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LIST OF ACRONYMS/ABBREVIATIONS

Acronym/Abbreviation	Phrase
ac	acre
ACT	Agency Coordination Team
AF	acre-feet
AOP	Annual Operating Plan
AOU	American Ornithologist Union
Assurance	Assurance District
BSNP	Missouri River Bank Stabilization and Navigation Project
C	channalized
^{o}C	Celsius
CFR	Code of Federal Regulations
cfs	cubic feet-per-second
cm	centimeters
cm/s	centimeters/second
CMFO	Columbia Missouri Field Office
Corps	U.S. Army Corps of Engineers
CPUE	catch-per-unit-effort
CRP	Construction Reference Plane
CWCP	Current Water Control Plan
DDE	Dichloro diphenyl dichloroethylene
DDT	Dichloro diphenyl trichloroethane
DEIS	Draft Environmental Impact Statement
DOI	Department of the Interior
DRD	Deputy Regional Director

Acronym/Abbreviation	Phrase
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
EWRP	Emergency Wetland Reserve Program
^oF	Fahrenheit
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FO	Field Office
fps	feet-per-second
FR	Federal Register
ft	feet
FY	fiscal year
GAO	General Accounting Office
GMP	General Management Plans
GSI	Gonadosomatic index
ha	hectares
ICM	Interim Conservation Measures
in	inches
IR	inter-reservoir
KAF	Thousand acre-feet
KCD	Kansas City District
Kcfs	Thousand cubic feet per second
kg	kilograms
km	kilometers
km^2	square kilometer
KR Operations	Kansas River Tributary Reservoir Operations
KWH	Kilowatt hours

Acronym/Abbreviation	Phrase
lbs	pounds
LMR	Lower Mississippi River
LTRM	long-term resource monitoring
LWRP	Low Water Reference Plane
MAF	million acre-feet
MDC	Missouri Department of Conservation
mi	mile
mi^2	square mile
MMR	Middle Mississippi River
MNRR	Missouri National Recreation River
MOU	Memorandum of Understanding
MR Operations	Operation of the Missouri River Main Stem Reservoir System
MR Projects	Three combined actions under consultation
MR	Missouri River
MRNRC	Missouri River Natural Resource Committee
msl	mean sea level
mtDNA	Mitochondrial DNA
MW	megawatts
NBS	National Biological Service
NDFO	North Dakota Field Office
NEPA	National Environmental Policy Act
NFH	National Fish Hatchery
NMFS	National Marine Fisheries Service
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NTU	Nephelometric turbitity units
NWR	National Wildlife Refuge

Acronym/Abbreviation	Phrase
oz	ounce
PCBs	polychlorinated biphenyls
PEIS	Programmatic Environmental Impact Statement
Pick-Sloan Program	Pick-Sloan Missouri River Basin Program
Plover	Great Plains population of the threatened piping plover
R-3	Region 3
R-6	Region 6
R&H	reservoir and headwaters
RD	Regional Director
RHA	Rivers and Harbor Act
RM	river mile
RPA	reasonable and prudent alternative
Service	U.S. Fish and Wildlife Service
SIUC	Southern Illinois University at Carbondale
Sturgeon	endangered pallid sturgeon
System	Missouri River Main Stem Reservoir System
Tern	Interior population of the endangered least tern
UC	unchannelized
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WAPA	Western Area Power Administration
WRDA 99	1999 Water Resources Development Act
WRDA	Water Resources Development Act
WRP	Wetland Reserve Program

LIST OF SCIENTIFIC NAMES

Common Name	Scientific Name
American Sycamore	*Platanus occidentalis*
Bald Eagle	*Haliaeetus leucocephalus*
Bigmouth Buffalo	*Ictiobus cyprinellus*
Black-billed Magpie	*Pica pica*
Blue Sucker	*Cycleptus elongatus*
Box Elder	*Acer negundo*
Burbot	*Lota lota*
Channel Catfish	*Ictalurus punctatus*
Cottonwood	*Populus deltoides*
Coyote	*Canis latrans*
Crow	*Corvus brachyrhynchos*
Domestic Dog	*Canis domesticus*
Elm	*Ulmus spp.*
Flathead Catfish	*Pylodictis olivaris*
Golden Eagle	*Aquila chrysaetos*
Great Blue Heron	*Ardea herodias*
Green Ash	*Fraxinus pennsylvanica*
Gray Bat	*Myotis grisescens*
Indiana Bat	*Myotis sodalis*
Lake Sturgeon	*Acipenser fulvescens*
Least Tern	*Sterna antillarum*
Mink	*Mustela vison*
Mulberry	*Morus rubra*
Old World Little Tern	*Sterna albifrons*
Oppossum	*Didelphis virginiana*

Common Name	Scientific Name
Paddlefish	*Polyodon spathula*
Pallid Sturgeon	*Scaphirhynchus albus*
Peregrine Falcon	*Falco peregrinus*
Piping Plover	*Charadrius melodus*
Plains Minnow	*Hybognathus placitus*
Prairie Rattlesnake	*Crotolus viridis viridis*
Raccoon	*Procyon lotor*
Red Cedar	*Juniperus virginiana*
Red-tailed Hawk	*Buteo jamaicensis*
Ring-billed Gull	*Larus delawarensis*
River Carp Sucker	*Carpiodes carpio*
Russian Olive	*Elaeagnus angustifolia*
Sauger	*Stizostedion canadense*
Scaleshell Mussel	*Leptodea leptodon*
Shorthead Redhorse	*Moyostoma macrolepidotum*
Shovelnose Sturgeon	*Scaphirhynchus platyrhynchus*
Sicklefin Chub	*Macrhybopsis meeki*
Silver Chub	*Macrhybopsis storeriana*
Smallmouth Buffalo	*Ictiobus bubalus*
Sturgeon Chub	*Macrhybopsis gelida*
Willow	*Salix spp.*

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II) Routine annual maintenance schedules - Bank Stabilization and Navigation Project

III) Summary of past impacts to the Missouri River ecosystem

IV) Population distribution of breeding and wintering bald eagles on the Missouri River main stem

V) Scientific evaluation of the role of river hydrology in the conservation of Missouri River endangered species

VI) Contingency plan for protection of least tern and piping plover nests and chicks

INTRODUCTION

In 1989, the U.S. Army Corps of Engineers (Corps) initiated formal section 7 consultation with the U.S. Fish and Wildlife Service (Service) under the Endangered Species Act (ESA) on Operations of the Missouri River Main Stem Reservoir System (MR Operations). The Service completed formal consultation and issued a biological opinion in November 1990. The Service issued a jeopardy opinion for the least tern (*Sterna antillarum*) and piping plover (*Charadrius melodus*) and a nonjeopardy opinion for the bald eagle (*Haliaeetus leucocephalus*). The pallid sturgeon (*Scaphirhynchus albus*), listed as endangered in late 1990, was not addressed by that opinion. In April 1991, and several times thereafter, the Service advised the Corps to reinitiate formal consultation on MR Operations because of the pallid sturgeon listing; lack of compliance with least tern and piping plover fledge ratios and other provisions of the reasonable and prudent alternative identified in the 1990 opinion; and significant changes to annual operations since the 1990 opinion.

In December 1993, the Corps determined that continuation of the current water control plan in the Master Manual or a change in plans may adversely affect several listed species and initiated section 7 formal consultation with the Service. The Corps and the Service agreed that the Master Manual consultation would satisfy the need to reconsult on current operations and consult for the first time on project effects on the pallid sturgeon. At the Corps' request, the Service issued a draft biological opinion simultaneously with the release of the Draft Environmental Impact Statement (DEIS) on the Missouri River Master Water Control Manual Review and Study in August 1994. The Service concluded jeopardy to the tern, plover, and pallid sturgeon, and nonjeopardy to the bald eagle. The Master Manual study has been delayed several times and consultation on the effects of current operations on the pallid sturgeon has not been completed.

Following the Flood of 1993, the Corps identified significant repair and maintenance work to flood-damaged training structures associated with the Missouri River Bank Stabilization and Navigation Project (BSNP). Because of potential adverse effects on the pallid sturgeon in 1994, the Service requested that the Corps consult on this project. The Corps agreed to informal consultation on the project, including Service review and consultation on individual projects. Formal consultation would begin when sufficient data on project effects and pallid sturgeon life history and habitat use were available as part of the Master Manual Review and Study.

Since 1994, the Service advised the Corps several times about its responsibilities under the ESA and reiterated its request for the Corps to reinitiate consultation on Operations. In April 1998, the Corps advised the Service of its intent to reinitiate the ESA process on current operations under the existing Master Manual. In December 1998, the Corps provided the Service a biological assessment on the "Operations of the Missouri River Main Stem Reservoir System" and related "Operations of the Kansas River Tributary Reservoirs" (KR Operations). In April 1999, the Corps also provided a biological assessment on the "Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project." In a March 30, 2000, letter, the Corps requested that formal consultation on the three projects, hereafter referred to as Missouri River Projects (MR Projects), begin on April 3, 2000.

Refer to the section "Consultation History" below for a complete history of the section 7 consultation on the Missouri River.

SPECIES COVERED IN THIS CONSULTATION

This consultation addresses the following listed species: threatened bald eagle, endangered Interior population of the least tern (tern), threatened Northern Great Plains population of the piping plover (plover), and endangered pallid sturgeon (sturgeon). To date, no critical habitat has been designated for these species. However, the Service is under a court order to propose critical habitat for the threatened Northern Great Plains population of the piping plover by May 31, 2001, and produce a final rule by September 30, 2001. As a result of informal consultation and the review of the Corps' biological assessments, the Service concurs with the Corps' findings that the MR Projects may adversely affect the least tern, piping plover, and pallid sturgeon. The Service also concurs with the Corps that the MR Projects are not likely to adversely affect the Indiana bat (*Myotis sodalis*), but does not concur with the Corps' finding that the MR Projects would not adversely affect the bald eagle.

The Service and the Corps initially agreed to include two candidate species, the sturgeon chub (*Macrhybopsis gelida*) and the sicklefin chub (*Macrhybopsis meeki*), in this consultation. Due to the complexity of this consultation, the Service and the Corps mutually agreed that the chubs not be included in this biological opinion. If the chubs are proposed for listing in the future, the Corps should enter formal conference with the Service at that time. The Service is currently under a court order to complete the 12-month finding on both chubs by April 2001.

The scaleshell mussel (*Leptodea leptodon*) was proposed for listing as an endangered species on August 13, 1999. However, for the following reasons, the Service and the Corps have agreed not to formally conference or address this species in this consultation.

Only two records (both single dead shells) of scaleshell exist for the main stem of the Missouri River. In 1981 and 1982, the Missouri River was surveyed from Santee to Omaha, NE (Hoke 1983). A single fresh dead shell was found during this study just below Gavins Point Dam, SD. That occurrence represents the westernmost record of scaleshell in North America. This species has been found in subsequent surveys on the Missouri River below Gavins Point Dam. In 1995, Clarke (1996) found no evidence of scaleshell in a survey conducted from Gavins Point Dam to 30 mi (48 km) downstream. However, high water conditions limited Clark's search efforts, and only 10 individual mussels were found. In 1999, the Omaha District of the Corps funded a mussel survey between Gavins Point Dam and Ponca, NE, a distance of 60 mi (96 km). In all, 355 live and 1,709 dead individual mussels, representing 16 species, were collected, but no living or dead scaleshell were found (Perkins and Backlund 2000). The second scaleshell record is a single fresh dead individual collected in 1990 from Gasconade County, Missouri. That specimen was found during an extensive survey conducted from Gavins Point Dam to St. Louis, MO (Hoke 2000). However, the site of this collection was subsequently destroyed.

Since no living scaleshell has been found in the Missouri River, the species habitat cannot be determined. However, both dead shells were collected from areas shielded from the main flow of the river in relatively stable, sandy bottoms with moderate current (Hoke 2000). Hoke (2000) described scaleshell as "extremely rare" and its habitat "very uncommon...and existing in only widely separated locales" in the Missouri River. Based on the criteria used to assign status to scaleshell populations, the Service considers the status of this potential population to be extirpated at this time. Of the two known Missouri River records for scaleshell, one locality has been destroyed and recent surveys have found no evidence of this species at or in the vicinity of the other site. Further, no other scaleshell specimens were found during Hoke's survey from Gavins Point Dam to St. Louis. More information is needed on the occurrence of scaleshell and its habitat in the Missouri River. Furthermore, more information is needed from Hoke's survey work on the Missouri River, which is unavailable at this time. The Service has concluded the scaleshell is not present in the project area and that a conference opinion is not appropriate at this time. If the Service becomes aware of additional information supporting the occurrence of the scaleshell on the Missouri River, section 7 conferencing can be reinitiated at that time.

CONSULTATION HISTORY

A history of consultation includes any informal consultation or prior formal consultations on the action; documentation of the initiation date of consultation; a chronology of subsequent requests for additional data, extensions; and other applicable past or current actions by the action agency. A comprehensive administrative record of this consultation, including all supporting and related materials, is located in the Service's North Dakota Field Office (NDFO) in Bismarck.

OPERATION OF THE MISSOURI RIVER MAIN STEM RESERVOIR SYSTEM

- 1986-89 - The Service and the Corps consulted informally on Operations of the Missouri River Main Stem System under the existing Master Water Control Manual.

- May 26, 1989 - The Corps' Missouri River Division transmitted an additional information report to the Service to supplement the Biological Assessment on Missouri River Operations and requested formal consultation under Section 7 of the ESA.

- June 27, 1989 - The Service's NDFO transmitted a letter to the Missouri River Division noting that formal consultation was initiated on May 30, 1989. The Service recognized that actions by Western Area Power Administration also influence Missouri River Operations, but assumes the Corps is the lead agency for formal consultation unless notified differently.

- July 25, 1989 - The Corps' Missouri River Division transmitted a letter to the Service's NDFO, which responded to requests for additional information to supplement the Corps Biological Assessment and consultation responsibilities under the ESA.

- September 8, 1989 - The Service's Missouri River Coordinator transmitted a letter to the Corps' Missouri River Division advising the Corps of a proposal to list the pallid sturgeon and responsibilities of Federal agencies to conference with the Service on proposed species when actions may jeopardize the continued existence of the species.

- October 26, 1989 - The Corps' Missouri River Division transmitted a letter to the Service's Missouri River Coordinator with comments on the proposal to list the pallid sturgeon as an endangered species.

- October 27, 1989 - The Service's NDFO transmitted a letter to the Corps' Missouri River Division advising the Corps to prepare a biological assessment and determine if conference on the pallid sturgeon with the Service is needed.

- December 13, 1989 - The Corps' Missouri River Division transmitted a letter to the Service's Regional Director (R-6) regarding the proposal to list the pallid sturgeon and the paucity of information on the species. The Corps suggested that more studies are needed to provide biologically sound assessments, opinions, and recommendations on the species.

- December 20, 1989 - The Corps' Missouri River Division responded to the Service's October 27 letter regarding the proposed rule for listing the pallid sturgeon and conferencing on the species. The Corps suggested that more data are needed before a scientifically supportable biological assessment or a biological opinion can be developed.

- January 25, 1990 - The Service's Deputy Regional Director (R-6) transmitted a letter to the Corps' Missouri River Division urging the Corps to immediately initiate conference discussions on the pallid sturgeon as required by section 7 regulations of the ESA.

- March 22, 1990 - The Corps' Missouri River Division transmitted a letter to the Western Area Power Administration (WAPA) in response to questions regarding the status of the consultation with the Service. The Corps advised WAPA that the formal consultation on the Corps operational change is limited to the Corps, as the action agency, and the Service. The Corps indicated it would provide WAPA a copy of the revised draft and discuss impacts.

- March 23, 1990 - The Corps' Missouri River Division transmitted a letter to the Service's Deputy

Regional Director (R-6) regarding the need to conference on the pallid sturgeon. The Corps agreed that conferencing is the proper course to follow, but recommended that it not follow the strict procedures but focus on pallid sturgeon data needs.

- May 8, 1990 - The Service's Regional Director (R-6) transmitted a letter to the Corps' Missouri River Division concurring with the decision to initiate an ESA conference on Missouri River Main Stem Operation impacts upon pallid sturgeon.
- May 18, 1990 - The Service transmitted a letter which entered informal consultation with the Corps on the Master Manual and provided general comments on the Master Manual Plan of Study and a list of threatened and endangered species [50 Code of Federal Regulations (CFR) Part 402.12(C)] known to occur in the project area.

- July 9, 1990 - The Service transmitted comments to the Corps on the Phase 1 Study Report and addressed the Corps' references to the ESA as "constraints" on operations. The Service referenced section 7(a)(1) of the ESA, which directs Federal Agencies to use their authorities to further the purposes of the ESA by carrying out programs for the conservation of listed endangered and threatened species, and recommended that endangered species conservation be factored into the Corps' planning process.

- July 13, 1990 - The Corps' Missouri River Division provided comments to the Service's Regional Director (R-6) on the final draft Biological Opinion on Operations of the Missouri River Main Stem System. In those comments, the Corps provided additional inference that it is the lead agency for consultation by indicating that it is responsible for generation of electric power and that WAPA is only responsible for transmission and disposal of power.

- October 24, 1990 - The Service submitted a Planning Aid Letter on Phase II of the Master Manual Review to the Corps, provided the Corps an updated species list, and again emphasized the section 7(a)(1) directives.

- November 14, 1990 - The Service issued a final biological opinion, concluding that the current Operations of the Missouri River system would likely jeopardize the continued existence of the least tern and piping plover and not jeopardize the bald eagle (U.S. Fish and Wildlife Service (USFWS) 1990a). The pallid sturgeon, listed as an endangered species on September 6, 1990, was not addressed by that biological opinion. The opinion advised the Corps that section 7 consultation should be reinitiated if new species are listed or if the Master Manual is revised and could affect listed species differently.

- 1990-1991 - Through the scoping process, the Service and Corps identified the tern, plover, bald eagle, and pallid sturgeon as the federally listed species most likely to be affected by continued system operation under the Master Manual or an alternative system operation, and therefore, incorporated specific considerations for these species into the Master Manual Review and Study.

- 1990-1992 - Throughout the scoping process, Phase I, and Phase II of the Master Manual Study, the Service recommended and the Corps adopted an ecosystem approach to the assessment of fish and wildlife resources, including threatened and endangered species. That approach helped to address candidate species that might be listed in the future. That list included, but was not limited to, the paddlefish (*Polyodon spathula*), blue sucker (*Cycleptus elongatus*), lake sturgeon (*Acipenser fulvescens*), sicklefin chub, and sturgeon chub. Early planning for those species could avoid problems with MR Operations and future listings.

- January 15-17, 1991 - Service staff attending a general Master Manual coordination meeting in Omaha recommended to the Corps that they should reinitiate formal consultation on Missouri River Operations because of the 1990 listing of the pallid sturgeon and the initiation of the Master Manual Study. Therefore, the Corps and Service discussed the interrelationship of MR Operations and the Master Manual and several options to most effectively address the agencies' endangered species responsibilities on both those actions.

- April 3, 1991 - The Service transmitted a letter to the Corps, which officially documented the rationale for the Corps to reinitiate formal section 7 consultation on MR Operations and procedurally remain in compliance with the regulations.

- April 10, 1991 - The Service transmitted a letter to the Corps which advised the agency of their responsibilities for ESA compliance on the Master Manual Study and provided an updated species list. Furthermore, the letter informed the Corps that a biological assessment, per se, is not required because the Master Manual Study is not a major construction activity, but the Corps must assess appropriate project information and determine whether the proposed action "may affect" listed species or habitats.

- June 10, 1991 - The Corps responded to the Service's April 3 letter and indicated that they would prepare a biological assessment on proposed changes to MR Operations to be completed by May 1992. The Corps would use information generated with analytical tools developed for the Master Manual Study and would provide the basis to determine if the project is likely to adversely affect the pallid sturgeon and formal consultation is warranted. A biological assessment was not provided in May 1992 or thereafter.

- October 4, 1991 - The Service's NDFO transmitted a letter to the Corps' Missouri River Division regarding ESA compliance on Missouri River Operations and reaffirmed the Service's recommendations of April 3, 1991, for the Corps to reinitiate formal section 7 consultation on the pallid sturgeon.

- April 15, 1992 - The Corps' Missouri River Division Office in Omaha transmitted a request to the Service's NDFO for ESA section 7 compliance information.

- April 28, 1992 - The Service's NDFO transmitted a reply to the Corps' Missouri River Division regarding ESA compliance.

- September - December 1992 - The Service coordinated extensively and met with the Corps and basin states on September 24, October 7, and November 9-10 on development of endangered species inputs and analysis of environmental quality alternatives for the Master Manual Study.

- December 18, 1992 - The Service transmitted a letter to the Corps that summarized endangered species inputs and evaluations of environmental quality alternatives. That letter, provided within the framework of informal consultation, documented respective agency efforts to incorporate endangered species considerations into the environmental quality alternatives formulation, evaluation, and selection processes for the National Environmental Policy Act (NEPA) review (i.e., Master Manual Study), and thereby, minimize or possibly preclude future conflicts during the formal section 7 consultation under the ESA. This letter also recommended adoption of a specific environmental alternative (DEQ12B) as the best implementable alternative for meeting ecosystem needs. Later in the Master Manual Study, the Corps withdrew DEQ12B and other environmental alternatives from the array of alternatives under consideration and reformulated the alternatives.

- February 17, 1993 - The Service and Corps met in Bismarck, ND, to further discuss the Service's December 18, 1992, letter; the section 7 consultation process; and the proposed Master Manual Draft Environmental Impact Statement (EIS).

- November 3, 1993 - Missouri River Division Engineer Colonel Schaufelberger called North Dakota Field Supervisor Joel Medlin to discuss the Corps' responsibilities and compliance with the ESA.

- November 19, 1993 - The Service and the Corps met in Omaha, NE, to discuss the Corps' alternative strategies for section 7 compliance and consultation.

- November 24, 1993 - Colonel Schaufelberger met with the Service's Regional Director from Region 6 (R-6) and agreed on a strategy to initiate formal consultation prior to the identification of the preferred alternative. Although that approach departs from the normal consultation process, the Corps recommended the approach to better integrate consideration of threatened and endangered species into the NEPA review and selection of a preferred alternative. A draft biological opinion would be issued simultaneously with the Draft EIS so that recommendations could be considered and possibly implemented in the Final EIS.

- December 8, 1993 - The Corps transmitted a letter to the Service which requested initiation of formal consultation on the Master Manual and requested inputs on the biological significance of the alternatives under consideration (with regard to the jeopardy standard) prior to the selection of a preferred alternative. They also determined that only the tern, plover, and the pallid sturgeon would be adversely affected by the alternatives under consideration.

- December 28, 1993 - The Service transmitted a letter to the Corps that acknowledged the Corps' request for formal consultation; concurred with their list of species affected, except the omission of the bald eagle; clarified our respective agency roles; and documented that their initiation package was incomplete.

- December 29, 1993 - The Service transmitted a letter to the state game and fish departments in the basin states that advised them of the Corps' request for formal consultation and requested any additional biological information that should be considered in the consultation. No responses were received from the states.

- January 24, 1994 - The Service submitted another letter to the Corps that provided a comprehensive list of consultation information needs the Corps must address to facilitate the Service's analysis of the effects of the Corps' action on listed species and preparation of a biological opinion.

