Fish and Wildlife Service's Nebraska Field Office at (308) 382-6468.

1(e): The Commission will reinitiate section 7 consultation when the Service receives documentation of pallid sturgeon fish kill mortalities totaling: a) two pallid sturgeon individuals in the Lower Platte River; or b) one pallid sturgeon individual in the Platte River Bypassed Reach. Pallid sturgeon mortalities documented for the Lower Platte River during the period of hydrocycling cessation will not count toward incidental take totals because these mortalities would not be a result of Project operations.

RPM 2. Ensure Project hydrocycling operations affecting pallid sturgeon feeding and sheltering in the Lower Platte River will not exceed take levels described in this Opinion.

Terms and Conditions of RPM 2:

2(a): The Commission shall replicate the analysis described in Objective 1 of *Appendix B* of the FLA (Final License Application). The analysis shall be conducted one out of every five year starting five years after issuance of the license. The analysis of the five year time period shall identify average annual differences (and seasonal differences) in flow and water surface elevation for: a) Site 3; b) Site 4; c) Platte River at North Bend; d) Platte River at Leshara; e) Platte River near Ashland; and f) Platte River at Louisville. These differences shall be separated by year type (i.e., wet, normal, and dry) as described in the FLA, Appendix B.

2(b): The District shall conduct a pallid sturgeon monitoring assessment once every five years. The start date for implementation of this term and condition shall occur one year after the period under Article 408 has ended. The methods for collection shall be comparable to that described by Hamel et al. (2014a) and shall include: a) use of standard fish collection gear; b) collection of individuals the spring, summer, and fall time periods; c) surveys conducted at sites selected at random throughout the Lower Platte River; d) every individual collected shall have length and weight measurements taken; and e) every individual collected shall be marked appropriately to identify any recaptures.

2(c): The District shall secure approval from the Service prior to modification of flows prescribed under Articles 404, 405, and 406 under all circumstances, including those modifications for short periods of time if required by operating emergencies that may be deemed beyond the control of the District.

2(d): Criteria for reinitiation of section 7 consultation will include: a) average annual stage and discharge differences at North Bend and Louisville is greater than described under Current Operations; b) average seasonal stage and discharge differences at North Bend and Louisville is greater than described under Current Operations; and c) relative condition of the captured pallid sturgeon has a median of 0.9 or less. Values for criteria a) and b) are listed under the "Current Operations Max – Min Difference" columns in Tables 5-1 through 5-6 in the FLA, Appendix B.

By March 1 of the following every fifth year of survey, the Commission shall submit an annual monitoring report to the Service summarizing results of monitoring under 2(a) and 2(b). The Commission will reinitiate section 7 consultation if the five-year monitoring report identifies two conditions: that either criterion a) or b) has been triggered, and criterion c) has been triggered. In summary, reinitiation shall occur when pallid sturgeon relative condition is similar to that reported on the Missouri River, and within day variability in Lower Platte River streamflow exceed that which is presently observed under Current Operations.

RPM 3. Minimize the likelihood of pallid sturgeon mortalities from monitoring activities under Article 408.

Terms and Conditions of RPM 3:

3(a): Only qualified individuals shall be authorized to conduct monitoring activities. Collection and handling pallid sturgeon will be done in accordance with the most recent version of the "*Biological Procedures and Protocol for Researchers and Managers Handling Pallid Sturgeon*." Individuals conducting monitoring activities shall transport, receive, and hold adult pallid sturgeons captured from the wild according to the provisions and procedures outlined in the most recent versions of approved propagation plans and "*Biological Procedures and Protocol for Researchers and Managers Handling Pallid Sturgeon*".

3(b): The Service is to be notified within 3 days if any pallid sturgeon dies during collection. Initial notification must be made to the Service's Nebraska Field Office at (308) 382-6468. Notification must include the date, time, precise location of the injured animal or carcass, and any other pertinent information. Care should be taken in handling sick or injured specimens to preserve biological materials in the best possible state for later analysis of cause of death, if that occurs. In conjunction with the care of sick or injured endangered or threatened species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed.

3(c): The Commission will reinitiate section 7 consultation when the Service receives documentation of pallid sturgeon fish kill mortalities total four fish. The Commission must submit annual reports associated with Article 408 to the Nebraska Field Office by March 1 of the following year of survey. The annual report shall include a summary of incidental take resulting from the implementation of Article 408. In the event that more mortality than is authorized occurs, all monitoring activities must immediately cease, and the Service's Nebraska Field Office at (308) 382-6468 must be contacted within 24 hours.

VIB. AMOUNT OR EXTENT OF TAKE (Interior Least Tern)

Incidental take of individual Interior least terns will occur as a result of proposed Project operations. That take will be in the form of harm resulting from the killing of Interior least tern eggs or chicks due to hydrocycling during the 30-year Commission license. Project operations will result in take totaling an anticipated maximum of 107 Interior least tern or eggs or chicks due to hydrocycling. Interior least tern nests usually contain 3 eggs or chicks. Annual nest loss is estimated to be 1.19 nests per year, or approximately six nests containing 3 eggs or chicks every 5 years. The Service has determined that hydrocycling operations result in take in the form of harm to Interior least terns by inundating river sandbars used by the species for breeding, which results in the death of chicks and eggs. Adult Interior least terns are excluded from the take estimate because of their ability to fly, thereby escaping the rising water.

EFFECT OF THE TAKE

In the accompanying Opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the Interior least tern or result in the destruction or adverse modification of critical habitat.

REASONABLE AND PRUDENT MEASURES TO MINIMIZE INCIDENTAL TAKE, AND CORRESPONDING TERMS AND CONDITIONS

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of the Interior least tern. In order to be exempt from the prohibitions of section 9 of the Act, the Commission must comply with the terms and conditions, which implement the reasonable and prudent measures, which outline required reporting requirements. These terms and conditions are non-discretionary.

RPM 1. Ensure Project hydrocycling operations affecting interior least tern reproduction in the Lower Platte River will not result in take that exceeds 107 Interior least tern individuals over the 30 year license period.

Terms and Conditions of RPM 1:

1(a): The Commission shall replicate the analysis described in Objective 1 of Appendix B of the FLA. The analysis shall be conducted one out of five year starting five years after issuance of the license. The analysis of the five year time period shall identify average annual differences (and seasonal differences) in flow and water surface elevation for: a) Site 3; b) Site 4; c) Platte River at North Bend; d) Platte River at Leshara; e) Platte River near Ashland; and f) Platte River at Louisville. These differences shall be separated by year type (i.e., wet, normal, and dry) as described in the FLA, Appendix B.

1(b): The Commission shall develop and implement a plan that identifies and monitors the amount and frequency of inundation to Interior least tern nests specifically due to the difference in stage variation caused by hydrocycling. This plan shall be submitted to the Service for approval by March 1, 2016. The plan should describe the relationship between nest elevations used by nesting Interior least terns on the lower Platte River and detail instances where daily stage variation from hydrocycling inundates nests or chicks.

1(c): The District shall secure approval from the Service prior to modification of flows prescribed under Articles 404, 405, and 406 under all circumstances, including those modifications for short periods of time if required by operating emergencies that may be deemed beyond the control of the District.

1(d): The Commission will reinitiate section 7 consultation when a) average annual stage and discharge differences at North Bend and Louisville is greater than described under Current Operations; b) average seasonal stage and discharge differences at North Bend and Louisville is greater than described under Current Operations; Values for criteria a) and b) are listed under the "Current Operations Max – Min Difference" columns in Tables 5-1 through 5-6 in the FLA, Appendix B. The Commission will reinitiate section 7 consultation if the five-year monitoring report identifies that either criterion a) or b) has been triggered.

1(e): By March 1 of the following year of nesting, the Commission shall submit an annual report to the Service documenting all studies, monitoring or research undertaken in term and condition 1(a) and 1(b) to document incidences of Interior least tern nest inundation resulting from hydrocycling. The Commission will reinitiate consultation when estimated nest inundation resulting from hydrocycling operations exceeds 107 eggs and/or chicks. In general terms, reinitiation shall occur when within day variability in Lower Platte River streamflow exceed that which is presently observed under Current Operations or the estimated number of nests expected to be inundated by hydrocycling is exceeded.

VIC. AMOUNT OR EXTENT OF TAKE (Piping Plover)

Incidental take of individual piping plovers will occur as a result of proposed Project operations, from mortality due to hydrocycling during the 30-year Commission license. Project operations will result in take totaling an anticipated maximum of 72 piping plover or eggs or chicks due to hydrocycling. Piping plover nests usually contain 4 eggs or chicks. Annual nest loss is estimated to be 0.62 nests per year, or approximately three nests containing 4 eggs every 5 years. The Service has determined that hydrocycling operations result in take in the form of harm to piping plovers by inundating river sandbars used by the species for breeding resulting in the death of chicks and eggs. Adult piping plovers are excluded from the take estimate because of their ability to fly, thereby escaping the rising water. The Service has determined that hydrocycling operations result in harm to piping plovers by inundating river sandbars used by the species for breeding.

EFFECT OF THE TAKE

In the accompanying Opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the piping plover or result in the destruction or adverse modification of habitat.

REASONABLE AND PRUDENT MEASURES TO MINIMIZE INCIDENTAL TAKE, AND CORRESPONDING TERMS AND CONDITIONS

The Service concludes the following RPMs are necessary and appropriate to minimize impacts of incidental take of the Piping Plover. In order to be exempt from the prohibitions of section 9 of the Act, the Commission must implement the RPMs and comply with their non-discretionary terms and conditions. These terms and conditions are

RPM 1. Ensure Project hydrocycling operations affecting piping plover reproduction in the Lower Platte River will not result in take that exceeds 72 piping plover individuals.

Terms and Conditions of RPM 1:

1(a): The Commission shall replicate the analysis described in Objective 1 of Appendix B of the FLA. The analysis shall be conducted one out of five year starting five years after issuance of the license. The analysis of the five year time period shall identify average annual differences (and seasonal differences) in flow and water surface elevation for: a) Site 3; b) Site 4; c) Platte River at North Bend; d) Platte River at Leshara; e) Platte River near Ashland; and f) Platte River at Louisville. These differences shall be separated by year type (i.e., wet, normal, and dry) as described in the FLA, Appendix B.

1(b): The Commission shall develop and implement a plan that identifies and monitors the amount and frequency of inundation to Interior least tern nests specifically due to the difference in stage variation caused by hydrocycling. This plan shall be submitted to the Service for approval by March 1, 2016. The plan should describe the relationship between nest elevations used by nesting Interior least terns on the lower Platte River and detail instances where daily stage variation from hydrocycling inundates nests or chicks.

1(c): The District shall secure approval from the Service prior to modification of flows prescribed under Articles 404, 405, and 406 under all circumstances, including those modifications for short periods of time if required by operating emergencies that may be deemed beyond the control of the District.

1(d): The Commission will reinitiate section 7 consultation when a) average annual stage and discharge differences at North Bend and Louisville is greater than described under Current Operations; b) average seasonal stage and discharge differences at North Bend and Louisville is greater than described under Current Operations; Values for criteria a) and b) are listed under the "Current Operations Max – Min Difference" columns in Tables 5-1 through 5-6 in the FLA, Appendix B. The Commission will reinitiate section 7 consultation if the five-year monitoring report identifies that either criterion a) or b) has been triggered.

1(e): The Commission shall submit an annual report to the Service documenting all studies, monitoring or research undertaken in term and condition 1(a) and 1(b) to document incidences of Interior least tern nest inundation resulting from hydrocycling by March 1 following a nesting season. The Commission will reinitiate consultation when estimated nest inundation resulting from hydrocycling operations exceeds 72 eggs and/or chicks. In general terms, reinitiation shall occur when within day variability in Lower Platte River streamflow exceed that which is presently observed under Current Operations or the estimated number of nests expected to be inundated by hydrocycling is exceeded.

VII. CONSERVATION RECOMMENDATIONS

1. To improve the likelihood of successful Interior least tern and piping plover nesting at the North SMA, the Service recommends District coordination with Service and NGPC to ensure nesting areas provide: a) habitat approximating the amount and quality used by

Interior least tern from 2008-2014, b) a source of easily accessible fresh water near areas set aside or used for nesting and, c) woody debris or other nest furniture capable of providing shade and refuge for Interior least tern chicks. Acceptable sources of water are ponded water (excavated below depth of ground water) or flowing water (can be from discharge slurry). If woody debris is not available on-site, woody debris or other natural materials could be transported on-site.

2. Establish a partnership with the Nebraska Off Highway Vehicle Association to educate and raise awareness within the recreational off-road vehicle community. The partnership would seek to establish mechanisms to educate entities or individuals that may use ORVs within the Loup River Bypassed Area.
3. Participate in water management planning efforts for the PRRIP and the Lower Platte River Basin to raise awareness of water protection needs for the federally listed species and Section 10(j) resources in the Loup and Platte Rivers. As the District correctly stated in their June 23, 2014, letter to Commission, the conservation of federal trust resources is a shared responsibility, and the Service would like to work with the District under these efforts to conserve these resources.

VIII. REINITIATION NOTICE

This concludes formal consultation on the action(s) outlined in the October 20, 2014 request for formal consultation. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation. Please refer to the incidental take statement of this Opinion that describes the criteria for reinitiation of formal consultation when the amount or extent of incidental take is exceeded.

APPENDIX A

REQUEST FOR CONSULTATION

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426
October 20, 2014

OFFICE OF ENERGY PROJECTS

Project No. 1256-031—Nebraska
Loup River Hydroelectric Project
Loup River Public Power District

Overnight Delivery

Kirk D. Schroeder, Acting Supervisor
U.S. Fish and Wildlife Service
Ecological Services
Nebraska Field Office
9325 South Alda Road
Wood River, Nebraska 68883

Reference: Endangered Species Matrix and Request to Initiate Formal Consultation

In the Draft Environmental Assessment (draft EA) for the Loup River Hydroelectric Project (project) issued on May 22, 2014,[1] Commission staff concluded that relicensing the project with its recommended measures is likely to adversely affect the whooping crane (*Grus americana*), interior least tern (*Sternula antillarum*), piping plover (*Charadrius melodus*), and pallid sturgeon (*Scaphirhynchus albus*). On June 4, 2014 Commission staff requested the initiation of formal consultation with the U.S. Fish and Wildlife Service (FWS), as required by Section 7 of the Endangered Species Act.

In response, FWS indicated in a July 2, 2014 letter that it had not received all of the information necessary to initiate formal consultation. FWS specified that significant effects identified in the *Aquatic Resources* section of the draft EA were not discussed in the *Threatened and Endangered Species* section. During a teleconference, held on August 13, 2014, Commission staff agreed to provide FWS with an effects matrix to better illustrate how effects to the aquatic environment could potentially impact each federally-listed species.

Enclosed is the matrix, which outlines project flow effects and how they relate to endangered species impacts under (1) baseline conditions, (2) the proposed action, and

[1] The draft EA for the project is available at the following link: http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20140522-3059.

(3) the staff-recommended alternative. Please acknowledge within 30 days whether the enclosed matrix provides you the additional information that you need to initiate formal consultation and, if so, provide us with your biological opinion on our findings no later than 135 days from receipt of this request, as required by 50 CFR § 402.14(e). If we don't hear from you within 30 days, we will assume that you have sufficient information to initiate consultation and will provide us with your biological opinion by March 5, 2015. Any requests for extensions of time should be submitted to the Commission and the applicant in a timely manner that allows for sufficient time for a mutual agreement to extend the 90-day formal consultation period as per section 402.14(e) of your regulations.

The Commission strongly encourages electronic filing. Please file your response using the Commission's eFiling system at http://www.ferc.gov/docs-filing/efiling.asp. For assistance, please contact FERC Online Support at FERCOnlineSupport@ferc.gov, (866) 208-3676 (toll free), or (202) 502-8659 (TTY). In lieu of electronic filing, please send a paper copy to: Secretary, Federal Energy Regulatory Commission, 888 First Street NE, Washington, D.C. 20426. The first page of any filing should include docket number P-1256-031.

If you have any questions, please call me at (202) 502-6359.

Sincerely,

Timothy Konnert, Chief
Midwest Branch
Division of Hydropower Licensing

Enclosure: Loup ESA Effects Matrix

BASELINE

Loup River Bypassed Reach

Ongoing Flow Effects	Interior Least Tern Effects	Piping Plover	Whooping Crane	Pallid Sturgeon
Sediment transport: reduced flow transports less sediment	Likely to adversely affect: a reduction in the sediment transported downstream can adversely affect sandbar formation and maintenance	Likely to adversely affect: a reduction in the sediment transported downstream can adversely affect sandbar formation and maintenance	Likely to adversely affect: Preferred habitat parameters are altered as the wetted width and unobstructed channel width were more narrow downstream of the project diversion, likely because of the reduction in flow through this reach, adversely affecting the transport of sediment and limiting scouring of banks/sandbars to prevent vegetation establishment. However it should be noted that few individuals have been observed in the vicinity of the project	No effect: no pallid sturgeon are known to occur in this reach
Flow rate: flow diversion reduces the flow rate and volume Flow area: flow decrease proportionally decreases flow area	Likely to adversely affect: a reduction in the flow rate and flow area can limit scouring of sandbars to facilitate the establishment of permanent vegetation, it also contributes toward changes in the number, size and position of sandbars in this reach	Likely to adversely affect: a reduction in the flow rate and flow area can limit scouring of sandbars to prevent the establishment of permanent vegetation, it also contributes toward changes in the number, size and position of sandbars in this reach		
Stage fluctuation: decreases natural fluctuation but increases project-related fluctuations because of sluicing	Not likely to adversely affect: project diversion limits habitat-forming flows in this reach; sandbars in this reach tend to be less suitable for nesting when compared to those upstream of the diversion so flow fluctuations affect few nests	Not likely to adversely affect: project diversion limits habitat-forming flows in this reach; sandbars in this reach tend to be less suitable for nesting when compared to those upstream of the diversion so flow fluctuations affect few nests	Not likely to adversely affect: although stage fluctuations could impact the preferred water depth for roosting, the water depth under flow conditions that occur most frequently (normal water year and medium flow) are similar under both diversion and no-diversion conditions	
Flow depletion: with reduced water in the bypassed reach less water is lost from the stream system	No effect: little depletion occurs because there is little to no flow in this reach	No effect: little depletion occurs because there is little to no flow in this reach	No effect: little depletion occurs because there is little to no flow in this reach	

Platte River Bypassed Reach

Ongoing Flow Effects	Interior Least Tern Effects	Piping Plover	Whooping Crane	Pallid Sturgeon
Sediment transport: reduced flow transports less sediment Flow rate: flow diversion reduces the flow rate and volume Flow area: flow decrease proportionally decreases flow area	Likely to adversely affect: effects similar to those in the Loup River bypassed reach, though to a lesser degree because of incoming flow from the upper Platte River	Likely to adversely affect: effects similar to those in the Loup River bypassed reach, though to a lesser degree because of incoming flow from the upper Platte River	Likely to adversely affect: effects similar to those in the Loup River bypassed reach, though to a lesser degree because of incoming flow from the upper Platte River	No effect: no pallid sturgeon are known to occur in this reach
Stage fluctuation: decreases natural fluctuation but increases project-related fluctuations because of sluicing	Not likely to adversely affect: project diversion limits habitat-forming flows in this reach; however sandbars in this reach tend to be less suitable for nesting when compared to those upstream of the diversion so flow fluctuations affect few nests	Not likely to adversely affect: project diversion limits habitat-forming flows in this reach; however sandbars in this reach tend to be less suitable for nesting when compared to those upstream of the diversion, so flow fluctuations affect few nests	Not likely to adversely affect: although stage fluctuations could impact the preferred water depth for roosting, the water depth under flow conditions that occur most frequently (normal water year and medium flow) are similar under both diversion and no diversion conditions	
Flow depletion: with less water in the bypassed reach less water is lost from the stream system	No effect: little depletion occurs because there is little flow in this reach	No effect: little depletion occurs because there is little flow in this reach	No effect: little depletion occurs because there is little flow in this reach	

BASELINE

Ongoing Flow Effects	Interior Least Tern Effects	Piping Plover	Whooping Crane	Pallid Sturgeon
Lower Platte River				
Sediment transport: sediment removal creates a sediment deficit in the vicinity of the tailrace return, peaking operations alters sediment transport, and less sediment originates in project bypassed reach	Likely to adversely affect: in the lower Platte River, in the vicinity of the tailrace return, the sediment deficit affects sandbar formation and maintenance	Likely to adversely affect: in the lower Platte River, in the vicinity of the tailrace return, the sediment deficit affects sandbar formation and maintenance	Not applicable: potential impacts to whooping cranes in this reach was not an issue that was deemed necessary for detailed analysis during project scoping. As such, whooping crane habitat parameters were not assessed in this reach	Likely to adversely affect: the loss of stream connectivity in the lower Platte River reduces the potential for pallid sturgeon movement and habitat in the river and the potential for spawning in the river reaches upstream of the confluence of the Elkhorn River
Flow rate: peaking alters sub-daily flow rate Flow area: flow fluctuations proportionally alter flow area	Likely to adversely affect: peaking operations have the potential to inundate established nests causing species mortality; although it is difficult to isolate peaking effects from other contributing factors, these flows can increase the wetted fringe of sandbars increasing the potential for collapse	Likely to adversely affect: peaking operations have the potential to inundate established nests causing species mortality; although it is difficult to isolate peaking effects from other contributing factors, these flows can increase the wetted fringe of sandbars increasing the potential for collapse		
Stage fluctuation: peaking alters sub-daily stage				Likely to adversely affect: daily peaking operations impact longitudinal connectivity
Flow depletion: an minor amount of water is retained in the stream system	No effect: the retained water is small in comparison to flows in the river	No effect: the retained water is small in comparison to flows in the river		No effect: the retained water is small in comparison to flows in the river
Loup Power Canal				
Sediment transport: sediment removal keeps the transport in the canal in balance	No effect: there are no sandbars within the canal that provide the required habitat	No effect: there are no sandbars within the canal that provide the required habitat	No effect: no habitat is present in the power canal	No effect: no pallid sturgeon are known to occur in the power canal
Flow rate: flow diversion increases the flow rate and volume Flow area: flow diversion increases the flow area Stage fluctuation: peaking alters sub-daily stage in the tailrace canal Flow depletion: an minor amount of water is retained in the stream system	No effect: no habitat is present in the power canal	No effect: no habitat is present in the power canal		
North Sand Management Area				
Sediment removal operations: Removal of sediment from the Loup Power Canal creates additional nesting habitat for interior least terns and piping plovers	Not likely to adversely affect: though there is the potential for individuals to be harmed by dredging and pumping activities (if they arrive prior to the suspension of said activities for nesting season), the additional sand provides additional off-river nesting habitat	Not likely to adversely affect: though there is the potential for individuals to be harmed by dredging and pumping activities (if they arrive prior to the suspension of said activities for nesting season), the additional sand provides additional off-river nesting habitat	No effect: whooping cranes do not utilize the North Sand Management Area.	Not applicable