- February 4, 1994 - The Corps responded to the Service's December 28, 1993, and January 24, 1994, letters and provided additional consultation information.

- February 9, 1994 - The Service and the Corps met in Omaha, NE, to further discuss and clarify information needs for initiation of formal consultation. The Corps agreed to provide additional information as needed during the consultation, or inform the Service if the data were not available.

- February 16, 1994 - The Service transmitted a follow-up letter to the Corps regarding the status of additional information for the consultation and officially concurred with the Corps' December 8, 1993, request for section 7 formal consultation on the Master Manual Study. The Service also requested an extension of time for completion of the draft biological opinion because of projected delays in the Corps' selection of a preferred alternative. The Service advised the Corps that it would need a minimum of 60 days from the date of receipt of all pertinent data on the preferred alternative to complete the biological opinion.

- February 28, 1994 - The Corps transmitted a letter that concurred with the Service's request and revised the schedule to complete the draft biological opinion by June 1, 1994.

- April 12, 1994 - Per the Corps' December 8, 1993, request for feedback on biological significance, the Service transmitted a letter to the Corps providing information and recommendations on the biological significance of the then current Master Manual environmental alternative flow series and permanent pool levels on fish and wildlife resources of the Missouri River ecosystem, in general, and specifically on threatened and endangered species. The intent of that information was to aid the Corps' evaluation of project alternatives and selection of a preferred alternative.

- May 9, 1994 - The Corps advised the Service and publicly announced the selection of a preferred alternative for the Draft EIS. They provided a description of the criteria and impact data used to select the preferred alternative and provided additional data for preparation of the draft biological opinion.

- May 16, 1994 - Following a review of the alternative, the Service advised the Corps informally that an extension of 30 days to complete the draft biological opinion was warranted because the preferred alternative was not one of the 400+ alternatives previously evaluated, and the information provided was incomplete to adequately analyze the alternative and formulate a draft biological opinion.

- May 20, 1994 - The Service transmitted a letter to the Corps with a list of data needs on the preferred alternative.
- May 26, 1994 - The Service transmitted a letter to the Corps formally requesting an extension until August 9, 1994, to complete the draft biological opinion.

- June 13, 1994 - The Corps transmitted a letter concurring with the Service’s request for an extension.

- June 13-16, 1994 - Following receipt of sufficient data to analyze the preferred alternative, the Service held an interoffice workshop to jointly address the effects of the Corps' preferred alternative on the listed species, formulate the biological opinion, and as appropriate, discuss reasonable and prudent alternatives, incidental take, and conservation recommendations.

- July 8, 1994 - The Service informally briefed the Corps on the status of the draft biological opinion while attending a Corps sponsored Master Manual workshop on the forthcoming Draft EIS.

- August 11, 1994 - Per the Corps’ request, the Service transmitted a letter and Draft Biological Opinion on the Missouri River Master Water Control Manual Review and Study to the Corps so that the Draft Biological Opinion could be released simultaneously with the Corps’ Draft EIS. The Service requested written comments from the Corps within 30 days, but never received any. As a result of delays in the Corps’ Master Manual schedule, the NEPA process is ongoing, as is the consultation. Thus, a Final Biological Opinion has not been completed.

- September 15, 1994 - Colonel Michael Thuss, Missouri River Division Engineer, transmitted a letter to Regional Director Morgenweck (R-6) regarding receipt of the Draft Biological Opinion. He indicated Corps comments would be provided by January 1, 1995. None were ever received. He also suggested that an extension of formal consultation until April 1995 was appropriate.

- March 7, 1995 - Willie Taylor, Department of the Interior, transmitted Department comments to Colonel Thuss on the Corps' Draft EIS on the Master Manual. Interior advised the Corps that the DEIS only superficially addressed ESA section 7 compliance and should include a more comprehensive discussion in the Final EIS (FEIS).

- April 3, 1995 - Colonel Thuss transmitted a memorandum to the Commanders, Kansas City (KCD) and Omaha Districts, advising them that federally threatened and endangered species and the Missouri River ecosystem need the Corps' immediate attention and endorsed a proactive approach to benefit listed species.

- June 29, 1995 - Deputy Regional Director (R-6) Terry Terrell transmitted a letter to Colonel Thuss requesting a meeting between Corps and Service staff to further discuss respective agency responsibilities for ESA compliance relative to the ongoing section 7 formal consultation on the Master Manual. Discussions focused on obligations for conservation of endangered species until completion of the Corps' Master Manual Study and issuance of the Service's Final Biological Opinion.

- July 11, 1995 - Service staff from R-6, Columbia Missouri Field Office (CMFO), NDFO, and Corps' Missouri River Division staff met in Denver to discuss issues addressed in the June 29, 1995, letter to the Corps. The Corps agreed that they should either request an extension on the formal consultation or reinitiate consultation on Missouri River Operations.

- December 1, 1995 - Service Regional Director Morgenweck and Corps Missouri River Commander Craig met in Denver to address the unresolved ESA compliance issue.

- March 7, 1996 - Staff from the Service (R-3 and 6), the Interior Solicitor's Office, and the Corps' Missouri River Division held a conference call to further discuss unresolved ESA compliance issues. The Corps advised the Service that it was reevaluating its options for ESA compliance, including termination, extension, or deferral of the ongoing formal consultation on the Master Manual and would send a letter to the Service soon.

- March 14, 1996 - The Corps' Missouri River Division Commander transmitted a letter to the Service Regional Director (R-6) requesting an extension of time to complete the Master Manual section 7 consultation. In addition, the Corps advised the Service that no comments would be provided on the 1994 Draft Biological Opinion because the future preferred alternative likely would be different. The Corps agreed to work with the Service to identify measures that could be implemented during the extended consultation period on the Master Manual to conserve the pallid sturgeon.

- April 12, 1996 - The Service's NDFO transmitted a letter to the Corps' Missouri River Division in Omaha agreeing to the Corps' request for an extension of the consultation until June 30, 1997, provided that mutually acceptable progress be made in identifying and implementing "interim conservation measures" to benefit pallid sturgeon, least tern, and piping plover.

- May 14, 1996 - An interagency meeting between the Corps, Service, and Environmental Protection Agency was held to discuss Missouri River issues, including interim conservation measures.

- June 12, 1996 - The Service's NDFO, following coordination with state game and fish departments and other Service offices, provided the Corps' Missouri River Division in Omaha a preliminary list of potential interim conservation measures that could be implemented in a timely manner under existing authorities to improve the environmental health of the Missouri River for listed species, and thus, meet the intent of the ESA during the administrative delay in completion of the Master Manual Study.

- July 16, 1996 - Service and Corps staff met in Omaha to discuss possible interim conservation measure projects to benefit listed species during the delay in completion of the Master Manual Study. The Corps agreed to provide the Service with a list of existing or ongoing projects related to restoration of Missouri River habitats, and develop task forces to conduct engineering and biological reviews of the Service's list of projects.

- July 16, 1996 - The Corps' Missouri River Division Commander transmitted a letter to the Service Regional Director (R-6) regarding the need for a biological assessment and potential conservation measures.

- July 31, 1996 - The Service's NDFO transmitted a letter to the Corps' Missouri River Division documenting agreements made at the July 16 meeting in Omaha on interim conservation measures.

- September 11, 1996 - The Service's NDFO transmitted a letter to the Corps' Missouri River Division providing an annotated list of Federal authorities or programs that might relate to the Service and interim conservation measures for listed species on the Missouri River.

- November 13, 1996 - The Service's Acting Regional Director (R-3) transmitted a letter to the Corps' Missouri River Division Engineer regarding a proposed December 17, 1996, meeting to discuss several endangered species issues including the Draft Biological Opinion, interim conservation measures, and tern and plover conservation.

- November 14, 1996 - Service and Corps staff met in Omaha to review progress on implementing interim conservation measures. The Corps indicated that Omaha District and KCD staff would further evaluate the Service's list of proposed projects, as well as Corps' proposals, from an engineering perspective; identify constraints and authorities; and present data in a matrix by March 1997.

- December 17, 1996 - The Service (staff and Regional Directors from R-3 and R-6) and Corps (staff and Missouri River Division Engineer) met in Minneapolis, MN, to address a number of Missouri River issues including ESA compliance.

- January 30, 1997 - Service Regional Directors (R-3 and 6) transmitted a letter to the Corps' Missouri River Division Engineer documenting discussions at the December 17, 1996, meeting. The Service reiterated its position that the Corps should reinitiate section 7 consultation on the effects of ongoing Missouri River operations and further address agency differences regarding ESA baseline and a reasonable and prudent alternative to avoid jeopardy.

- March 3, 1997 - The Service's NDFO transmitted a letter to Larry Cieslik, Master Manual Project Manager, regarding interim conservation measures and related information the Corps had not provided.

- April 8, 1997 - Service staff (R-3 and 6) and Corps staff (Missouri River Region) met in Omaha to review progress in implementation of interim conservation measures. The Service expressed concern about lack of ESA compliance. The Corps provided a matrix and engineering categorization of the Service's list of potential projects, but requested biological standards. The Service indicated this information had been provided at the November meeting, that all projects on the list were important to listed species, and referred the Corps to the 1994 Draft Biological Opinion for the Master Manual revision for information on habitat restoration needs and guidelines. The Service offered to provide the information separately from the biological opinion, if necessary. The Service and Corps discussed current Corps activities to benefit listed species, and agreed to maintain communication through regular coordination meetings.

- June 28, 1997 - The Service's NDFO transmitted a letter to Larry Cieslik, Master Manual Project Manager, providing reformatted standards and guidance to help the Corps prioritize interim conservation measures from a biological perspective. The Service urged the Corps to immediately select and implement projects in Fiscal Year 97 to confirm the Corps' commitment to interim conservation measures.

- July 18, 1987 - Service Regional Directors (R-3 & 6) transmitted a letter to the Corps' Brigadier General Griffin (Commander, Northwestern Division) regarding a disagreement between the Corps and the Service on the environmental baselines to be used for the ESA and NEPA analyses on the Master Manual Review and Study.

OPERATION OF THE KANSAS RIVER RESERVOIR SYSTEM

- January 30, 1997 - The Service's Kansas Field Office transmitted a letter to KCD informing them of the presence of terns and plovers on the Kansas River and requesting a coordination meeting.

- February through May 1997 - The Service and Corps biologists held infrequent informal discussions regarding terns and plovers. No formal actions or responses occurred.

- July 9, 1997 - The Service transmitted a second letter to the Corps referencing the January 30 letter, requesting a response, and recommending a meeting.

- July 24, 1997 - A meeting was held among the Corps, Service, Kansas Department of Wildlife and Parks (KDWP), and Kansas Biological Survey after the tern and plover nesting season to talk in general terms about future management for the birds. The Corps proposed a plan to keep the Kansas River gauge at Wamego below 7.5 ft (2.3 m), if possible, to protect a few still unfledged chicks.

- August 4, 1997 - Corps and Service staff conducted a site visit to one of the known 1997 nesting sites to get an idea of elevation of nesting areas compared with river stage, though by this time they were no longer in use.

- April 6, 1998 - The Corps arranged a meeting to discuss Service recommendations for the upcoming nesting season.

- May 12, 1998 - The Corps arranged a meeting with the Service and Dr. Boyd, Baker University, least tern biologist, to discuss nests on the Kansas River. The Corps pledged to work with resource agencies to determine nesting status on the Kansas River and to work within operational frameworks to attempt to avoid a taking.

- June 11, 1998 - Corps and Service staff conducted a site visit to determine nesting status of terns and plovers, and to again identify elevation of lowest active nests relative to river stage.

- July 1, 1998 - The KCD of the Corps transmitted a letter to the Service's Kansas Field Office outlining the Corps' efforts to date to coordinate with the Service and try to conserve the least tern and piping plover (i.e., avoid a taking), and to specify their plans to protect known nests identified on June 11.

- July 9, 1998 - The Service transmitted a letter responding to the Corps' July 1 letter. The Service recognized the Corps' involvement to date and provided a summary of the 1998 tern and plover nest survey information.

- 1999 - 2000 - Service and Corps staff held frequent conversations before and during the nesting season, with the Corps attempting to regulate reservoir releases to avoid raising river stage above elevations identified for active nests. Uncontrolled runoff events resulted in unavoidable take of nests in 1999.

OPERATION AND MAINTENANCE OF THE MISSOURI RIVER BANK STABILIZATION AND NAVIGATION PROJECT

- January 25, 1990 - The Service transmitted a letter from Deputy Regional Director, R-6, to MR Division (Omaha) acknowledging receipt of the Corps' letter on data needs for pallid sturgeon. The Service supports the Corps' proposal to establish a technical advisory team to coordinate pallid studies. The Service explains the section 7 consultation process, and urges the Corps to immediately initiate conference discussions on the pallid sturgeon in anticipation of consultation, should the species be federally listed.

- 1992 - The Service's Regional Director, R-3, transmitted a letter to KCD requesting the Corps partner with the Service on a pallid sturgeon study in the Lower Missouri River to provide data needed for effective coordination on permits, the BSNP, and the Master Manual.

- April 7, 1993 - The Service's CMFO transmitted a letter to the Corps' KCD requesting help to fund pallid sturgeon monitoring and research to address information needs related to section 7 consultation responsibilities.

- November 16, 1993 - The Service's CMFO transmitted a letter to the Corps' KCD notifying the Corps that they should conduct section 7 consultation on the repair of flood damages to the BSNP.

The Service noted the bald eagle and the pallid sturgeon occur along the length of the project. The Service stated that the bulk of the work to be done did not warrant emergency consultation procedures (50 CFR 402.05). The Service noted that the project, as a whole, constitutes a "major construction activity" and therefore requires a biological assessment. The Service also mentioned ESA prohibitions on irretrievable commitment of resources until the consultation is complete.

- December 9, 1993 - The Corps' KCD transmitted a letter to the Service's CMFO in response to the November 16 letter. The Corps acknowledged ESA responsibilities for repairs to BSNP. Subsequent conversations between the two agencies established a Corps' commitment to work closely with the Service to ensure ESA responsibilities were met. The Corps will consult on each individual repair and did not mention work towards a biological assessment. Pallid sturgeon monitoring request is being evaluated as an option, but the Corps does not believe it is necessary for coordination on the repair work.

- January 11, 1994 - The Corps' KCD transmitted a list of BSNP repairs to the Service's CMFO. Reference is made to a January 6, 1994, interagency coordination meeting and the Corps agrees to notch structures for aquatic habitat.

- February 8, 1994 - The Corps' Omaha District transmitted a letter to the Service's Nebraska/Kansas FO. The Corps provided notice of repair work to BSNP, determined no effect on the bald eagle, peregrine falcon, and pallid sturgeon, and asked for Service comments. The Corps wants to address work as one unit and provided maps and description of work items.

- February 24, 1994 - The Service's CMFO transmitted a letter to the Corps' KCD regarding proposed flood repairs to the BSNP. The Service continued to express concern regarding degradation of aquatic habitats and the need for aquatic restoration to benefit the pallid sturgeon, and provided specific recommendations for several structures. The Service acknowledged the Corps' commitment to repairs as described; a monitoring program to evaluate aquatic habitat relative to those repairs; field studies to determine pallid sturgeon habitat need and use in the Lower Missouri River; further modification to remove adverse effects of structures; and entering into formal consultation if warranted by monitoring and habitat assessment results. The Service noted that with the Corps' commitments, the Service and the Corps can remain in informal consultation.

- March 8, 1994 - The Corps' KCD transmitted a letter to the Service's CMFO regarding FY-94 operations and maintenance work on the BSNP. This letter detailed work items and requests Service comments.

- April 13, 1994 - The Service's Nebraska/Kansas Field Office transmitted a letter to the Corps' Omaha District. The Service concurred with no adverse affect from repairs to the BSNP on peregrine falcon, least tern and piping plover. The Service did not concur with no adverse affect on bald eagle and pallid sturgeon. The Service provided specific recommendations for structure repairs and recommended that the Omaha District participate in efforts similar to those of KCD (e.g., monitoring, sturgeon studies, etc.), and noted, with such efforts the Service and the Omaha District can continue in informal consultation.

- April 11, 1994 - The Service's CMFO transmitted a letter to the Corps' KCD regarding FY-94 work. The Service noted importance of aquatic habitats to pallid sturgeon, sicklefin and sturgeon chubs, and other native fish. The Service also noted presence of wintering bald eagles along the river. The Service provided specific recommendations for several work items and the Service requested written confirmation of the Corps' commitments to Missouri River data needs as noted in the February 24, 1994, letter. The Service mentioned that during a March meeting, the Corps' technical and financial assistance to those data collection needs was uncertain. The Service also noted several information needs that must be met to effectively consult.

- May 10, 1994 - The Service's CMFO transmitted a letter to the Corps' KCD regarding a proposed revetment repair at Rushville Bend. The Service noted that the project is within the range of the pallid sturgeon and that the Corps should determine whether the project was likely to adversely affect the pallid sturgeon. If so, the Corps would need to enter formal consultation with the Service.

- September 27, 1994 - The Service's CMFO transmitted a letter to the Corps' KCD expressing appreciation for the Corps' assistance with the Missouri Department of Conservation (MDC)/National Biological Service fish habitat use study. Information from those efforts will contribute substantially to determining the effects of the BSNP on pallid sturgeon.

- February 28, 1995 - The Corps' KCD transmitted a memorandum to the Service's CMFO and MDC detailing proposed FY-95 operations and maintenance work items.

- March 13, 1995 - The Corps' KCD transmitted a letter to the Service's CMFO requesting comments on the proposed FY-95 work (one of two contracts), acknowledging pallid sturgeon data needs, and asking Service assistance to the Corps in meeting their ESA responsibilities.

- March 31, 1995 - The Service's CMFO transmitted a letter to the Corps' KCD regarding FY-95 work items. The Service provided specific comments on several work items. The Service acknowledged support for the notching program and other features to retain aquatic habitat diversity. The Service expressed appreciation for the Corps' commitment to organize and fund fisheries habitat needs. The Service noted a bald eagle nest near Waverly Bridge and recommended a buffer area around the nest. The Service concurred with no adverse effect on the eagle, Indiana bat, gray bat (*Myotis grisescens*), peregrine falcon (*Falco peregrinus*), and pallid sturgeon.

- May 10, 1995 - The Corps' KCD transmitted a letter to the Service's CMFO requesting comments on the proposed FY-95 work (second of two contracts) and assistance to the Corps in meeting their ESA responsibilities.

- June 12, 1995 - The Service's CMFO transmitted a letter to the Corps' KCD regarding FY-95 work items (on second contract). The Service again supported the notching program and other features to retain aquatic habitat diversity. The Service provided specific comments on several work items and concurred with no adverse effect on listed species.

- December 17, 1996 - A meeting was held with the Service's Regional Directors (R-3, R-6), and Corps, Missouri River Division. The Service addressed concerns on the Master Manual Process and asked the Corps to continue to fund the Benthic Fish Study to help fill fisheries data gaps.

- April 16, 1997 - A coordination meeting between the Service and KCD was held. The Service and Corps agreed to annual coordination meetings. KCD agreed to consider specific recommendations for dike materials, agreed to do before and after monitoring of selected locations, and covered proposed work for FY-97. The Service recommended maintaining aquatic habitat diversity. The Service also briefed the Corps on the status of the Master Manual consultation and interim measures. The Service stated that its does not think the Corps is in compliance with the ESA regarding the pallid sturgeon and may ask for a biological assessment, and that it could lead to consultation on the BSNP as part of a comprehensive consultation on the Missouri River.

- April 21 and 22, 1997 - The Corps' KCD faxed the Service's CMFO scheduled work for FY-97.

- May 12, 1997 - The Service's CMFO transmitted a letter to the Corps' KCD regarding maintenance work items for FY-97. The Service stated no effect to listed species, provided certain conditions were met. The Service supported the Corps' efforts to notch and otherwise modify structures to improve aquatic habitat. The Service provided specific recommendations on several work items.

- July 18, 1997 - The Corps' KCD faxed the Service's CMFO additional work items scheduled for FY-97.

- July 28, 1997 - The Service's CMFO transmitted a letter to the Corps' KCD regarding additional work items for FY-97. The Service stated no effect to listed species, provided certain conditions were met. The Service supported the Corps' efforts to notch and otherwise modify structures to improve aquatic habitat. The Service provided specific recommendations on several work items.

- August 11, 1997 - The Corps' KCD faxed the Service's CMFO an additional work item scheduled for FY-97.

- August 11, 1997 - The Corps' KCD faxed the Service's CMFO additional work items scheduled for FY-97.

- September 2, 1997 - The Corps' KCD faxed the Service's CMFO additional work items scheduled for FY-97.

- September 16, 1997 - The Service's CMFO transmitted a letter to the Corps' KCD regarding additional work items for FY-97. The Service stated no effect to the pallid sturgeon, provided certain conditions were met. The Service provided specific recommendations on the repairs and emphasized the need to maintain aquatic habitat diversity. The Service also noted the Corps' commitment to monitor results of the work and noted that a hybrid pallid sturgeon had been sampled adjacent to a project site.

HISTORY FOR COMBINED CONSULTATION ON MISSOURI RIVER PROJECTS (MR PROJECTS): MISSOURI RIVER OPERATIONS, KANSAS RIVER OPERATIONS, AND BANK STABILIZATION AND NAVIGATION PROJECT

- August 5, 1997 - Service Deputy Regional Director (R-6) transmitted a letter to the Corps' Deputy Commander (Northwestern Division in Omaha) regarding a coordination meeting scheduled for October 8.

- August 12, 1997 - Service Regional Director (R-6) transmitted a letter to the Corps' Missouri River Region requesting reinitiation of formal consultation on Missouri River Operations, initiation of formal consultation on the BSNP, and initiation of consultation on interconnected activities under joint operational processes of upstream Bureau of Reclamation dams. The Service noted four reasons for formal consultation and provided further detail in an enclosure. The Service requested a response within 30 days.

- September 26, 1997 - The Service's Nebraska Field Office transmitted a letter to Congressman Bereuter's office to inform him of several ongoing issues between the Service and Corps regarding lack of ESA compliance.

- October 8, 1997 - Service Regional Directors (R-3 and 6), Corps Deputy Engineer (Northwestern Division, Omaha), Environmental Protection Agency Regional Administrators (R-VII and VIII) and respective agency staff met to discuss issues of mutual concern on the Missouri River.

- November 12, 1997 - Service and Corps staff held a conference call to discuss technical issues relating to the ESA baseline and scope of section 7 consultations on interrelated Missouri River projects like the Bureau of Reclamation Dams.

- April 1, 1998 - The Corps' Missouri River Region transmitted a letter to the Service responding to the August 12, 1997, consultation request. The Corps agreed to prepare a biological assessment and to initiate consultation on current river operations if they determine adverse effects to listed species. The Corps does not agree to assess the effects of the BSNP with current operations because they are separately authorized. The Corps will determine course of action on BSNP pending district review of project effects on listed species. The Corps does not believe that the

Bureau projects should be included because the Corps has operation authority only when the reservoir pools are in exclusive flood control zones. The

Service and Corps discussed timelines for initiation of formal consultation and submission of biological assessments.

- June 12, 1998 - A meeting was held between the Service (R-3 & 6) and the Corps' Omaha District. All agreed on the importance of moving the consultation forward. The Service suggested spending time working on potential Reasonable and Prudent Alternatives/Reasonable and Prudent Measures (RPA/RPMs), while the Corps completes the biological assessment. The Service noted that, given the 1990 biological opinion and 1994 draft biological opinion, it is clear there are adverse effects to the listed species.

- October 6, 1998 - A meeting was held between the Service (R-3 & 6) and the Corps (Northwestern Division and Omaha District) to discuss the need to consult on the Corps' Missouri River projects. The Corps agreed to prepare a biological assessment on current river operations by December 1, 1998, and hopes to complete consultation by spring. The Corps agreed to prepare a biological assessment on BSNP sometime next spring.

- October 16, 1998 - The Corps' Northwestern Division transmitted a letter to the Service (R-3& 6) agreeing to prepare a biological assessment for current Missouri River operations by December 1and a schedule for the biological assessment for the BSNP by December 1. The letter also noted future coordination on upper basin bank stabilization projects/permits.

- November 4, 1998 - Service Regional Director (R-6) transmitted a letter to Corps Brigadier General Griffin (Northwestern Division) as a follow-up documentation of discussions during the October 6 meeting and schedules for receipt of biological assessments.

- November 4-5, 1998 - A meeting was held with the Service (R-3 & 6) and the Corps (Northwestern Division and Omaha and KCD). The group discussed details/background of BSNP and noted coordination with the Service on maintenance work; scoped issues for the biological assessment; assumed that the project will be maintained under current river operations and current mitigation projects in place; and also discussed needs for the biological assessment on operations and interrelatedness of Kansas River operations. The Corps anticipated a separate biological assessment for the Kansas River by spring. The agencies agreed that consultation efforts will focus on how to improve conditions for listed species and should include the process of adaptive management. The Service recommended that the Corps consider a consultation that combined the currents operations, BSNP, and Kansas River operations. The Corps agreed to consider the approach based on outcomes of the biological assessments.

- November 16, 1998 - Service Regional Director (R-6) transmitted a letter to the Corps' Northwest Division, acknowledging October 16, 1998, letter and noting that respective staffs have begun coordination. After receipt of the biological assessment, the Service will determine schedule for the biological opinion, which normally is completed within 135 days. The Service also acknowledged proposed consultation schedule for the BSNP.

- November 24, 1998 - The Corps' Northwest Division transmitted a letter to the Service (R-6) on the consultation. The Corps projected an April 1, 1999, completion of the BSNP biological assessment. The Corps understands that concerns in the letter have been discussed in subsequent meetings and assigned to staff. The Corps enclosed meeting notes from the November 4-5, 1998, meeting.

- December 4, 1998 - Brigadier General Griffin transmitted a letter and biological assessment to the Service's Regional Directors (R-3 and 6) on the effects of the Operation of the Missouri River Main Stem Reservoir System under the current Water Control Plan on listed species, as well as the effects of certain Kansas River Reservoir System projects as they relate to main stem operations. The Corps concluded that operations are likely to adversely affect the pallid sturgeon, piping plover, and least tern, and requested consultation.

- December 17, 1998 - The Service's CMFO transmitted a letter to the Corps' KCD regarding federally listed species in the BSNP area that should be considered in the biological assessment. The Service also included the sturgeon and sicklefin chubs.

- January 12-13, 1999 - A coordination meeting was held between the Corps (Northwestern Division and Omaha and KCD) and the Service (R-3 & 6). Staff discussed timeline for consultation, coordination with states, tribes, and public, and major biological issues. The Service noted that there should be no questions whether BSNP may affect the species and we should expedite our discussion to focus on conservation strategies. The agencies agreed that the scope would focus on maintenance of existing structures and the 1988 maintenance guidelines, not project construction. Draft biological assessment should be ready by mid-March. The Service noted that the bald eagle will be considered in the consultations on both current operation and BSNP.

- February 17-19, 1999 - A coordination meeting was held between the Corps (Northwestern Division and Omaha and KCD) and the Service (R-3 & 6). The Corps detailed Kansas River operations and information limitations. The Service and Corps discussed species information needs and potential action to improve habitats on the Missouri River.

- March 25, 1999 - A coordination meeting was held between the Corps (Northwestern Division and Omaha and KCD) and the Service (R-3 & 6) to further discuss specifics of the projects and species needs.

- April 19, 1999 - Brigadier General Griffin transmitted a letter to the Service's Regional Director (R-6) with additional information and a request to amend the proposed action to include all operations of the Kansas River Reservoir System in the consultation.

- April 19, 1999 - Brigadier General Griffin transmitted a letter to the Service's Regional Directors

(R-3 and 6) and the Biological Assessment for the Operations and Maintenance of the Missouri River Bank Stabilization and Navigation Project. The Corps concluded that the project is likely to adversely affect the pallid sturgeon and least tern and requested consultation.

- April 29-30, May 20-21, July 7-8, September 28-29, November 16-17, December 15-16, 1999 and January 25-26, 2000 - Coordination meetings were held between the Service and Corps as part of the ongoing informal consultation on Missouri and Kansas River Operations and the BSNP.

- September 1, 1999 - The Service's NDFO transmitted a letter to the Corps' Deputy Commander, Northwestern Division, on the Corps' evaluation and selection of a preferred alternative for the Revised Draft EIS on the Missouri River Master Manual Review and Study. The Service advised the Corps that recommended elements of an environmentally preferred alternative not adopted as part of a preferred Master Manual alternative would be addressed during the ongoing Section 7 consultation process.

- October 22, 1999 - The Service's Acting Missouri River Coordinator transmitted a letter to the basin States' Governors, State game and fish departments, basin native american tribes, and copies to delegates of the Missouri River Basin Association, Missouri River Natural Resources Committee, and tribal game and fish departments providing an early alert of the section 7 consultation and requesting inputs on biological issues that may be useful during the consultation (Appendix I).

- November 2, 1999 - The Mni Sose Intertribal Water Rights Coalition, Inc. transmitted a letter to the Service acknowledging receipt of the Service's October 22 letter.

- November 10, 1999 - The Director of Montana Fish, Wildlife & Parks transmitted to the Service biological inputs for the consultation.

- November 10, 1999 - The South Dakota Department of Game, Fish and Parks transmitted a letter to the Service on the consultation.

- December 9-15, 1999, and January 7, 2000 - The Service's Missouri River Coordinator transmitted letters to several Federal agencies and Mni Sose inviting them to a briefing in Denver on the status and current direction of the consultation process (Appendix I).

- January 26, 2000 - Service and Corps staff provided a briefing for Federal agencies in Denver, CO, of the current status of the section 7 consultation on Missouri and Kansas River projects.

- January 26-27, 2000 - Service and Corps staff held a section 7 coordination meeting in Denver.

- January 31, 2000 - The Service's NDFO transmitted a letter to the Corps' Missouri River Region Office in Omaha expressing concerns on the Corps' new preferred alternative for the Master Manual Review and Study. The Service advised the Corps that without changes, the Service's conclusion of jeopardy in the 1994 draft biological opinion likely would not change.

- February 4, 2000 - Staff from the Service and Corps met in Denver to brief the Service's Regional Directors (R-3 and 6) and Corps' Northwestern Division Commander on the status of the ongoing section 7 consultation on Missouri and Kansas River projects.

- February 18, 2000 - Service and Corps staff from the Washington, Regional, and Field Offices participated in a conference call on the Corps' Northwestern Division's preferred alternative for the Missouri River Master Manual and implications to listed species.

- February 25, 2000 - Service and Corps Regional and Field Office staff participated in a conference call on the Master Manual preferred alternative. Service staff advised the Corps that the preferred flow releases from Gavins Point Dam likely will not preclude jeopardy to federally listed species.

- March 2-3, 2000 - Service and Corps staff held a section 7 coordination meeting to discuss the Corps' Master Manual preferred alternative and changes necessary to likely avoid jeopardy to listed species, and the ongoing consultation and its link to the Master Manual.

- March 16, 2000 - Service staff met on the section 7 consultation with staff of the Corps, USGS, and MRNRC in Omaha to discuss endangered species monitoring needs.

- March 20, 2000 - Service Regional Directors (R-3 & 6) met with the Corps' Brigadier General Strock (Commander, Northwestern Division) to discuss the ongoing informal consultation on the Missouri River projects.

- March 27, 2000 - The Missouri Department of Conservation transmitted a letter to the Acting Missouri River Coordinator and advised the Service of its intent to provide biological input for the Service's Section 7 consultation.

- March 28, 2000 - Service Regional Directors (R-3 & 6) transmitted a letter to the Corps' Brigadier General Strock (Commander, Northwestern Division) outlining the key elements necessary to conserve listed species and help restore some semblance of the form and function of the Missouri River required by those species.

- March 30, 2000 - Corps Brigadier General Strock (Commander, Northwestern Division) transmitted a letter to the Service's Regional Directors (R-3 & 6) responding to the Service's March 28 letter. The Corps requested initiation of section 7 formal consultation on Operations of the Missouri River Main Stem Reservoir System under the current water control plan, Operations of the Kansas River Tributary Reservoirs, and Operations and Maintenance of the Missouri River Bank Stabilization and Navigation Project begin on April 3. The Corps also endorsed an independent scientific review of supporting materials for recommended changes in annual operations.

- March 30, 2000 - Environmental Defense filed a “60-day Notice of Intent to Sue Under the Endangered Species Act for Operation of the Missouri River Main Stem System and Related

Activities.” The notice was filed against the Department of the Interior (Service) and the Department of the Army (Corps).

- March 30, 2000 - American Rivers filed a “60-day Notice of Intent to Sue for Violations of the Endangered Species Act and the Administrative Procedure Act Caused by Missouri River Dam Operations” against the Secretary of the Army and the Interior.

- April 3-4, 2000 - Service and Corps staff met in Minneapolis, MN, as part of the ongoing coordination on the section 7 consultation.

- April 5, 2000 - Service staff from the NDFO and the Missouri River Coordinator met with Congressional Field Office staff from North Dakota’s delegation (Senator Conrad and Dorgan, and Congressman Pomeroy) and provided an update on the current status of coordination and the section 7 consultation with the Corps on the Missouri River.

- April 7, 2000 - The Service’s NDFO transmitted a letter to the basin States’ Governors, State game and fish departments, basin native american tribes, and copies to delegates of the Missouri River Basin Association, Missouri River Natural Resources Committee, and tribal game and fish departments advising them of initiation of formal section 7 consultation with the Corps and requesting inputs on biological issues that may be useful during the consultation (Appendix I).

- April 7, 2000 - The Service’s NDFO transmitted a letter to the Corps’ Northwestern Division identifying monitoring studies for pallid sturgeon as related to the proposed flow enhancement from Fort Peck Dam.

- April 10, 2000 - The Service’s NDFO transmitted a letter to basin States’ Senators and Congressman advising them of initiation of formal section 7 consultation with the Corps on Missouri and Kansas River projects (Appendix I).

- April 10-11, 2000 - Service staff met with Corps staff in Omaha to identify and discuss variations in the Service’s proposed elements of a Master Manual alternative for modeling analysis.

- April 11, 2000 - The MRBA transmitted a letter to the Service (R-6 Regional Director) and the Corps (General Strock) regarding participation in the ongoing consultation.

- April 11, 2000 - Assistant Regional Director (R-3) John Blankenship transmitted a letter to the MRBA clarifying information presented at an MRBA meeting on April 3. He noted that 45 days is used to prepare the biological opinion and that a 45-day public review period will not be held.

- April 11, 2000 - Staff from the Service, Corps, MRBA, and MRNRC met with Field Office staff for the Nebraska Congressional delegation (Senators Kerrey and Senator Hagel, and

Congressman Bereuter, Terry, and Barrett) and briefed them on the current status of the section 7 consultation and the relationship to the Master Manual Review and Study.

- April 13, 2000 - The Service's Missouri River Coordinator transmitted a letter to several Federal agencies advising them of initiation of formal section 7 consultation with the Corps and requesting final inputs on biological issues that may be useful during the consultation (Appendix I).

- April 19, 2000 - The Director of the Montana Fish, Wildlife & Parks transmitted a letter to the Service offering biological expertise, if needed.

- April 20, 2000 - Service Deputy Regional Director (R-6) transmitted a letter to American Rivers regarding the 60-day Notice of Intent to Sue and extended an invitation to a meeting in Bismarck, ND, to discuss the ongoing consultation and biological inputs to the process.

- April 24, 2000 - American Rivers transmitted a letter to the Service accepting the invitation to attend the April 25 meeting and noting the intent to provide biological information to assist the consultation.

- April 25, 2000 - Service Deputy Regional Director (R-6) transmitted a letter to the Corps' Brigadier General Strock (Commander, Northwestern Division) providing information on propagation needs for pallid sturgeon that will be addressed in the ongoing consultation.

- April 25, 2000 - At the request of the MRBA, Service and Corps staff hosted a meeting in Bismarck, ND, to gather additional biological data for the section 7 consultation. Representatives of the MRBA, MRNRC, American Rivers, Mo-Ark Association/Missouri Levee and Drainage District Association, and the ND Sport Fishing Congress participated.

- April 25, 2000 - Service and Corps staff met in Bismarck, ND, to review the results of preliminary modeling analyses on variations in the Service's proposed elements of a Master Manual alternative and assess benefits to listed species.

- April 25 to May 12, 2000 - The Service received 15 pieces of correspondence from the States, Tribes, and other interested parties regarding the ongoing section 7 consultation (Appendix I).

- May 2, 2000 - Because of the controversial nature of flow management from Gavins Point Dam, a Corps/Service Interagency Peer Review Subcommittee submitted three questions to a scientific peer review panel for review and inputs. The questions related to an analysis of the scientific basis for flows and habitat quality below Gavins Point Dam.

- May 3, 2000 - The Tribal Chairman of the Three Affiliated Tribes of the Fort Berthold Reservation transmitted a letter to the Service's NDFO regarding opinions on Missouri River management and

Secretarial Order No. 3206.

- May 8, 2000 - The South Dakota Department of Environment and Natural Resources transmitted a letter to the NDFO advising the Service of its intent to provide comments for the Section 7 consultation.

- May 8, 2000 - The Kansas Department of Wildlife and Parks transmitted comments to the Service for use in the Section 7 consultation on the Missouri River.

- May 12, 2000 - The State of South Dakota transmitted comments to the NDFO for use in the Section 7 consultation on the Missouri River.

- May 12, 2000 - The State of Missouri transmitted comments to the Service's Director on issues it believes may influence the Service's Section 7 consultation with the Corps and the Draft Biological Opinion.

- May 22, 2000 - Prairie Hills Audubon Society submitted information and arguments to the Secretary of the Army and the Interior related to 60-day Notices of Intent to Sue filed by Environmental Defense and American Rivers.

- May 24-25, 2000 - Service and Corps staff met in Bismarck to further coordinate on the ongoing section 7 consultation.

- June 7, 2000 - The State of Missouri transmitted a letter to the Secretary of the Interior informing him that Missouri reserves the right to file suit for longstanding violations of the ESA and the Administrative Procedures Act related to the Secretary's failure to designate critical habitat for the pallid sturgeon, interior least tern, and piping plover, three species under consideration in the Missouri River consultation.

- June 9, 2000 - The Service's NDFO transmitted the Preliminary Internal Draft Biological Opinion on Missouri and Kansas River Operations and the BSNP to the Corps' Northwestern Division.

- June 19, 2000 - The Corps' KCD transmitted a letter to the Service's Regional Directors (R-3 & 6) with supplemental information on annual work schedules for the routine maintenance activities on the BSNP.

- June 23, 2000 - Corps Brigadier General Strock (Commander, Northwestern Division) transmitted a letter to the Service's Regional Directors (R-3 & 6) providing initial comments on the Preliminary Internal Draft Biological Opinion on Missouri River projects.

- June 27, 2000 - Service Regional Director (R-6) transmitted a letter to the Corps' Brigadier General Strock (Commander, Northwestern Division) stating the Service's position on the potential construction of a new fish hatchery at Fort Peck. The letter stated that due to existing expertise, infrastructure, and process, the Service does not believe that developing additional pallid sturgeon capability at a new Fort Peck Hatchery is a high priority at this time.

- June 27-29, 2000 - Service and Corps staff held a coordination meeting in Portland, OR, to address Corps comments on the Preliminary Draft Biological Opinion on the Missouri River Section 7 Consultation and direction for the consultation.

- July 10, 2000 - A coordination meeting was held in Washington between Service Director Jamie Clark, Regional Directors Morgenweck (R-6) and Hartwig (R-3), Assistant Secretary of the Army Joe Westphal, and other Service and Corps staff regarding the framework of conservation measures needed to avoid jeopardizing the continued existence of listed species on the Missouri River.

- July 12, 2000 - Service Regional Director (R-6) transmitted a letter to the Corps' Brigadier General Strock (Commander, Northwestern Division) summarizing discussions at the coordination meeting on July 10 and requesting feedback from the Corps on the acceptance of the elements discussed within this letter as being reasonable and prudent.

- July 26, 2000 - Corps Brigadier General Strock (Commander, Northwestern Division) transmitted a letter to the Service's Regional Director (R-6) responding to the Service's July 12 letter and documenting actions the Corps intends to take to address the Service's recommendations.

- July 31, 2000 - Service Regional Director (R-6) transmitted a letter to the Corps' Brigadier General Strock (Commander, Northwestern Division) and the Service's Draft Biological Opinion on the Missouri River projects. The Service noted that some sections of the draft are still under revision. The Service also noted that the Corps has not committed to implementing all of the actions necessary to avoid jeopardy to listed species and requested comments on the draft.

- August 4, 2000 - Corps Brigadier General Strock (Commander, Northwestern Division) transmitted a letter to the Service's Regional Director (R-6) acknowledging receipt of the Draft Biological Opinion and requesting a 45-day extension of the formal consultation from August 15, 2000 to about October 1. The Corps also agreed to meet to discuss and attempt to resolve outstanding issues.

- August 8, 2000 - The Service's Acting Deputy Regional Director (R-6) transmitted a letter to the Corps' Brigadier General Strock (Commander, Northwestern Division) acknowledging receipt of the Corps' August 4 letter and agreeing to an extension for completion of the Missouri River Biological Opinion by October 1.

- August 17, 2000 - The State of Missouri transmitted a letter to the President expressing concerns on recommendations by the Service to the Corps during the Missouri River section 7 consultation for flow modifications from Missouri River dams to benefit the least tern, piping plover, and pallid sturgeon.

- August 21, 2000 - The Service's NDFO transmitted a Revised Draft Biological Opinion to the Corps' Northwestern Division. Additional revisions are likely as discussions between Service and Corps staff continue.

- August 22, 2000 - The State of Missouri filed suit against Secretary of the Interior Bruce Babbitt and Service Director Jamie Clark to enjoin the defendants from continuing to violate the ESA and from consulting under section 7 of the ESA with respect to listed species for which the Service has not designated critical habitat, and to require the Service to initiate and complete the critical habitat designation process.

- August 31, 2000 - Service and Corps staff met in Minneapolis, MN, to discuss Corps' comments on the Draft Biological Opinion and the Corps' July 26 letter on commitments.

- September 1, 2000 - The Corps' Northwestern Division posted the Service's August 21, 2000, Draft Biological Opinion on its website and provided the public a 30-day review period to submit comments. The Corps will transmit comments of a biological nature to the Service.

- September 20, 2000 - Service Regional Directors Morgenweck (R-6) and Hartwig (R-3), Corps' Brigadier General Strock (Commander, Northwestern Division), and respective staff met in Denver, CO, to continue discussions and attempt to resolve issues related to the Draft Biological Opinion.

- September 21, 2000 - The State of Missouri transmitted a letter to the Assistant Secretary of the Army requesting a 60-day comment period for review of the Draft Biological Opinion posted on the Corps' website.

- September 22, 2000 - Service Regional Director (R-6) transmitted a letter to the Corps' Brigadier General Strock (Commander, Northwestern Division) to clarify the Service's understanding of the Corps' public review process on the Draft Biological Opinion.

- September 25, 2000 - Corps Brigadier General Strock (Commander, Northwestern Division) transmitted a letter to the Service's Regional Director (R-6) regarding the public review process and requested that the formal consultation period for completion of the Biological Opinion be extended into November 2000. The General noted that an extension would not delay completion of the Revised Draft EIS for the Master Manual in spring 2001.

- October 4, 2000 - Service Regional Director (R-6) transmitted a letter to the Corps' Brigadier General Strock (Commander, Northwestern Division) responding to the Corps' September 25 letter. The Service granted an extension of the consultation and advised the biological opinion would be completed by November 13.

- October 4, 2000 - Service Regional Director (R-6) transmitted a letter to Senator Burns (MT) advising the Senator that the Corps controls the public review process and requests for extensions of the review period.

- October 16, 2000 - Corps Brigadier General Strock (Commander, Northwestern Division) transmitted a letter to the Service's Regional Director (R-6) which addressed several actions concerning completion of the Missouri River Biological Opinion. The Corps also provided Corps and public comments on the Draft Biological Opinion, an analysis of the navigation channel and summer low flows, and alternative language on the element of the Reasonable and Prudent Alternative dealing with Gavins Point flows.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

An ESA section 7 consultation addresses the effects of a Federal action on listed species and the ecosystems upon which they depend. An ecosystem approach to endangered species and action analysis is consistent with section 2(b) of the Act which states that "The purposes of this ESA are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved . . ." The ESA Consultation Handbook (USFWS and NMFS 1998) suggests that consideration be given to conducting ecosystem-based consultations when ongoing or future agency activities may affect one or more species within a regional planning area. When the Federal action at issue is complex or has wide-ranging effects, an ecosystem approach to ESA Section 7 consultation may be appropriate. An "ecosystem approach" means that the Service looks at the action and its effects throughout an ecosystem, such as a river.

The Corps and the Service agreed that the current ESA section 7 consultation falls within these guidelines. Thus, the current consultation on Corps activities is an ecosystem-based consultation and the biological opinion addresses the continuation of the following ongoing MR Projects:

? Operation of the Missouri River Main Stem Reservoir System (MR Operations)
? Operation of the Kansas River Tributary Reservoir System (KR Operations)
? Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project (BSNP)

The combined consultation and biological opinion on MR Projects is warranted because the projects each affect the listed species and the ecosystems upon which they depend in the Missouri and Kansas River systems; all are interrelated or interdependent actions; and the species are wide-ranging. Impacts to listed species from one project often overlap another project and thus, distinguishing impacts is very difficult. In addition, a single, comprehensive biological opinion provides greater opportunity and flexibility for the Corps to address species needs under the combined project authorities.

ACTION AREA

The combined action area for this consultation includes the area directly and indirectly affected by the three projects under consultation. This includes most of the Missouri River main stem, the Kansas River, and portions of major tributaries and the Middle Mississippi River where listed species are influenced by the Corps' MR Operations, KR Operations, and BSNP. MR Operations primarily affects the area of the Missouri River and its reservoir system from the headwaters of Fort Peck Lake in Montana downstream to the mouth of the river near St. Louis, MO, river mile (RM) 0 at the confluence with the Mississippi River. The point furthest upstream where the Corps regulates Missouri River flows is at Reclamation's Canyon Ferry Dam in Montana when the reservoir is in the flood pool. MR Operation begins at Fort Peck Dam in Montana and continues downstream to Gavins Point Dam on the South Dakota-Nebraska border 811 mi (1304 km) upstream from the Missouri River's confluence with the Mississippi River. Additionally, tributary inflows into and downstream from the System influence operations. Therefore, the action area for this biological opinion is the Missouri River Basin. However, the thrust of the opinion will be confined to the Missouri River main stem from the headwaters of Fort Peck Lake to its confluence with the Mississippi River.