PROPOSED ACTION

Additional 25 cfs in the Loup River bypassed reach (50 cfs leakage) ambient temperature at Genoa or Columbus is forecast to reach or exceed 98 degrees Fahrenheit

Flow Effects Compared to Baseline		Interior Least Tern Effects	Piping Plover	Whooping Crane	Pallid Sturgeon
Loup River Bypassed Reach					
Sediment transport Flow rate Flow area	The proposed flow increase would have minimal effect on these parameters	Likely to adversely affect: same as baseline	Likely to adversely affect: same as baseline	Likely to adversely affect: same as baseline	No effect: no pallid sturgeon are known to occur in this reach
Flow depletion		No effect: same as baseline	No effect: same as baseline	No effect: same as baseline	
Stage fluctuation	Project-related fluctuations because of sluicing would continue	Not likely to adversely affect: same as baseline	Not likely to adversely affect: same as baseline	Not likely to adversely affect: same as baseline	
Platte River Bypassed Reach					
Sediment transport Flow rate Flow area	The proposed flow increase would have minimal effect on these parameters	Likely to adversely affect: same as baseline	Likely to adversely affect: same as baseline	Likely to adversely affect: same as baseline	No effect: no pallid sturgeon are known to occur in this reach
Flow depletion		No effect: same as baseline	No effect: same as baseline	No effect: same as baseline	
Stage fluctuation		Not likely to adversely affect: same as baseline	Not likely to adversely affect: same as baseline	Not likely to adversely affect: same as baseline	
Lower Platte River					
Sediment transport Flow rate Flow area	The proposed flow increase would have minimal effect on these parameters	Likely to adversely affect: same as baseline	Likely to adversely affect: same as baseline	Not applicable: see baseline	Likely to adversely affect: same as baseline
Flow depletion		No effect: same as baseline	No effect: same as baseline		No effect: same as baseline
Stage fluctuation		Likely to adversely affect: same as baseline	Likely to adversely affect: same as baseline		Likely to adversely affect: same as baseline
Loup Power Canal					
Sediment transport Flow rate Flow area Flow depletion	The proposed flow increase would have minimal effect on these parameters	No effect: same as baseline	No effect: same as baseline	No effect: same as baseline	No effect: no pallid sturgeon are known to occur in the power canal
Stage fluctuation	No effect				

STAFF ALTERNATIVE

Flow Recommendation: Seasonal minimum flows in the Loup River bypassed reach (100 cfs from October through March, 275 cfs April through September)

Project Operational Effects in the Loup River Bypassed Reach

Flow Effects Compared to Baseline	Interior Least Tern Effects	Piping Plover	Whooping Crane	Pallid Sturgeon
Sediment transport: additional flow transports slightly more sediment	Likely to adversely affect: increasing sediment transport would help to maintain existing sandbars, although base flows would be much smaller than flows upstream of the project diversion	Likely to adversely affect: increasing sediment transport would help to maintain existing sandbars, although base flows would be much smaller than flows upstream of the project diversion	Likely to adversely affect: these flows are too low to significantly increase scour of banks/sandbars or the unobstructed channel width; however, it would increase wetted widths in the reach, help to restrict vegetation establishment, additional flow may attract more prey species, and should not adversely affect the preferred depth roosting parameters	No effect: no pallid sturgeon are known to occur in this reach
Flow rate: base flow is much larger Flow area: flow increase proportionally increases flow area	Likely to adversely affect: increases the wetted width in this reach throughout the year, provides greater habitat connectivity for species prey, and the additional flow also restricts vegetation growth; however, flows are still much greater upstream of the project diversion	Likely to adversely affect: increases the wetted width in this reach throughout the year, provides greater habitat connectivity for species prey, and the additional flow also restricts vegetation growth; however, flows are still much greater upstream of the project diversion		
Stage fluctuation: project-related sluicing fluctuations continue but amplitude is slightly less because of base flow	Not likely to adversely affect: project diversion limits habitat-forming flows in this reach; however sandbars in this reach tend to be less suitable for nesting when compared to those upstream of the diversion, so flow fluctuations affect few nests	Not likely to adversely affect: project diversion limits habitat-forming flows in this reach; however sandbars in this reach tend to be less suitable for nesting when compared to those upstream of the diversion, so flow fluctuations affect few nests	Not likely to adversely affect: given that the depth roosting parameter was similar under diversion and no-diversion conditions, no adverse effects are anticipated (see baseline)	
Flow depletion: additional flow in the bypassed reach results in a minor loss of flow from stream system	Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat	Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat	Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat	

Platte River Bypassed Reach

Flow Effects Compared to Baseline	Interior Least Tern Effects	Piping Plover	Whooping Crane	Pallid Sturgeon
Sediment transport: additional flow transports more sediment Flow rate: base flow is somewhat larger Flow area: flow increase proportionally increases flow area Stage fluctuation: project-related sluicing fluctuations continue but amplitude is slightly less because of base flow Flow depletion: additional flow in the bypassed reach results in a minor loss of flow from stream system	See above: same effect as Loup River bypassed reach	See above: same effect as Loup River bypassed reach	See above: same effect as Loup River bypassed reach	No effect: no pallid sturgeon are known to occur in this reach

STAFF ALTERNATIVE

Lower Platte River

Flow Effects Compared to Baseline	Interior Least Tern Effects	Piping Plover	Whooping Crane	Pallid Sturgeon
Sediment transport: slightly more sediment from bypassed reaches will be available but is insufficient to mitigate for the sediment deficit in the vicinity of the tailrace return caused by the Project's sediment removal operations; peaking operations would slightly alter sediment transport	Likely to adversely affect: the impacted area is limited to the lower Platte River in the vicinity of the tailrace return where the sediment deficit affects sandbar formation and maintenance	Likely to adversely affect: the impacted area is limited to the lower Platte River in the vicinity of the tailrace return where the sediment deficit affects sandbar formation and maintenance	Not applicable: potential impacts to whooping cranes in this reach was not an issue that was deemed necessary for detailed analysis during project scoping. As such, whooping crane habitat parameters were not assessed in this reach	Likely to adversely affect: the minimum flows passing through the Loup and Platte River bypassed reaches would potentially help to maintain channels formed during high flows that occur in the lower Platte River; however it is unlikely to completely mitigate project effects
Flow rate: more constant water supply provides a slightly larger base flow Flow area: flow increase proportionally increases flow area Stage fluctuation: peaking and sluicing operations continue, the amplitude of which are lessened by the seasonal minimum flow	Likely to adversely affect: base flow will not be sufficient to mitigate the effects of peaking operations that have the potential to inundate established nests; although it is difficult to isolate peaking effects from other contributing factors, these flows can increase the wetted fringe of sandbars increasing the potential for collapse	Likely to adversely affect: base flow will not be sufficient to mitigate the effects of peaking operations that have the potential to inundate established nests; although it is difficult to isolate peaking effects from other contributing factors, these flows can increase the wetted fringe of sandbars increasing the potential for collapse		Likely to adversely affect: additional base flows would help to reduce the amplitude of stage fluctuations, though only slightly, thus longitudinal connectivity could still be adversely impacted
Flow depletion: a minor loss of flow from the bypassed reach would be unavailable	Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat	Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat		Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat

Loup Power Canal

Flow Effects Compared to Baseline	Interior Least Tern Effects	Piping Plover	Whooping Crane	Pallid Sturgeon
Sediment transport: sediment removal keeps the transport in the canal in balance regardless of flow Flow rate: flow decreases Flow area: flow reduction decreases area Stage fluctuation: no effect Flow depletion: no effect	No effect: no habitat is present in the power canal	No effect: no habitat is present in the power canal	No effect: no habitat is present in the power canal	No effect: no pallid sturgeon are known to occur in the power canal

STAFF ALTERNATIVE				
Flow Recommendation: Maximum diversion of flow into the power canal (2,000 cfs from March through June)				
Loup River Bypassed Reach				
Flow Effects Compared to Baseline	**Interior Least Tern Effects**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**
Sediment transport: larger flow rates and flow volume transports greater amounts of sediment Flow rate: the flow rate would increase by a maximum of 1,500 cfs during storm events Flow area: flow increase proportionally increases area	Likely to adversely affect: allows for more frequent channel-forming flows to pass through this reach and increase the availability of food sources; over time an increase in sediment transport, wetted widths, and velocity all have the potential to increase channel width, though the magnitude of these changes are unclear	Likely to adversely affect: allows for more frequent channel-forming flows to pass through this reach and increase the availability of food sources; over time an increase in sediment transport, wetted widths, and velocity all have the potential to increase channel width, though the magnitude of these changes are unclear	Likely to adversely affect: these flows would increase the wetted width and facilitate the scour of banks/sandbars, as well as, over time provide an increase in the unobstructed channel width; the effect on the depth of roosting parameter is unclear because it will vary based on the available flow	No effect: no pallid sturgeon are known to occur in this reach
Stage fluctuation: project-related sluicing fluctuations continue	Not likely to adversely affect: there would be higher stage fluctuations during flow events, but this is similar to what would occur in a natural system, and can encourage birds to nest higher on their chosen sandbars	Not likely to adversely affect: there would be higher stage fluctuations during flow events, but this is similar to what would occur in a natural system, and can encourage birds to nest higher on their chosen sandbars	Not likely to adversely affect: given that the depth roosting parameter was similar under diversion and no-diversion conditions, no adverse effects are anticipated (see baseline)	
Flow depletion: additional flow in the bypassed reach results in a minor loss of flow from stream system	Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat	Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat	Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat	
Platte River Bypassed Reach				
Flow Effects Compared to Baseline	**Interior Least Tern Effects**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**
Sediment transport: larger flow rates and flow volume transports greater amounts of sediment Flow rate: the flow rate would increase by a maximum of 1,500 cfs during storm events Flow area: flow increase proportionally increases area Stage fluctuation: project-related sluicing fluctuations continue Flow depletion: additional flow in the bypassed reach results in a minor loss of flow from stream system	See above: same effect as Loup River bypassed reach	See above: same effect as Loup River bypassed reach	See above: same effect as Loup River bypassed reach	Likely to adversely affect: the maximum diversion would increase the number of days when flows in the Platte River bypassed reach would be greater than 4,400 cfs thus providing potential access for pallid sturgeon to this river reach; however, it would not completely mitigate the effects of project operation Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat

STAFF ALTERNATIVE

Lower Platte River

Flow Effects Compared to Baseline	Interior Least Tern Effects	Piping Plover	Whooping Crane	Pallid Sturgeon
Sediment transport: slightly more sediment from bypassed reach will be available but will not mitigate the sediment deficit in the vicinity of the tailrace return caused by the Project's sediment removal operations; peaking operations would slightly alter sediment transport	Likely to adversely affect: additional sediment from the bypassed reaches would help to make up for the sediment deficit in this reach; however it is unlikely to completely mitigate project effects	Likely to adversely affect: additional sediment from the bypassed reaches would help to make up for the sediment deficit in this reach; however it is unlikely to completely mitigate project effects	Not applicable: potential impacts to whooping cranes in this reach was not an issue that was deemed necessary for detailed analysis during project scoping. As such, whooping crane habitat parameters were not assessed in this reach	Likely to adversely affect: the maximum diversion would more frequently provide the 4,400 cfs target flow in the lower Platte River, it will also increase stage fluctuations because of the additional flows coming from the bypassed reaches
Flow rate: the flow rate would increase by a maximum of 1,500 cfs during storm events Flow area: flow increase proportionally increases area Stage fluctuation: peaking operations continue	Likely to adversely affect: the flow rate would slightly dampen the amplitude of the peaking affects, although downstream nests could still be inundated	Likely to adversely affect: the flow rate would slightly dampen the amplitude of the peaking affects, although downstream nests could still be inundated		
Flow depletion: a minor loss of flow from the bypassed reach is unavailable	Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat	Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat		Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat

Loup Power Canal

Flow Effects Compared to Baseline	Interior Least Tern Effects	Piping Plover	Whooping Crane	Pallid Sturgeon
Sediment transport: sediment removal keeps the transport in the canal in balance regardless of flow Flow rate: flow decreases Flow area: flow reduction decreases area Stage fluctuation: no effect Flow depletion: no effect	No effect: no habitat is present in the power canal	No effect: no habitat is present in the power canal	No effect: no habitat is present in the power canal	No effect: no pallid sturgeon are known to occur in the power canal

STAFF ALTERNATIVE

Flow Recommendation: Minimum Flow in the lower Platte River (4,400 cfs from May 1 through June 8)

Loup River Bypassed Reach

Flow Effects Compared to Baseline	Interior Least Tern Effects	Piping Plover	Whooping Crane	Pallid Sturgeon
Sediment transport: additional flow transports more sediment Flow rate: more flow is available in bypassed reach when project cannot operate Flow area: flow increase proportionally increases flow area	Not likely to adversely affect: the minimum flow in the lower Platte River would provide for additional maintenance flows in the Loup River bypassed reach, and slightly more sediment transport, during dry years; this would benefit the species by providing greater habitat connectivity for species prey, and the additional flow in years when water is the most limited	Not likely to adversely affect: the minimum flow in the lower Platte River would provide for additional maintenance flows in the Loup River bypassed reach, and slightly more sediment transport, during dry years; this would benefit the species by providing greater habitat connectivity for species prey, and the additional flow in years when water is the most limited	Likely to adversely affect: these flows are too low to significantly increase scour of banks/sandbars or the unobstructed channel width; however, it will increase wetted widths in the reach, should restrict vegetation establishment, additional flow may attract more prey species, and it should not adversely affect the preferred depth roosting parameters	
Stage fluctuation: project-related fluctuations because of sluicing continues but amplitude is less when project cannot operate	Not likely to adversely affect: during low-flow periods in dry years, when the project is not operating, there will be a natural fluctuation in flow stage and flow area; although there is some potential to inundate nests, this would only occur early in the breeding/nesting season making it unlikely that many nests would be affected	Not likely to adversely affect: during low-flow periods in dry years, when the project is not operating, there will be a natural fluctuation in flow stage and flow area; although there is some potential to inundate nests, this would only occur early in the breeding/nesting season making it unlikely that many nests would be affected	Not likely to adversely affect: given that the depth roosting parameter was similar under diversion and no-diversion conditions, no adverse effects are anticipated (see baseline)	No effect: no pallid sturgeon are known to occur in this reach
Flow depletion: additional flow in the bypassed reach results in a minor loss of flow from stream system	Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat	Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat	Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat	

Platte River Bypassed Reach

Flow Effects Compared to Baseline	Interior Least Tern Effects	Piping Plover	Whooping Crane	Pallid Sturgeon
Sediment transport: additional flow transports more sediment Flow rate: more flow is available in bypassed reach when project cannot operate Flow area: flow increase proportionally increases flow area Stage fluctuation: project-related fluctuations because of sluicing continues but amplitude is less when project cannot operate	See above: same effect as Loup River bypassed reach	See above: same effect as Loup River bypassed reach	See above: same effect as Loup River bypassed reach	Likely to adversely affect: flow contributed by the Loup River would pass through the Platte River bypassed reach (on some occasions when all flows are not diverted through the tailrace canal) and slightly increase the frequency by which flows in the Platte River bypassed reach would be greater than 4,400 cfs, potentially allowing for pallid sturgeon to reach the Platte River bypassed reach
Flow depletion: additional flow in the bypassed reach results in a minor loss of flow from stream system				Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat

STAFF ALTERNATIVE

Lower Platte River

Flow Effects Compared to Baseline	Interior Least Tern Effects	Piping Plover	Whooping Crane	Pallid Sturgeon
Sediment transport: additional sediment from bypassed reach is available Flow rate: less peaking because of required minimum flows Flow area: flow increase proportionally increases flow area	Likely to adversely affect: additional sediment from the bypassed reaches would help to make up for the sediment deficit in this reach during dry years; however it is unlikely to significantly increase habitat in this reach due to continued project operations	Likely to adversely affect: additional sediment from the bypassed reaches would help to make up for the sediment deficit in this reach during dry years; however it is unlikely to significantly increase habitat in this reach due to continued project operations	Not applicable: potential impacts to whooping cranes in this reach was not an issue that was deemed necessary for detailed analysis during project scoping. As such, whooping crane habitat parameters were not assessed in this reach	Likely to adversely affect: the additional flow has the potential to improve longitudinal connectivity for pallid sturgeon movements in the lower Platte River during the 38-day period
Stage fluctuation: peaking operations continue but amplitude is reduced. Run-of-river operation would eliminate project fluctuation.	Likely to adversely affect: reduces the number of days that peaking would occur, therefore reducing the amplitude of stage increases for up to 38 days, though downstream nests could still be inundated both before and after this 38-day period	Likely to adversely affect: reduces the number of days that peaking would occur, therefore reducing the amplitude of stage increases for up to 38 days, though downstream nests could still be inundated both before and after this 38-day period		
Flow depletion: a minor loss of flow from the bypassed reach is unavailable	Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat	Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat		Not likely to adversely affect: the minor loss of flow is unlikely to affect species habitat

Loup Power Canal

Flow Effects Compared to Baseline	Interior Least Tern Effects	Piping Plover	Whooping Crane	Pallid Sturgeon
Sediment transport: sediment removal keeps the transport in the canal in balance regardless of flow Flow rate: flow decreases Flow area: flow reduction decreases area Stage fluctuation: no effect Flow depletion: no effect	No effect: no habitat is present in the power canal	No effect: no habitat is present in the power canal	No effect: no habitat is present in the power canal	No effect: no pallid sturgeon are known to occur in the power canal

STAFF ALTERNATIVE

Additional Staff Recommendations				
Recommendation-Specific Measures	**Interior Least Tern Effects**	**Piping Plover**	**Whooping Crane**	**Pallid Sturgeon**
Recommendation: Pallid Sturgeon Monitoring Plan				
Develop a plan to verify and monitor the success of staff recommended flows in improving longitudinal connectivity for pallid sturgeon	Not applicable	Not applicable	Not applicable	Likely to adversely affect: potential adverse effects from accidental take of pallid sturgeon while conducting monitoring efforts
Recommendation: Consultation for Whooping Cranes				
Periodic consultation with the resource agencies to review updated information about whooping cranes	Not applicable	Not applicable	Not likely to adversely affect: consulting with the resources agencies to evaluate the whooping crane population in the project vicinity would evaluate the necessity of additional protection, mitigation, and enhancement measures	Not applicable
Recommendation: Tern and Plover Monitoring Plan				
Develop a plan to monitor the presence and habitat use of interior least terns and piping plovers	Not likely to adversely affect: development of this plan would provide insight into how the recommended flows are affecting river morphology and sandbar formation, as well as nesting and habitat use information about each species	Not likely to adversely affect: development of this plan would provide insight into how the recommended flows are affecting river morphology and sandbar formation, as well as nesting and habitat use information about each species	Not applicable	Not applicable
Develop a management plan for the North Sand Management Area	Not likely to adversely affect: this plan would ensure the protection of nesting habitat in the North Sand Management Area	Not likely to adversely affect: this plan would ensure the protection of nesting habitat in the North Sand Management Area	Not applicable	Not applicable

Appendix B

Service's Approach to Evaluating Effects of the Proposed Action in the Biological Opinion

Background - On June 4, 2014, the Federal Energy Regulatory Commission (Commission) requested formal consultation pursuant to section 7 of the Endangered Species Act (Act) with the U.S. Fish and Wildlife Service (Service) for the Loup River Hydroelectric Project (Project; No. 1256-031). The Commission's May 22, 2014, Draft Environmental Assessment serves as the Biological Assessment. The Staff Alternative represents the Commission's proposed federal action. In a July 2, 2014, response to the Commission, the Service concluded that formal consultation could not be initiated because additional information was needed in accordance with (50 C.F.R. § 402.14 (c)). Specifically, differences between the Service's and the Commission's definition of the environmental baseline and its relationship to the Staff Alternative made it difficult to evaluate how the proposed federal action may affect federally listed species.

The Commission hosted a conference call with the Service on August 13, 2014, to discuss the Service's July 2, 2014 comments. While the Commission stated that projects cannot operate without a license, the Commission specified that their environmental baseline represents existing project conditions (i.e., the no-action alternative). The Service and Commission discussed information necessary for completing the initiation package for formal consultation and the Commission agreed to develop an Endangered Species Matrix (matrix) to illustrate how effects under the Staff Alternative could potentially impact each federally-listed species.