The Corps operates and maintains the Missouri River BSNP from Sioux City, IA, at RM 735 to the mouth. Tributaries that may influence MR and KR Operations and the Middle Mississippi River below the confluence which may be affected by operations also are included within the action area. The action area for KR Operations includes the river from its formation at Junction City, KS, below Milford Reservoir on the Republican River, downstream about 170 mi (274 km) to its mouth and confluence with the Missouri River at Kansas City, Kansas and Missouri.

Overall management of these three projects falls under the purview of the Corps' Northwestern Division in Portland, Oregon; the Missouri River Region in Omaha, NE; the Omaha District in Omaha; and the KCD in Kansas City, MO. The Corps' Reservoir Control Center in the Missouri River Region Office was established in 1954 to plan, regulate, and coordinate the operation of the Missouri River Main Stem Reservoir System, as well as provide oversight on the regulation of the Corps tributary reservoirs and the flood control regulations of Bureau of Reclamation (Reclamation) projects authorized for flood control. Operations, management, and technical support is provided by the District Offices.

OPERATION OF THE MISSOURI RIVER MAIN STEM RESERVOIR SYSTEM

Generic Description of Project and Authorizing Legislation

The Missouri River originates on the eastern slope of the Rocky Mountains near Three Forks, MT, and flows 2,320.7 mi (3,734 km) through Montana, North Dakota, South Dakota, Iowa, Nebraska, Kansas, and Missouri to its confluence with the Mississippi River near St. Louis, MO. The Missouri River is the second longest river in the United States. Its basin drains approximately 529,350 mi^2 (1,371,017 km^2), including 9,700 mi^2 (25,123 km^2) in Canada; all of Nebraska; most of Montana, Wyoming, North Dakota, and South Dakota; about half of Kansas and Missouri; and smaller parts of Iowa, Colorado, and Minnesota. The primary tributaries are the Yellowstone, Marias, Niobrara, James, Platte, and Kansas Rivers.

The Corps' Missouri River Main Stem Reservoir System (System) (Figure 1) consists of six integrated dams and reservoirs located in Montana, North Dakota, South Dakota, and Nebraska. Reservoir releases from the System eventually go through the lower most dam and enter the lower river which includes the Missouri River BSNP from Sioux City, IA, to the mouth at St. Louis, MO. The six main stem dams and reservoirs are Fort Peck (Fort Peck Lake), Garrison (Lake Sakakawea), Oahe (Lake Oahe), Big Bend (Lake Sharpe), Fort Randall (Lake Francis Case), and Gavins Point (Lewis and Clark Lake). Construction of the main stem dams was completed in 1964. The System first filled to normal operating level in 1967. The System contains 73.4 million acre-feet (MAF) of storage. This capacity constitutes over 70 percent of the total storage in the basin's 1,300 plus reservoirs.

The Pick-Sloan Missouri River Basin Program (Pick-Sloan Program), authorized under the Flood Control Act of 1944, authorized construction of all the main stem projects with the exception of Fort Peck, which was originally authorized by the River and Harbor Act of 1935. The Fort Peck Power Act of 1938 authorized construction of power facilities at the project while the Flood Control Act of 1944 authorized multiple-purpose regulation of this project similar to the other main stem projects.

Congressionally authorized purposes of the main stem projects are flood control, irrigation, navigation, recreation, fish and wildlife conservation, municipal water supply, water quality control, and power generation. The Corps has responsibility for the operation of the dams while Reclamation has the responsibility to determine the use of reservoir water for irrigation. Once the Corps determines that water in a main stem reservoir may be used for irrigation, Reclamation obtains Congressional authorization under Reclamation laws. After irrigation works are constructed, Reclamation administers the irrigation use of the water. The Corps also schedules hydropower generation based on project release requirements. The Western Area Power Administration (WAPA) markets and transmits the energy generated at the six main stem powerplants.

The Pick-Sloan Program called for an efficient use of the waters of the Missouri River basin for all purposes. A later amendment to Section 1 of the Flood Control Act of 1944 under the Pick-Sloan Program (O'Mahoney-Millikin Amendment) established that navigation use of the System shall only be considered so long as it does not conflict with any beneficial consumptive use that exists now or in the future. Thus, Congress has authorized multiple System purposes, and the Corps exercises discretion over operation of the System for those purposes.

The descriptions or synopses of MR Operations were extracted or paraphrased from several Corps documents. These include the following: "Missouri River Main Stem Reservoir System Reservoir Regulation Manual" or "Master Manual" (USACE 1979); "The biological assessment concerning the effects of System operations on the interior least tern and piping plover" (USACE 1987); the "Additional information report on the operation of the System for interior least terns and piping plovers" (USACE 1989a); and the 1999 – 2000 Annual Operating Plan (AOP).

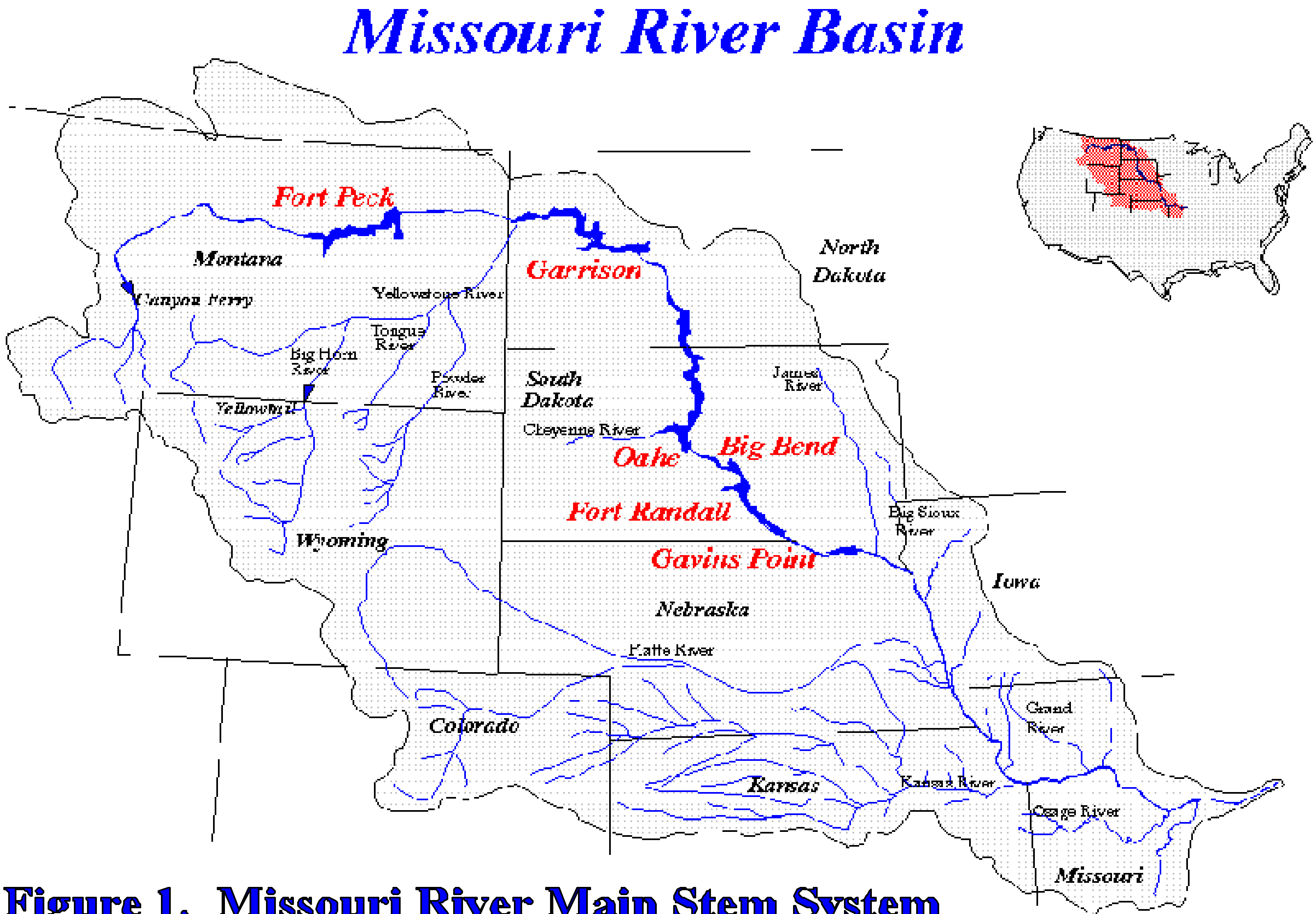

Figure 1. Missouri River Main Stem System

Together, the Corps' Master Manual and each year's AOP guide the operation and management of the Missouri River System. The Master Manual is the umbrella document that provides the guidance and criteria for System storage and releases to meet the authorized project purposes. The AOP falls under the framework of the Master Manual and provides flexibility for intrasystem management. Consequently, actions involving these two guidance documents are not mutually exclusive but are often interrelated. The Master Manual, AOP, and other more specific operational functions of the System are addressed in detail in subsequent sections.

Master Manual

The Missouri River Master Manual for the operation of the Main Stem Reservoir System was first published in December 1960. The Master Manual received minor revisions in 1973, 1975, and 1979. This document " . . . presents the basic objectives and the plans for . . . optimum fulfillment . . ." of the multiple use for which the System was authorized and constructed. The Master Manual recognizes that, in order to obtain project benefits, the System must be integrated "hydraulically and electrically" (USACE 1979).

The Master Manual prescribes operation of System storage and release for the multiple project purposes of flood control, irrigation, downstream municipal and industrial water supply and water quality, navigation, hydropower production, recreation, and fish and wildlife. On the basis of priorities established in the Master Manual, between 1960 and 1986, flood control was the highest priority, and fish and wildlife and recreation were considered subservient to all other authorized project purposes. However, since 1986 when two bird species were listed, threatened and endangered species have been given consideration (and fish and wildlife given higher consideration) in the development of AOPs. Although hydropower and water supply provide about 70 percent of the economic benefits, System release criteria for Gavins Point Dam are currently influenced most by navigation considerations. The navigation considerations are overridden by the need to either cut back releases for downstream flood control or evacuate flood control storage space in the reservoirs. The Corps operates the System to achieve the maximum possible overall benefits consistent with the purposes established by law.

The Corps initiated the Master Manual Review and Update Study early in November 1989 in response to a request from several Governors from the upper Missouri River basin. The original manual was 30 years old, had been subject to only minor revisions, and changes in the uses relying on the System had occurred. The navigation industry on the lower river had not grown as expected while the recreation industry associated with the river reaches and reservoirs in the upper basin had grown significantly. Ecological impacts were better understood and several species were listed as threatened or endangered. Most importantly, a major drought from 1987 to 1993 resulted in the first prolonged use of water from the carryover multiple use storage zone of the System. That drought had major impacts on some recreation facilities adjacent to the upper three reservoirs and on some water supply and irrigation intakes.

Current Water Control Plan

Criteria for operations under the Master Manual's current water control plan (CWCP) include how reservoir storage is divided and how water is released from reservoirs during navigation and non-navigation seasons. The current division of System storage of 73.4 MAF is shown in Figure 2. The sizes of the exclusive and annual flood control zones are based on storage requirements for major flood events, the height of the dams, and the elevation and capacity of the spillways.

The largest portion of the System storage capacity, 53 percent, is designated for carryover multiple uses during droughts (1-year and extended). Most of the carryover multiple use storage exists behind Fort Peck, Garrison, and Oahe Dams. Fort Randall Dam has a relatively small carryover multiple use zone, and Big Bend and Gavins Point Dams have no carryover multiple use zone. The water in the System carryover multiple use zone is designed to provide for all authorized purposes during drought periods. This zone is operated so that it remains full during periods of normal inflow, but is gradually drawn down during drought periods. Releases from this zone during drought periods are one of several major concerns of the Master Manual Study.

The Master Manual provides criteria for releases from the carryover multiple use zone for navigation service level, navigation season length, and non-navigation service level from the System. Each criterion relates to the amount of water in System storage. The criteria were designed so that, as the amount of water stored in the System is reduced during an extended drought, more stringent cutbacks in System releases are made to conserve water as the drought period lengthens. The criteria were designed so that the water in the carryover multiple use zone would be completely used if the drought of the 1930's duration and severity were repeated.

Support for navigation on the Missouri River below Sioux City is provided by the release of water from the Main Stem Reservoir System. At Sioux City, flows of 25 thousand cubic feet per second (Kcfs) to 31 Kcfs (minimum to full navigation service) result in channel depths of approximately 8 and 9 ft (2.4-2.7 m), respectively, in the navigation channel. Most of the water needed to maintain these flows is released from Gavins Point Dam, because the river receives little inflow between the dam and Sioux City. At Kansas City, 35 to 41 Kcfs is necessary to provide 8 to 9 ft, respectively, of navigation channel depth; however, flow in the Missouri River at Kansas City is greatly influenced by the flow from major tributaries including the Platte and Kansas Rivers. Corresponding navigation target levels at Omaha and Nebraska City, Nebraska, are 25 to 31 and 31 to 37 Kcfs, respectively. The channel width for minimum service and full service navigation is 200 and 300 ft (61-91.5 m), respectively.

The navigation season length also is determined on the basis of the amount of water in storage. A full-length season, 8 months (i.e., March 23 to November 22 at Sioux City; April 1 through December 1 at St. Louis), is supported by System releases if water in storage is 41 MAF or more on July 1. Between 41 and 25 MAF, the navigation season closing date is shortened progressively from November 22 to

September 7, depending on the amount of water in storage. If storage is 25 MAF or less, then System releases support a minimum season of 5.5 months (i.e., March 23 to September 7 at Sioux City). As System storage approaches the permanent pool level of 18.1 MAF, navigation support is suspended.

NOTE: NEED TO GET FIGURE 2 FROM CORPS The winter non-navigation target release also is determined on the basis of water in System storage. The CWCP specifies that if water in System storage is 58 MAF or higher on September 1, then approximately 16 Kcfs is released from Gavins Point Dam for the lower river. If storage is 43 MAF or less, about 12 Kcfs is released. If storage is between the two levels, the release is prorated proportionally.

The CWCP specifies a minimum flow in the spring through fall period to provide water for intakes below the System when water in System storage is not sufficient to provide navigation flows. This flow is currently estimated to be 9 Kcfs.

Intrasystem regulation refers to the manner in which water in storage is distributed among the upper three reservoirs in the System. The upper three reservoirs contain nearly all the water used during drought to meet Congressionally authorized project purposes. Currently, the amount of water stored in these three reservoirs is balanced annually. This operation leads to an equal distribution of the effects of drought drawdown among all three reservoirs. Similarly, in extremely high inflow years, the excess water is distributed among the three so that one reservoir does not carry the burden of storing the high runoff.

Flood control constraints are applied to the System releases from Gavins Point Dam to minimize flooding on the lower river caused by inflows downstream of the System. The flood control constraints are triggered when river flow is predicted to exceed the "target flow" by a specified amount at any of three lower river locations (Omaha, Nebraska City, or Kansas City). The target flow for these three locations is tied to the navigation "service level". Normally, the “service level” is based on the navigation flow requirements. In high inflow years, the “service level” must be increased to the amount needed for navigation based on the amount of water that is forecasted to be evacuated from the System to get to the base of the flood control zones by March 1 of the following year. The “service level” for each month of the year, and thereby target flow, is determined by the amount of water currently in System storage and forecasted runoff for the remainder of the year (see Plate 44 - Missouri River Master Water Control Manual, USACE 1979).

When downstream flows are predicted to exceed the flood constraint flow levels, the Gavins Point Dam release is reduced such that flows will remain at or below the target flow levels of the flood control constraints. These constraints have been named for two designated minimum target levels. The constraint that would be initiated first is termed the "full service" constraint. Gavins Point Dam releases are reduced to full service target flow at Sioux City or the target flow at the location it is being exceeded, whichever is the smaller reduction. The second and more restrictive constraint is termed the "minimum service" constraint. Gavins Point Dam releases are reduced to the minimum service target flow at Sioux City or the target flow at the location it is be exceeded, whichever is the smaller reduction, for this constraint. Each of these two flood control constraints initiates cutbacks in System release at different flow levels. For the full service constraint, reduction of System release is initiated to ensure that downstream river flows do not exceed target flow by more than:

- 10 Kcfs @ Omaha
- 10 Kcfs @ Nebraska City
- 30 Kcfs @ Kansas City

For the minimum service constraint, reduction of system release is initiated to ensure that downstream river flows do not exceed target flow by more than:

- 15 Kcfs @ Omaha
- 20 Kcfs @ Nebraska City
- 60 Kcfs @ Kansas City

According to the Master Manual, the Corps has a leeway of 5 Kcfs after considerations are given to antecedent, current, and projected hydrometeorologic conditions. Also, for the CWCP, System release to the lower river is never reduced to less than 6 Kcfs.

The System also includes hydropower peaking for electric generation. These peaking patterns are adjusted each spring and summer based on minimizing stage fluctuations to spawning fish downstream of Fort Randall Dam and on field surveys of the elevation of nesting terns and plovers downstream of Garrison and Fort Randall Dams. For more information on the typical hydropower peaking patterns, see the Draft EIS Technical Report entitled "Volume 4: Hydraulic Studies Upstream from Gavins Point Dam", dated July 1994, Appendix A - Peaking Pattern Analysis (USACE 1994).

A 3-day cycle of spiked releases from Gavins Point Dam during drought periods was followed during the mid-1987 to mid-1993 drought to save water and help nesting terns and plovers. The anticipated late-summer release necessary to support navigation was identified, and the releases from Gavins Point Dam were cut back for 2 days before the maximum release is held for the third day. A 3-day cycle was followed because it takes about 2 days for the sand to dry out enough that the least tern or piping plover will scrape a new nest at a lower elevation than the target elevation. As the anticipated later summer release requirement was approached, the amount of cutback in releases over the 2-day lower flow period was reduced.

In non-drought periods, the Corps maintains a flat release from Gavins Point Dam unless downstream flooding is occurring. The flows are then reduced for a 2-day period before being brought back up for a day. This cycle continues until the flooding subsides and the flat release occurs again.

Annual Operating Plan

Based on the guidance within the Master Manual, the AOP provides the guidance and flexibility for hourly, daily, monthly, seasonal, and annual operations of specific reservoirs and reaches of the river. Much of the operational flexibility is from internal or intrasystem regulation by transfer of storage from one project to another. Using the guidance of the Master Manual, an AOP has been prepared every year since 1953 to summarize the operations for the past year and to describe the planned operation for the next year. The AOP also includes a 5-year projection for System operations.

AOP issues are intrasystem balance restraints and rules for moving water between each of the six reservoirs and dams. Intrasystem regulation accomplishes several objectives. First, it balances storage to keep one project from rising above flood control limits while another falls below desirable conservation levels. Second, it affects stages on the open river between projects when control of those stages is desirable. Third, it manipulates reservoir levels to improve conditions for fish spawn while providing adequate releases for riverine uses of fish spawn, threatened and endangered species, recreation, irrigation, and water supply. Perhaps the most persistent and frequently analyzed objective of the internal regulation is maintenance of seasonal capability of the hydroelectric power system. The AOP restraints for the CWCP, as provided by the Corps, are presented in Table 1.

Flood Control

Operations for flood control require the availability of empty storage space. The System is operated, when practical, to prevent flows originating above or within the System from flooding downstream reaches of the Missouri River. The bulk of the flood control in the System is achieved through specified storage zones on the primary storage reservoirs (Fort Peck, Garrison, and Oahe) (88 percent). Two storage zones deal with flood control (See Figure 2): (1) the annual flood control and multiple-use zone to store the seasonal runoff that is evacuated during the non-flood season, and (2) the exclusive flood control zone to store surplus runoff during extremely large runoff periods. Flood control operations, by nature of the unpredictability of flood events, are dealt with as-needed. Generally, the System is regulated such that all reservoirs are at or near the base of their respective annual flood control zone on March 1. This is somewhat flexible due to upstream tributary reservoir storage space or the fact that some storage can be transferred to other projects if the space is available. However, travel time (up to 11 days to reach its confluence with the Mississippi) and the large amount of uncontrolled inflows limits the effectiveness of flood control on the lower river.

Irrigation

No federally developed irrigation projects (Section 8, Flood Control Act of 1988) are being served directly from the System. Sufficient storage exists and adequate releases could be maintained to satisfy Federal irrigation requirements when they develop. Private irrigators currently withdraw water from the river reaches as well as directly from the reservoirs.

Releases for irrigation below the System are not scheduled from Gavins Point; however, usually an ample supply of water exists for irrigators because of the scheduled releases for other downstream uses. During extended drought periods, System releases are cut back to conserve the remaining supply, which helps to ensure water for beneficial upstream consumptive purposes including irrigation.

Table 1. Annual Operating Plan Restraints for the Current Water Control Plan .[1]

Fort Peck

- Tern and plover nesting season includes the full months of June, July, and August.
- Maximum daily average release is determined at the beginning of the nesting season, and it varies depending on the forecasted water that needs to move in a given year. Minimum fish spawn release is 3 Kcfs every month.

Garrison

- Tern and plover nesting season includes the full months of June, July, and August
- Maximum daily average release is determined at the beginning of the nesting season, and it varies depending on the forecasted water that needs to move in a given year.
- Maximum hourly peaking flows for hydropower are limited based on the maximum daily average value during the nesting season.

Oahe

- A minimum of 3 Kcfs is released on weekends in the summer for fish and downstream recreation.

Big Bend

- None

Ft. Randall

- Tern and plover nesting season includes the full months of June, July, and August.
- Maximum daily average tern releases are based on the Gavins Point Dam release.
- Minimum fish spawning releases during April, May, and June.
- Minimum fish spawning release is always something less than the average expected regulation discharge. For example, for monthly average flows of 25 Kcfs and above, the absolute minimum fish spawning release is 20 Kcfs. Similar average to minimum discharge points at other locations included 20 and 15 Kcfs, and 15 and 10 Kcfs. The day-to-day fluctuations when the average flows were below 15 Kcfs were believed to be too low to provide worthwhile minimum fish spawn flows.

Gavins Point

- Tern and plover nesting season includes the full months of June, July, and August.
- Tern and plover releases are generally about 29 Kcfs and 23 Kcfs for full and minimum service, respectively, until the birds appear to be ready to start nesting. The releases are then stepped up an additional amount to ensure that navigation targets are met downstream from Sioux City as tributaries generally have lower flows as the summer progresses.
- Lower releases in response to downstream flooding are generally limited to 2 days. On the third-day, the release is increased to the pre-reduced rate to prevent the birds from nesting at lower elevations during the tern and plover nesting season. This pattern is followed unless prolonged downstream flooding is forecasted or a major reduction is required that the 3-day pattern will not allow. During the last drought (mid-1987 through mid-1993), a three-day peaking pattern was followed throughout the summer to conserve water. Generally, the minimum release is limited to 8 to 9 Kcfs less than the normal release; however, numerous complaints were received when the flow fluctuation was greater than 6 Kcfs.

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[1] Tern and plover flow restraints are terminated from a reservoir when any reservoir gets in the exclusive flood control zone and evacuation is imperative.

Experience has shown that the estimated minimum daily average releases necessary for adequate continuous irrigation pumping stages below the projects in the May to September time frame are as follows: Fort Peck 7K-8 Kcfs, Garrison 15K-16 Kcfs, Fort Randall and Gavins Point 15 Kcfs. These estimates assume normal inflow between the project and irrigation intakes. Hourly release restriction criteria which relates to specified daily average release rates is put into effect to prevent large sags in river stage below Fort Peck and Garrison during the irrigation season.

During times of low daily average release, several hours of minimum hourly release can occur for irrigation, which can be followed by an abrupt increase in release for power peaking to establish higher nesting elevations for endangered bird nesting. This can cause larger than normal stage fluctuations in the first 20 mi (32 km) or so downstream of the Garrison and Fort Randall powerplants. During times of extended drought or flood control, releases at the projects may be cut back causing pumping stages to drop below necessary intake operating levels

Municipal, Industrial, and Rural Water Supply

Storage and releases are maintained to provide (1) pools no lower than the top of the permanent pool for water withdrawals from the reservoir, and (2) releases from the dams to conform to those minimums spelled out in the Master Manual (USACE 1979).

The main stem reservoirs are operated in a manner to provide streamflow in intervening reaches between the reservoirs and in the lower Missouri River reach from Yankton, SD, to the mouth at St. Louis, MO. About 1600 water intakes are located along the Missouri River both within and below the System. Below the System, the intakes provide for water for municipal water supply; power plant cooling water; and commercial, industrial, and domestic uses. To supply the minimum water quantity for water supply, winter, spring/fall, and summer non-navigation flow requirements are expected to be 12 Kcfs, 9 Kcfs, and 9 Kcfs, respectively. Reductions for extreme flood events may cause system releases to be as low as 6 Kcfs, as was the case during the flood of 1993. Releases this low, although extremely rare, can uncover large amounts of habitat for terns and plovers and have the potential to interfere with a return to higher release rates later in the nesting season. The low System non-navigation release rates are always accompanied by low release rates from most of five upstream reservoir projects to distribute the conservation of water. This can affect tern and plover nesting below all projects except Oahe and Big Bend.

When it becomes necessary to reduce System releases at Gavins Point Dam below minimum service navigation flows, continued surveillance of these downstream intakes is necessary and additional releases are made when required to assure adequate water supplies for intake operation. This situation has the potential to affect tern and plover nesting if releases have to be increased significantly after a previous lower established release has been in place during tern and plover nest initiation.

Channel degradation, sandbar formation, and improper intake elevation and screens may give rise to pumping problems. Under normal open water conditions, a minimum daily average release of 3 Kcfs from Fort Peck is satisfactory for municipal water supply. At Garrison, it is desirable to maintain minimum daily average release no lower than 10 Kcfs during the open water season. No restrictions on minimum releases from Oahe and Big Bend are necessary for adequate service to water intakes since the headwaters of downstream reservoirs usually extend to near the upstream dam sites. Mean daily releases of 1K to 5 Kcfs are adequate to meet supply requirements below Fort Randall while below Gavins Point flows considered necessary for water quality control may or may not be sufficient for water supply requirements depending upon tributary contributions. As they occur, those problems may require a temporary increase in release rates. Temporary increases may have the potential to interfere with tern and plover nesting which has been initiated in close proximity to the river's water surface.

Navigation

System release levels for navigation are based on the available water supply behind the dams and lower river inflow/river stage. In general, as System storage decreases, so does the amount of water for navigation. Monthly release levels for navigation are based on downstream flow targets along the river. Full service stream flow targets for navigation include 31 Kcfs at Sioux city and Omaha, 37 Kcfs at Nebraska City, and 41 Kcfs at Kansas City. During a drought, minimum service stream flow targets for navigation include 25 Kcfs at Sioux City and Omaha, 31 Kcfs at Nebraska City, and 35 Kcfs at Kansas City. Release levels can vary between minimum service and full service (or greater) to navigation, depending on System storage. Between May 10 and August 20 each year, generally a flat release is made from Gavins Point Dam at a level projected to provide the necessary navigation support flows downstream during the normally dry late July and August months. Those flows help to preclude taking of tern and plover nests. The length of the navigation season will also be shortened in extended droughts from the traditional 8-month season, with the length also depending on the available water in System storage. At very low System storage levels (i.e., as the storage approaches near 18 MAF), navigation service is discontinued. Flow rates, combined with channel stabilization and navigation structures, were designed to provide for the 9-foot-deep, 300-foot-wide channel during an 8-month navigation season (April 1 to December 1). In years when evacuation of the flood storage zones requires releases above those normally required for navigation, the season length is extended an additional 10 days to end on December 1. Navigation criteria are presented in detail in the Master Manual (USACE 1979).

Power Production

The System operates to optimize power production and maximize revenues within established priorities with equitable service to other functions. The WAPA markets main stem Missouri River hydropower to firm customers in the Pick-Sloan Eastern Division. WAPA markets the hydroelectric power from the System based on two factors. The first factor is the capacity that would be available in December and August (summer and winter peaks) of a repetition of the drought year 1961. The second is the energy that can be supported by the long-term average summer and winter energy available from the System. The only project releases currently not used for power generation are those made to satisfy flood control storage evacuation requirements that exceed generation capacity.

Water Quality

The System operates, when practicable, at or above the minimum flows established by State water quality standards subject to Environmental Protection Agency (EPA) standards. Water quality requirements for releases from projects are described in detail in the Master Manual (USACE 1979).

Downstream water requirements were established by the Federal Water Pollution Control Administration in 1969 and reaffirmed by the EPA in 1974. Refer to Table 2 below for minimum daily flow requirements on the Missouri River below the System. The minimum daily flow requirements established for water quality control are designed to prevent operational problems at municipal drinking water intakes and municipal and steam/nuclear power plant intakes at numerous intakes below the system. With System storage at high levels, releases for navigation and for system power production purposes during the non-navigation season will be at levels which operating experience has indicated are adequate for all downstream needs including water quality. Water quality problems may require increased releases during extended low-flow periods.

Table 2. Minimum Daily Flow Requirements (cfs) for Adequate Dissolved Oxygen.

Metropolitan Area	December thru Feb	March thru Apr	May thru Sept	June thru Nov	October
Sioux City	1,800	1,350	1,800	3,000	1,350
Omaha	4,500	3,375	4,500	7,500	3,375
Kansas City	5,400	4,050	5,400	9,000	4,050

Specific water quality problems detected at Missouri River main stem projects in the late 1990s were the exceedence of state standards for several parameters. Specific Corps AOPs list the issues and problems identified at each of the main stem projects for these years. Water quality issues and problems in main stem reservoirs along with standards and quality criteria exceedences for main stem reservoirs and releases are provided in the Corps' biological assessment on MR Operations (USACE 1999). A separate Annual Water Quality Report is prepared each year by the Corps.

Recreation

The six large lakes of the System and the reaches between and below these lakes provide recreation opportunities to residents of the States through which the river flows, as well as neighboring States.

The Corps of Engineers alone has 169 recreation areas on the Missouri River from Ft. Peck Dam to Gavins Point Dam (http://www.nwo.usace.army.mil/html/ Lake_Proj). Recreational activity is a source of income for businesses catering to boating, hunting, fishing, camping, and other recreational pursuits, as well as service establishments located near the river.

A variety of recreational opportunities exist on the System and the Lower River. Water-based recreation includes boating, boating-related activities, and swimming. Sport fishing is a primary component of recreation along the entire system. The wetlands along the river corridor provide waterfowl habitat, and waterfowl hunting is popular. Hunting for small and large game such as squirrel, rabbit, and deer occurs on land along the reservoirs and river. The aesthetically pleasing character of the lakes and river reaches attract sightseers. Camping facilities vary from fully developed to primitive. Factors that affect recreation along the System include the health of the economy, fishing success, trends in vacation and recreational activity, the price of gasoline, the character and condition of the recreation and access areas, local celebrations that increase the general population base for a brief period, promotional activities, and information provided by public and private sources.

More than two-thirds of the recreational opportunities are associated with the six main stem lakes. Over 80,000 ac (32,400 ha) of recreational lands exist along nearly 6,000 mi (9,654 km) of lake shoreline. Since construction of the dams, development of recreational facilities and opportunities for recreation have increased. The introduction of additional fish species attracted large numbers of anglers to the lakes. Road improvements made the lakes and river reaches more accessible. Recently, the national trend towards outdoor recreation and the number of recreationists willing to travel longer distances have added to recreational visitation along the reservoirs.

River recreation, like reservoir recreation, is predominately water-based, with boating and fishing as major activities. Portions of the river above Fort Peck Lake, below Fort Randall Dam, and below Gavins Point Dam have been designated "National River Reaches" under the National Wild and Scenic River Act.

Reliable releases and reservoirs at adequate levels are most desirable for recreationists, marina operators, resort operators, and others. Unfortunately, because of the seasonable variability and distribution of runoff and evacuation of water for various functions, these are difficult to accomplish. Nevertheless the Corps has, through the years, planned releases below the various projects to better serve recreationists and has had the opportunity to lessen the rate of drawdown at certain projects. Special release rates below some of the projects for fishing, fishing tournaments and boating have been scheduled. At low reservoir levels, some boat ramps are unusable while recreational areas at upper ends of reservoirs may not provide access to the reservoirs. Low river flows affect boat access and maneuverability. For aesthetic reasons, some visitors are less likely to frequent lakes or streams that have noticeably low water levels. Certain kinds of fishing and hunting depend upon adequate lake levels and river flows. Visitors are less likely to frequent reservoirs and river reaches at low water for aesthetic reasons.

In the 1987 to 1993 drought, access was reduced and many lake recreational areas were closed. Many boat ramps had to be extended and facilities had to be improved at the recreation sites that were still open to minimize over crowding. Overall, the quality of recreation at the System reservoirs suffered during the drought. The Corps tries to operate for river recreators both within and below the System, and during the majority of the years, recreational use opportunities along the Missouri River have been outstanding.

Fish and Wildlife

The six reservoirs of the System contain a diverse community of coldwater, coolwater, and warmwater fishes. The upper three reservoirs have been stocked with coldwater game and forage species to take advantage of the coldwater retained through the summer and fall in the deeper waters of the reservoirs. Fish in the lower three reservoirs and the warmer waters of the upper three reservoirs include native and non-native species that have adapted to the lake habitat along with forage fish. Coldwater fish are also raised in hatcheries and stocked in the reservoirs. The exception is at the Fort Peck project where lake trout are supported by some natural reproduction along the face of the dam. Most of the warmwater and coolwater species spawn in lake shallows or in tributary streams. Because natural spawning and rearing habitat is limited, especially in low-water years, some warmwater and coolwater fishes such as walleye are stocked. The success of fish in the System and the lower river depends on habitat conditions. In the upper three reservoirs, low water levels during droughts limit coldwater fish habitat and shallow spawning and rearing habitat or warmwater and coolwater species. In the lower three reservoirs, high inflow and outflow reduce lake productivity and cause young fish to be flushed from the reservoirs. Native fish, in the river reaches, which includes the pallid sturgeon, are naturally adapted to the high, warm, and muddy spring and early summer flows, and lower late summer and fall flows characteristic of historic Missouri River flows. Cold, clear tailwaters of the upper three dams are more conducive to trout and salmon, but not the native paddlefish, sturgeon, and other fishes.

Fish production and growth in the System is related to releases and reservoir levels. Therefore, when compatible with other project purposes, special reservoir operations for fish and wildlife are undertaken. The operation of the System dams has altered the natural streamflow of the Missouri River thus altering the habitat of native riverine fish species, as well as that of other flora and fauna. With an increasing voice in the 1990's, biologists throughout the basin have conveyed to the Corps that the health of the entire Missouri River ecosystem is dependent upon a more natural spring rise. To date no simulated "spring rise" has been attempted although from about the mouth of the Platte River in Nebraska to St. Louis, a spring rise due to flows from the large number of uncontrolled tributary streams usually occurs. A spring-summer rise usually occurs on the Yellowstone River in Montana due to the large uncontrolled area of that basin. The System reservoirs are producing more sport fish than the river did before impoundment. The Corps has tried to honor as many of the annual requests of the Missouri River Natural Resources Committee as possible by manipulating dam releases to provide rising spring reservoir levels and scheduling certain minimum releases during the annual spawning periods. The Corps realizes that forage fish reproduction is also very important. Except for flood control, water releases are not reduced in the May-June spawn reaches of the System for fish spawning in this time period.

The Corps meets annually with the Missouri River Natural Resources Committee (MRNRC), which is comprised of biologists from the States and some Federal agencies, to identify pool levels and project releases desired for effective management of fish and wildlife resources of the System. The MRNRC has three technical sections (i.e., Fish Technical Section, Tern and Plover Subcommittee, and Wildlife Section) that help formulate recommendations. The MRNRC makes recommendations to the Corps for terns and plovers, native fish, reservoir and tailwater sport fisheries, and reservoir and river recreation. They provide recommendations on the Annual Operating Plan, Missouri River Master Manual, and specific issues as needed. For example, the MRNRC has recommended a procedure of operating one reservoir for fish production in one year while compensating the System with manipulation of other reservoirs. This operation is referred to as unbalancing of the System to benefit one of the project purposes, in this case, fish and wildlife. MRNRC recommendations are only incorporated into System regulations within the physical and functional limits of the other purposes for which the System operates.

Intrasystem Regulation

Operation of the System depends on the annual inflow, or water supply, cycle. Usually, plains and mountain snowmelt and spring and summer rainfall result in rising pools and increasing storage accumulation that peaks in July and then declines through the winter. Thus, intrasystem regulation is patterned to take advantage of the annual cycle. Each month, the net supply of water into the System is determined and release rates are established for that month.

The storage capacity of the System is designed with operational zones that were originally developed to provide beneficial service to the multipurpose functions. These operational zones (see Figure 2) include exclusive flood control capacity, annual flood control and multiple-use capacity, carryover multiple-use capacity, and permanent storage capacity and have been identified for each reservoir (Table 3). In general, releases from the System fall into two classes: (1) releases made in support of navigation, and (2) daily releases made during the non-navigation season for water quality and supply as well as for power production and flood evacuation purposes. If conditions outside the norm (i.e., years with above normal water supply exist, release schedules are adjusted in accordance with the Master Manual (USACE 1979).

From April through November (navigation season) of the majority of years, releases are based on navigation and flood storage evacuation requirements, and primary power loads are supplied using all six dams. In dry years with lower System storage (e.g., mid-1987 through mid-1993), less water is released for navigation to conserve water. The releases are determined by the March 15 and July 1 storage checks. Fort Peck and Garrison summer releases are intentionally set higher than in the spring or fall to allow the hydropower generation to better meet the higher summer electricity needs of the

region. These releases are adjusted as needed for intrasystem regulation purposes. During the fall, the Fort Randall pool is drawn down to permit generation during the winter when the pool is refilled by transferring water from Fort Peck and Garrison Dams to peaking plants at Oahe and Big Bend Dams. The power needs during the winter are supplied primarily with Fort Peck and Garrison releases and peaking capacity of Oahe and Big
Bend. System releases are designed to provide equitable service to power and navigation, except when they are overridden by the flood control function of the System.

Table 3. System project information (adopted from 1999-2000 AOP)

Project	Fort Peck	Garrison	Oahe	Big Bend	Fort Randall	Gavins Point	Total
Reservoir	Fort Peck	Sakakawea	Oahe	Sharpe	Francis Case	Lewis & Clark	
Date of Closure	1937	1953	1958	1963	1952	1955	
Drainage Area[1]	57.5	123.9	62.1	5.8	14.2	16.0	279.5
Damming Height (feet)	220	180	200	78	140	45	N/A
Storage (MAF)[2]							
Flood Control							
Exclusive	1.0	1.5	1.1	0.1	1.0	0.1	4.7
Annual	2.7	4.2	3.2	0.1	1.3	0.1	11.7
Carryover	10.8	13.1	13.5		1.6		39.0
Inactive	4.2	5.0	5.4	1.7	1.5	0.3	18.1
Gross	18.7	23.8	23.1	1.9	5.4	0.5	73.4
Annual Release (MAF)[3]	8.0	18.6	21.3	21.3	22.3	24.6	
Annual Sediment Inflows (KAF)[4]	18.1	25.9	19.8	4.3	18.3	2.56	111.4
Power Facilities							
Average Gross Head (feet)	194	161	174	70	117	48	
Powerplant Discharge Capacity (Kcfs)[5]	16.0	38.0	54.0	103.0	44.5	36.0	
Generator Capacity (MW)[6]	185	518	786	497	293	132	2,436

Annual Energy (Million kWh)[7]	1,170	2,472	2,898	1,052	1,846	749	10,187

1. Thousand square miles
2. Million acre-feet
3. 1967-1999 average from Reservoir Control Center database
4. Thousand acre-feet
5. Thousand cubic feet per second
6. Megawatts
7. Kilowatt hours

In years of excess water, System releases above full service navigation requirements are required to evacuate water in flood control storage. With normal or less than normal water supply, navigation and power releases during the open water season are based on existing and anticipated System storage. This may result in less than full service navigation and a shortened navigation season.

Short-and Long-Term Adjustments

Historically, the Master Manual has been the primary basis to guide day-to-day operational decisions. The Corps has used its discretionary authority to make operational adjustments to the specific numerical criteria contained in the Master Manual. Some of those changes occur during the short-term, i.e., within the span of a year as part of the implementation of an AOP. Others are made over a span of years based on experience, and those can be referred to as long-term adjustments.

Short-term adjustments include a variety of considerations. Some of the more obvious are those that are made in response to short-term extremes of nature. For example, during floods on the lower river, Gavins Point Dam releases are reduced in response to the flood control constraints. Those reductions are tempered by the Corps' judgment on whether a cutback in releases will affect the magnitude (peak discharge) or duration (number of days) of flooding on the lower river. In 1997, discretionary management was used in response to the high amount of water in System storage and the anticipated mountain snow-pack runoff. The initial releases made from the System were higher than the Master Manual indicated. That decision proved to be very beneficial as the total runoff for the year was the greatest on record and the highest releases on record were required later in the year to move this record runoff. Periodically, individuals make requests for short-term adjustments in releases to allow an activity to be completed without adverse effects from river flows. For example, construction activities in the channel are enhanced when flows are maintained below a certain level. The Corps considers the required flow adjustment, and, based on engineering judgment, a change in operations may be made.

Based on prior experience and requirements based on Federal legislation, long-term adjustments have been made in Main Stem Reservoir System operations. The most significant long-term adjustment in operations was made in response to the 1990 U.S. Fish and Wildlife Service's Biological Opinion prepared in response to the listing of the endangered interior least tern and threatened piping plover. Summertime peak power releases from Fort Peck, Garrison, Fort Randall, and Gavins Point Dams have been modified to limit adverse impacts to these two bird species. Fort Randall Dam releases were flat loaded during a portion of the summer in 1999 to limit impacts to the birds. Also, other long-term adjustments may be made based on required adjustments to the Master Manual when the Review and Update Study is completed.

System Limitations

System regulation is affected by storage and discharge limitations. Those limitations have been addressed in some of the information presented previously in this section of the biological opinion. Some of those limitations will be restated here along with others that have not been discussed previously.

Storage changes beyond specified levels limit System releases. For example, when inflows are low and system storage is in carryover multiple use zone, releases to serve navigation are reduced as System storage decreases. Eventually, if storage declines near 18 MAF, navigation releases are suspended and releases are reduced to the specified water supply or water quality target requirements. Conversely, when inflows are high into some unit of the System and storage in one of the reservoirs goes into the exclusive flood control zone, releases from the reservoirs upstream from this reservoir will be reduced until the exclusive flood control zone is evacuated.

The lower river's flood control constraints also limit releases from the System. Those limitations depend on the magnitude and duration of the downstream flooding.

Over the years of System operation, sediments have accumulated in the headwaters of each reservoir, and that deposition is now resulting in release limitations from four of the reservoirs. Deposition has caused higher local river stages. Because of floodplain development, the Corps' flexibility to manage river levels has been reduced. Limitations may be imposed because of the delta buildup at the headwaters of Lake Sakakawea, Lake Oahe, Lake Sharpe, and Lewis and Clark Lake. The extent of the limitations depend on the amount of tributary inflow above each delta, the time of the year, and the last time high flows were moved through the delta. One example of this limitation is that flows past Bismarck, North Dakota historically were limited to 20 Kcfs in many years during the formation of ice. The continued build up of the delta and floodplain development has resulted in the flow being as low as 18 Kcfs to prevent flooding during ice-in.

Minimum flow limitations (daily and hourly) also exist at various locations within the System at various times of the year. There are no minimum daily flow requirements from the Oahe or Big Bend projects except that, at Oahe, weekend releases during the daytime hours of the recreation season are typically held above 3 Kcfs in the interest of downstream fishing and boating (recreation activities). Also, minimum daily releases from Fort Peck and Fort Randall Dams are typically maintained during the fish spawning seasons (fish and wildlife). At Fort Peck, Garrison, Fort Randall, and Gavins Point Dams, minimum daily releases are generally those necessary to supply water quality control and water intake requirements, and those releases generally meet irrigation requirements. In the recent drought (mid-1987 through mid-1993), releases were further reduced to 3 Kcfs from Fort Peck Dam and 10 Kcfs from Garrison Dam during the non-irrigation season. Nearly uniform peaking release patterns are established during the nesting season for terns and plovers at Fort Peck, Garrison, and Fort Randall Dams for birds nesting downstream.

During periods of extended high flows on the lower river, navigation is generally suspended to limit wave erosion on levees. At that time, releases from Gavins Point Dam may be cut back to 6 Kcfs (generally meets water intake needs for the City of Yankton, South Dakota) and to zero from Fort Randall Dam for a portion of the day (some releases are required to refill Lewis and Clark Lake and to provide water for the City of Pickstown, South Dakota).

System Flexibility

Much of the flexibility of the System is derived from internal regulation (intrasystem regulation) that allows transfer of storage from one project to another. Inflows to the System are subject to some regulatory control by upstream tributary reservoirs and System releases necessary to support downstream water requirements defined within a relatively narrow range.

While a routine operational pattern is followed (as discussed previously), detailed routings of specific flood events are not a part of the AOP and can be dealt with as-needed. That allows flexibility within the internal regulation capabilities. Additional flexibility is found in planning navigation release requirements from Gavins Point Dam, because the amount of the May increase in navigation flow above the level required at that time is a matter of operating judgment each year and is determined by anticipated downstream runoff conditions.

Synthetic Models for System Regulation

To aid System regulation, the Corps uses five synthetic, statistically developed flow levels to reflect yearly runoff into each main stem project and the Missouri River upstream of Sioux City, IA. The levels allow examination of System performance under normal (i.e., median), reduced (i.e., lower quartile and lower decile), or increased (i.e., upper quartile and upper decile) inflow conditions. Those levels are described below:

1. An Upper Decile Year – One with one chance in ten of greater inflows.

2. An Upper Quartile Year – One with one chance in four of greater inflows.

3. A Median Year – One with an equal chance of greater or lower inflows.

4. A Lower Quartile Year – One with one chance in four of lower inflows.

5. A Lower Decile Year – One with one chance in ten of lower inflows.

Based on the alternative runoff forecasts, the August 1 System storage, and public input, the Corps prepares an AOP each fall and finalizes it in December. Refer to Table 3 for project data pertinent to modeling and System operations.