The Commission's matrix was received by the Service on October 20, 2014. In the matrix, the Commission described how Project operations in the environmental baseline are "likely to adversely affect" the Interior least tern, piping plover, whooping crane, and pallid sturgeon. The matrix also described how certain adverse effects to federally listed species are minimized under the Staff Alternative. Page 4-22 of the Service's Endangered Species Consultation Handbook (handbook) states that the environmental baseline does not include the effects of the action under review in the consultation; therefore, it is the Service's determination that the Commission's description of the environmental baseline in the matrix is inconsistent with the Act because Project operations in the environmental baseline cannot adversely affect federally listed species.

Service's Approach for the Biological Opinion – To adequately evaluate the effects of the Staff Alternative, the Service would have had to develop an environmental baseline that did not include Project operational effects to the species. The Service applied the following guidance from the handbook for this biological opinion. Page 4-28 describes how new licenses issued by the Commission for existing hydropower projects represent a new commitment of resources. Therefore, a section 7 analysis of the project's effects on listed species is done in the same way as new projects.

The handbook provides the following approach for analyzing effects of a license:

1. The total effects of all past activities, including effects of the past operation of the project, current non-Federal activities, and Federal projects with completed section 7 consultations, form the environmental baseline.

2. To this baseline, future direct and indirect impacts of the operation over the new license or contract period, including effects of any interrelated and interdependent activities, and any reasonably certain future non-Federal activities (cumulative effects), are added to determine the total effect on listed species and their habitat.

In accordance with the handbook, the Service has developed the following approach for this biological opinion.

1. The environmental baseline is defined as: a) no diversion into the Project canal for the purpose of hydropower production; b) existing Project infrastructure remains in place; and c) current habitat conditions that have been formed through past Project operations represent a starting condition for the environmental baseline

2. The environmental baseline will also include the following assumptions: a) species habitat conditions are expected to change under a no diversion baseline; and b) species status in the action area is expected to be different under a no diversion baseline.

3. The effects of the Staff Alternative will include: a) diversion of water into the Project canal for the purpose of hydropower production; and b) Commission license articles serving as conservation measures to minimize adverse effects of Project diversion to federally listed species.

APPENDIX C

GLOSSARY OF TERMS and SPECIES LIST

Glossary of Terms

Act – Endangered Species Act

Assessment – Collective biological assessment/environmental assessment submitted by the Commission on May 22, 2014, and the Endangered Species Matrix submitted by the Commission on October 20, 2014.

Augmentation Program - pallid sturgeon conservation augmentation program

AWBP - Aransas-Wood Buffalo whooping crane population

cm - centimeters

CFS – Cubic Feet per Second

CLMU - Central Lowlands Management Unit, pallid sturgeon management unit

Commission – Federal Energy Regulatory Commission

Current Operations – Loup River Hydroelectric Project under current license articles. Current Operations was referred to as the "No-Action Alternative" by the Commission in their National Environmental Policy Act evaluation.

District - Loup River Public Power District

DPS - Distinct Population Segment

EO - Executive Order

F - Fahrenheit

EA - Environmental Assessment

Environmental Baseline – Operations represent "No Diversion into the Power Canal" as described by the Commission on Page 85 of the Assessment. Rationale for use of a no diversion condition as the environmental baseline is described in Appendix B of the Opinion.

in - inches

IPCC - Intergovernmental Panel on Climate Change

ISR – Initial Study Report

kV - kilovolt

Loup River Bypassed Reach – A 34.2-mile-long river segment between the Project diversion and the confluence with the Platte River

Lower Platte River – A 101.5-mile-long river segment between the Project tailrace return and the confluence with the Missouri River

MBTA - Migratory Bird Treaty Act

MOU - Memorandum of Understanding

msl – mean sea level

MW - Megawatt

NDNR - Nebraska Department of Natural Resources

NPPD - Nebraska Public Power District

NGP - Northern Great Plains population piping plovers

NGPC - Nebraska Game and Parks Commission

NWR - National Wildlife Refuge

Opinion – Biological Opinion

ORV - off-road vehicles
PCB - polycholorinated biphenyls
Platte River Bypassed Reach – A 2.1-mile-long river segment between the Loup River confluence and the Project tailrace return
POCs - designated points of contact
Project - Loup River Hydroelectric Project
PRRIP - Platte River Recovery Implementation Program
RM – river mile
Sediment Deficit – this term is specifically applied to Project operations at the Project Tailrace. This occurs when water transported from the Project tailrace and enters the Lower Platte River. A sediment deficit occurs when the Project Tailrace water removes sediment from the local supply in the Lower Platte River which comprises of the river bed, banks, and sandbars.
Service – U.S. Fish and Wildlife Service
SMA – Sand Management Area
Staff Alternative –The Staff Alternative is preferred alternative under the National Environmental Policy Act evaluation and is the proposed action for evaluation under section 7 of Act.
TPCP - Tern and Plover Conservation Partnership
TPWD - Texas Parks and Wildlife Department
USACE - U.S. Army Corps of Engineers
USGS - U.S. Geological Survey

Species List

American crow (*C. brachyrhynchos*)
American kestrel (*F. sparverius*)
bighead carp (*Hypophthalmichthys nobilis*)
bigmouth buffalo (*Ictiobus cyprinellus*)
black-crowned night heron (*Nycticorax nycticorax*)
black carp (*Mylopharyngodon piceus*)
black mangroves (*Avicennia germinans*)
boat-tailed grackle (*Quiscalus major*)
common carp (*Cyprinus carpio*)
common raven (C*orvus corax*)
coyote (*Canis latrans*)
emerald shiner (*Notropis atherinoides*)
feral hog (*Sus scrofa*)
fish crow (*Corvus ossifragus*)
freshwater drum (*Aplodinotus grunniens*)
gizzard shad (*Dorosoma cepedianum*)
grass carp (*Ctenopharyngodon idella*)

great blue heron (*Ardea herodias*)
great horned owl (*Bubo virginianus*)
Interior least tern (*Sternula antillarum*)
largemouth bass (*Micropterus salmoides*)
loggerhead shrike (*Lanius ludovicianus*)
northern harrier (*Circus cyaneus*)
opossum (*Didelphis virginiana*)
paddlefish (*Polyodon spathula*)
pallid sturgeon (*Scaphirhynchus albus*)
peregrine falcon (*Falco peregrinus*)
piping plover (*Charadrius melodus*)
raccoon (*Procyon lotor*)
red fox (*Vulpes vulpes*)
ruddy turnstone (*Arenaria interpres*)
sand shiner (*Notropis stramineus*)
sanderling (*Calidris alba*)
silver carp (*Hypophthalmichthys molitrix*)
spotfin shiner (*Cyprinella spiloptera*)
striped skunk (*Mephitis mephitis*)
western prairie fringed orchid (*Platanthera praeclara*)
white bass (*Morone chrysops*)
whooping crane (*Grus americana*)
zebra mussel (*Dreissena polymorpha*)
carps and minnows (*Cyprinidae*)
catfish (*Ictalurus* sp.)
gulls (*Larus* spp.)
shad (*Dorosoma* spp.)
sunfish (*Lepomis* spp.)
top minnows (*Fundulus* spp.)

APPENDIX D

Hydrology and River Geomorphology under Environmental Baseline and Staff Alternative

I. HYDROLOGY AND RIVER GEOMORPHOLOGY UNDER THE ENVIRONMENTAL BASELINE

Description of the Environmental Baseline

Page 4-30 of the Service's Endangered Species Consultation Handbook describes the environmental baseline as the total effects of all past activities, including effects of the past operation of the project, current non-Federal activities, and Federal projects with completed section 7 consultations. The Commission's Assessment determined that the Staff Alternative adversely affects the least tern, piping plover, pallid sturgeon, and whooping crane. One overarching theme in the Assessment is the interconnected nature of the Loup River Bypassed Area, Platte River Bypassed Area, and Lower Platte River. Loup and Platte River hydrology, sediment supply, and sediment transport influence the local geomorphology of these rivers (i.e., processes that shape a river over time) which in turn influence species habitat and species use. In this section, the Service will describe the representative hydrology and geomorphology conditions in the Environmental Baseline. Subsequent sections will extract information from the Hydrology and Geomorphology section to characterize species habitat and use.

As stated in the Description of the Proposed Action, the Staff Alternative is the Commission's authorization of a new major license to the District to operate and maintain Project operations. Under this scope, the Service views the environmental baseline for this action to represent a condition where there is no diversion of flow into the power canal for the purpose of power production, although structures (e.g., diversion, canal, powerhouses, and lakes) remain in place. The Service's environmental baseline reflects "No Diversion into the Power Canal" as described by the Commission on Page 85 of the Assessment and will be subsequently referred to as the "No Diversion" condition. It is important to note that the Environmental Baseline represents a broader condition of hydrology, geomorphology, habitat, and species use while the No Diversion condition represents the operational hydrology within the Environmental Baseline. The Service also recognizes that geomorphology, species habitat, and species use presently observed in the Loup and Platte Rivers were influenced by decades of Project operation under the existing license (hereby referred to as Current Operations). To adequately describe the Environmental Baseline, it is important for the Service to describe present conditions under Current Operations and then compare that with how project conditions would change under the No Diversion condition.

Loup River Bypassed Reach

A. Loup River Hydrology

The Loup River Basin encompasses 15,200 square miles and with 2,602 kilometers (4,337 miles) of streams in central Nebraska (Bliss and Schainost, 1973). The Loup River Basin accounts for nearly one-fifth of the state's total land area and contains seven major river systems including the South Loup, Middle Loup, North Loup, Dismal, Calamus, Cedar, and Loup Rivers. There are three major reservoirs within the basin including Sherman (off-stream of the Middle Loup River and fed by a man-made canal), Davis Creek (on Davis Creek) and Calamus (on the Calamus River). The Sherman, Davis, and Calamus Reservoirs are Bureau of Reclamation projects built to supply irrigation water to irrigation districts in the watershed and to provide a limited amount of flood control.

The Loup River, which is about 68 miles long, originates in Howard County, Nebraska about 5 miles northeast of St. Paul, Nebraska and about 20 miles north of Grand Island, Nebraska. The Loup River is formed by the confluence of the North and Middle Loup Rivers. The Loup River Basin originates in Sheridan County, Nebraska, and extends about 260 miles downstream to where it empties into the Platte River in Platte County, Nebraska.

The South Loup River originates to the west in McPherson County, Nebraska, and flows southeastward where it joins the Middle Loup River in Howard County, Nebraska (about 15 miles northwest of Grand Island, Nebraska). The South Loup River flows through an area of loess hills and receives most of its flow from rainfall and runoff (Fowler 2005). The North and Middle Loup Rivers flow through the Sandhills region and are primarily fed by groundwater springs from the Ogallala Aquifer, resulting in the Loup River providing a steady, dependable flow of water into the Platte River year-round. The lower Platte River's[37] hydrograph and base flow benefit from the influence of groundwater-fed Loup and Elkhorn Rivers, which are considered to have some of the most stable flows when compared to rivers worldwide (Bentall, 1989). Though somewhat modified by diversions for irrigation and hydropower production, the Loup River maintains a fairly constant year-round flow because it receives the majority of its input from upstream groundwater . On average, the Loup River contributes 34 percent of the discharge annually for the lower Platte River (Peters and Parham 2008).

In the Commission's Assessment, the Loup River Bypassed Reach is 32.2 miles in length. The Commission divided the Loup River into two stream segments, which are upstream and downstream of Beaver Creek, because of the flow contributions from Beaver Creek to Loup River streamflow. The stream segment downstream from the Project diversion to the Beaver Creek confluence is 6.2 miles in length, and the stream segment downstream of the Beaver Creek confluence to the Loup River confluence with the Platte River is 25 miles in length.

A1. Loup River Streamflow Summary

Figure 1 depicts the median annual flow for the Loup River at Genoa and Loup Power Canal under Current Operations. Figure 1 was developed using streamgage daily records for the Loup River near Genoa (USGS Gage No. 06793000) and Loup Power Canal near Genoa (USGS Gage No. 06792500) from 1980 to 2009. The Environmental Baseline for Loup River at Genoa was derived by summing values for Loup River near Genoa and Loup Power Canal near Genoa for each of the respective days within a calendar year because. Under the Environmental Baseline, it is expected that all water diverted historically would bypass the Project diversion under the No Diversion condition.

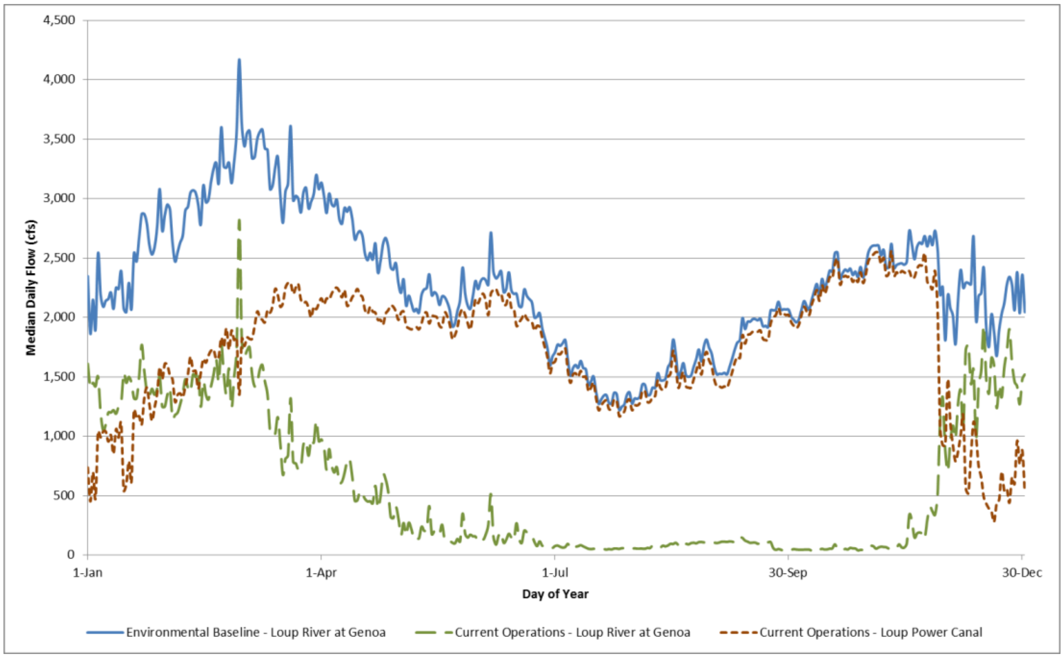

Figure 1. Median annual flow for Environmental Baseline and Current Operations from 1980 to 2009. Data for this figure was obtained from the USGS Gage Stations for Loup River near Genoa and Loup Power Canal near Genoa.

Water quantity estimates for the Loup River at the Project diversion structure were calculated from data collected from two USGS gages (Table 1) summed for the water years 1944 through 2010. These estimates take into consideration water removed for the project dredging activities in the settling basin, evaporation, seepage, and the fact that there are no substantial inflows between the diversion intake and the USGS gage in the power canal. One USGS gage is located near Genoa, Nebraska (gage no. 06793000) in the Loup River bypassed reach and about 6 miles downstream from the diversion weir with a period of record from 1944 through 2010. The other USGS gage (gage no. 06792500) is located at the skimming weir, about 1.9 miles downstream from the entrance to the power canal, and with a period of record between water year 1938 through 2010. Combining the flow data from both of the above gages (i.e., in the Loup River bypassed reach and in the power canal) provides an estimate of flows in the Loup River as it reaches the point where water is diverted into the power canal. As a result, average daily maximum flows in the Loup River ranges from 7,990 cfs (in January) to 73,940 cfs (in August). Whereas, average daily mean flows ranged from 1,542 cfs (in August) to 3,460 cfs (in March).

Table 1. Average daily minimum, mean, and maximum flows by month on the Loup River at the Loup Project diversion weir, for water years 1944 to 2010[a] (Source: Assessment Table 1).			
Month	Minimum Flow (cfs)	Mean Flow (cfs)	Maximum Flow (cfs)
January	304	2,180	7,270
February	367	2,930	26,500
March	293	3,530	33,100
April	1,290	2,930	18,700
May	854	2,710	18,600
June	283	3,010	69,300
July	133	1,810	29,900
August	64	1,590	72,600
September	398	1,880	11,500
October	957	2,220	11,400
November	164	2,390	7,210
December	66	2,090	5,120

[a] Calculated for the period October 1, 1943, through September 30, 2010, using flow records from USGS Gage 06793000 on the Loup River near Genoa and USGS Gage 06792500 on the Loup power canal near Genoa. Flows at the point of diversion were calculated by adding the flows at these two gages.

There is a great deal of flow variability in the Loup River bypassed reach as flows in the Loup River are diverted into the power canal. This variability of flows is highlighted by the many months of the year when there is zero flow in the 32.2-mile-long Loup River bypassed reach (Table 2). For 6 out of 12 months, the minimum flow in the Loup River bypassed reach is zero, and is low for the remainder of the year. The low minimum flows in the Loup River bypassed reach contrasts markedly with the average daily maximum flow of 70,800 cfs in August, which is a result of the frequent thunderstorms during this month.

Table 2. Average daily minimum, mean, and maximum flows by month on the Loup River near Genoa, Nebraska for water years 1944 to 2010[a] (Source: Assessment Table 3).			
Month	Minimum Flow (cfs)	Mean Flow (cfs)	Maximum Flow (cfs)
January	8	998	5,200
February	7	1,430	25,000
March	17	1,620	31,700
April	4	715	17,300
May	0	655	16,200
June	0	1,010	66,300
July	0	366	27,500
August	0	262	70,800
September	0	270	8,880
October	0	193	8,550
November	2	455	6,460
December	3	1,110	5,000

[a] Calculated for the period October 1, 1943, through September 30, 2010, using flow records from USGS Gage 06793000 on the Loup River near Genoa.

Beaver Creek, the largest of three creeks entering the Loup River bypassed reach, has a drainage area of 429 square miles. The other two much smaller creeks are Looking Glass Creek and Dry Cherry Creek. Beaver Creek is located about 6.2 miles downstream from the diversion weir. USGS gage (no. 06794000) is located on Beaver Creek about three miles upstream from the mouth of the creek. Monthly flow summaries for Beaver Creek are listed in Table 3. In the Assessment, the Commission projected streamflow in the Loup River downstream from the Project Diversion through the addition of 85 cfs, which is the median annual flow at Beaver Creek for the period from 1941 to 2012 (USGS, 2013).

Table 3. Average daily minimum, mean, and maximum flows by month on Beaver Creek near Genoa, Nebraska for water years 1941 to 2010[a] (Source: Assessment Table 4).			
Month	Minimum Flow (cfs)	Mean Flow (cfs)	Maximum Flow (cfs)
January	15	85	800
February	32	139	4,400
March	30	195	4,820
April	55	170	1,650
May	55	187	5,940
June	24	247	7,010
July	0	137	10,000
August	1	93	7,220
September	3	81	1,150
October	33	86	942
November	30	91	1,070
December	17	87	680

[a] Calculated for the period October 1, 1940, through September 30, 2010, using flow records from USGS Gage 06794000 on Beaver Creek near Genoa.

<u>A2. Consumptive Losses, Loup River Bypassed Reach and Power Canal</u>

Consumptive uses under the Environmental Baseline were separated by the following conditions as described by the Commission: 1) water in the power canal and reservoirs; 2) water in the power canal, but reservoirs are dry; or 3) power canal and reservoirs are dry. Since the Commission did not specify which operational condition is most representative of a No Diversion condition, the Service will consider all three operational conditions in this section. Ranges for consumptive losses under a no diversion condition ranges from 25.2 to 33.9 cfs under a Normal Year, 22.0 to 30.7 under a Dry Year, and 27.1 to 35.2 under a Wet Year (Table 4).

A comparison of all No Diversion conditions described within the Assessment shows that all conditions would increase evaporative losses when compared to Current Operations. There is little difference in consumptive loss of streamflow under the Environmental Baseline versus the remaining No Diversion condition. The maximum difference between Current Operations and a No Diversion condition is 9.3 cfs (Table 4).

Table 4. Summary of consumptive losses for wet, dry, and normal years for the power canal and Loup River bypassed reach (Source: Loup Power District 2011, as modified by Commission)

		Current Operations[1]	No Diversion into the Power Canal[1]		
			Completely Watered[2]	Reservoirs Dewatered[3]	Completely Dewatered[4]
Normal Year -2005					
Loup Power Canal	Total Consumptive Loss	9.5	8.7	2.7	0.0
Loup River Bypassed Reach	Total Consumptive Loss	15.4	25.2	25.2	25.2
Sum of Both	Total Consumptive Loss	25.0	33.9	27.9	25.2
Dry Year - 2006					
Loup Power Canal	Total Consumptive Loss	9.5	8.6	2.7	0.0
Loup River Bypassed Reach	Total Consumptive Loss	11.9	22.0	22.0	22.0
Sum of Both	Total Consumptive Loss	21.4[5]	30.7[5]	24.8	22.0
Wet Year -2008					
Loup Power Canal	Total Consumptive Loss	9.0	8.1	2.5	0.0
Loup River Bypassed Reach	Total Consumptive Loss	17.1	27.1	27.1	27.1
Sum of Both	Total Consumptive Loss	26.1	35.2	29.6	27.1

[1] Loss is in cubic feet per second.
[2] The power canal and reservoirs are assumed to be completely full of water
[3] The power canal is assumed to be completely full of water and the reservoirs are assumed to be completely dry
[4] The power canal and the reservoirs are assumed to be completely dry.
[5] Maximum 9.3 cfs difference between Current Operations and a No Diversion condition.