Conservation Measures for Threatened and Endangered Species

Since completion of System construction, terns and plovers have nested above and below all the dams except Big Bend Dam. The birds most susceptible to project releases are those birds nesting in river reaches downstream of Fort Peck, Garrison, Fort Randall, and Gavins Point Dams.

Since 1986, the Corps, whenever possible, regulates the System to reduce potential flooding of tern and plover nests on the Missouri River. River stages downstream of four of the main stem dams are closely monitored and releases are adjusted during the nesting season to prevent nest inundation. The Corps operates uniform peaking release pattern during the summer at Fort Peck, Garrison, and Fort Randall Dams for listed birds nesting along the river below these projects. Additionally, releases from Gavins Point Dam are increased in early May when the birds arrive to provide the System flexibility by forcing the birds to nest on high sandbars so that the Corps can meet navigation target flows later in the nesting season when downstream tributary flows begin their normal decline in July and August.

Water level management during the drought years of mid-1987 to mid-1993 on river reaches containing essential tern and plover habitat has reduced the number of nests and chicks inundated during the nesting season. However, loss of nests and chicks continued because flows were regulated such that limited habitat was available to the birds. Schwalbach (1988) found that birds nested higher and further from the water's edge in 1987 when habitat was more readily available than in 1986 when habitat was limited.

In 1995, the Corps initiated a flat release downstream of Gavins Point Dam. Although not a designed conservation measure, high flows during the post-drought years have also scoured vegetation off existing sandbars and low-lying areas on the islands. Also, the prolonged high releases in the record runoff year of 1997 created many new sandbars. The highest fledge ratios in recent history were recorded in 1998 after the creation of this large area of new suitable habitat in 1997. These type of flows characterize the hydrology necessary to restore, create, and maintain sandbar and adjacent shallow water habitat.

As habitat diminishes with time (i.e., sandbars erode and vegetation establishes on those sandbars and the islands) water levels may again be manipulated within inches of tern and plover nests. That operation leaves no flexibility to accommodate for wind, rain, or other conditions affecting river levels and causing flooding of nests or chicks. Management of water levels to produce only limited amounts of habitat for the birds results in reduced productivity.

The Corps has tried one option to reduce operational conflicts between the birds and other project purposes – development of suitable tern and plover nesting habitat at higher elevations (USACE 1992; 1993a,b,c,d; 1994a). The Corps' actions to provide higher habitat have been successful in attracting nesting birds, although initial productivity on those islands was limited because of predation and lack of forage. Predator management is now an integral part of Corps' tern and plover conservation activities (USACE 1993a).

When System storage is medium to high during early summer, opportunities for steady releases for terns and plovers are limited when inflows are high. The Corps interprets its flood control authority as requiring that System flood control storage be evacuated in a safe and expeditious manner so that the System is ready to store a major flood event upstream from one or more of the System reservoirs in that year and is empty by March 1 of the following year. That may require evacuation of the flood control storage zones during the normal flat release period of early May to late August. That could result in limited availability of nesting habitat and the loss of nests and chicks. Limited habitat was available in 1997 during the record runoff of that year and the resulting high reservoir levels from March through August.

Downstream flooding on the lower river may also result in cutbacks of releases from Gavins Point Dam and, in turn, Fort Randall Dam during the nesting season. Those cutbacks may be for only 2 days as the Corps tries to return to the flat release; however, chicks may be mobile and get to parts of sandbars where they are stranded and swept off the low-lying areas when the flow is brought back up. In the event of more extensive downstream flooding, the cutback may be for an extended period. The Corps thoroughly analyzes the situation before abandoning the return to the flat release rate every third day.

In summary, competing multipurpose demands (e.g., navigation and flood control) may conflict with uniform or constrained peaking summer releases for terns and plovers in downstream areas. Operations for reservoir project purposes (e.g., flood control) will often conflict with reservoir nesting habitat, as well as downstream habitat because balancing System storage can conflict with uniform and constrained hydropower peaking summer releases. The Corps has been committed to operate for terns and plovers since 1986 and has been integrating the birds into their AOPs within the operational constraints of the Master Manual.

The Corps also has developed an extensive monitoring and management program for least terns and piping plovers on the System since 1986.   Monitoring work includes annually locating and mapping colony and nest site locations, conducting systematic breeding pair censuses, participating in the international piping plover census, determining nest fates and annual recruitment rates (fledge ratios), and evaluating annual habitat trends. Weekly surveys of all known nesting sites are undertaken during the breeding season. Site locations, nest status, fledge counts, and occurrent site conditions are recorded on Corps standardized data cards and are inputted daily into the Corps web-based data management system. These data are then available on a near real-time basis to reservoir regulators, Service personnel, and other affected agencies. Daily coordination is undertaken between Corps field biologists and Reservoir Control Center and\or the Service to determine operational strategies to protect tern and plover nests and chicks.

In addition to incorporating flow regulation, reducing the impacts of predation, human disturbance, and degrading habitat conditions are also integral parts of the Corps management activities on the System. Predator aversion has included the use of nest enclosure cages, strobe lights, electric barrier fences, and in cooperation with animal damage control agents, removal of local problem predators. Public outreach has become a focal point of Corps management activities and serves to educate people about least terns, piping plovers and the efforts being made to protect them. Local interpretive programs, school presentations, brochures, radio and television spots, boat ramp interpretive signs, video documentaries, etc. all serve to increase awareness of the species. Additionally, nesting sites with historic propensities for human disturbance are posted with restricted access signs and roped off to prevent nest and chick losses. The Corps has undertaken a whole host of habitat enhancement projects since 1987. Removal of vegetation through hand-pulling, herbicide applications, mowing, burning, tilling, discing, capping with gravel, blasting, and scouring with heavy equipment has been used to prolong the suitability of existing sandbars. New islands where built and elevation of existing islands increased through the use of floating artificial islands, sand fences, dredging, and bulldozing. Habitat protection measures to retard erosion have included oyster shell applications, shoreline erosion arrestor bags, and sand bags. During recent years of record inflow (1995-1997) these created habitats provided the only available nesting sites along several Missouri River reaches. Since 1997, extensive high elevation habitats have occurred throughout the System and large scale habitat enhancement activities have not been undertaken.

The Corps has been committed to, and funded, an active research program to further the science and understanding of least tern and piping plover biology and the effects of System impacts on their survival. *Conservation of Least Terns and Piping Plovers Along the Missouri River and Its Major Western Tributaries in South Dakota* (Schwalbach 1988) and *Distribution and Productivity of Least Terns and Piping Plovers Along the Missouri and Cheyenne Rivers in South Dakota* (Dirks 1990) were two initial studies undertaken to determine the distribution of least terns and piping plovers in South Dakota and to identify those factors that may be affecting their survival. *Influence of Predation On Least Tern and Piping Plover Productivity Along the Missouri River in South Dakota* (Kruse 1993) described the impact of predation and evaluated several predator aversion alternatives. *Nesting Ecology of the Interior Least Tern on the Yellowstone River, Montana* (Bacon 1996) and *Distribution, Productivity, and Habitat Use by Interior Least Terns and Piping Plovers on the Niobrara River in Nebraska* (Adolf 1998) provided insight into habitat suitability, habitat selection, nesting chronology and recruitment rates on rivers with near-natural hydrographs dominated by mountain snowpack and plains snowmelt runoff, respectively.

Current research projects include an evaluation of wild reared and captive reared piping plover survival.

That study is determining survival rates of fledged piping plovers raised in the wild and of captive reared plovers released back into the wild. It is also evaluating behavioral differences between wild and captive released birds. *Foraging Ecology of Northern Great Plains Piping Plovers,* a study of foraging behavior and forage abundance and availability will be started in August 2000 to investigate differences in growth rates and fledge dates between local populations of piping plovers on the Missouri River and between Missouri River and Prairie Coteau birds. *The Habitat Conservation and Recovery Plan*, an effort to describe and quantify habitat and habitat changes, is being developed. This project will also identify priority habitat areas to focus future management efforts.

In 1995, the Corps began a significant and continuing contribution to least tern and piping plover biological information with their commitment to the least tern and piping plover captive rearing program. Development of captive rearing protocols, understanding embryonic development, collection of tern and plover vital rate information, nutritional data, rate of gain and morphological aging tables, contribution of samples to genetic typing studies, development of radio transmitter attachment protocols, insights into pre-migratory plover chick survival and leg band placement recommendations are all products of the captive rearing program initiated as a result of the high runoff into the System in 1995. That program has resulted in state-of-the-art facilities constructed at Gavins Point Project and is available for future research activities.

The Corps has not modified day-to-day operations to specifically consider the bald eagle or pallid sturgeon. However, the needs of the pallid sturgeon are not fully known, so Corps actions to date have been research-based. Since the late 1980's the Corps has funded radiotelemetry studies of pallid sturgeon movement in Montana. The Corps also has funded several of the priority tasks identified within the 1993 Pallid Sturgeon Recovery Plan. Tasks funded by the Corps include the following:

? genetic studies
? a larval sturgeon identification key
? additional radiotelemetry studies of sturgeon species in the channelized Missouri River
? sturgeon food habits studies in South Dakota
? sturgeon food habits studies in Montana
? public awareness (signs at boat ramps, angler information, videos, coloring books)

In addition to the above tasks, the Corps conducted a multi-year benthic fish study (1996-1998), which included the Missouri River from above Fort Peck Dam to St. Louis, as well as the Yellowstone River. The pallid sturgeon is found in such small numbers that, by studying its guild, the benthic fish group, information can be gained on the health of the group that can be statistically verified. The benthic fish group also includes fish that are proposed for listing. Data from the benthic fish study provides multi-year baseline information on species, catch per unit effort, Index of Biotic Integrity, and age & growth by reach. Three years of data also provided an indication of annual variance for these parameters.

OPERATION OF THE KANSAS RIVER RESERVOIR SYSTEM

Generic Description of Project and Authorizing Legislation

Clinton, Perry, Tuttle Creek, Milford, Waconda, Wilson, and Kanopolis are the primary downstream flood control dams in the Kansas River basin. Each is located on one of the major tributaries. Waconda is managed by Reclamation, and the other structures are Corps projects. An additional 10 Reclamation reservoir projects and one Corps lake are upstream of these dams providing flood reduction capability mainly in the intervening reaches. Of the total 60,600 mi^2 (156,954 km^2)of basin drainage area, about 9,700 mi^2 (25,123 km^2) is uncontrolled. The uncontrolled drainage area above Wamego is about 5,900 mi^2 (15,281 km^2)and above Fort Riley it is about 5,130 mi^2 (13,287 km^2).

The Corps' projects were authorized by various acts of Congress. The Flood Control Act of 1938 contained a general comprehensive plan for flood control in the Missouri River basin and authorized the construction of Tuttle Creek and Kanopolis lakes. The Pick-Sloan Missouri River Basin Program (Pick-Sloan Program), under the Flood Control Act of 1944, authorized Wilson Lake and most of the upstream projects. The Flood Control Act of 1954 added Milford and Perry lakes as units of the comprehensive plan for flood control in the Missouri River basin. Clinton Lake was authorized by the Flood Control Act of 1962.

The Corps projects are authorized for flood control, water supply and water quality, recreation, and fish and wildlife, either through the initial authorizing legislation or through succeeding acts of Congress. Milford, Tuttle Creek, and Perry are also authorized to support navigation flows on the Missouri River. Harlan County, Waconda, and the other Reclamation projects are authorized for irrigation. The specific authorizations for Tuttle Creek Lake and Milford Lake are listed in Table 4.

The Kansas River is formed near Junction City in central Kansas by the confluence of the Republican and Smoky Hill Rivers. The Republican and Smoky Hill Rivers have their headwaters in northeast Colorado and flow eastward about 500 mi (804.5 km) to Junction City. From Junction City, the combined Kansas River continues to flow eastward about 171 mi (275 km) to join the Missouri River at Kansas City, Missouri and Kansas. The entire basin has a maximum width of 140 mi (225 km) and a total area of 60,060 mi^2 (155.555 km^2) Of this total, the Republican River drainage includes 24,955 mi^2 (64,633 km^2), and the Smoky Hill drainage includes 19,951 mi^2 (51,673 km^2). The remaining drainage area below Junction City includes about 15,154 mi^2 (39,248 km^2). The Kansas River is a major tributary of the Missouri River, comprising about one-ninth of the total drainage area of the Missouri River basin. About 60 percent of the Kansas River basin lies in the northern half of Kansas, with the remaining portions of the basin in southern Nebraska south of the Platte River and in northeast Colorado.

Table 4: Kansas River Tributary Reservoirs

Project	Operating Purposes	Authorized Purposes	Authorizing Laws
Tuttle Creek Lake			
	Flood Control	Flood Control	PL 75-761, PL 77-228, PL 78-534
	Water Supply	Water Supply	PL 85-500
	Water Quality	Water Quality	PL 83-780
	Fish and Wildlife	Fish and Wildlife	PL 85-624
	Recreation	Recreation	PL 83-780, PL 78-534
	Navigation	Navigation	PL 83-780
Milford Lake			
	Flood Control	Flood Control	PL 83-780
	Water Supply	Water Supply	PL 85-500
	Water Quality	Water Quality	PL 83-780
	Fish and Wildlife	Fish and Wildlife	PL 85-624
	Recreation	Recreation	PL 83-780, PL 78-534, PL 79-526
	Navigation	Navigation	PL 83-780

The basin lies entirely within the Interior Plains region and within the Great Plains and Central Lowlands physiographic provinces. The typical landforms are broad flatlands to rolling hills dissected by the river valleys, with several irregular escarpments facing east or southeast. The western headwaters are at an elevation of about 5,500 ft (1,677 m), and the river drops to an elevation of about 750 ft (229 m) at Kansas City. Stream slopes east of Junction City average about 2 ft/mile. Water travel times are in the range of 30 to 60 mi (48-96 km) per day. The upland silty to clay loams are derived from the interbedded shale, sandstone, and limestone bedrock. Floodplain soils are generally sandy to gravelly, particularly in the glaciated portion of the basin downstream of Junction City. The channel of the Kansas River below Junction City is relatively wide and shallow with a meandering course and a sandy bed. A number of gravel and sand operators have permits to remove material from the bed of the lower Kansas River. Channel widths vary from 300 to 1,000 ft (91.5 - 305 m) between high banks 15 to 20 ft (4.6 - 6.1 m) high, locally 30 ft (9.2 m).

A bank stabilization study of the Kansas River was conducted in the 1980s to document stable and unstable river reaches and high erosion areas and the causative factors. Many individual reaches now showing a high degree of activity do not correlate well with reaches that were highly active in earlier years. An example is the Eudora Bend upstream of DeSoto. On the other hand, the Silver Lake reach upstream of Topeka shows signs of being active in earlier years, but it is now relatively stable.

The basin climate varies from low humid in eastern Kansas to semiarid in eastern Colorado and some western areas in Kansas and Nebraska. Average annual rainfall decreases from east to west, varying from 36 in. to 14 in. (91-36 cm). The variations from normal climatic conditions from season to season and from year to year are very great. The climatic history of the basin includes intense and prolonged rainfall during some years and severe droughts and dust storms in others without a fixed cyclic pattern.

The decade from 1950 to 1960 included the maximum flood of record as well as a severe drought period comparable to the most severe 5 years of drought in the 1930s. The more memorable climatic event was the prolonged wet spell during the spring and summer of 1993, climaxed by a series of strong storms that in many cases resulted in the highest lake elevations of record. The resulting high river flows carved new channels and scoured existing sand bars, creating good habitat for the least terns and piping plovers.

Generally, floods and the associated damages are of two classifications. The first, less frequent but more severe, is flood flows due to prolonged periods of rainfall which saturate the soils, raise the water table, and bring the streams to bankfull stage. These are climaxed by a period of intense rainfall producing considerable and extensive damage to both rural and urban developments, with major losses occurring at urban and industrial centers. The 1993 flood was of this type. The second, which is more frequent, is the overflow produced by storms of the cloudburst type over small areas and result in considerable local damage to crops, lands, transportation facilities, and other properties in rural areas, with possibly some urban damage. Those flash floods are seldom of sufficient volume or duration to cause general flooding of the mainstream valleys.

The natural vegetation type in the river bottomlands is floodplain forest and grasslands, which is composed of medium to tall broadleaf deciduous forest with a dense understory. Bottomland wetlands with occasionally wet prairies interrupted this deciduous forest growth. Most of the eastern two-thirds of the basin have been converted to irrigated and dryland corn, wheat, milo, soybeans, melons, and alfalfa. The hill land is largely devoted to pasture and hay. The western areas tend more to dry land farming. Irrigation activity is the largest contributor to basin runoff depletions, with lake evaporation adding about 20 percent to the total. The historic average runoff at DeSoto is about 5.4 MAF. A recent study of Kansas River basin depletions conducted by the Bureau of Reclamation for the Corps indicates that annual basin depletions at the 1996 level of development total about 1.2 MAF, of which about 75 percent occurs upstream of Junction City in the Smoky Hill and Republican River basins (USBR 1999).

The U.S. Geological Survey (USGS) and National Weather Service, in cooperation with the Corps and other agencies, maintain a system of stream gauges and meteorological stations along the Kansas River. Table 5 lists pertinent data about the current stream gauges along the main stem of the Kansas River. The Wamego gauge has been used as the target flow gauge in recent years for managing upstream lake releases for the benefit of the terns and plovers. Despite the increase in irrigation depletions over the years, there appears to be an increase in basin runoff not just due to the recent wet years. For instance, the average runoff at DeSoto, reflecting 25 years of additional record since the Bonner Springs gauge was discontinued, is much higher than the latter. A similar comparison can be made with the Fort Riley and Ogden gauges.

Table 5: USGS Stream Gauges Along the Kansas River

Stream Flow Gauge	USGS ID No.	River Mile	Basin Area (Sq. Miles)	Period of Record	Avg Annual Flow (cfs)	Avg Annual Runoff (AF)
Fort Riley	06879100	168.9	44,870	1963 - current	2,974	2,155,000
Ogden	06879500	166.8	45,200	1917-26 27-51	2,645	1,916,000
Wamego	06887500	126.9	55,280	1919 - current	5,286	3,829,000
Belvue	06888350	115.0	55,870	1982 - current	7,443	5,392,000
Topeka	06889000	83.1	56,720	1917 - current	5,948	4,309,000
Lecompton	06891000	63.8	58,460	1936 – current	7,511	5,441,000
DeSoto	06892350	31.0	59,756	1917 – current	7,577	5,489,000
Bonner Springs	06892500	20.8	59,928	1917-73	6,766	4,902,000

Operation of Tributary Lakes and Local Protection Projects

Specific operations for various lake purposes are described in following sections (USACE 1966). Typically, the flood control pools are designed to store runoff from major floods up to about the 1993 flood level. Typically, they continue to store water until downstream flows drop below about 60 percent of the channel capacities. The target flows vary with the amount of stored water in the lakes (see the later section on flood control). Stored flood flows are then evacuated as rapidly as the downstream channel capacities allow. When flooding is not occurring, the Corps attempts to maintain the lake elevations near the multipurpose pool level to benefit lake recreation and fish and wildlife. Minor releases at some projects are managed to benefit downstream fish and wildlife and special requests from river users. Minimum releases are maintained for water quality control in the first reach downstream. Large portions of the multipurpose pools at Milford, Tuttle Creek, Perry, and Clinton have been purchased or reserved by the State of Kansas for downstream municipal and industrial water supply in cooperation with the Kansas River Water Assurance District No. 1. Releases from the contracted storage must be approved by the Kansas Water Office. The live storage in the multipurpose pools at the irrigation projects likewise has been contracted to irrigation districts. A portion of each multipurpose pool is reserved for sediment storage and fishery conservation. A portion of the multipurpose pools at Milford, Tuttle Creek, and Perry are also reserved for maintenance of navigation flows on the Missouri River.

Levee and bank protection projects to protect principally urban areas along the Kansas River and major tributaries are designed to operate in conjunction with the reservoir projects to prevent flooding of those areas from the most severe flood events of record. Local protection projects downstream of the lakes are designed to be effective during the standard project flood, similar to the 1951 flood. The primary local protection projects on the Kansas River include the Kansas Cities (three units along the Kansas River, four units along the Missouri River), Lawrence, Topeka (eight units), Manhattan, and Fort Riley. Local protection projects have also been constructed at Abilene and Salina on the Smoky Hill River and at a number of locations along tributaries.

Flood Control

The lower basin lakes, augmented with the upstream reservoir system and the local protection works, are intended to provide a high degree of protection for the urban population centers along the Kansas River, including the Kansas Citys, when operated as a system. The severity of floods over rural areas will also be greatly reduced, but without agricultural levees this type of damage will continue to be substantial during major floods. The lower basin lakes have a combined capacity of 5.16 MAF specifically allocated to flood control which is supplemented by an additional 1.73 MAF of upstream flood storage capacity. The flood control capability of the Kansas River system of lakes also extends downstream along the Missouri River to Waverly. During major floods, the Kansas River system flood storage capacity is coordinated with the capacity from the main stem reservoirs upstream of Omaha to provide flood control benefits along the lower Missouri River and the Mississippi River downstream of St. Louis.

General flood control criteria are as follows: (1) Flood control storage space is reserved for the control of floods. (2) Releases are made to evacuate accumulated flood control waters only when the river channels downstream can pass the releases without resulting in further flooding, accounting for local inflows and travel time. (3) In determining priority of releases from individual projects, consideration is given to the unoccupied flood control storage space in each lake and the potential that future basin runoff upstream of a dam will fill the flood control pool behind that dam. The equation also accounts for travel times to downstream flood damage centers in such a manner that flood control benefits are maximized. (4) The seasonal hydrologic characteristics of each inflow basin are recognized in developing the plan for evacuating accumulated flood storage. (5) Surcharge storage above the normal flood control pool is used only in conjunction with the respective spillways to control floods in excess of project capacity and to preserve the safety of the respective structures.

The flood control pool at each lake is divided into three zones for each season in diagrammatic form termed the Seasonal Guidelines. The zones are designated in order from lowest to highest as Phase I, II, and III. Phase I storage occurs with every significant flood flow requiring flood control storage. Releases made to evacuate stored water in this zone should not exceed about 60 percent of channel capacity downstream. This provides a margin of safety if an unexpected storm arrives, increasing local inflows below the dam. As the lake fills, the chance that a future storm will fill the remaining flood control pool storage space increases, as does the danger to the dam and downstream damage centers. Therefore, it becomes more urgent to evacuate the accumulated flood storage. In the Phase II zone, releases are made to essentially fill the downstream channel capacity up to the flood stage. This means that an unexpected storm will likely result in out-of-bank flows at the damage center. The Phase III zone is usually the last 10 percent of the flood pool. At this point, flood control operations begin to transition to a surcharge operation. Releases are intended to fill the downstream channels to a level that will not exceed what the Weather Service refers to as moderate flooding. This can result in damage to agriculture and outbuildings, but homes and businesses should still be protected. The portions of the flood pool assigned to each zone varies seasonally to reflect the higher probability of major rainstorms in the spring.