A3. Trends in Loup River Streamflow

The Service has reviewed the existing scientific and commercial data available to determine if hydrology described in Section A1 is expected to express the same variability throughout the 30-50 year evaluation period of this Opinion. A summary of the existing data is provided in the Hydrology and River Geomorphology Appendix. Service review of published reports has identified conflicting trends in Loup River hydrology upstream and downstream of the Project diversion. In consideration of these conflicting reports, the Service will apply hydrology described in Section A1 as the representative hydrology 30-50 year evaluation period of this Opinion. However, the Service will consider as part of the Environmental Baseline information from Stanton et al. (2010) that estimates reductions in in Beaver Creek streamflow of up to 50 cfs by 2055.

B. Loup River Stream Temperature

Water temperature is affected by atmospheric conditions, topography, streambed, stream discharge, and groundwater inflows (Łaszewski 2013; Olden and Naiman, 2010; Cassie, 2006). Surface water diversions have been documented to decrease the thermal capacity of a river and thus, increase the likelihood of high temperature events and resulting in impacts to federal trust resources. A large volume of water takes longer to be heated or cooled than a small one (Gu and Li 2001), and low discharge leads to more pronounced diel temperature fluctuations (Ward 1985). Streamflow diversions would lead to small volumes of water that are more responsive to ambient conditions (Ward 1985). Sinokrot and Gulliver (2000) and Meier et al. (2003) have linked water diversions to higher summer stream temperatures through the use of heat balance models.

Reducing the anthropogenic effect to a river's temperature regime is important for the ecological integrity of the biotic systems linked to river temperature. For example, the life cycles for freshwater insects and fish respond to the aggregated effects of thermal units (i.e., the accumulation of daily temperatures above some threshold) and absolute temperatures (Olden and Naiman, 2010). Fish species also have both chronic and acute temperature thresholds for survival, growth, and reproduction (Olden and Naiman, 2010). On page 127 of the Assessment, the Commission identified that lower Loup River streamflow had a higher probability of exceeding the state water quality standard for temperature (i.e., 90° F), and determined that there was a 60 percent probability for exceeding state standards for water temperature in the Loup River bypassed reach when flows were less than 150 cfs (Figure 13 of the Assessment). The Commission's conclusions are consistent with the Service's review of scientific literature described above in this section. Under the Environmental Baseline, Loup River streamflow is higher throughout the year compared to Current Operations (Figure 1). Based on information provided in the Assessment, the probability of exceeding the state water quality standard for temperature (i.e., 90° F) in the Loup River is higher under Current Operations because of low water conditions facilitated by project operations, but this relationship cannot be quantified.

C. Loup River Geomorphology
This section describes the relationship between Loup River hydrology, sediment supply, and sediment transport and how these processes collectively influence the local geomorphologies (i.e., processes that shape a river over time) which in turn influences species habitat and use. Environmental Baseline hydrology was previously described in Section A of this Opinion. This section describes the present condition of sediment supply and transport, and geomorphology. Then, we compare describe how present sediment supply and transport, and geomorphology is expected to change under the Environmental Baseline because of changes to present hydrology under the No Diversion condition.

The following describes terminology used by the Commission in their assessment. Sediment yield is used to describe the quantity of sediment that is supplied to a stream. Sediment is supplied though erosion of sediments from lands adjacent to a river. Sediment transport is the ability of a river's stream flow to move the sediment supplied to a river. For example, the Commission stated that in a flow limited system, river geomorphology will respond changes in stream flow. Species habitat is also responsive to changes in stream flow. For example, sandbars used by the species represent a condition where a portion of the sediment supplied to the river was not transported by stream flow and remained in the form of a sandbar. The Service will elaborate further in the following relationships between hydrology, sediment supply, sediment transport, and geomorphology in subsequent sections. The Commission also stated in the Assessment that a river is considered flow limited when the sediment supply is greater than what a river transport. If a river's ability to transport sediment is greater than what the surrounding area can supply, the river is considered supply limited.

1. Present Condition of Channel
Rivers in the Loup Basin drain from a northwest to southeast direction. The upper portion of the Loup River basin is set within the Nebraska sandhills; the lower portion of the basin traverses through dissected plains. The North and Middle Loup Rivers represents a braided, relatively strait river system (Brice 1964), and the Loup River maintains the same braided character downstream of the North Loup and Middle Loup Rivers. It is these conditions that form a relatively wide and shallow Loup River with mid-channel sandbars.

An assessment of channel stability in the Action Area is an important component in understanding sediment supply under the Environmental Baseline. Channel instability can indicate changes in sediment supply and transport trends which could affect the Environmental Baseline of the remainder of this section. Service review of published reports has identified A review of existing information indicates that channel degradation is not evident in the Loup River Bypassed Reach (see Hydrology and Geomorphology Appendix for additional information). The absence of channel degradation in the Loup River Bypassed Reach supports two assumptions in this Opinion about the present condition of the geomorphology of the bypassed reach that will be carried forward to the remainder of this discussion:

1. The absence of channel degradation supports the Commission's conclusion that the bypassed reach represents a flow-limited stream in which there is more sediment than the river has capacity to transport. Flow-limited streams are responsive to changes in streamflow, and therefore, certain species habitat variables are also responsive to changes in streamflow. This is an important assumption in the Commission's Assessment in that differences in flow in the Loup River Bypassed Reach under the Environmental Baseline and Staff Alternative will result in changes in channel characteristics that could be important to the species.

2. The absence of degradation provides some level of assurance that the effects of reduced sediment supply upstream of the Project diversion are not evident in the Loup River Bypassed Reach.

   Although the Commission concluded that the Loup River Bypassed Reach is flow limited, they acknowledged in their assessment the potential for interruptions in sediment supply could be caused by Project operations. The Commission provided in their Assessment, a sediment budget that could be used to identify potential Project effects to sediment supply throughout the Action Area. In Table 23 of the Assessment, the Commission describes the sediment supply (i.e., average annual yield in tons per year) and sediment transport capacity (tons per year) at different points across the Loup and Platte Rivers. In their analysis, the Commission calculated the amount of sediment removed from the settling basin at an average of 2,004,800 tons per year. The Commission also calculated the amount of sediment returned to the Loup River through the South SMA (i.e., 561,300 tons per year) and the amount deposited in Lake Babcock (i.e., 350,000 tons per year). The Commission used these totals to calculate a net 1,793,500 tons of sediment per year that is removed from the Loup and Platte Rivers under Current Operations (4,910 tons per day). The effect of the sediment removal is most severely felt in the Lower Platte River as diverted water in the Project canal returns to the Platte via the tailrace return (Assessment, page 24). Effect of sediment removal to the Platte River will be discussed in the geomorphology sections for the Platte River Bypassed Reach and the Lower Platte River.

   Previous paragraphs have described: 1) current sediment supply in the Loup River basin, 2) trends in sediment supply, and 3) a description of how past Project operations have affected sediment supply. The following discussion will detail sediment transport. The Commission described the Loup River Bypassed Reach as a flow-limited stream in which there is more sediment than the river has capacity to transport. Therefore, differences in flow in the Loup River Bypassed Reach under the Environmental Baseline and Staff Alternative will result in changes in channel characteristics that could be important to the species.

   Because the Loup River is a flow-limited system, the geomorphology of the Loup River Bypassed Reach reflects decades of Project operations which altered river hydrology and sediment transport. Relatively higher flows within a year represent those flows that shape a channel's river bed and banks. There are many indexes used to characterize channel forming flows. Two types of channel forming flows referenced in the Assessment are effective discharge and dominant discharge. The Commission described effective discharge as the increment of discharge that transports the largest fraction of the sediment load over a period of years. Dominant Discharge is described as the theoretical discharge that, if constantly maintained in an alluvial stream over a long period of time, would produce the same channel geometry that is produced by the long-term hydrograph. Because Effective Discharge was infrequently applied in the Assessment, the Service elected to use dominant discharge for the remainder of this Opinion.

Tables 5 and 6 demonstrate how differences in hydrology can result in differences in channel form and species habitat. Channels in Loup River Bypassed Reach are influenced by Project diversions while the Loup River upstream of the diversion is unaffected. These differences in hydrology, as a result of the Project diversion, results in differences in channel characteristics for the Loup River upstream versus downstream of the diversion.

Table 5 summarizes data obtained from an aerial imagery review conducted on five randomly selected river miles in the Loup River bypassed reach (along with five randomly selected river miles in the Loup River upstream of the diversion weir). Variables described in Table 5 are frequently applied as habitat variables for whooping crane, least tern, and piping plovers. Wetted widths were defined as the edge of the water at one bank to the edge of the water at the opposite bank. The unobstructed channel width was calculated as the horizontal distance across a channel between visual obstructions. In this study, visual obstructions are defined as a bank and/or perennial vegetation with a combined height greater than 3 feet. Percent channel width is the wetted channel width divided by the unobstructed channel width. The average channel width in the bypassed reach is below what is observed upstream of the diversion; and there are more point bars in the bypassed reach than what is found upstream. A proportion of dry sand area is greater below the diversion.

Table 5. Habitat parameters on the Loup River at sites upstream and downstream of the Loup Project diversion weir based on aerial imagery review (Source: Assessment Table 45).		
Habitat Parameter	Upstream of Point of Diversion	Loup Bypassed Reach
Whooping Crane Habitat		
Wetted Channel Width	399 to 569 feet Average[a] - 442 feet	131 to 402 feet Average[a] - 153 feet
Percent Channel Width	38 to 54% Average[a] - 42%	20 to 61% Average[a] -23%
Unobstructed Channel Width (bank to bank)	1,050 to 1,077 feet	652 to 669 feet
Least Tern and Piping Plover Habitat		
Unobstructed Channel Width (bank to bank) for terns and plovers	1,050 to 1,077 feet	652 to 669 feet
Dry sand area	Average[a] 2.22 acres	Average[a] 8.66 acres
Vegetation cover on dry sand area (percent)	Average[a] 12.1%	Average[a] 12.8%
Average location of sandbars (point or mid-channel)	Mid-Channel	Point
Valley width	--	15.2 to 24.3 miles

[a] Average is based on analysis of normal flow years.

In Table 6, observed measurements of parameters from whooping crane habitat are listed along with calculations for the parameters, by HEC-RAS modeling, for upstream and downstream of the diversion weir. Overall, upstream parameter values are greater than downstream parameter values with the exception of shallow water habitat which was similar upstream and downstream. Differences upstream versus downstream, as described in Tables 5 and 6, support the Commission’s conclusion that channel form is responsive to changes in flow; therefore, changes in hydrology under the Staff Alternative is likely to affect channel conditions in the Loup River Bypassed reach.

Table 6. Whooping crane habitat parameters on the Loup River at sites upstream and downstream of the Loup Project diversion weir based on hydraulic modeling (Source: Assessment Table 46).		
Habitat Parameter	Upstream of Point of Diversion	Downstream of Point of Diversion
Wetted Channel Width	676 to 784[a] feet	160 to 499[a] feet
Percent Channel Inundated	82 to 95%[a]	25 to 78%[a]
Unobstructed Channel Width (from bank to bank)	825 feet	640 feet
Depth of water for roosting (Shallow water habitat)	33 to 42%[b]	24 to 40%[b]

[a] Range of wetted channel widths and inundation percentages are based on range of flows for a normal flow year.
[b] Percentages are based on analysis of normal water flow years

2. Channel Conditions under the Environmental Baseline using a Fixed Bed Scenario

In this section, variables that describe channel form in the Loup River Bypassed Reach are described for Current Operations and the Environmental Baseline under what is termed a fixed bed scenario. A fixed bed scenario is a way of modeling a river's response to changing flows. In the fixed bed scenario, the channel bed and banks are static and the only variable that changes is the amount of flow moving through the channel. As additional flow is introduced into the bypassed reach under the Environmental Baseline, the condition of the channel would resemble that described within the fixed bed scenario. These conditions would typically represent the initial years under No Diversion hydrology of the Environmental Baseline. It is important to recognize that the Loup River Bypassed Reach channels presently observed were formed through decades of operation under Current Operation hydrology. Adjusting to the new channel forming hydrology under the Environmental Baseline, channels in the bypassed reach will over time change shape to accommodate increase in flow, and discussion on these changes will be described in Section C3. This section will discuss only the fixed bed conditions for the Environmental Baseline.

Tables 7 and 8 summarize HEC-RAS model output using fixed bed scenario. Both tables generally describe channel conditions under Current Operations and the Environmental Baseline. The variable exposed channel width is the portion of the channel above the water surface, and between the banks of the channel. The exposed channel widths under the No Diversion hydrology is lower compared to widths under Current Operations.

Table 7. Average percentage of exposed channel widths for Loup River Bypassed Reach (Source: Assessment Table 50).		
Calendar year of Analysis (water year)	Bypassed Reach (Site 2)	
	Current Operations	No Diversion Condition
Channel Width (linear feet)	640	640
2006 (Dry)	63	14
2005 (Normal)	46	10
2008 (Wet)	41	10

Table 8. Percentage of exposed channel width at Site 2, in the Loup River bypassed reach located downstream of the Loup Project diversion weir during various flows in the Loup River for water years 2005, 2006, and 2008 (Source: Loup River Public Power District, 2012a; Appendix D).

Calendar Year of Analysis (water year)	Low Flow (75% Exceedance)				Medium Flow (50% Exceedance)				High Flow (25% Exceedance)			
	Current Operations		No Diversion		Current Operations		No Diversion		Current Operations		No Diversion	
	Summer		Summer		Summer		Summer		Summer		Summer	
	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late
2006 (Dry)	86	87	16	26	69	65	4	19	40	31	3	15
2005 (Normal)	75	70	5	22	80	35	3	16	22	26	3	13
2008 (Wet)	67	63	5	21	46	33	3	15	10	24	3	10

The applicant also performed similar HEC-RAS analysis for the width of the channel when the water depth within the channel was 0.8 feet or less (a surrogate for whooping crane roosting habitat) for the Loup River upstream and downstream from the diversion weir (Table 9). Downstream of the Project Diversion, Current Operations the condition had lower percentages water depths of 0.8 foot or less for normal and wet conditions, but percentages were higher for dry conditions.

Table 9. Results of HEC-RAS analysis showing the average percentage of channel widths with water depths of 0.8 foot or less in the Loup River upstream and downstream of the Loup Project diversion weir during Current Operations and during no diversion conditions (Source: Assessment Table 48).			
Calendar Year of Analysis (water year)	Upstream	Downstream	
		Current Operations	No Diversion Condition
Channel Width (linear feet)	825	640	640
2006 (Dry)	38	24	30
2005 (Normal)	38	30	24
2008 (Wet)	34	30	20

3. Expected Change in Channels under Environmental Baseline Hydrology

As described previously, channel form under No Diversion hydrology within the Loup River Bypassed Reach will change from conditions presently observed in the reach. The first change would represent an increase the quantity of sediment transported under the No Diversion condition (Table 10) that corresponds to increases in bypass flows. Under Current Operations, a percentage of total Loup River streamflow is diverted into the Project canal which reduces flow and sediment transport in the bypassed reach. However, the No Diversion hydrology would increase transport sediment through the Loup River Bypassed Reach at quantities similar to that upstream of the diversion. Similarly with increases in hydrology and sediment transport under the Environmental Baseline, there is a corresponding increase in channel forming flows (i.e., dominant discharge). The dominant discharge would increase from 790 - 1,080 cfs observed under Current Operations to 2,190 - 3,420 cfs under the Environmental Baseline (Table 11).

Table 10. Percent of total Loup River streamflow and annual sediment transported in tons at the Genoa streamgage (Source: Assessment Table 30 and Table 5-5 of FLA, Appendix J).						
	2008 (Wet)		2006 (Dry)		2005 (Normal)	
	% Bypassed	1,000 Tons	% Bypassed	1,000 Tons	% Bypassed	1,000 Tons
No Diversion	100	5,220	100	2,670	100	3,410
Current Ops	40	2,540	28	802	35	1,264
Difference	60	2,680	78	1,868	65	2,146
Difference Tons per Day		7,342		5,118		5,879

Table 11 further describes how differences in dominant discharge explain differences in channel variables when comparing Current Operation to the Environmental Baseline. Current Operations represent the current condition of channels in the Loup River Bypass Area. In the Environmental Baseline, increased streamflow in the Loup River Bypass Area will facilitate changes in geomorphology. An anticipated increase in the dominant discharge, resulting from additional flow downstream from the diversion, would facilitate increases in average annual sediment transported, unobstructed width, and wetted width. It is also likely that over time mid-channel bars, which are represent bars typically found upstream of the diversion, would start to form in Loup River Bypassed Reach.

Table 11. A comparison of channel characteristics under Current Operations and No Diversion that is likely to be realized due to changes in dominant discharge.

	Current Operations	No Diversion
Dominant Discharge (cfs)[a]	790 - 1,080	2,190 - 3,420
Unobstructed Width (ft) [b]	652 - 669	1,050 – 1,077
Wetted Width (ft)[b]	131 - 402	399 - 569
Sandbar Position [b]	Point Bar	Mid-channel Bar

[a] Sediment Transport Modeling (Table 30 of Assessment)
[b] Aerial Imagery Analysis (Table 45 of Assessment)

Additionally, the Assessment also reported results related to sandbars:

- On average, there are fewer sandbars per river mile below the diversion weir, though they are generally larger in size (ranged from 1.73 to 23.44 acres).
- Sandbars below the diversion weir had a higher percentage of bare sand, likely because of their larger size.
- Sandbars below the diversion weir generally had a higher percentage of vegetation, though all average vegetation percentages were less than 21 percent.
- Most sandbars located below the diversion weir were point bars and located along riverbanks, while, on average a greater percentage of mid-channel bars exist above the diversion weir.

However, woody vegetation established along the banks of the Loup River Bypassed Reach may inhibit the ability of the flow regime under the No Diversion condition of the Environmental Baseline to immediately change channel form similar to what was observed on the Platte River (Tal et al. 2004). It is difficult to predict the time it will take to change the channel. Channel change may take many years, decades, or even centuries to reach a dynamic equilibrium. Channel change could also occur overnight or over a period of weeks, especially in an ice jam condition where ice may focus flow toward bank lines and remnant channel areas. The temporal scale for this Opinion is 30 to 50 years, so this places a time frame limitation on expected changes. The following discussion identifies what optimally can be expected regarding changes from No Diversion operations under the Environmental Baseline recognizing that optimal conditions may not be recognized within the 30-50 year time frame for evaluation.

Platte River Bypassed Reach

Platte River Bypassed Reach Hydrology

1. Platte River Bypassed Reach Streamflow Summary

As described in Loup River Hydrology - Section A1, under a No diversion condition, all of the streamflow would bypass the Project diversion and would continue down the Loup River Bypassed Reach. Streamflow in the Loup River would be generally higher in the Environmental Baseline when compared to what is presently observed (Figure 1). Higher streamflow in the Loup River would result in higher streamflow in the Platte River Bypassed Reach as the Loup River enters into the Platte River. The absence of quantifiable streamflow information from the Commission presently limits the Service's ability to quantify how streamflow in the Platte River Bypassed Reach would change under the Environmental Baseline.

2. Consumptive Losses Platte River Bypassed Reach

Loup River Hydrology, Section A2 describes how evapotranspiration in the Loup River would reduce the quantity of streamflow in the Loup River Bypassed Reach under the No Diversion condition of the Environmental Baseline. The increase in evaporation is expected to reduce streamflow in the Platte River Bypassed Reach by 9.3 cfs or less.

3. Trends in Platte River Bypassed Reach Streamflow

Reductions in in Beaver Creek streamflow of up to 50 cfs by 2055, as described by Stanton et al. (2010) would also reduce flows in the Platte River Bypassed Reach.

Platte River Bypassed Reach Stream Temperature

Similarly to what was described within the Loup River Bypassed Reach, changes in hydrology under the No Diversion condition are expected to increase streamflow in the Platte River Bypassed Reach. This increase in streamflow in the Platte River Bypassed Reach will decrease likelihood of temperature exceedences in that reach. However, the relationship between streamflow and temperature exceedance was not evaluated in the Assessment which, in turn, limits the Service's ability to quantify this relationship within the Environmental Baseline.

Platte River Bypassed Reach Geomorphology

1. Present Condition of Channel

The Commission's Assessment described approximately 69 percent of the total Loup River flow was diverted by the Project under Current Operations. The diversion of streamflow reduces channel forming flows which reduces the annual sediment transported through the bypass (Table 12). This reduction in dominant discharge would also apply to the Platte River Bypassed Area; we would expect an initial reduction in the overall flow width (Table 12). However, over time we would expect bank erosion and an increase in channel width. The North Bend and Site 5 are in the Lower Platte River are located further downstream in the Lower Platte River and are included for reference.

Table 12. Dominant discharge, flow widths, and sediment transported at locations in the Platte River Bypassed Reach and Lower Platte River (Source: Assessment Tables 24 and 25).

	Dominant Discharge (cfs)	Flow Width (ft)	Sediment Transported (Tons)
Site 3[a]	2,400	871	1,040
Site 4[a]	3,900	1,062	2,440
North Bend Gage	4,100	1,079	1,940
Site 5[b]	3,650	990	2,080

[a] For reference, Site 3 is located within the Platte River Bypassed Reach while Site 4 is immediately downstream of the tailrace return. The distance between study sites is approximately 4.3 miles.

[b] Approximately one mile downstream of the North Bend Gage.

The Assessment and the Final License Application describe a condition where channels in the Platte River Bypassed Reach had adjusted as a means for compensating for the sediment deficit at the Project tailrace return. In other words, as streamflow leaves the Project tailrace and enters the Lower Platte River, the additional water from the tailrace increases the Lower Platte River's capacity to convey sediment. This increased transport capacity creates a local sediment imbalance where the quantity of sediment transported below the tailrace return is greater than the upstream supply of sediment from the Platte River Bypassed Reach. This imbalance is also referred to by the Commission as a sediment deficit because Current Operations remove 87.1 percent of the sediment that enters the power canal (Assessment, Page 102).

The water diverted into the Project canal has the majority of sediment removed within the Project settling basin, so when the water is returned at the tailrace, it does not have the corresponding sediment. As reduced sediment water is returned at the Project tailrace return, the river compensates for the reduction in sediment by eroding material from the channel bed. Additionally, to compensate for the sediment imbalance, channels near the tailrace return have adjusted in width to balance incoming sediment at the tailrace return with sediment leaving the tailrace return. Specifically, overall channel widths upstream of the tailrace return in the Platte River Bypassed Reach are 1,100 feet compared to the 1,700 feet downstream of the tailrace return.

2. Channel Conditions under Environmental Baseline using a Fixed Bed Scenario

An evaluation of channel conditions under Environmental Baseline hydrology was not provided by the Commission in the Assessment and was not considered further in this Opinion.

3. Expected Change in Channels under Environmental Baseline Hydrology

Table 12 describes dominant discharges and flow widths for locations along the Platte River. As stated previously, Site 3 is located within the Platte River Bypassed Reach while Site 4, North Bend, and Site 5 are downstream of the Project tailrace return in the Lower Platte River. Because of their location downstream of the tailrace return, Site 4, North Bend, and Site 5 have dominant discharges and flow widths that are greater than values at Site 3. It is reasonable to expect, however, that greater streamflow under the No Diversion condition in the Platte River Bypassed Reach would increase dominant discharges and flow widths to that comparable to downstream study sites.

The No Diversion condition would eliminate the sediment deficit at the Project tailrace return. Water diverted at Project diversion has the majority of sediment removed under Current Operations through dredging operations, so water returned at the tailrace return is below sediment transport capacity. In the No Diversion condition, no water is diverted at the Project diversion, and all Loup River streamflow is expected to flow through the Platte River Bypassed Reach. Thus under the No Diversion condition, sediment transported in the Platte River Bypassed Reach is expected to increase by approximately 840,000 to 1,850,000 tons annually to reflect sediment transport that is similar to downstream study sites (Table 13).

Table 13. Sediment transported at study sites downstream of the Project tailrace. Developed from Table 5-12 of FLA, Appendix B

Site	Sediment Transported (1,000 Tons per Year)	Transport in Excess to Site 3 (1,000 Tons per Year)	Transport in Excess (Tons Per Day)
Site 4	2,440	1,400	3,835
North Bend	2,890	1,850	5,068
North Bend2	1,880	840	2,301
Site 5	2,030	990	2,712

The Commission concluded that changes to Project operations that introduce sediment (e.g., under the Environmental Baseline) would be similarly accommodated through the changes to the channel width rather than a change in slope (Assessment, page 119). The Service finds that the Commission's conclusions are consistent with Assessment studies. An increase in channel widths at the Platte River Bypassed Reach would be expected because of the elimination of the sediment deficit. Similar to what was described in the Loup River Bypassed Reach, time needed for full channel adjustments to be realized under No Diversion condition is unknown. The discussion in this section describes what optimally can be expected regarding changes from No Diversion operations recognizing that optimal conditions may not be immediately observable.

Lower Platte River

Platte River Hydrology

<u>1. Platte River Streamflow Summary</u>

Figure 2 shows the different levels of streamflows at the North Bend streamgage using the period of record from 1980 to 2009. The 5 and 95 percent exceedance intervals, in general, represent the extreme lower and higher values within the 30-year period record. Half of the flows values in the period of record fall are within 25 and 75 percent exceedance interval with the median flow representing the midpoint of all flows.

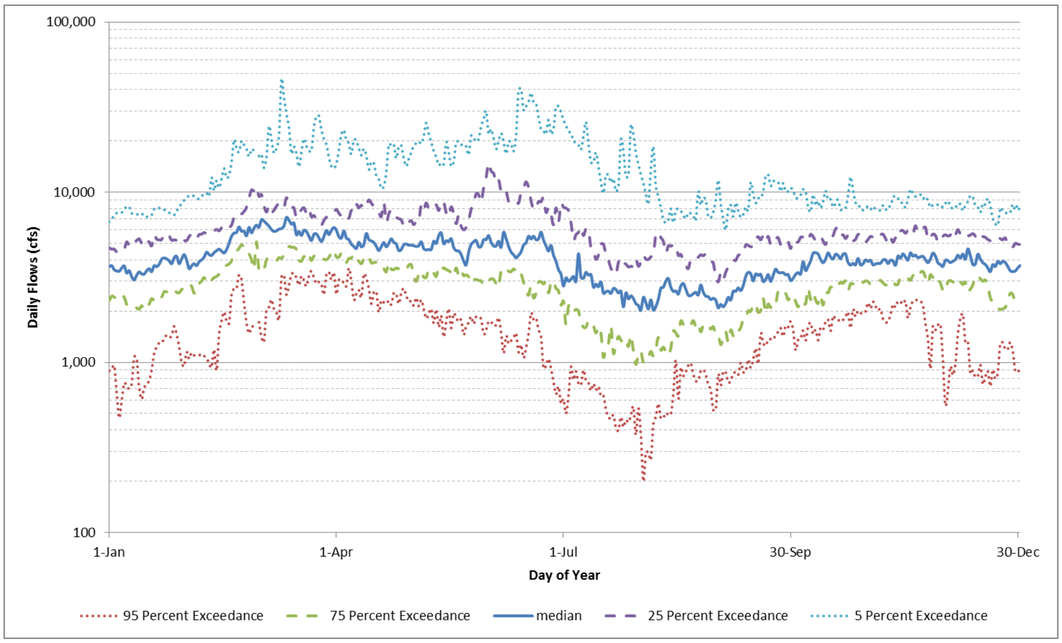

Figure 2. Exceedence intervals for Platte River streamflow at North Bend gage using the period of record from 1980 to 2009.

Water quantity estimates for the Lower Platte River are also summed for North Bend streamgage for the water years 1944 through 2010 (Table 14).

Table 14. Average daily minimum, mean, and maximum flows by month on the Platte River near North Bend, Nebraska for water years 1949 to 2010[a] (Source: Assessment Table 9).			
Month	Minimum Flow (cfs)	Mean Flow (cfs)	Maximum Flow (cfs)
January	324	3,370	11,000
February	706	5,240	22,000
March	700	7,050	82,300
April	1,670	5,890	31,000
May	814	5,800	34,500
June	250	6,730	64,900
July	36	3,620	46,000
August	126	2,510	57,600
September	153	3,020	25,700
October	846	3,760	18,400
November	450	4,080	11,000
December	228	3,530	11,900

[a] Calculated for the period October 1, 1948, through September 30, 2010, using flow records from USGS Gage 06796000 on the Platte River at North bend.

2. Daily Fluctuations in Streamflow

Water in the Project canal is stored in Lake Babcock and Lake North with the intent of releasing the water through the Columbus powerhouse to generate power. The maximum capacity for releases through the Columbus powerhouse is 4,800 cfs. Water is stored in times of low power demand and is released during periods of high demand. The available capacity for storage in in Lake Babcock and Lake North allows for hydropower releases of 4,800 cfs for up to five hours during high power demand, and the no releases are made for the remainder of the day. This on and off cycle of releases is termed by the Commission as hydrocycling.

Tables 5-1 through 5-6 in the FLA, Appendix B details how Project hydrocycling under Current Operations affect the within day variability in Lower Platte River streamflow. Under Current Operations, the difference between the daily maximum and minimum flow at North Bend gage range from 2,750 cfs to 4,150 cfs on an average annual basis. The difference in daily maximum and minimum water surface elevations at the North Bend gage range from 0.94 feet to 1.09 feet on an average annual basis.

No Diversion hydrology of the Environmental Baseline represents a condition where total Loup River streamflow would continuously bypass the Project diversion and no hydropower production would occur. Thus, hydrocycling and its effects to daily streamflow fluctuations would be eliminated under the No Diversion condition. The within day variability in stream flow immediately downstream of the Project tailrace return (i.e., North Bend streamgage) varies from 600 to 1,130 cfs under the

Environmental Baseline. This represents a decrease in within day variability of 2,150 to 3,020 cfs when compared to Current Operations. Within day variability in stage at the North Bend streamgage is expected to decrease by 0.73 to 0.92 feet under the Environmental Baseline.

3. Present Trends in Platte River Streamflow

The Service has reviewed the existing scientific and commercial data available to determine if hydrology described in Section A1 is expected to express the same variability throughout the 30-50 year evaluation period of this Opinion. A summary of the existing data is provided in the Hydrology and River Geomorphology Appendix. Service review of published reports has identified conflicting trends in Lower Platte River hydrology. In consideration of these conflicting reports, the Service will apply hydrology described in Section A1 as the representative hydrology 30-50 year evaluation period of this Opinion. However, the Service will consider as part of the Environmental Baseline information from NDNR (2014) that described how lag effects from current development through 2014 in the Lower Platte Basin would result in a 64 cfs reduction in streamflow upstream of the North Bend streamgage and a 398 cfs upstream of Louisville streamgage by the year 2039 (NDNR 2014). NDNR (2014) anticipates further declines in streamflow due from new water uses which is described further in the Cumulative Effects section of this Opinion.

4. Federal Actions that have Completed Consultation

The PRRIP a cooperative effort between the states of Colorado, Nebraska, and Wyoming, the U.S. Department of Interior, water users from the states, and environmental groups. The PRRIP was developed to offset adverse effects to federally listed species resulting from federal water-related activities in the Platte River basin above the Loup River confluence (i.e., central Platte River). One of the goals of the PRRIP is to test the assumption that, by managing flows for federally listed species in the central Platte River, benefits would accrue to pallid sturgeon habitat located in the lower Platte River. Members of the PRRIP have committed to provide 130,000-150,000 thousand acre feet of managed flows for central Platte River species by the end of calendar year 2019. While there is no agreement to continue the PRRIP beyond 2019, federal water-related activities would need to ensure that their operation will not jeopardize the continued existence of federally listed species in the lower Platte River.

Platte River Stream Temperature

Water temperature is affected by atmospheric conditions, topography, streambed, stream discharge, and groundwater inflows. Stream temperatures in the Lower Platte River were recorded at the Louisville streamgage from November 1974 to September 1981 before a lapse of data collection occurred. Stream temperatures were once again collected on a seasonal basis from May 2007 to present. In that time, stream temperatures reached an average daily maximum of 36.4°C on July 19, 2012, which exceeded the previous maximum of 36.0°C on July 24, 1977 (USGS 2013; USGS 2011).

Reduced streamflow in the Lower Platte River is expected to decrease the thermal capacity of the river and thus, increase the likelihood of high temperature events. The No

Diversion condition is expected to decrease streamflow by a small amount (9.1 cfs) due to evaporative losses compared to the 82 to 477 cfs decline expected within 25 years as a result of water development not associated with the Project.

Platte River Geomorphology

Many studies have documented the encroachment of in-channel vegetation resulting in the contraction of the channel belt for the central and lower Platte River (Williams 1978; Eschner et al. 1983; Johnson 1997; Simons and Associates 2000). Johnson (1994) indicated that Platte River channels originally contracted as a result of the construction and operation of large upstream dams, but has since been in a state of dynamic equilibrium.

Joeckel and Henebry (2008) noted the abandonment of large Platte River anabranches as a significant contributor to overall channel narrowing over time for study sites in the Lower Platte River. Channel widths at their study site downstream of the Loup-Platte confluence, which encompasses the Project tailrace return, varied the most because of the abandonment of two larger, long-lived anabranches during the study period.

Smith (1972) and Crowley (1983) provided a description of sandbars in the Lower Platte River that was relatively large in size and height. These large bars were labeled macroform-scale bedforms by Horn et al. (2012). Horn et al. (2012) also described how these macroform-scale bedforms are presently being replaced by sandbars of moderate size and height (i.e., macroform-scale bedforms). Based on their research findings, the authors suggested that effects of flow and sediment transport, not specified in their study, are leading to the gradual abandonment of the Lower Platte River system. Additional discussion is provided in the Hydrology and River Geomorphology Appendix.

<u>1. Present Condition of the Channel</u>

As stated previously, water is diverted into the Project diversion and sediment transported by this water is removed at the settling basin and deposited on the North and South Sand Management Areas. Because the returned water is has only a small amount of sediment, that water will transport sediment from the local sediment supply. The continued return of water through the Project tailrace would result in continued erosion of the local sediment supply which comprises of the river bed, banks, and sandbars. This erosion of local sediment supply from the project tailrace is referred to as the “sediment deficit”.

Pages 124 and 125 of the Commission’s Assessment provide a summary on how past Project operations under the Current Operations have affected channel geometry in the Lower Platte River. The removal of 1,793,500 tons of sediment per year from the Loup and Platte rivers requires adjustment in channel dimensions so sediment transport capacity matches the flow and sediment alternations to maintain channel stability. The Commission in their Assessment states that channel adjustments affect channels located both upstream and downstream of the Project tailrace return; however, the Commission did not describe the spatial extent of the upstream/downstream effects. Additional studies were evaluated by the Service to determine the longitudinal extent of Project effects to Lower Platte River channels.

Schmidt and Wilcock (2008) summarized information showing that interruption of sediment transport in alluvial river systems can result in significant impacts to sandbars and riparian ecosystems. The authors noted that components of degradation include: a) channel incision; b) winnowing of the bed; c) pool scour without associated lowering of the longitudinal profile; and d) erosion of bars. These impacts are likely to be more pronounced immediately downstream of reservoirs or in this case the tailrace return. The Service has reviewed the existing scientific and commercial data available to determine if any of the effects described by Schmidt and Wilcock (2008) is present in the Lower Platte River. A review of this information is described in greater detail in the Hydrology and River Geomorphology Appendix.

Channel Incision - The Commission, in their Assessment, noted that downstream of the tailrace canal, the lower Platte River channel has more open water, which appears to be deeper. These characteristics extend about 2 miles downstream of the tailrace canal where the river channel regains its appearance similar to that observed for the Platte River channel located upstream of the tailrace outlet weir. Similar observations were reported by Elliott et al. (2009) where authors document a higher proportion of deep water immediately downstream of the Project tailrace return. References to deep water could indicate channel incision, but it should be noted that deep water was restricted to two miles downstream of the project Tailrace Return and no channel incision was detected channel at the North Bend stream gage that is closest to the project Tailrace Return (approximately 29 miles) (Chen et al. 1999).

Erosion of Bars - The Commission's Assessment estimates that project effects to river geomorphology affects sandbar formation and maintenance at the vicinity of the tailrace. In addition, it is reasonable to consider Project deficits at the Project may contribute to systemic bar degradation described by Horn et al. (2012) throughout the Lower Platte River. This is a reasonable conclusion when considering the removal of 1,793,500 tons of sediment per year from the Loup and Platte Rivers under Current Operations.

2. Expected Change in Channels under Environmental Baseline Hydrology

Channel Change Resulting from Changes in Sediment Transport

Change in hydrology in the Loup River Bypassed Reach is likely to change the geomorphology of the Lower Platte River. As described in Section A, the increase of sediment transported under the "No Diversion" condition is likely to increase sediment transport to the Lower Platte River compared to Current Operations. Under this baseline, the Service assumes that any diverted flow to fill canals and/or reservoirs would not be returned to the Lower Platte River via the Project tailrace return. Under the No Diversion Condition, flow through the Loup River Bypassed Area and Platte River Bypassed Area would transport additional sediment to the Lower Platte River. Additionally, the sediment deficit of 1,793,500 tons per year from Current Operations would cease to exist under the Environmental Baseline. The following discussion will describe how additional sediment transported to the Lower Platte River, under the No Diversion condition may affect Lower Platte River geomorphology.

Under the No Diversion hydrology, much more sediment would be transported through the Loup River Bypassed Reach into the Lower Platte River. The Commission concluded that channel geometry and sediment transport conditions would change in response to sediment augmentation to maintain equilibrium, the specific effects on channel characteristics and sandbar formation, height, position or abundance were not been established. While there is no direct sediment transport studies for the Staff Alternative, certain inferences could be made using study results for alternative operations as described in Pages 117 through 125 of the Assessment.

As stated previously, Current Operations remove 1,793,500 tons of sediment per year from the Loup and Platte rivers, which equate to 4,910 tons per day. To investigate effects of sediment deficits from project operation, the Commission required a sediment transport study where differing rates of sediment augmentation were supplied at the Project tailrace ranging from 550 to 7,600 tons per day. The addition of sediment at the Project tailrace resulted in changes in channel slope upstream and downstream of the Project tailrace. However, the change in channel slope resulted in little change to dominant discharge, and therefore, limited changes to channel widths are expected (i.e., expected change of -0.9 to 0.3 percent).

The Commission concluded that changes to the Project operations that introduce sediment (e.g., under the No Diversion condition would be similarly accommodated through changes to the channel width rather than a change in slope (i.e., channel incision) (Assessment, page 119). In light of study conclusions, the Service determined that the Commission's conclusions that adjustments would occur via wider channel widths under No Diversion operations is consistent with existing studies. Additionally, the elimination of the sediment deficit under the No Diversion operation has the potential to reverse observed bar degradation in the Lower Platte River, but limited information prevents the Service's ability to determine the extent of restored bar formation processes.

Channel Changes as a Result of Changes in Hydrology

As described in the Lower Platte River hydrology section, there are two generalized changes in hydrology that might be expected under a No Diversion conditions when compared to Current Operations: 1) total streamflow and 2) within day variability in streamflow. In consideration of the 30-50 year evaluation time period, it is likely that there will be an overall reduction in Lower Platte River streamflow. The changes are largely a result of lagged effects of groundwater development in which there is expected reduction in streamflow of 64 cfs reduction in streamflow upstream of the North Bend streamgage and a 398 cfs upstream of Louisville streamgage by the year 2039 (NDNR 2014). In earlier sections, the Service notes that the increase in evaporation under in the Environmental Baseline of up to 9.1 cfs that is additive to aforementioned losses due to water development. Nevertheless, under the No Diversion condition, this minimal reduction in streamflow is likely to slightly decrease the dominant discharge, total sediment transported, and channel width in the Lower Platte River.

The elimination of hydrocycling under the Environmental Baseline does result in a slight decline in dominant discharge, total sediment transported, and channel width. The dominant discharge would decrease by 2 and 3 percent and sediment transport would be reduced by 1.9 to 3.6 percent. Channel widths immediately downstream of the Project tailrace return would increase from 1,060.6 feet to 1,072.4 feet (up to an 11.8 foot increase). Supplemental information is provided in the Hydrology and River Geomorphology Appendix.

Climate Change Effects in Loup and Platte River Basins

The following information was obtained from: "Understanding and Assessing Climate: Implications for Nebraska" (University of Nebraska, 2014). In general, annual temperatures will increase significantly, and the number of high-stress days will increase. Annual precipitation depths will remain constant or slightly increase, with more of precipitation coming in heavy rainfall events. Droughts will increase in magnitude and intensity. Soil water moisture is anticipated to decrease. In addition, late spring through early summer flows may be reduced in the Platte River due to the reduction of snowpack across the central and northern Rockies.

Temperature across Nebraska are projected to increase by 4-5^{o}F (low emission scenarios) to 8-9°F (high emission scenarios) by the last quarter of the twenty-first century (2071-2099). The range of temperature projections emphasizes the fact that the largest uncertainty in projecting climate change beyond the next few decades is the level of heat-trapping gas emissions that will continue to be emitted into the atmosphere and not because of model uncertainty.

Under both low and high emissions scenarios, the number of high temperature stress days over 100°F is projected to increase substantially in Nebraska and the Great Plains region. By midcentury (2041-2070), this increase for Nebraska would equate to experiencing typical summer temperatures equivalent to those experienced during the 2012 drought and heat wave.

Current trends for increased precipitation in the northern Great Plains are projected to become even more pronounced. The greatest increases for the northern Great Plains states so far have been in North and South Dakota, eastern Montana, and most of eastern Nebraska. Little change in precipitation in the winter and spring months is expected for Nebraska. Any increases in the summer and fall months are expected to be minimal and precipitation may be reduced during the summer months in the state. An increase in the percentage of average annual precipitation falling in heavy rainfall events has been observed for portions of the northern Great Plains states, including eastern Nebraska, and the Midwest. This trend is expected to continue in the decades ahead. Flood magnitude has been increasing because of the increase in heavy precipitation events. Soil moisture is projected to decrease by 5-10 percent by the end of the century, if the high emissions scenario ensues.

A major concern for Nebraska and other central Great Plains states is the current and continued large projected reduction in snowpack for the central and northern Rocky

Mountains. This is due to both a reduction in overall precipitation (rain and snow) and warmer conditions, meaning more rain and less snow, even in winter. Flows in the Platte and Missouri rivers during the summer months critically depend on the slow release of water as the snowpack melts. These summer flows could be greatly reduced in coming years.