At Wamego, the Corps found in the last 2 years that Kansas River stages above 8 ft (2.4 m) (about 12 Kcfs) would potentially wash away nesting terns and plovers. This compares to a Phase I regulating discharge at Wamego of 14.5 ft (4.4 m) (about 39 Kcfs), a flood stage of 19.0 ft (5.8 m) (about 65 Kcfs), and a Phase III stage of 21.0 ft (6.4 m) (76 Kcfs). Regulating the river at Wamego to an 8-ft (2.4 m) target stage has the effect of increasing the average amount of flood water stored in the upstream reservoirs. As the probability that the flood control pools will fill into the Phase II and Phase III zones increases, downstream flood protection is reduced and the probability of damage increases.

Analysis of the flow duration curves for Wamego shows that except for reduction of floodflows, present lake regulation plans have only a limited effect on the downstream flow regime. Extremely low flows are increased in duration, low to moderate flows (representing 60 to 80 percent of the flow days) were reduced in duration, moderately high flows (representing the upper 10 to 20 percent of flows) were increased, and high flood flows at the upper 1 to 5 percent of the curve were reduced. Regulation of the lakes is largely a pass-through operation with little long-term carryover storage. A significant portion of the high streamflows on the main stem Kansas River is generated by uncontrolled drainage and cannot be altered by the existing system.

Municipal, Industrial, and Rural Water Supply and Water Quality

Minimum releases from each of the Federal reservoirs in the Kansas River basin were established during the original design and authorization process using U.S. Public Health Service guidelines for downstream water quality needs along the tributary before it reaches the Kansas River. Minimum releases range from 7 cfs to 100 cfs. Clinton is also authorized to provide supplemental low flow releases for downstream fisheries during April through September. Authorizations were also included at Milford, Tuttle Creek, and Perry lakes for low flow supplementation for water quality on the lower Kansas River and the Missouri River at Kansas City. Releases for water quality supplementation can be adjusted according to changing conditions, but current water control plan documents anticipate total releases from the three reservoirs on the order of 500 cfs for the Kansas River and to 3 Kcfs at Kansas City. Milford, Tuttle Creek, and Perry lakes also are authorized to provide short-term releases for navigation supplementation at Kansas City of as much as 4 Kcfs. Tuttle Creek is the primary reservoir source for navigation supplementation.

Under the Water Supply Act of 1958, and amended by the Federal Water Pollution Control Act amendments of 1961, State and local interests were authorized to purchase storage rights in the multipurpose pools of most Federal lakes. The Act also set the policy of recognizing the primary responsibility of States and local interests to develop water supplies for domestic, municipal, industrial, and other purposes. Since then, the State of Kansas has reserved or purchased most of the multipurpose storage in Milford, Tuttle Creek, Perry, and Clinton allocated for various water supply purposes. The water supply storage also covers low flow supplementation needs for water quality on the Kansas River, but not on the Missouri River.

The State of Kansas initially reserved storage in Milford and Perry Lakes under the terms of the Federal Water Supply Act of 1958 and the State Water Plan Act passed by the 1963 Kansas Legislature. In 1965 the State of Kansas enacted the "State Water Plan," which is supplementary to the State Water Plan Act and implementing the same. And in 1986 the Kansas legislature enacted the Water Assurance Program Act. That legislation assigned to the Kansas Water Office the authority to negotiate with the Federal government to contract for multipurpose storage in each lake for water supply and quality, which in turn would be contracted to local users. Water right holders are thereby provided with water during times of low flow, while the state operates the lakes in a river basin as a system for increased efficiency in water delivery to other potential users. It also established long-range planning procedures and goals for flood control, conservation, development, utilization, and disposal of the waters of the state. None of the provisions in the State Water Plan Act were intended to conflict with flood control or conservation plans already authorized for the projects.

The Kansas Water Office then assisted in the formation of the Kansas River Water Assurance District No. 1 and entered into a Memorandum of Understanding with the Department of the Army to give the state the first purchase option for multipurpose storage in Tuttle Creek and a number of other lakes in Kansas. The Assurance District includes municipal and industrial water right holders along the Kansas River from Junction City in the west to the Kansas-Missouri border in the east. Reserve capacity in Milford and Perry previously purchased under the State Water Plan Act was then transferred to the Assurance program. Separate contracts for municipal water supplies from Clinton Lake are not affected by the Assurance program. The State of Kansas has now contracted for use of 300,000 AF of the total 390,000 AF of multipurpose storage at Milford, 50,000 AF of the total 300,000 AF at Tuttle Creek, 150,000 AF of the total 210,000 AF at Perry, and 89,200 AF of the total 125,000 AF available at Clinton. Portions of the remaining storage in each lake are reserved for sediment. Releases for low flow supplementation on the Kansas River beyond the specified minimum lake releases are coordinated with the Kansas Water Office and through them with the Assurance District and other state offices.

Irrigation

Irrigation developments during the 1800's began under riparian law and were later controlled to varying degrees by the State governments. The more extensive developments occurred in the western parts of the basin, particularly in the Republican River drainage area in Nebraska and Colorado. In the State of Kansas, water appropriations were first recognized by the legislature in 1866. Acts in 1907 and subsequent years strengthened the law and recognized other water uses. Irrigation is part of the authorized project uses of all Reclamation reservoirs in the District. It is also an authorized use of the Harlan County multipurpose pool. All authorized irrigation storage space in Federal lakes in the District has been contracted out to irrigation districts. Reclamation regulates the release of water from this contracted storage at all of its projects as well as from the Harlan County multipurpose pool. Irrigation releases are not a factor in controlling flows at Wamego.

Navigation

The Missouri River navigation season normally lasts from about April 1 to December 1 at its mouth. The length of the season and the level of navigation support are dependent on main stem water supplies. Maintenance of navigation flows on the Missouri River is one of the uses of the main stem reservoirs. However, the authorizations for Milford, Tuttle Creek, and Perry Reservoirs on Kansas River tributaries include supplemental flows for maintenance of navigation on the main stem of the Missouri River (PL 83-780). Water from lower Kansas River basin reservoirs may be used effectively to augment releases from the main stem reservoirs when natural gains in flow between Nebraska City and Kansas City are less than the increase in requirements for navigation, or a maximum of about 4 Kcfs.

The Corps has established guidelines in the Water Control Manuals for the release of water from the joint use storage space available in each lake. The guidelines are intended to balance the needs of the multiple purposes authorized at each lake. The joint use space is used for navigation and water quality supplemental flows, recreation, fish and wildlife, and sediment storage. It is separate from the multipurpose space specifically allocated to water supply.

For example, the Corps' guidelines specify that supplemental releases for navigation from Tuttle Creek are limited each year to that storage above elevation 1072 msl. during the main recreation season from Memorial Day through Labor Day. Following Labor Day and throughout the remainder of the Missouri River navigation season, supplemental storage for Missouri River navigation purposes will be limited each year to that storage above elevation 1061 msl except that sufficient reserve storage above this elevation will be retained at the end of the navigation season to assure maintenance of Kansas River low flows. Releases for navigation supplementation are coordinated with the Kansas Water Office and the Corps' Reservoir Control Center.

Hydropower

No provision has been made for lake releases in the interest of hydropower, but the Bowersock Mill plant at Lawrence is kept informed of changes in lake releases and forecasts of flows above and below the plant. A non-Federal sponsor could request a Federal Energy Regulatory Commission license to install a hydropower plant at any of the dams, but the application would have to be evaluated against other project and uses.

Recreation

The growing population in the Kansas River basin, as elsewhere, has led to increasing demands for outdoor recreational opportunities. The lower Kansas River basin lies in a region practically devoid of natural outdoor recreational opportunities, particularly of an aquatic nature. Water sports or activities carried out on land adjacent to water are the most sought after forms of recreation. Facilities in and near the Kansas River valley for water-related recreational activities consist of the four Federal projects, six lakes under the jurisdiction of the State of Kansas, and many other lakes under the jurisdiction of county or city governments.

A comprehensive master plan for recreational purposes and land management for each project in the basin has been prepared in coordination with the National Park Service, the Service, the U. S. Public Health Service, the Kansas Department of Forestry, KDWP, the Kansas Park and Resources Authority, and the Kansas Board of Health. Provisions have been made at each lake for interior roads, parking areas, boat launching ramps, group shelters, comfort stations, drinking water supplies, and other facilities for picnicking or camping.

Optimum recreational use of the lakes depends on maintaining the lake elevations near the multipurpose pool level, particularly for the boat ramps, marina facilities, and swim beaches. Moderate rises in the pools do not have a large impact on recreation. Some boat ramps and beaches become unusable when more that 25 percent of multipurpose pools are lost. Most of the recreational use occurs in the summer, but fishing and hunting access is important throughout the year.

Fish and Wildlife

A wide variety of fish and game species occur within the Kansas River basin but aquatic resources can be limited in the western parts of the basin due to long periods of little or no stream flow. In the more humid eastern parts of the basin, natural stream flows are sufficient to support significant populations of fish and other aquatic organisms. Some mammals, birds, and fish species provide significant recreational opportunities for anglers, hunters, and non-consumptive recreationists. Rapidly developing interest in hunting and fishing has resulted in increased pressure on the land and water for all uses, often to the detriment of natural resources. Water development programs are assisting in maintaining those resources at a level commensurate with their importance by providing for fish and wildlife considerations in the planning, construction, and operation of the projects. Comprehensive State and Federal wildlife management programs have been initiated in response to the growing concern over the depletion of those resources.

Close cooperation between the KCD office, project operating personnel, and KDWP has resulted in operation plans recognizing lake fish and wildlife management objectives. One significant feature of this cooperation is the annual approval of water level management plans at each lake. Those plans modify the effective multipurpose pool elevation for water release guidance to benefit fish and wildlife and recreation on the lake. The maximum modifications add to or reduce the flood pools about 5 percent of the total flood control storage space during certain seasons. Those plans are reviewed and modified annually in cooperation with the states. In recent years, additional provisions have been reviewed and approved for downstream flow management in hopes of benefitting downstream fisheries as well.

The typical water level management plan for Tuttle Creek Reservoir calls for a low winter level for ice control and to provide additional buffer storage for large winter and spring flows. Once the lake ice cover is established, the pool is maintained at a steady level to reduce shoreline and riprap erosion and displacement. In the spring, a slow pool rise is preferred to enhance fish spawning. For the same reason, large releases are minimized to prevent washing fish spawners along the face of the dam downstream. Later in the spring and in the summer, the pool is usually maintained close to the multipurpose level to enhance recreation and maximize flood control benefits during the wet season. Sometimes in the late summer or early fall, the pool may be lowered to enhance shoreline vegetation growth. Then later in the fall the pool is allowed to rise when water is available to inundate the growth and maximize waterfowl habitat and hunting access. In late December the pool is lowered to its winter level.

System Limitations

The ability to control flooding at tern and plover nesting sites is limited due to long travel times from the controlling lakes and the opportunities for large uncontrolled local inflows. In general, the water travel time with bank full flows is about 40-50 mi (64-80 km) per day. The travel time from Kanopolis, Wilson, and Waconda lakes to Junction City is about 4 days, and therefore those lakes are typically not operated for points below Enterprise. The travel time from Ft. Riley to DeSoto is another 4 days, with another day travel time to the Missouri River control point at Waverly. During low and moderate flows, the travel time increases about 50 percent. Most of the tern and plover nesting occurs in the reach from Manhattan to below Topeka. Wamego tends to be the index gauge in that reach. Only Milford and Tuttle Creek are in a position to reduce flood flows at Wamego. During moderate and high flood flows, the controlling damage point for lake regulation often becomes Waverly, because of the restricted channel capacity on the Missouri River at that point.

The longer the travel time for flows from a lake to a downstream target flow point, the less chance the lake will be able to provide effective stage control because of the incidence of local inflows. From Milford Lake to Wamego travel time is about 2 days, and from Tuttle Creek to Wamego it is about 1 day. For points within one day travel time downstream, the lake releases can be reduced soon enough to have a large impact on potential flood flows, although sometimes the flood flows cannot be entirely eliminated. Peak local flows generally occur in the intervening local reach within one day after a storm, and the effectiveness of the lake decreases rapidly after one day and with the magnitude of the storm.

The normal regulating flood discharge at Wamego is 39 Kcfs (stage of 14 ft). That was exceeded during just one flood event in 1999, but multiple events are common in many years. The 1999 target stage of 8 ft (about 12 Kcfs) at Wamego to benefit bird nesting on the sandbars is normally exceeded many times. Flood control regulation primarily reduces very high flows and increases the duration of very low flows. Normally, it has little impact on moderate flow levels.

Use of stored lake water to maintain low river flows for water supply and water quality is more effective than flood control since the primary concern is maintaining base flows. Normal minimum lake releases are supplied by natural inflows. Special releases from multipurpose storage for downstream flow support is generally only necessary during extended drought, and the maximum lake release is approximately 1 Kcfs, and rarely 4 Kcfs for Missouri River navigation.

The maximum flow targets at Waverly on the Missouri River often limit flood control storage releases from the Kansas River lakes. During high flow years on the main stem, such as in 1997, this limitation can occur more often than restrictions due to flows on the Kansas River itself. In some years, approvals are obtained to regulate to the Phase II flow target at Waverly instead of the Phase I target. That can sometimes result in larger releases than normal from the Kansas River lakes after a flood at Waverly.

The Kansas River lakes have substantial multipurpose pool storage, but under current operation plans they have limited ability to support moderate flows on the Kansas River. Wet years provide more opportunity for downstream flow support than dry years when lake inflows are low and there is little opportunity to store water for later releases. The multipurpose pools at all Reclamation reservoirs have been contracted to irrigation districts. Limited portions of the multipurpose pools at the four lower Kansas River lakes are reserved for support of downstream navigation flows and sediment. Larger portions have been contracted to the State of Kansas for water supply and quality control. The contracted space is only utilized for downstream releases during drought situations. Drawdowns from the multipurpose pool level can have a negative impact on lake recreation and fish and wildlife.

System Flexibility

Much of the flood control flexibility of the reservoir project system is derived from the ability to regulate each lake within broad bands defined by the seasonal phase diagrams. Flexibility increases when normal basin runoff occurs. The flexibility of the system becomes much more restricted as the flood control pools and the urgency to evacuate accumulated flood control storage increases. Because the Kansas River basin is subject to prolonged droughts it is desired to maintain the lakes at multipurpose pool. This also enhances recreation opportunities and fish and wildlife habitat. While a routine operational pattern is followed, detailed plans for specific floods are not a part of the normal operating plans. Additional flexibility is in planning navigation release requirements, since the increase in navigation flow above minimum levels is a matter of operating judgment each year and is determined by system storage that year.

Conservation Measures for Threatened and Endangered Species

The large and prolonged flood flows of 1993 scoured a number of sandbars in the Kansas River of vegetative cover. The Federally listed interior least tern and piping plover were discovered nesting for the first time on the Kansas River in 1996 on several recently scoured sand bars in Wabaunsee County between Manhattan and Wamego. That was the first documented account of piping plovers nesting in Kansas, and the first account of least terns nesting on the Kansas River.

In 1997, the KDWP conducted an aerial survey of the Kansas River for these species. Although piping plovers were not visible from an airplane, the observers did locate two separate sites with least tern activity upstream of Wabaunsee and downstream of Wamego. Additionally, they observed potential nesting habitat for both species in the river as far downstream as St. Marys. Similar monitoring of nesting activities occurred in 1998 and 1999. The monitoring in 1999 was conducted by Dr. Boyd of Baker University and funded by the Corps of Engineers.

Lake operations during the nesting season have been altered since 1998 to avoid adverse impacts to listed species. During the nesting season, the Corps has coordinated extensively with the Manhattan office of the Service to avoid adverse impacts. In general, the altered lake operation has involved reducing target stages on the Kansas River to avoid flooding existing nests with releases from Corps lakes. In coordination with the Service, weekly field observations are made of nest sites and a river elevation is maintained that will provide protection for the nests. No water is released from Corps lakes which would increase river stages and inundate nests. Releases from Corps lakes are only increased when there is a decrease in the baseflow of the Kansas River and then only enough to maintain the existing river stage. Releases from Corps lakes are reduced when a rise in the unregulated baseflow of the Kansas River occurs upstream of the nesting colonies. The Service is consulted with after any unregulated high flows occur on the river that flood nests and also prior to resuming normal lake operations.

The KCD will continue monitoring the Kansas River in the future for nesting piping plovers and least terns and continue to coordinate lake operations during the nesting season with the Service.

OPERATION AND MAINTENANCE OF THE MISSOURI RIVER BANK STABILIZATION AND NAVIGATION PROJECT

Generic Description of Project and Authorizing Legislation

Three major authorities have shaped the present condition of the BSNP. Those are the River and Harbor Acts (RHA) of 1912, 1927 and 1945. The 1912 RHA authorized a 6-ft (1.8 m) deep channel from the mouth to Kansas City, MO. The 1927 act authorized a 6-ft (1.8 m) deep by 200-ft (61 m) wide channel, and extended the project to Sioux City, IA. The 1945 act increased the authorized channel to 9-ft (2.7 m) deep by 300-ft (91 m) wide. The existing project extends 735 mi (1,182 km) from Sioux City, IA to the mouth of the Missouri River near St. Louis, MO, and maintains a 9-ft (2.7 m) deep by 300-ft (91 m) wide channel. The project consists mainly of revetments along the outsides of bends and transverse dikes along the insides of bends to force the river into a single active channel that is self-maintaining. Approximately 200 million tons of stone was placed during original construction (75 million in the Omaha District and 125 million in the KCD). The bulk of the construction was completed after World War II during the 1970s, and 99 percent of the sill structures were constructed before 1981. Significant new structures were constructed after the floods of 1993, 1995, and the high water of 1997, and many other structures have been modified by lowering or notching as part of the operation and maintenance of the project.

Operation and Maintenance

Maintenance on the Missouri River BSNP can be broken into two categories, routine and non-routine. They can be distinguished by the type of work and/or the event(s) that cause the need for the maintenance. Either type of maintenance can be needed to support both project functions of bank stabilization and navigation. Non-routine actions are not programmatic in nature and therefore require separate ESA compliance, and are not addressed in this Biological Opinion.

Routine maintenance, as a rule, is preventative in nature. In other words, maintenance is pro-actively scheduled to prevent project deficiencies (excessive shoaling, thalweg meander, etc), and is caused by normal run-off conditions and ice. Routine maintenance can be generally described as replacement of stone lost to normal hydrologic cycles and general deterioration of riprap material. That does not involve new structures, structure extensions, and with the exception of marker clumps generally does not include raising the elevation of structures. However, routine maintenance is necessary for the continued integrity and function of the existing structures of the BSNP. That maintenance is usually funded through routine, or baseline, budget allocations. Nearly all maintenance work for Omaha District (RM 735 - 498) is performed from a floating plant by in-house labor forces. The KCD (RM 498 - 0) uses its in-house labor forces to perform 10 percent of the maintenance. The rest is performed by contract. A list of structures and their typical routine maintenance needs are summarized in Table 6.

Table 6. Routine maintenance associated with the Missouri River Bank Stabilization and Navigation Project.

Structure Type	Description of Maintenance Needs
Revetments	Scour along the toe can cause the upper bank paving to slide down the bank leaving the upper bank exposed to erosion. Small holes (< 50 ft) (15.2 m) do not cause problems for either bank stabilization or navigation unless there is some landward feature (chute, oxbow, etc.) that can cause a major change in flow around the bend. Holes from 50 to 100 ft (15.2-30.5 m) in length can begin to cause navigation problems. Tows navigating at night can begin to lose site of the bankline. Also, as the bankline becomes irregular, the channel roughness changes, which can lead to changes in the shoaling pattern within the sailing line. Holes larger than 100 ft (30.5 m) are generally considered navigation hazards, and may lead to thalweg instabilities if not corrected.
Dikes	Routine over topping, riprap material breakdown, and ice action all tend to deteriorate the crown and riverward ends of the dikes. Minor losses in length do not generally lead to project deficiencies, particularly for dikes in the middle portion of the bend, as long as consecutive dikes are not noticeably damaged. Minor damage to the crown of a dike is not cause for alarm, as long as most of the crown is at the maintenance elevation. Significant and/or prolonged over topping can lead to flanking of the dike, which if severe enough can lead to shoaling in the sailing line. On rare occasions routine dike deterioration can lead the thalweg stability concerns.
Sills	Routine sill damage is caused by continuous over topping and ice action, and is totally related to navigation problems. Sills were constructed in locations where thalweg meander historically cased navigation problems. Even small deterioration of the sills can cause navigation problems.
Crossing Control Structures (Kickers)	Kickers are routinely damaged by over topping, riprap material breakdown, and ice action. Their purpose is to provide a more reliable depth through the crossing by effectively narrowing the active river channel. A deteriorated kicker will lead to instability of the cross and can itself become a very serious navigation hazard.

Occasionally, existing structures are salvaged, and the stone from one structure is used to maintain others within the general area. Salvage operations are conducted mostly in the reach above Decatur, Nebraska (RM 691), and are generally conducted in the winter months. Extensive salvage work also involves considerable disturbance of the high bank. Hired labor performs nearly all of this work.

Non-routine maintenance that is not preventative is aimed at local problems caused by deterioration of existing structures. Those problems can be chronic, transient, or occur only once. Reach or system problems are not addressed through routine maintenance, as they generally require major structural modifications.

Deferring routine maintenance for a single season has only a slight impact to project performance.

Changes in the channel and over bank conditions are relatively small, on both a spatial and temporal scale. There is generally no measurable increase to top width or change in the depth distribution through the bend, but rather a change in the location of deep and shallow water. Continued deferment will lead to thalweg meander over longer reaches and possibly some erosion of the high bank adjacent to the channel. However, changes in depth distributions, increases in top width, and channel avulsions are not likely as the base/toe of the individual structures is well entrenched. That has been demonstrated in a five-mile long test reach in the upper part of the project.

The physical configuration of dikes, sills and kickers may deteriorate, as discussed in Table 6, following the performance of routine maintenance procedures. The river's response to this changed condition may be the development of conditions which provide less than optimum conditions for navigation. That response may also be more pronounced within specific discharge ranges.

One such response is shoaling. Shoaling in the channel may result in reduced depths and/or reduced top width. If the problem persists over an extended period of time or is significant enough to impede navigation, river structures in the immediate vicinity are repaired to design lines and grades. If repairing structures to lines and grades does not correct the problem, additional structures may need to be designed and constructed. However, shoaling problems rarely require additional structures as the original layout provides for a reliable navigation channel over a wide range of flow conditions.

Another such river response is bank erosion. Dikes, on occasion, become flanked permitting water to flow between the dike and the bankline. The primary cause of flanking are stages which consistently run 5 to 10 ft (1.5-3.1 m) above the construction reference plane (CRP) elevation for an extended period of time, overtopping the dike and eroding the bankline. The construction reference plane (CRP) was established to aid the design of river structures on the Missouri River BSNP. CRP is an imaginary sloping plane that is approximately the elevation of average low flows on the Missouri River. The CRP was initially established by the Missouri River Commission in 1889, with subsequent revisions by the Corps in 1931, 1938, 1960, 1973, 1982, and 1990.