Drought is a critical issue for Nebraska. This was demonstrated clearly during 2012, which was the driest and hottest year for the state based on the climatological record going back to 1895. Although the long-term climatological record does not yet show any trends in drought frequency or severity from a national perspective, there is some evidence of more frequent and severe droughts recently in the western and southwestern U.S., respectively. Looking ahead, however, the expectation is that drought frequency and severity in Nebraska would increase—particularly during the summer months—because of the combination of increasing temperatures and the increased seasonal variability in precipitation that is likely to occur. Modeling studies show that drought, as indicated by the commonly used Palmer Drought Severity Index (PDSI), is expected to increase in the future. The PDSI uses temperature and precipitation data to estimate relative dryness. Temperature increases could result in widespread drying over the U.S. in the latter half of the twenty-first century, with severe drought being the new climate normal in parts of the central and western U.S.

II. HYDROLOGY AND RIVER GEOMORPHOLOGY UNDER THE STAFF ALTERNATIVE

Loup River Bypassed Reach

Effects of Staff Alternative on Loup River Hydrology

This section qualitatively describes how the proposed Staff Alternative affects the hydrology of the Loup River Bypassed Reach. The Commission identified two License Articles designed to maintain flow protections in the Loup River Bypassed Reach. The following License Articles are a part of the Staff Alternative:

- License Article 404 attempts to maintain a minimum flow of 100 cfs at the Genoa stream gage from October 1 through March 30, contingent on having appropriate flows upstream.
- Also under Article 404, a minimum flow requirement of 275 cfs will be maintained at the Genoa stream gage from April 1 through September 30, contingent on appropriate upstream inflows.
- Article 406 limits the maximum diversion to 2,000 cfs from March 1 through June 30 thereby providing a potential addition of 1,500 cfs through the bypass during high flow events. Current operation can divert a maximum of 3,500 cfs into the Loup Power Canal.

1. Loup River Streamflow Summary

Figure 3 provides a comparison of the median daily streamflow for the Loup River at Genoa for both the Environmental Baseline and Staff Alternative using a 30-year period of record (i.e., 1980 to 2009). Figure 3 also shows the quantity of flow that is expected to be diverted into the Loup Power Canal under the Staff Alternative. The limit in the maximum diversion of 2,000 cfs (License Article 406) provides the greatest quantity of streamflow into the Loup River Bypassed Reach in early March. Streamflow in the Loup River Bypassed Reach then declines gradually in March where streamflow is supported by 275 cfs minimum flow requirement at the Genoa (License 404). The 275 cfs minimum flow is maintained until September 30 after which the 100 cfs minimum flow is maintained (License Article 404). At approximately late November, flows in the Loup River Bypassed Reach increase above the 100 cfs minimum. Under the Staff Alternative with License Articles 404 and 406 in place, the total volume of water flowing through the Loup Power Canal would be 1,177,892 acre-feet (71 percent of total) while the total volume flowing through the Loup River at Genoa would be 485,094 acre-feet (29 percent of total).

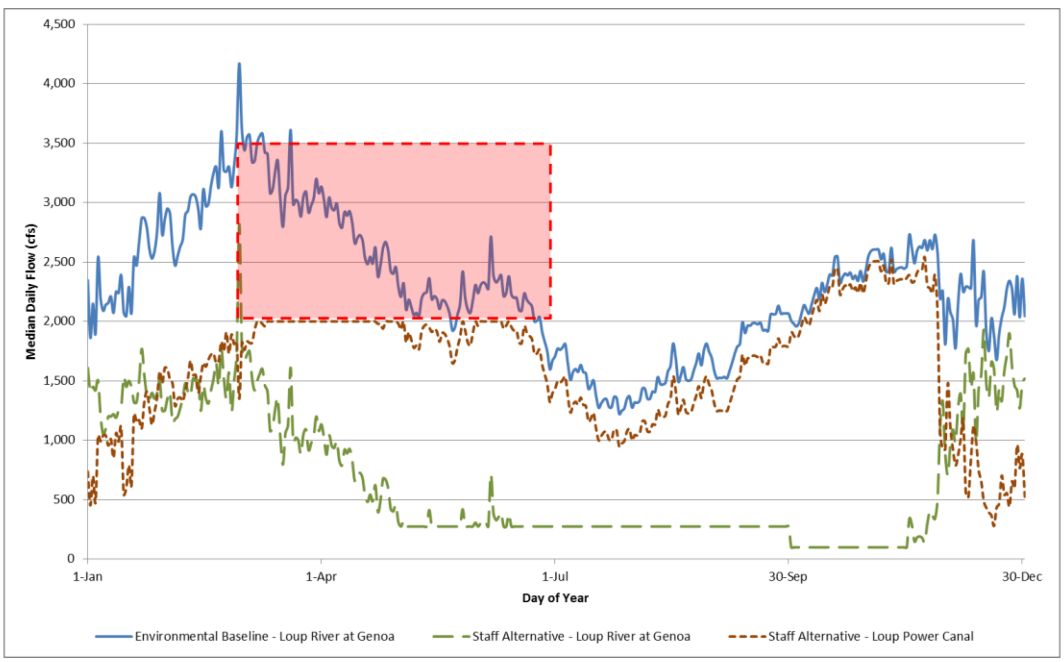

Figure 3. Median streamflow for: 1) Loup River at Genoa under the Environmental Baseline; 2) Loup River at Genoa under the Staff Alternative; and 3) Loup Power Canal under the Staff Alternative. The red box identifies the time period when the maximum diversion into the Loup Power Canal is reduced from 3,500 cfs to 2,000 cfs.

Figure 4 provides a comparison of the median daily streamflow for the Loup River near Genoa for both Current Operations and the Staff Alternative. The combination of flow requirements under Articles 404 and 406 demonstrate that the conservation measures under the Staff Alternative increase streamflow above that presently observed under Current Operations. Improvements in streamflow under the Staff Alternative are projected to last from March 1 through mid-November. Flow requirements under Article 404 does not improve streamflow from late November through the end February.

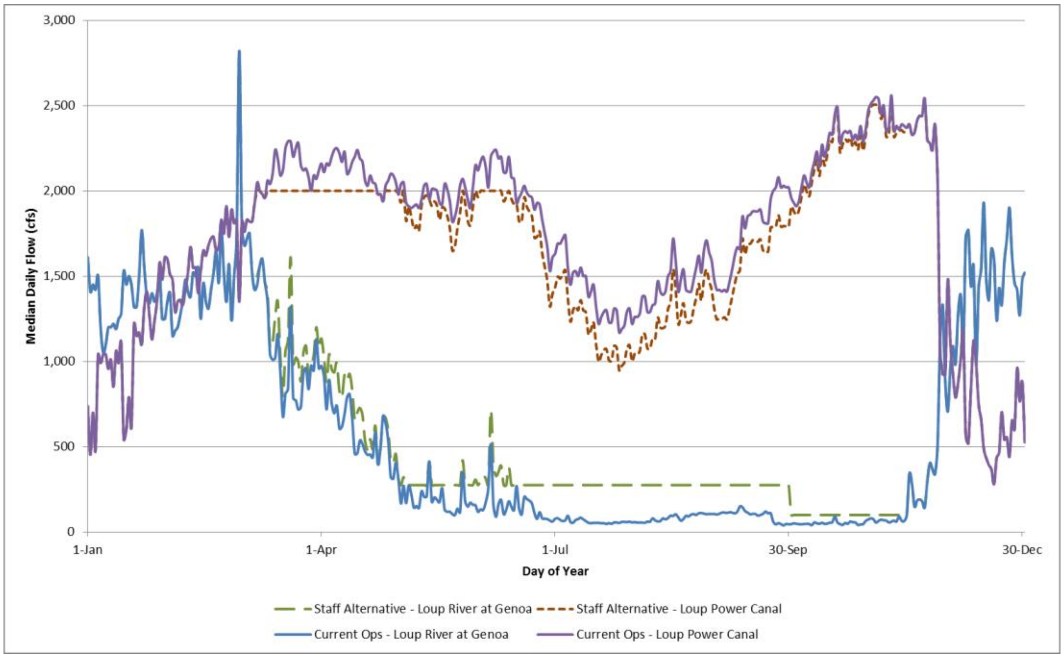

Figure 4. Median streamflow for: 1) Loup River at Genoa under the Staff Alternative; 2) Loup Power Canal under the Staff Alternative; 3) Loup River at Genoa under Current Operations; and 4) Loup Power Canal under Current Operations.

2. Consumptive Losses for the Loup River Bypassed Reach

As described in the Environmental Baseline section, the No Diversion condition increases evaporation which results in a total decrease in streamflow of up to 9.3 cfs when compared to the present current operating condition. Total quantity of streamflow lost through evaporation in the Loup River Bypassed Reach under the Staff Alternative is greater than what is presently observed under Current Operations, but far less than what is projected under the Environmental Baseline (Figures 3 and 4). Because total streamflow under the Staff Alternative represents a midpoint between Current Operations and the Environmental Conditions, streamflow losses through evaporation would fall between the two conditions; however, the amount of evaporative loss was not provided for the Staff Alternative in the Assessment. The Service addressed this data deficiency by recognizing that the Staff Alternative would decrease evaporative losses compared to the Environmental Baseline, but the increase in streamflow under the Staff Alternative is expected to be less than 9.3 cfs.

3. Trends in Loup River Streamflow

The Environmental Baseline referenced studies that could be used to predict trends in future hydrology. However, conflicting information in these studies does not provide a single clear trend in order to generalize net changes in hydrology. Similarly to the

Environmental Baseline, the Service cannot recognize any trend in flows for the Loup River at the Project Diversion. The Service recognizes that base flows for Beaver Creek are expected to decline significantly as a result of existing water development. Beaver Creek base flows are likely to decline by approximately 40 cfs by the year 2055 (Stanton et al. 2010).

Staff Alternative Effects to Loup River Stream Temperature

Figure 3 compares daily median streamflow values for the Loup River at Genoa under the No Diversion condition and Staff Alternative. The lowest median streamflow value under the No Diversion condition during the summer months (i.e., June through August) is 1,223 cfs on July 26. There are a number of days where 275 cfs would be maintained under the Staff Alternative during the summer months. When comparing the streamflow values to temperature exceedences in Figure 13 of the Assessment, the probability of a daily exceedence of lethal temperature standards under the No Diversion condition is approximately 18 percent or less. While the probability of a daily exceedance of lethal temperature standards under the Staff Alternative is approximately 28 percent or less. In summary, the Staff Alternative is more susceptible to high temperature exceedences when compared to the Environmental Baseline, but it is less likely that such temperature exceedances will occur when compared to Current Operations.

Additionally, air temperatures in the Platte River basin are likely to increase. University of Nebraska (2014) projects a substantial increase in air temperatures of 100°F in Nebraska and the Great Plains region. By midcentury (2041-2070), this increase for Nebraska would equate to experiencing typical summer temperatures equivalent to those experienced during the 2012 drought. It is reasonable to conclude that high stream temperature exceedences in the Loup River Bypassed Reach would increase as a result of increased high temperature events and lower streamflow.

Loup River Geomorphology

1. Channel Conditions under the Environmental Baseline

As described in detail in the Environmental Baseline, channels in the Loup River Bypassed Reach are narrower than channels upstream of the Project diversion. Additionally, sandbars in the Loup River Bypassed Reach are typically point bars whereas mid-channel bars are found upstream. The reason for these differences is the quantity and timing of flows that are diverted into the Loup River Bypassed Reach.

Under the No Diversion condition, Loup River streamflow would bypass the Project diversion (Figure 3) and no flow would be diverted into the Loup Power Canal. The additional flow in the Loup River Bypassed Reach would, over time, be expected to increase channel width to approximate conditions found upstream of the Project diversion. Under No Diversion hydrology, unobstructed channel width would increase from 652 – 669 feet to 1,050 – 1,077 feet. The wetted width would increase from 131 – 402 feet to 399 – 569 feet. Additionally, sandbars in the Loup River Bypassed Reach would change position from point bars to mid-channel bars.

2. Channel Geometry under the Environmental Baseline using a Fixed Bed Scenario

As stated previously under the No Diversion hydrology, the additional flow in the Loup River Bypassed Reach would increase channel width over time to reflect conditions found upstream of the Project diversion. The Service described within the Environmental Baseline section a condition when water is first delivered through a channel under the No Diversion condition. When the full amount of water is allowed to flow though the Platte River Bypassed Reach under No Diversion hydrology, the large quantities of water in a narrow channel will create a situation where water in the channel would become deeper and more swift with less bare sand present. However, over time, channel width would increase. A summary of anticipated changes are discussed in subsection C2 in the Loup River section of the Environmental Baseline.

3. Expected Change in Channels Under Staff Alternative Hydrology

The hydrology expected under the Staff Alternative is likely to change the morphology of the Loup River Bypassed Reach. There will be more flow in the bypass than what was provided under Current Operations, but flows are far less than that in the No Diversion condition. The reduction in flow though the bypassed reach described in Section A1, is likely to change the condition of the channel that resembles conditions that are somewhere between what is present upstream and downstream of the Project Diversion. Therefore, variables such as unobstructed channel width, wetted channel width, sandbar position, sandbar size, and proportionate depths would similarly represent a midpoint upstream versus downstream of the Project Diversion.

Table 15 provides the ranges upstream and downstream of the Project diversion. For example, channel widths upstream of the Project diversion range from 1,050 to 1,077 feet which corresponds to higher flows upstream. Channel width downstream of the Project diversion ranges from 652 to 669 feet because of corresponding lower flows. Because the Staff Alternative represents an intermediate between Current Operation and No Diversion hydrology, channel widths are likely to reflect a similar, but undefined, intermediate point. In a review of Table 30 in the Assessment, channel widths would tend to be most similar to those described under Current Operations.

Table 15. Projected range of outcomes in stream channel parameters under the Staff Alternative.	
	Staff Alternative (SA)
Dominant Discharge (cfs)[a]	790 to 1,080[c] ≤ SA ≤ 2,190 to 3,420[d]
Unobstructed Width (ft) [b]	652 to 669[c] ≤ SA ≤ 1,050 to 1,077[d]
Wetted Width (ft)[b]	131 to 402[c] ≤ SA ≤ 399 to 569[d]
Sandbar Position [b]	Point Bar[c] ≤ SA ≤ Mid-channel Bar[d]

[a] Table 30 in Assessment
[b] Table 45 in Assessment
[c] Representative of Current Operation hydrology
[d] Representative of Environmental Baseline hydrology

Table 16 compares differences in sediment transported under the Staff Alternative when compared to the No Diversion condition. The Service recognizes that there are differences between the Staff Alternative adopted by the Commission and the surrogate for the Staff Alternative in Table 16. The Service applied an operational scenario termed "*Year Round Max Flow - 2000 cfs plus minimum flow of Qd by year from April through August*" (Table 5-5 of FLA, Appendix J) as the surrogate for the Staff Alternative. However, the Commission did not include an evaluation of the Staff Alternative in their Assessment. The Service has determined that the surrogate in Table 16 closely approximates the Staff Alternative and represents the best available information to describe the Staff Alternative.

Under the Staff Alternative, approximately one half of the Loup River streamflow is expected to be diverted when compared to the No Diversion condition. This results in a decrease in total sediment transported in the Loup River Bypassed Reach to 1,430,000 (Staff Alternative) from 1,630,000 tons per year (No Diversion). Less sediment transported through the Loup River Bypassed Reach would reduce sediment supplied to the Platte River, and this affect is discussed in greater detail in the Platte River Bypassed Reach and Lower Platte River sections.

Sediment transport is expected to increase under the Staff Alternative when compared to what is presently observed under Current Operations. An additional 338,000 to 1,250,000 tons of sediment are expected to be transported on an annual basis as well when compared to Current Operations.

Table 16. Sediment transported at the Genoa streamgage under the Staff Alternative, Current Operations, and No Diversion Condition. Developed from Table 5-5 of FLA, Appendix J

	2008 (Wet)		2006 (Dry)		2005 (Normal)	
	% Bypassed	1,000 Tons	% Bypassed	1,000 Tons	% Bypassed	1,000 Tons
Staff Alt[1]	56	3,790	43	1,140	47	1,780
No Diversion	100	5,220	100	2,670	100	3,410
Difference	-44	-1,430	-47	-1,530	-53	-1,630
Difference Tons per Day		-3,918		-4,192		-4,466
Current Ops	40	2,540	28	802	35	1,264
Difference	16	1,250	15	338	12	516
Difference Tons per Day		3,424		926		1,413

[1] Staff Alternative represented as "Year Round Max Flow - 2000 cfs plus minimum flow of Q_d by year from April through August" as represented in Table 5-5 of FLA, Appendix J.

Similar to the No Diversion condition, woody vegetation established along the banks of the Loup River Bypassed Reach may inhibit the ability of the flow regime under Staff Alternative to change channel form. To address the time needed for channel adjustment, the Service recommended reshaping of sandbars, including vegetation removal, which allows for the channel to more quickly adjust to changes in the flow regime. However, Article 414 discusses the possibility for sandbar shaping, but in absence of firm commitments, the potential effects from sandbar shaping are not considered further in this Opinion.

Platte River Bypassed Reach

Effects of Staff Alternative on Platte River Hydrology

1. Platte River Bypassed Reach Streamflow Summary

The Commission in their Assessment did not provide representative hydrology in the Platte River Bypassed Reach for the Staff Alternative. Figure 3 shows the reduction in streamflow for the Loup River Bypassed Reach under the Staff Alternative which would, in turn, reduce flows to the Platte River Bypassed Reach. Total flow diverted into the Loup Power Canal is expected to range from 280 to 2,500+ cfs, and these diversions are expected to reduce streamflow in the Platte River Bypassed Reach by similar quantities.

2. Consumptive Losses in the Lower Platte River Reach

The reduction in steamflow in the Loup River Bypassed Reach under the Staff Alternative will reduce evaporation and thus deliver additional flow to the Platte River Bypassed Reach of less than 9.3 cfs. However, the increase in streamflow of up to 9.3

cfs is relatively small compared to the total water diverted into the Loup Power Canal (Figure 3).

Staff Alternative Effects to Platte River Stream Temperature

As observed in Figure 3, total streamflow in the Loup River Bypassed Reach is expected to be reduced under the Staff Alternative when compared to the No Diversion condition. This decrease in streamflow in the Platte River Bypassed Reach will increase likelihood of temperature exceedences in the reach. However, the relationship between streamflow and temperature exceedance was not evaluated in the Assessment which, in turn, limits the Service's ability to quantify this relationship and compare it to the No Diversion condition. The increase in streamflow of less than 9.3 cfs due to reduced evaporation rates is relatively small compared to the total water diverted into the Loup Power Canal, and would do little to offset the effects of the Project diversion on stream temperature exceedences.

Additionally, air temperatures in the Lower Platte river basin are likely to increase. The University of Nebraska (2014) projects a substantial increase in air temperatures frequency of 100°F in Nebraska and the Great Plains region. By midcentury (2041-2070), this increase for Nebraska would equate to experiencing typical summer temperatures equivalent to those experienced during the 2012 drought. It is reasonable to conclude that high stream temperature exceedences in the Platte River Bypassed Reach would increase as a result of increased high temperature events and lower streamflow.

Effects of Staff Alternative on Platte River Bypassed Reach Geomorphology

1. Channel Conditions under the Environmental Baseline

Channel flow widths upstream of the Platte River Bypassed Reach would represent a range from 990 to 1,079 feet which is similar to (Table 12). Under the No Diversion condition, sediment transported in the Platte River Bypassed Reach is expected to increase from approximately 840,000 to 1,850,000 tons. Total sediment transported to the Lower Platte River at the Project tailrace return totals 1,800,000 to 2,890,000 tons per year (Table 13).

2. Expected Change in Channels Under the Staff Alternative

The hydrology under the Staff Alternative is likely to change the morphology of the Platte River Bypassed Reach. There is more flow in the bypass than what was provided under Current Operations, but flows are less than that in the Environmental Baseline. Because Staff Alternative hydrology represents an intermediate between the No Diversion condition and Current Operations, channel widths are likely to reflect a similar, but undefined, intermediate point. Under Staff Alternative hydrology, channel flow widths would decrease from the baseline condition (i.e., 999 to 1,079 feet); however, channel widths would be greater than what is presently observed under Current Operations (i.e., 871 feet) (Table 12).

Lower Platte River

Effects of the Staff Alternative on Lower Platte River Hydrology

This section describes how the Staff Alternative affects the hydrology of the Lower Platte River. The Staff Alternative includes License Article (405) that affects Lower Platte River hydrology:

Article 405. *Minimum Flow in the Lower Platte River.* States that the licensee shall maintain a continuous minimum flow of 4,400 cubic feet per second, or inflow, whichever is less, from May 1 through June 7 in the lower Platte River, as measured at the U.S. Geological Survey gage no. 06796000 at North Bend, Nebraska, to facilitate longitudinal connectivity for pallid sturgeon movements in the lower Platte River between the project's outlet weir and North Bend. Inflow, as defined here, is the instantaneous flow at the North Bend gage while the project is operating in a non-hydrocycling mode or is not diverting flow into the power canal.

Service notes that, in many sections of the Assessment, the Commission did not conduct analyses of the No Diversion condition and Staff Alternative; rather, the Commission often uses surrogates for both. Specifically for Lower Platte River hydrology, the Commission uses a Run of Canal operation. The Service will use Run of Canal conditions as a surrogate for the Environmental Baseline and the Current Operations as a surrogate for the Staff Alternative. In absence of a direct evaluation of the Staff Alternative, the Service applied the best scientific and commercial data available define the effects of the Staff Alternative.

1. Lower Platte River Streamflow Summary

Figure 5 shows the different levels of streamflows for the Platte River at the North Bend streamgage. The 5 and 95 percent exceedences, in general, represent the upper and lower extremes in streamflow variability at the North Bend streamgage. For reference, half of the daily streamflow measurements fall within the 25 and 75 percent exceedance intervals with the midpoint of streamflow values represented by the median. The red box in Figure 5 represents the application of the minimum flow of 4,400 cfs at North Bend (License Article 405). Under the description of the Staff Alternative, Project hydrocycling may occur prior to May 1 and after June 7. Additionally, Project hydrocycling may occur at flows above 4,400 cfs from May 1 through June 7. Figure 5 shows half of the years of operation under the Staff Alternative where no hydrocycling would occur within the May 1 through June 7 time frame because flows would be below 4,400 cfs.

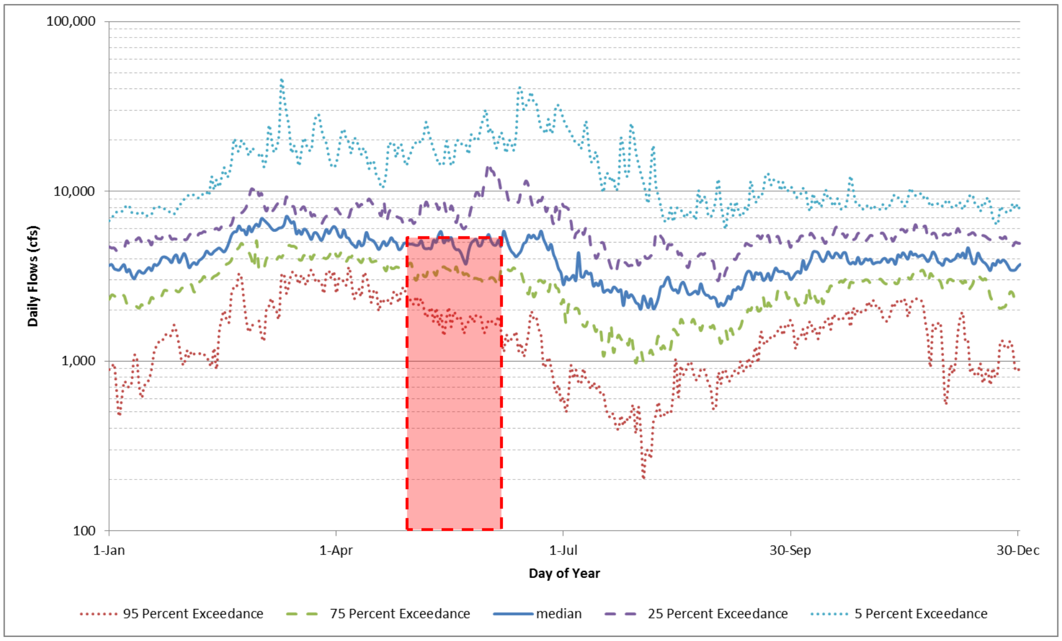

Figure 5. Streamflow variables for the Platte River at North Bend. The red box identifies the time period when a 4,400 cfs minimum streamflow is to be maintained at North Bend streamgage from May 1 through June 7.

For the remaining days when hydrocycling is allowed, flow requirements for the Loup River Bypassed Reach (i.e., Articles 404 and 406) are likely to change how Project hydrocycling operations would occur under the Staff Alternative. Project hydrocycling under the Staff Alternative would be changed in two ways: 1) it would improve the minimum combined flow upstream of the Project tailrace return, and 2) it would reduce the volume available for power production. Additional discussion on how Project hydrocycling is affected by Articles 404 and 406 is provided in the Appendix E.

2. Consumptive Losses in the Lower Platte River Reach

As described in Loup River Hydrology-Section A2, the Staff Alternative is expected to increase Lower Platte River streamflow at amount that is less than 9.3 cfs compared to the baseline. However, the increase in streamflow under the Staff Alternative is relatively small when compared to expected declines in streamflow due to non-federal water uses.

3. Trends in Platte River Streamflow

NDNR (2014) projected a 64 cfs reduction in streamflow upstream of the North Bend streamgage and a 398 cfs reduction upstream of Louisville streamgage by the year 2039 as a result of lagging effects from existing water uses. NDNR (2014) anticipates further declines in streamflow due to new water uses which is described further in the Cumulative Effects section of this Opinion. The Platte River Recovery Implementation Program (PRRIP) was developed to offset adverse effects to federally listed species resulting from federal water-related activities in the Platte River basin above the Loup

River confluence (i.e., central Platte River). Changes in central Platte River hydrology under the PRRIP could improve that amount of streamflow in the Lower Platte River; however, the adaptive, incremental nature of the PRRIP limits the Service's ability to project how future PRRIP operations would affect the Lower Platte River hydrograph.

Staff Alternative Effects to Platte River Stream Temperature

As described in Loup River Hydrology-Section A2, the Staff Alternative is expected to increase Lower Platte River streamflow at amount that is less than 9.3 cfs compared to the baseline. This increase in streamflow for the Lower Platte River will decrease the likelihood of temperature exceedences in the reach. However, this relationship between streamflow and temperature exceedance was not evaluated in the Assessment which, in turn, limits the Service's ability to quantify this relationship within the Environmental Baseline. When comparing the streamflow values to temperature exceedences in Figure 13 of the Assessment, it is reasonable to project that increases in streamflow of less than 9.3 cfs would provide limited benefit in minimizing stream temperature exceedences in the Lower Platte River.

Additionally, air temperatures in the Lower Platte River basin are likely to increase due to climate change. It is reasonable to conclude that high stream temperature exceedences in the Lower Platte River would increase as a result of increased high temperature events and lower streamflow.

Effects of Staff Alternative on Lower Platte River Geomorphology

1. Present Condition of the Channel

Operations under the No Diversion condition are expected to change channel geomorphology in the Lower Platte River. The increase of sediment transported under the No Diversion condition is likely to increase sediment transport to the Lower Platte River compared to what is presently observed. Under the No Diversion condition, sediment transported in the Platte River Bypassed Reach is expected to increase by approximately 840,000 to 1,850,000 tons. Under Current Operations, total sediment transported to the Lower Platte River at the Project tailrace return totals 1,800,000 to 2,890,000 tons per year. The No Diversion condition would eliminate the sediment deficit at the Project tailrace return. Channel incision documented in the Lower Platte River extending approximately two miles below the Project tailrace return would be eliminated resulting in channel widening primarily in the Platte River Bypassed Reach. The elimination of channel incision could rebuild sandbars within the affected two miles and possibly further downstream.

Changes in hydrology under the No Diversion condition are not expected to significantly change channel width and depth beyond what is presently observed (Assessment, Table 26). Channel widths would range from 1,060.6 feet in width immediately downstream of the Project tailrace return to 998.8-1,078.9 feet near North Bend (Assessment, Table 26).

2. Expected Change in Channels Under the Staff Alternative

The operations under the Staff Alternative have the ability to change baseline Lower Platte River hydrology under two broad categories: 1) it would change flow quantity and 2) changes in within day variability of streamflow would be expected. The Staff Alternative is expected to increase Lower Platte River streamflow at an amount that is less than 9.3 cfs. The increase in streamflow would increase the channel forming discharge (i.e., dominant discharge) which is not expected to significantly change channel widths. The Commission did not analyze how changes in flow quantity would affect dominant discharge in the Lower Platte River. A comparison of dominant discharge and channel widths in Tables 25 and 26 of the Assessment indicates that the increase in streamflow of up to 9.3 cfs is likely to result in small increases in channel width. The addition does little to offset the decreasing trend in Lower Platte River streamflow as projected by NDNR (2014).

Regarding Staff Alternative changes in within day variability Lower Platte River streamflow and hydrocycling operations would increase the dominant discharge which, in turn, would increase the channel width. In a review of Table 26 of the Assessment, channel widths immediately downstream of the Project tailrace return would increase from 1,060.6 feet to 1,072.4 feet (up to an 11.8 foot increase) (Assessment, Table 26).

Because diversions into the Loup Power Canal are would occur under the Staff Alternative, water returned to the Lower Platte River would be conveyed through the Project tailrace return, and thus a sediment deficit is expected to continue. The Service recognizes that the sediment deficit is expected to be less than what was described under Current Operations (1,793,500 tons per year) because of additional sediment transported under License Articles 404 and 406. The flow increases in the Loup River Bypassed Reach, as a result of the license articles, are expected to transport additional sediment compared to Current Operations at the Genoa streamgage (i.e., increases ranging from 338,000 to 1,250,000 tons per year), but it is not known to what extent this increase in Loup River sediment transport would be realized in the Lower Platte River.

Channel incision that is presently observed downstream of the Project tailrace return would also be present under the Staff Alternative. The reduced sediment deficit under the Staff Alternative would minimize the extent of the incision. Since present channel incision is limited to two miles downstream of the Project tailrace return, the extent of channel incision under the Staff Alternative would be relatively small compared to the extent of the Lower Platte River. Additionally, sediment deficits could affect bar formation processes beyond the area of channel incision, but this effect was not characterized in the Assessment.

APPENDIX E

EXTENDED DISCUSSION ON PROJECT HYDROCYCLING

A. Project Hydrocycling – Introduction

The following is a summary of Project hydrocycling in the Assessment. Water in the Project canal is stored in Lake Babcock and Lake North with the intent of releasing the water through the Columbus powerhouse to generate power. The maximum capacity for releases through the Columbus powerhouse is 4,800 cfs. Water is stored in times of low power demand and is released during periods of high demand. The available capacity for storage in in Lake Babcock and Lake North allows for hydropower releases of 4,800 cfs for up to five hours during high power demand, and the no releases are made for the remainder of the day. This on and off cycle of releases is termed by the Commission as hydrocycling.

The Commission in their Assessment has also summarized the effects of Project hydrocycling, under the Staff Alternative, to pallid sturgeon:

> *The staff-recommended minimum flow of 4,400 cfs in the lower Platte River as measured at North Bend to enhance pallid sturgeon movements (i.e., longitudinal connectivity) in the lower Platte River, is a targeted approach for improving conditions for pallid sturgeon, albeit for a small period of time (i.e., 38 days). However, for the remainder of the year, project peaking operations would continue to cause alterations in water elevations in the lower Platte River, with the magnitude of these water level changes varying somewhat with the distance downstream from the project. There would continue to be adverse effects on the pallid sturgeon in the lower Platte River as nonproject related water use and withdrawals, and storage at upstream dams, all affect the water supply to the lower Platte River that is crucial for creating pallid sturgeon habitat, and facilitating movements of pallid sturgeon in the lower Platte River.*

The Commission's summary was based on an evaluation of Staff Alternative in the Assessment. In review of the Commission's evaluation, the Service identified two major limitations in the Commission's Assessment that affect the Service's ability to quantify effects of the Staff Alternative to pallid sturgeon: 1) analyses provided by the Commission only reported on effects of Current Operations and not the Staff Alternative, and 2) variables reported in the Assessment and in the Final License Application were different from variables in the scientific literature that are linked to species occurrence. A description of pallid sturgeon effects under Current Operations are provided in Tables 59 and 60 in the Assessment (with supporting text).

As discussed previously, the Commission in their Assessment described Project hydrocyling to the pallid sturgeon. However, the evaluation of hydrocycling effects in the Assessment and Final License Application applied variables different from what was used by Hamel et al. (2014b). Hamel (2014b) applied the variable "coefficient of diel variation" (hereby referred to as CV) as a means of characterizing the within day variability in streamflow. Additional steps were required by the Service to transform variables used in the Assessment to CV applied by Hamel et al. (2014b). To accomplish this task, the Service will first discuss methods adopted by the Commission. Subsequent sections will describe how variable used in the Assessment could be reconfigured to characterize CV values. The last part of this appendix will describe how license articles under the Staff Alternative would affect CV.

Service notes that, in many sections of the Assessment, that the Commission did not conduct analyses of the Environmental Baseline and the Staff Alternative; rather, the Commission often uses surrogates for both. Specifically for Lower Platte River hydrology, the Commission references the run-of-canal (interchangeably used with Run-of-River) in place of the Environmental Baseline, and the Current Operations is closest to representation of the Staff Alternative. The Service will also apply similar naming conventions for the remainder of this appendix.

B. Describing Baseline Conditions without Hydrocycling

To project the hydrology under Environmental Baseline conditions, that do not include hydrocycling, the Service will use information compiled by the District within their Hydrocycling study. The Loup Power District was required to develop, as part of *Study 2.0 – Hydrocycling*, an alternative operating condition where the project would continuously pass inflows through the project's power canal system with no storage in either of the project reservoirs (i.e., Run-of-River operations). The Service will use the Run-of-River operations, as the best available information, to characterize Environmental Baseline conditions.

Table 1 contains the range of daily flow and stage under Run-of-River operations that is averaged on an annual and seasonal basis, for locations on the Platte River. Study site locations in Table 1 include one site upstream of the tailrace canal and five sites downstream of the tailrace canal. Site 3, in the Platte River bypassed reach, is unaffected by hydrocycling operations. Within Table 1, the average daily ranges are fairly constant through the reach. At the Site 3, the annual ranges are generally the smallest in terms of flow and the largest in terms of feet, which may be indicative of the lack of flow contributed by the Loup River and the site's narrower channel. Below the canal return, the average daily range of flows over the year is fairly consistent in terms of flow within each respective year. The largest difference between upstream and downstream occurred in 2008 (wet) when Site 4 average daily range equaled 1,130 cfs, and downstream at USGS gage at Louiville experienced a 1,400 cfs average. The least difference occurred during 2006 (Dry) when the difference between locations was 70 cfs. The stages also experienced average fluctuations between 0.15 (Louisville 2006 [dry]) to 0.26 feet (Site 4 2006 [dry] and 2009 [normal]).

On a seasonal basis, flow at Site 3 exhibits variations that are similar to downstream locations during 2008 (wet), and experienced less variation during the other two periods. Stage at Site 3 has an average range of 0.10 feet greater than Site 4 during the 2009 (normal) and 2008 (wet), and the average range was 0.05 feet less than Site 4 in the 2006 (dry). At Site 4 and downstream fluctuations as measured by flow generally increased from upstream to downstream, with 2008 (wet) year having the largest difference in average range from 2,000 cfs at Site 4 to the 2,740 cfs at USGS gage at Louisville. The average daily range of stages, on a seasonal basis, were between a minimum of 0.10 (at

Louisville gage during 2006[dry]) to 0.28 feet (Site 4 during 2009 [normal], and USGS gage at Louisville during 2008 [wet]).

As described above, baseline hydrology would not include hydrocycling, and therefore would experience daily fluctuations that are nearly equivalent to what presently occurs at Site 3.

Table 1. Average Annual and Seasonal Range of Daily Flow and Water Surface Elevation for Run-of-River Operations (Source: Loup River Public Power District, 2011c)

Location on Platte River	Average daily range of Run-of-River operations (cfs)			Average daily range of Run-of-River operations (feet)		
	Wet 2008	Dry 2006	Normal 2009	Wet 2008	Dry 2006	Normal 2009
Annual						
Site 3 – Upstream of the tailrace canal	950	420	840	0.33	0.30	0.41
Site 4 – Downstream of the tailrace canal	1,130	610	1,020	0.23	0.26	0.26
USGS Gage 06796000 – North Bend	1,130	600	1,020	0.20	0.17	0.21
USGS Gage 06796500 - Leshara	1,170	580	1,040	0.18	0.16	0.21
USGS Gage 06801000 - Ashland	1,370	660	1,150	0.19	0.22	0.21
USGS Gage 06805500 - Louisville	1,400	630	1,130	0.19	0.15	0.18
Seasonal (May 1 through August 15)						
Site 3 – Upstream of the tailrace canal	1,850	110	890	0.38	0.21	0.38
Site 4 – Downstream of the tailrace canal	2,000	260	1,070	0.26	0.25	0.28
USGS Gage 06796000 – North Bend	2,010	250	1,060	0.26	0.13	0.22
USGS Gage 06796500 - Leshara	2,120	260	1,100	0.24	0.13	0.21
USGS Gage 06801000 - Ashland	2,650	320	1,270	0.25	0.22	0.23
USGS Gage 06805500 - Louisville	2,740	310	1,270	0.28	0.10	0.21

C. Simplified Comparison between Environmental Baseline and Current Operations

Table 2 compares the average annual and seasonal differences between Current Operations and Run-of-River. In Table 2, Site 3 is upstream of the Project tailrace return and is therefore not affected by Project hydrocycling. Because Site 3 is not affected by Project hydrocycling, there is no difference between Current Operations and Run-of-River. For the remaining streamgages, the differences between Current Operations and Run-of-River is, in general, greatest immediately downstream of the Project tailrace return (i.e., Site 4), and the least difference is observed at the Louisville streamgage.

Table 2. Average Annual and Seasonal Differences in the Daily Range for Flow and Water Surface Elevation Under Current and Run-of-River Operations (Source: Loup River Public Power District, 2011c, as modified by the Service)

Location on Platte River	Average difference between the daily maximum and minimum flow (cfs)			Mean difference between the daily maximum and minimum stage (feet)		
	Wet 2008	Dry 2006	Normal 2009	Wet 2008	Dry 2006	Normal 2009
Annual						
Site 3 – Upstream of the tailrace canal	0	0	0	0	0	0
Site 4 – Downstream of the tailrace canal	3,030	2,210	2,730	1.08	1.59	1.04
USGS Gage 06796000 – North Bend	3,020	2,150	2,740	0.77	0.92	0.73
USGS Gage 06796500 - Leshara	2,970	2,180	2,450	0.72	0.86	0.66
USGS Gage 06801000 - Ashland	2,950	2,180	2,460	0.65	1.03	0.62
USGS Gage 06805500 - Louisville	2,920	2,170	2,210	0.56	0.64	0.51
Seasonal (May 1 through August 15)						
Site 3 – Upstream of the tailrace canal	0	0	0	0	0	0
Site 4 – Downstream of the tailrace canal	3,040	2,110	2,520	0.96	2.08	1.12
USGS Gage 06796000 – North Bend	3,030	2,000	3,569	0.69	1.12	0.71
USGS Gage 06796500 - Leshara	2,990	2,020	2,460	0.64	0.95	0.69
USGS Gage 06801000 - Ashland	2,880	2,080	2,430	0.56	1.34	0.67
USGS Gage 06805500 - Louisville	2,890	2,010	2,410	0.49	0.62	0.51

Table 3 applies information from Tables 1 and 2 to show a simplified, direct comparison between Current Operations and Run-of-River operations. Only values at the North Bend and Louisville streamgage were applied in Table 2 which reflects the two streamgages evaluated by Hamel et al. (2014b). It is the values in Table 3 that will be used to calculate the CV values that will be applied in the pallid sturgeon baseline and effects.

Table 3. Average annual difference between the daily maximum and minimum flow (cfs) for Current Operations and Run-of-River.

	North Bend		Louisville	
Year Type	Current Ops	Run-of-River	Current Ops	Run-of-River
Normal (2009)	3,760	1,020	3,540	1,130
Dry (2006)	2,750	600	2,800	630
Wet (2008)	4,150	1,130	4,320	1,400

D. Using Daily Hydrographs to develop Coefficient of Diel Variation

CV is calculated by dividing the standard deviation of subdaily flows with a 24 hour period by mean flow for that period (Zimmerman et al. 2010). In case of Hamel et al. (2014), the authors used 15 minute readings from USGS streamgages to develop the standard deviation and mean daily discharge and then multiplied the quotient by 100 to convert decimal values to whole values. Hamel et al. (2014b) calculated CV at two USGS streamgages in the Lower Platte River: 1) North Bend [Gage 06805500] and 2) Louisville [Gage 06796000]. At the North Bend gage, Hamel et al. (2014b) reported higher CV values and higher variability in values compared to the Louisville gage. The authors also identified that a CV in the 90th percentile (i.e., CV = 32), a large daily change, has a lower probability of pallid sturgeon occurrence compared to CV in the 10th percentile (i.e., CV = 8).

Figures 1-6 provide a visual representation of hydrographs associated with CVs of differing magnitudes. Examples used in Figures 1-6 were selected to display the upper and lower ranges of CV values at each of the streamgages. Figures 1-6 included several days of subdaily flows as a means for visually showing effects of hydrocycling under Current Operations on the within day variability of streamflow.

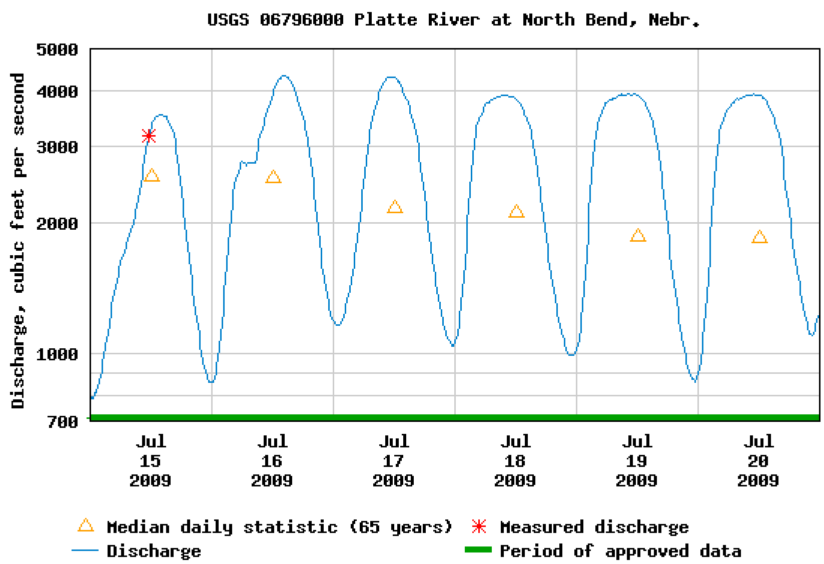

Figure 1. Representation of a hydrograph with a high CV (i.e., CV = 47) for the North Bend streamgage. CV was calculated for the July 16, 2009, in which the daily mean was 2,554 cfs and standard deviation 1,208 cfs.

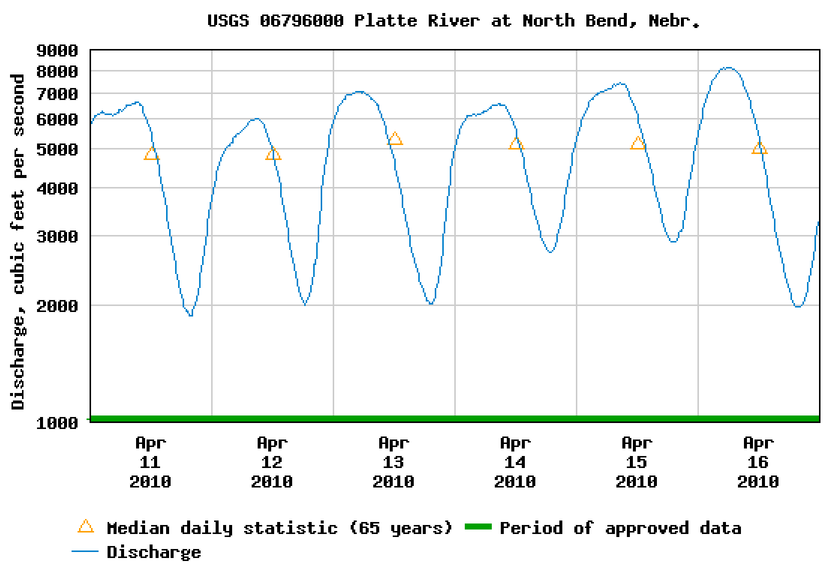

Figure 2. Representation of a hydrograph with a median CV (i.e., CV = 28) for the North Bend streamgage. CV was calculated for the Apr 14, 2010, in which the daily mean was 4,941 cfs and standard deviation 1,366 cfs.

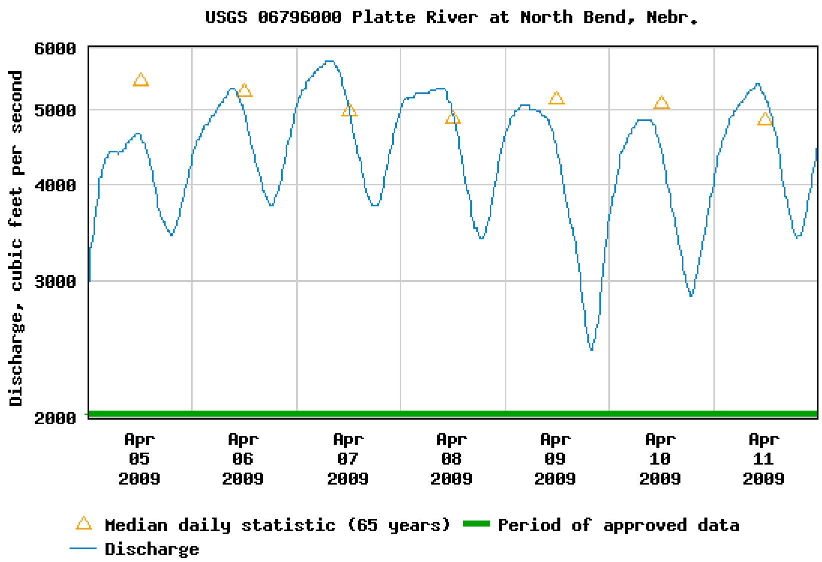

Figure 3. Representation of a hydrograph with a low CV (i.e., CV = 10) for the North Bend streamgage. CV was calculated for the Apr 6, 2009, in which the daily mean was 4,596 cfs and standard deviation 482 cfs (source USGS).

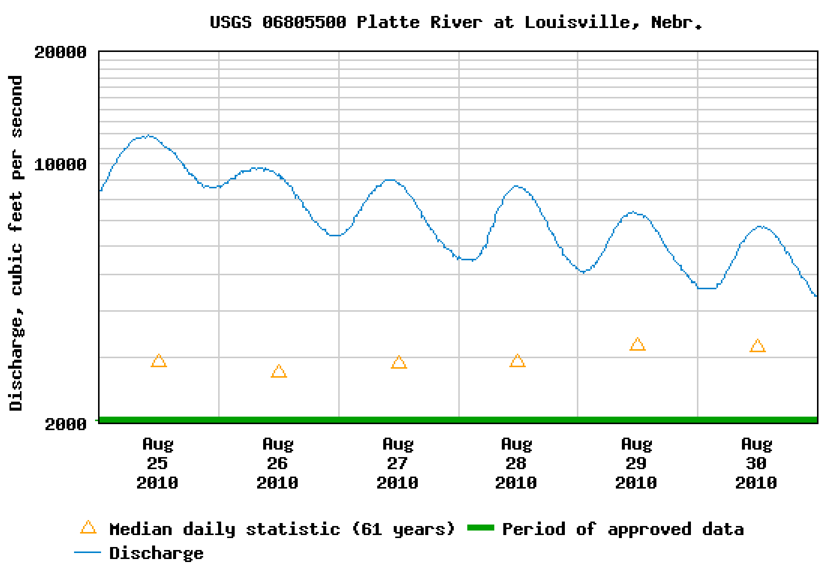

Figure 4. Representation of a hydrograph with a high CV (i.e., CV = 18) for the Louisville streamgage. CV was calculated for the Aug 28, 2010, in which the daily mean was 6,801 cfs and standard deviation 1,191 cfs (source USGS).

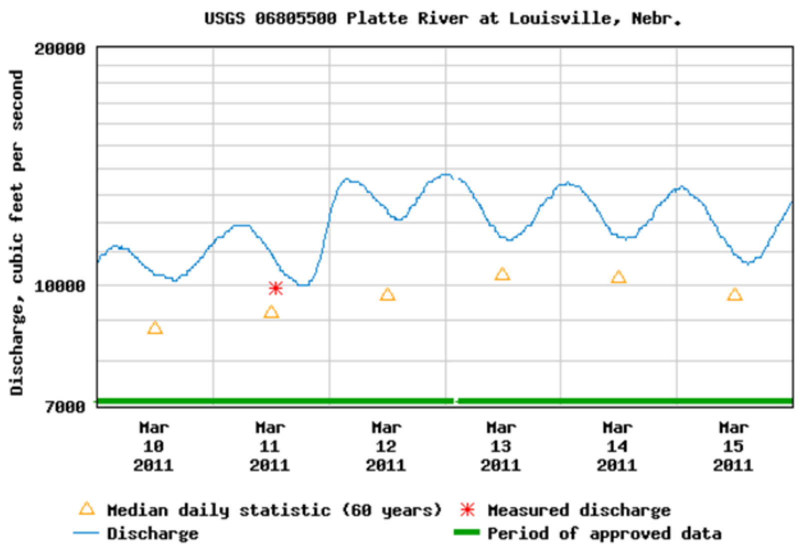

Figure 5. Representation of a hydrograph with a low CV (i.e., CV = 4) for the Louisville streamgage. CV was calculated for the March 12, 2011, in which the daily mean was 12,963 cfs and standard deviation 542 cfs (source USGS).

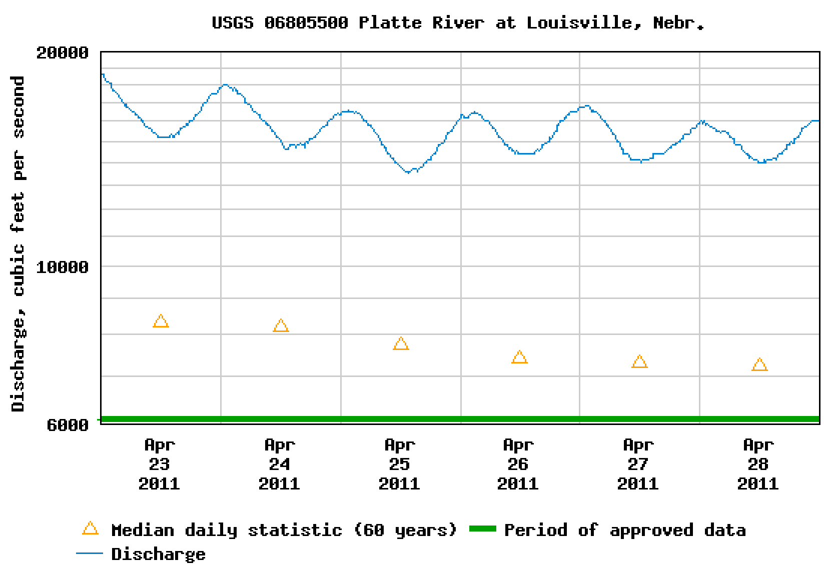

Figure 6. Representation of a hydrograph with a low CV (i.e., CV = 7) for the Louisville streamgage. CV was calculated for the Apr 25, 2011, in which the daily mean was 15,064 cfs and standard deviation 1,036 cfs (source USGS).

Flow statistics for selected daily hydrocycles from Figures 1-6 are listed in Table 4. Higher mean daily flows have lower CV values for days with similar variability. For example, a CV of 28 at North Bend has a daily mean of 4,941 cfs and a range of 5,020 cfs. The CV of 47 at North Bend has a smaller daily range (i.e., 3,280 cfs) to that of CV 28 which should result in a lower CV value; however, the smaller mean daily flow for

CV 47 (i.e., 2,554 cfs) results in a much higher CV. Similar differences in mean daily flow help to explain the difference between CV 7 and CV 18 at Louisville. Figures 7 and 8 provide a side-by-side comparison of daily hydrographs under different CV values for the North Bend and Louisville gages, respectively.

Table 4. Statistics for selected a range of CV at the North Bend and Louisville streamgages. Subdaily flow data were recorded at 15 minute intervals were used to calculate variables.

Date	Gage	Mean	St Dev	CV	Max	Min	Range
April 6, 2009	North Bend	4,596	482	10	5,320	3,750	1,570
July 17, 2009	North Bend	2,554	1,208	47	4,320	1,040	3,280
April 14, 2010	North Bend	4,941	1,366	28	6,570	2,720	5,020
August 28, 2010	Louisville	6,801	1,191	18	8,640	5,200	3,440
March 12, 2011	Louisville	12,963	542	4	13,800	12,100	1,700
April 25, 2011	Louisville	15,065	1,036	7	16,600	13,500	3,100

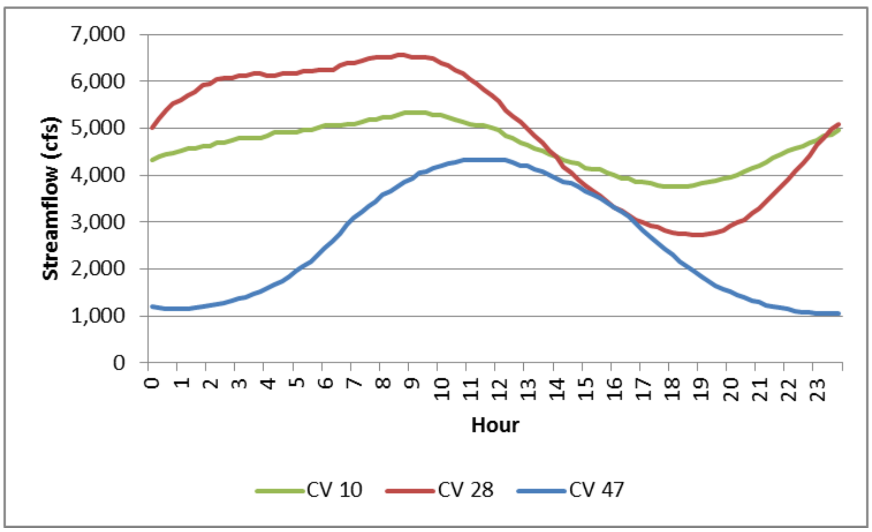

Figure 7. Daily hydrograph for the range of CV values for the North Bend gage as reported in Figures 1-3.

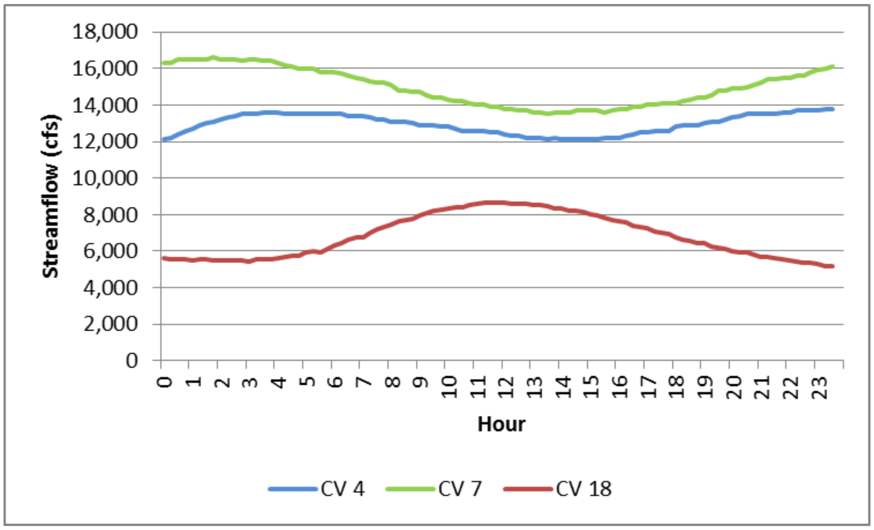

Figure 8. Daily hydrograph for the range of CV values for the North Bend gage as reported in Figures 4-6.

D. Developing Coefficient of Diel Variation for Environmental Baseline and Staff Alternative

Because the Assessment did not apply the CV variable in their analyses, the Service was required to develop a process that converted variables used in the Assessment to CV values. As stated previously, the CV is calculated by dividing the standard deviation of subdaily flows with a 24 hour period by mean flow for that period. The Assessment evaluated the effects of hydrocycling by comparing the average daily range in flow (or stage) for the Current Operations and Run-of-River operations. The average daily ranges in flow can be extrapolated to account for one variable in the CV calculation (i.e., standard deviation of subdaily flows with a 24 hour period). In order to compare differences in average daily range in flow, it would be necessary to keep the second variable constant (i.e., mean flow for the 24 hour period). The Service in this section will keep the mean 24 hour flow constant while applying within day variability in flows described in Table 3.

The following steps describe the process applied by the Service used to develop the adjusted CV values in Table 5.

1. **Mean Daily Discharge** - Mean daily flow used in this analysis were extracted from Table 2 of the FLA Appendix B in which mean daily flow at North Bend is 4,938 cfs (period of record from 1949 – 2009) and mean daily flow at Louisville gage is 8,273 cfs (period of record 1953 – 2009).
2. **Range (Normal Year Type)** – Normal year type was selected as a means of comparing Current Operations to Run-of-River operations under a typical year. Average annual difference between the daily maximum and minimum flow was extracted from Table 3 to characterize "Range (Normal Year Type)" in Table 5. For example in Table 3 under Normal year type, the average annual difference between the daily maximum and minimum flow for Current Operations at the

North Bend and Louisville was 3,760 and 3,540, respectively. These values were applied in Table 5 under Range (Normal Year Type).

3. **Comparable Range from Table 4** – Values under Range (Normal Year Type) was compared to range values in Table 4 under each of the respective stream gages. Values with the closest fit find the closest fit are listed in Table 5 under the "Comparable Range from Table 4". For example, range value for North Bend streamgage in Table 4 that had the closest match to 3,540 cfs was 3,280 cfs that occurred on April 14, 2010.
4. **St Dev from Table 4** – Standard deviation was extracted from the same row under Table 4. For example, the daily hydrograph for April 14, 2010, at the North Bend gage had a range of 3,820 cfs and a standard deviation of 1,208 cfs.
5. **CV from Table 4** – CV was extracted from the same row under Table 4. For example, the CV for April 14, 2010, at the North Bend gage had a range of 3,820 cfs and a CV of 47.
6. **Adjusted CV** – The "Adjusted CV" is calculated by dividing the values from "St Dev from Table 4" by the values from "Mean Daily Discharge". The quotient is then multiplied by a hundred and then rounded to the nearest whole number.

Table 5. Support information used to calculate adjusted CV values for the North Bend and Louisville streamgages under a Normal year type.

	North Bend		Louisville	
	Current Operations	Run-of-River	Current Operations	Run-of-River
Mean Daily Discharge[1]	4,938	4,938	8,273	8,273
Range (Normal Year Type) [1]	3,540	1,130	3,760	1,020
Comparable Range from Table 4[1]	3,280	1,570	3,440	1,700
St Dev from Table 4[1]	1,208	482	1,366	542
CV from Table 4	47	10	18	4
Adjusted CV	24	10	17	7

[1] All values are in CFS.

As described in Table 5, the adjusted CV values for Current Operations are 24 and 17 for North Bend and Louisville streamgages, respectively. CV values for Current Operations is higher than values for Run-of-River operations which are 10 and 7 for North Bend and Louisville streamgages, respectively. The Service acknowledges that the adjusted CV values provided in Table 5 do not reflect the broad range of conditions that would be observed throughout the period of record. However, these values do provide a good representation of conditions under a Normal Year Type with and under average flow conditions.

E. Sensitivity of CV to Commission's Conservation Measures

This section will describe how conservation measures adopted by the Commission as license articles would affect species use in the Lower Platte River. Article 404 attempts to maintain a minimum flow of 100 cfs at the Genoa stream gage from October 1 through

March 30 and a minimum flow of 275 cfs at the Genoa stream gage from April 1 through September 30. Article 406 limits the maximum diversion from 2,000 cfs, compared to a 3,500 maximum diversion, from March 1 through June 30 which provides a potential addition of 1,500 cfs through the bypass during high flow events. These Loup River bypassed flows under the Staff Alternative improves the minimum combined flow upstream of the Project tailrace return. This section describes how the license articles adopted by the Commission would affect the CV and species use in the Lower Platte River.

The Service has adopted several assumptions in the evaluation of the license articles. First assumption is that flow maintained in the Loup River Bypassed Reach arrives at the North bend gage with no degradation from conveyance losses and/or water diversions. The second assumption is that hydrocycling would occur throughout the year as conditions are available, and hydrocycling would occur on top of base flows facilitated by the existing license. The third assumption is that the shape of a hydrocycle would remain constant with changes made only to base flows. Figure 9 depicts the application of these assumptions for a single hydrograph at the North Bend gage. Similar to what would be expected, different bypass flows provide differing base flows to a daily hydrograph.

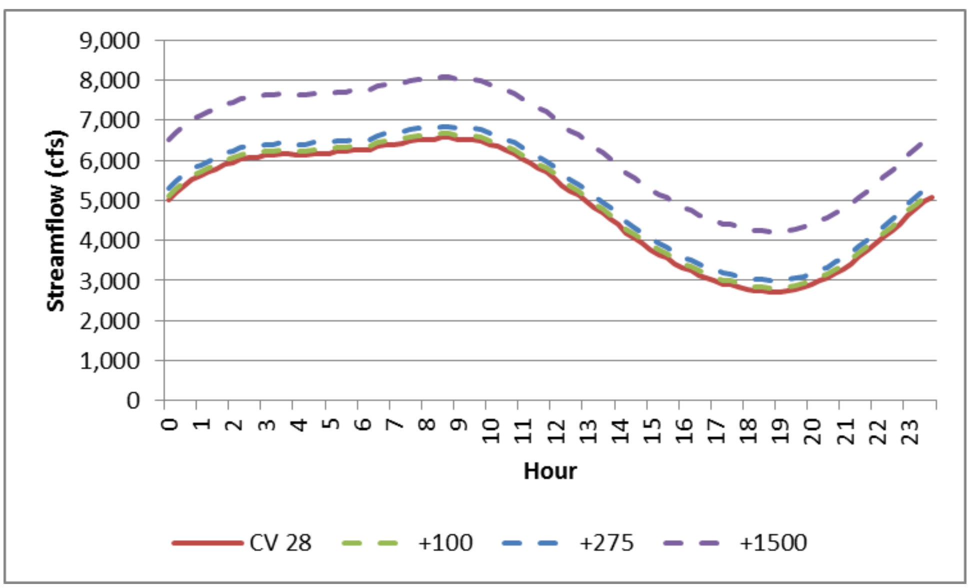

Figure 9. Daily hydrograph for CV 28 at the North Bend gage with 100, 275, and 1,500 cfs added to the base of the hydrograph.

Adjusted daily hydrographs in Figure 9 was also replicated for CV values of 10 and 47 at North Bend. Table 6 shows how the CV is affected by differing base flows. CV is relatively insensitive to the addition of a 100 cfs base flow where the addition of 1,500 cfs to the base flow results in the greatest change in CV. Also, CV that is higher in value is more sensitive to increases in base flow. For example, the CV of 47 observed on July 17, 2009, is reduced to 30 when 1,500 cfs is added to the base of the hydrograph.

Table 6. Changes in CV at the North Bend streamgage resulting from additions to base flow using values.					
Date	Gage	CV	CV+100	CV+275	CV+1500
April 6, 2009	North Bend	10	10	10	8
July 17, 2009	North Bend	47	46	43	30
April 14, 2010	North Bend	28	27	26	21

APPENDIX F

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