The dikes most susceptible to flanking are dikes that do not extend back into the bank and that do not have adequate scour protection near the bank. In general, once a dike becomes flanked, the bank erodes rapidly forming a deep scarp landward of the dike. Scarps range in size from 3 to 10 ft (.9-3.1 m) long and can erode landward as much as 25 ft (7.6 m). The cross sectional area between the dike and the bank is dependant on the proximity and layout of adjacent structures. Flanked dikes are repaired by extending the dike landward into the high bank. Most dike extensions are less than 25 ft (7.6 m) long. Revetments also may fail due to scour along the toe leaving the upper bank unprotected, as discussed in Table 6. If repairs are warranted, the revetment is repaired to design lines and grades.

Maintenance of the Kenslers Bend portion of the river (RM 753.5 to 735) is very similar to the maintenance of the navigation portion of the project with the following exceptions. First, the Kenslers

Bend Project is a bank stabilization project only. Therefore there are no sills or kicker structures to maintain, and second, all maintenance is aimed at preventing channel meander. Thalweg meander is quite common. Maintenance activities include replacement of stone on dikes and repair of large holes in the revetments, in an effort to prevent general channel meander. The structures in this reach of the river are subject to the same maintenance guidelines as mentioned above. Maintenance is not performed on this reach of the river each year. Stone from some structures is salvaged for use elsewhere, and few structures have been almost completely salvaged.

Changes to Established Operation and Maintenance Practices

Original maintenance called for all structures to be maintained at their as-built lines and grades. That was expensive and logistically difficult, requiring as much as 1,000,000 tons of maintenance riprap in some years. As the self-maintaining channel became established and maintenance costs increased, structures located landward of the high bank were giving a lower priority. In 1988 the KCD and Omaha District along with the Missouri River Division developed new formal maintenance guidelines that are still in use today. Those guidelines were intended to: (1) reduce operation and maintenance costs, (2) manage encroachment of the high bank into the channel, and (3) help identify structures for salvage. Presently, approximately 120,000 tons of riprap is placed per year (20,000 in the Omaha District and 100,000 in the KCD) or approximately 0.06 percent of the original construction. The results of implementing the new maintenance guidelines are: (1) the maintenance elevation of nearly every structure has been lowered, (2) critical structures have been identified and are given a high priority, and (3) structures are allowed to deteriorate further before maintenance is initiated. Those guidelines have achieved two fo the intended goals; reduced maintenance costs and encroachment of high bank into the channel.

History of Modification for Fish and Wildlife Habitat Improvement

Since 1974, the Corps has restored some side-channel connections and increased habitat diversity in the channelized Missouri River by notching dikes or otherwise modifying channel structures (Burke and Robinson 1979). As of June 1980, Omaha District had completed 344 and Kansas City District completed 962 notches. Both Districts continue to modify structures as the opportunities arise, provided impacts are not expected to occur to bank stabilization and navigation. Some notches have resulted from deferred maintenance, but some also have been repaired. The total number of notches for Omaha District has not changed or changed very little since June 1980. Kansas City District kept accurate records of their notch program until 1990. As of March 1990, the KCD had a total of 1,880 notches, which included 168 rootless dikes. The Corps estimates the KCD has constructed 40 notches each year since then (John LaRandeau, pers. comm. 2000, Corps of Engineers, Omaha, NE).

Notching is designed to prevent shoaling around a wing dike from accreting to the adjacent bank. It is one way to maintain aquatic habitat and improve fisheries habitat value associated with those structures. Notching dikes or revetments adjacent to publically owned lands (e.g., Jameson Island, MO) can increase channel width and diversity, and create substantial shallow-water/sandbar complexes at certain river stages. After the 1993 Flood, revetment repairs that allowed continued riverine connection to off-channel scours and chutes have also helped maintain habitat diversity and value, particularly for riverine fishes. Because of limited monitoring, however, we currently can not quantify the extent of habitat benefits from those efforts.

Conservation Measures for Threatened and Endangered Species

The Omaha and Kansas City District will coordinate their respective future routine annual maintenance schedules as agreed to during recent information consultation between the Corps and the Service (Appendix II). As part of this coordination process, the Corps will explore alternative maintenance practices such as notch enlargement, vein dikes, chevrons, etc., in lieu of standard maintenance practices. The alternative maintenance practices will be aimed at increasing depth and velocity diversity, while maintaining the authorized project functions. These actions will be similar to many of the non-routine maintenance activities that were completed after the 1993 Flood, and resulted in the preserving and/or creation of significant fish and wildlife habitat at locations such as Jameson Island in Missouri. The Service believes that these habitats also likely benefit listed threatened and endangered species. In 1999, larval pallid sturgeon were found for the first time in 50 years on the lower Missouri River at Lisbon Bottoms.

Dependent on Congressional action, the Corps will also seek implementation of the expanded Missouri River BSNP Fish and Wildlife Mitigation as authorized by Section 334(a) of the 1999 Water Resources Development Act (WRDA 99).

Refer to the Section on Interrelated and Interdependent Actions for additional discussion on the Mitigation Project.

STATUS OF LISTED SPECIES RANGE WIDE

This section presents the biological or ecological information relevant to formulating the biological opinion. Appropriate information on the species' life history, its habitat and distribution, and other data on factors necessary to its survival, is included to provide background for analysis in later sections. This analysis documents the effects of all past human and natural activities or events that have led to the current range wide status of the species.

BALD EAGLE

References for the information are listing documents, the Northern States Bald Eagle Recovery Plan (USFWS 1983), the Pacific Bald Eagle Recovery Plan (USFWS 1986a), a proposal to delist the bald eagle [64 Federal Register (FR) 36454], and the Corps' Biological Assessments on Missouri and Kansas River Operations (USACE 1998a) and the BSNP (USACE 1999a).

Species Description

Haliaeetus leucocephalus is the only species of sea eagle native to North America. The female bald eagle usually weighs 10 to 14 lbs (4.5-6.4 kg) in the northern sections of the continent and is larger than the male, which weighs 8 to 10 lbs (3.6-4.5 kg). Birds nesting in the north are larger and heavier than birds of the south, with the largest birds nesting in Alaska and Canada and the smallest birds nesting in Arizona or Florida. The wings span 6 to 7 ft (1.8-2.1 m).

Historic and Current Range Wide Distribution

Historically, the bald eagle nested in at least 45 of the contiguous 48 states. The bald eagle ranges throughout much of North America, nesting on both coasts from Florida to Baja California, Mexico in the south, and from Labrador to the western Aleutian Islands, Alaska, in the north. An estimated 250,000 - 500,000 bald eagles lived on the North American continent before the first Europeans arrived. The breeding range of the bald eagle was greatly diminished during the 19th and 20th centuries. Present-day breeding occurs primarily in northern California, Alaska, Oregon, Washington, Minnesota, Wisconsin, Michigan, Maine, the Chesapeake Bay area, Florida, the tri-state corner of Idaho, Montana, and Wyoming, and in parts of Canada.

Bald eagles winter throughout the country but are most abundant in the West and Midwest. Approximately 16,000 bald eagles were counted during the 1992 nationwide midwinter survey of the lower 48 States (Florida, Maine, and Washington data were only partial or incomplete), and approximately 12,000 bald eagles were counted during the 1993 midwinter surveys with 36 States reporting.

Life History

Bald eagles are long lived. The longest living bald eagle known in the wild was reported near Haines, AK, as 28 years old (Schempf 1997). It is presumed that once bald eagles mate the bond is long-term, though documentation is limited. Variations in pair bonding are known to occur. If one mate dies or disappears, the other will accept a new partner.

Bald eagle pairs begin courtship about a month before egg-laying. In the south, courtship occurs as early as September; in the north, as late as May. The nesting season can encompass about 6 months. Incubation lasts approximately 35 days and fledging takes place at 11 to 12 weeks of age. Parental care may extend 4 to 11 weeks after fledging (Wood et al. 1998). The fledgling bald eagle is generally dark brown except the underwing linings, which are primarily white. Between fledging and adulthood the bald eagle's appearance changes, with feather replacement each summer. Young dark bald eagles may be confused with the golden eagle (*Aquila chrysaetos*). The bald eagle's distinctive white head and tail are not apparent until the bird fully matures, at 4 to 5 years of age.

As they leave their breeding areas, some bald eagles stay in the general vicinity while most migrate for several months and hundreds of miles to their wintering grounds. Eagles seek wintering (non-nesting) areas offering an abundant and readily available food supply with suitable night roosts. Night roosts typically offer isolation and thermal protection from winds. Carrion and easily scavenged prey provide important sources of winter food in terrestrial habitats far from open water. Young eagles may wander randomly for years before returning to nest, usually in or close to natal areas.

Population Status and Trends

The bald eagle was listed as endangered under the Endangered Species Protection Act (Act) of 1966 on March 11, 1967 (32 FR 4001). On February 14, 1978 (43 FR 6233), the species was listed as endangered in 43 states except Washington, Oregon, Minnesota, Wisconsin, and Michigan, where it was listed as threatened. On July 12, 1995 (60 FR 36000) the eagle was reclassified as threatened in all 48 conterminous states. On July 6, 1999 (64 FR 36454), the Service proposed to delist the species in the 48 conterminous states. The bald eagle also occurs in Alaska and Canada, where it is not at risk and is not protected under the ESA; and in small numbers in northern Mexico.

At its low point in 1963, an estimated 487 nesting pairs of bald eagles resided in the lower 48 states. In 1998, due to recovery efforts of the Service in partnership with other Federal agencies, tribes, state and local governments, conservation organizations, universities, corporations, and thousands of individual Americans, this number rose to nearly 6000 nesting pairs with close to 7000 young produced.

The recovery goal for the northern states recovery region, which includes most of the project area, is to reestablish a self-sustaining population and to have 1,200 occupied breeding areas by the year 2000 (USFWS 1983). Delisting goals were met in 1991, with 1,349 occupied breeding areas distributed over more than 20 states and an estimated average productivity since 1991 of greater than 1.0. In 1998, the estimated number of occupied breeding areas for the Northern States Recovery Region exceeded 2,200. Some of the states with the most rapidly expanding areas of bald eagle nesting include Iowa, where between 1990 and 1998 the bald eagle population increased from 8 to 83 occupied breeding areas, with more than 100 estimated for 1999. In this same period, Missouri has gone from 11 to 45 occupied breeding areas (53 for 1999).

The recovery goal for the Pacific recovery region, which includes the State of Montana, is to reestablish a self sustaining population and to have a minimum of 800 nesting pairs (USFWS 1986a). Delisting goals for the region were met in 1991. Montana's goal of 121 pairs of nesting bald eagles and attainment of breeding population goals in 80 percent of its management zones (6 out 7 zones) also was met in 1991. The only zone where the breeding population goal was not met was zone 47, which encompasses all of the Missouri River in the State.

Habitat and Food Requirements

Habitat Characteristics - The bald eagle is a bird of aquatic ecosystems. It frequents estuaries, large lakes, reservoirs, major rivers, and some seacoast habitats. Bald eagles usually nest in trees near water, but are known to nest on cliffs and (rarely) on the ground. Nest sites are usually in large trees near shorelines in relatively remote areas that are free of disturbance. The trees must be sturdy and open to support a nest that is often 5 ft (1.5 m) wide and 3 ft (.9 m) deep. Adults tend to use the same breeding areas year after year and often use the same nest, though a breeding area may include one or more alternate nests. In winter, bald eagles often congregate at specific wintering sites that are generally close to open water and offer good perch trees and night roosts. Bald eagles tend to nest and roost away from residential development and human activity.

Food and Feeding Habits - Although the diet of bald eagles is almost exclusively composed of fish, they are opportunistic and will take waterfowl, gulls, and carrion. The species may also use prairies if adequate food is available. Wintering bald eagles depend on suitable night and severe weather roosts in sheltered timber stands (Steenhoff 1976) with an abundant, readily available food supply. Most wintering eagles are found near open water where they feed on fish and waterfowl, often taking those that are dead, crippled, or otherwise vulnerable.

Range Wide Distribution and Abundance of Habitat

Bald eagle habitat is distributed throughout much of North America's aquatic ecosystems. To facilitate the recovery of the bald eagle and the ecosystems upon which it depends, the Service divided the lower 48 States into five recovery regions. The bald eagles subject to this consultation are part of the Northern States Population. Bald eagles nesting in the Upper Midwest (e.g., northern Minnesota) winter in areas such as the Upper Mississippi River, the Missouri River, Great Lakes shorelines, and river mouths in the Great Lakes area.

Factors Affecting the Species Range Wide

Habitat Loss and Degradation - Nesting populations of bald eagles were reduced greatly in many states during the 19th century. Those early declines are attributed primarily to loss of habitat plus mortality from shooting and trapping. Those problems have continued and even accelerated in some localities. Loss of habitat is perhaps the most serious negative factor and certainly the most difficult to halt and reverse. The destruction of secure habitats through land development and increased human activity is adversely affecting the suitability of breeding, non-breeding, and wintering areas and is likely to increase in the future. However, the Service and other Federal, state, tribal and local cooperators from across the Nation have funded and carried out many tasks described within recovery plans. Some habitat threats, however, continue to exist. Those include habitat loss from development and encroachment along the floodplain as an indirect result of flood control; loss and projected losses of riparian communities from direct and cumulative effects of bank stabilization and other river training devices; and declining riparian communities due to lack of regeneration from lack of natural hydrographs and adequate flows in the spring. However, under current laws and existing management strategies, adequate habitat in breeding, non-breeding, and wintering areas has been protected and bald eagle populations have expanded rangewide.

Disturbance, although difficult to assess and evaluate, has been suggested as a cause of reproductive failure in some breeding areas and a factor that adversely affects the suitability of wintering and non-breeding areas. Eagles vary in their response to human activity with some individuals being tolerant while others are easily disturbed. Human disturbance of bald eagles is a continuing threat that may increase as numbers of bald eagles increase and human development continues to expand into the rural areas. Numerous studies have documented that most bald eagles will flush from the nest site if disturbed by human presence (Fraser et al. 1985, McGarigal et al. 1991). Nesting can fail if the disturbance occurs frequently, and the adults may or may not nest again. Through the ESA recovery process, management guidelines have been developed for bald eagle nesting and wintering sites in various portions of the species' range. These practices have successfully reduced human disturbance to bald eagles.

Pollution/Contaminants - The pesticide Dichloro diphenyl trichloroethane (DDT) came into widespread use after World War II. Initially, DDT was sprayed extensively along coastal and other wetland areas to control mosquitos (Carson 1962). Ingestion of DDT through the eagle's diet of fish, waterfowl, gulls, and other prey resulted in eggshell thinning. As a result, many eggs broke when incubated by the parent, while others suffered embryonic mortality and failed to hatch. By the early 1960s, recruitment had dropped and population numbers plummeted. In response to human health risks associated with DDT, it was banned from use in 1972.

By 1976, registrations of dieldrin, heptachlor, chlordane, and other toxic persistent pesticides were canceled for all but the most restricted uses in the United States. Most uses of polychlorinated biphenyls (PCBs) were restricted in 1977 and continued to be phased out during the 1980s (Schmitt and Bunck 1995).

During the 1970s, the Service implemented a monitoring program to examine the long-term trends in the presence of pesticides and other harmful chemicals in fish and wildlife (Schmitt and Bunck 1995). Fish, starlings, and duck wings were collected nationwide between 1972 and 1985. The program tracked a downward trend of DDT concentrations in fish, starlings, and ducks wings paralleled by declining DDE (a degradation product of DDT) concentrations in bald eagle eggs and increasing eagle eggshell thickness (Wiemeyer et al. 1993). Concentrations of other persistent insecticides such as heptachlor, dieldrin, endrin, and chlordane were also documented as declining nationally in fish, starlings, and duck wings.

High concentrations of mercury cause a variety of neurological problems in bald eagles. Flight and other motor skills can be significantly altered. High mercury concentrations may also reduce the hatching rate of eggs. Concentrations of mercury in fish declined significantly from 1969 through 1974 as a result of restriction on its uses, but concentrations have not changed appreciably since 1974. Recent findings have highlighted the importance of atmospheric transport in the maintenance of elevated Hg concentrations and the accumulation of mercury in certain areas, such as Lake Champlain and the Florida Everglades (Schmitt and Bunck 1995).

The most important source of lead affecting bald eagles is waterfowl wounded with lead shot. The requirement in 1991 to use nontoxic shot for waterfowl hunting has reduced the threat of lead poisoning to bald eagles.

LEAST TERN

Species Description

Least terns are the smallest members of the subfamily Sterninae and family Laridae of the order Charadriiformes, measuring approximately 21-24 cm long with a 51 cm wingspan. The sexes are alike with a black-capped crown, white forehead, grayish back and dorsal wing surfaces, snowy white undersurfaces, legs of various orange and yellow colors depending on the sex, and a black-tipped bill whose color also varies depending on sex (Watson 1966, Davis 1968, Boyd and Thompson 1985). Immature birds have darker plumage than adults, a dark bill, and dark eye stripes on their white foreheads.

The least tern in North America was described by Lesson in 1847 (Ridgway 1895, American Ornithologists' Union (AOU) 1957, 1983). The least tern in interior North America was later described as a race of the Old World little tern (*Sterna albifrons*). As a result of studies on vocalizations and behavior, this group is now recognized as a distinct species, with the interior least tern recognized as a subspecies (*Sterna antillarum athalassos*) (AOU 1957, 1983, Johnson et al. 1998).

Historic and Current Range Wide Distribution

The interior least tern is migratory and historically bred along the Mississippi, Missouri, Arkansas, Red, Rio Grande, and Ohio river systems (Coues 1874, Youngworth 1930, 1931, AOU 1957, Hardy 1957, Burroughs 1961, Anderson 1971, Ducey 1981). The range extended from Texas to Montana and from eastern Colorado and New Mexico to southern Indiana. Incidental occurrences of least terns have been reported in Michigan, Minnesota, Wisconsin, Ohio, and Arizona (Campbell 1935, Jung 1935, Mayfield 1943, Janssen 1986, Phillips et al. 1964, Monson and Phillips 1981).

The interior least tern continues to breed in most of its historic breeding range (Figure 3), although its distribution is generally restricted to less-altered river segments (USFWS 1990a). It breeds along the lower Mississippi River from approximately Cairo, Illinois south to Vicksburg, Mississippi (USFWS

1990). In the Great Plains, it breeds along: (1) the Missouri River and many of its major tributaries in Montana, North Dakota, South Dakota, Nebraska, and Kansas; (2) the Arkansas River in Oklahoma and Arkansas; (3) the Cimarron and Canadian Rivers in Oklahoma and Texas; and (4) the Red River and Rio Grande River in Texas (USFWS 1990a).

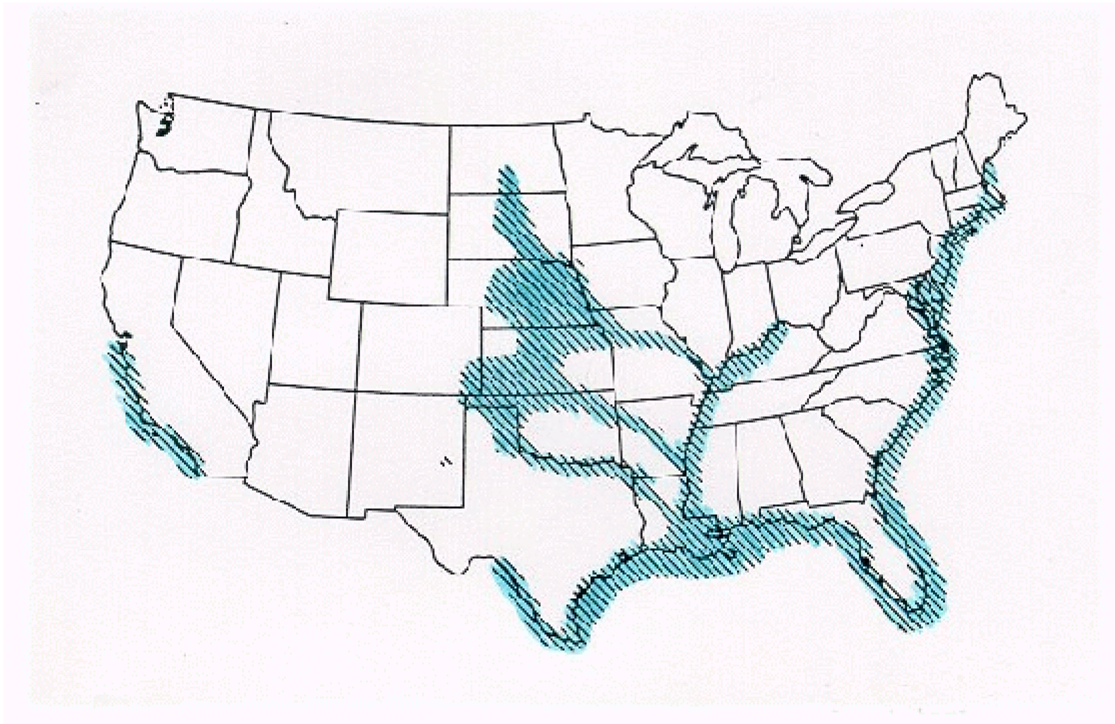

Figure 3. Approximate breeding range of the least tern in the United States (adapted from Thompson et al. 1997).

Opportunistic nesting has recently been recorded in Iowa (Dinsmore et. al 1999) and Colorado (Nelson 1999).

Current wintering areas of the interior least tern remain unknown (USFWS 1990a). Least terns of unknown populations/subspecies are found during the winter along the Central American coast and the northern coast of South America from Venezuela to northeastern Brazil (USFWS 1990a).

Life History

Reproductive Biology - Least terns spend 4 to5 months at their breeding sites. They arrive at breeding areas from late April to early June (Youngworth 1930, Hardy 1957, Wycoff 1960, Faanes 1983, Wilson 1984, USFWS 1987). Courtship occurs at the nesting site or at some distance from the nest site (Tomkins 1959). It includes the fish flight, an aerial display involving pursuit and maneuvers culminating in a fish transfer on the ground between two displaying birds. Other courtship behaviors include nest scraping, copulation and a variety of postures and vocalizations (Hardy 1957, Wolk 1974, Ducey 1981).

The nest is a shallow and inconspicuous depression in an open, sandy area, gravelly patch, or exposed flat. Small stones, twigs, pieces of wood and debris usually lie near the nest. Least terns nest in colonies as small as a single pair to 100+ pairs and nests can be as close as just a few feet apart or widely scattered up to hundreds of feet (Ducey 1988, Anderson 1983, Hardy 1957, Kirsch 1990, Smith and Renken 1990, Stiles 1939). The birds usually lay two to three eggs (Anderson 1983, Faanes 1983, Hardy 1957, Kirsch 1987, 1988, 1989, Sweet 1985, Smith 1985). Both sexes share incubation which generally lasts 20 to 25 days but has ranged from 17 to 28 days (Moser 1940, Hardy 1957, Faanes 1983, Schwalbach 1988). Least tern chicks hatch within one day of one another and stay near the nest bowl for several days. Departure from colonies by both adults and fledglings varies, but is usually complete by early September (Bent 1921, Stiles 1939, Hardy 1957).

Growth and Longevity - Young least terns are somewhat precocial and are brooded for about 6 days after hatching. At that time, they are strong enough to wander from the nest on their own. Chicks are able to fly by about 20 days after hatching, but do not become competent at fishing until after migrating from the breeding grounds in the fall (Hardy 1957, Tomkins 1959, Massey 1972, 1974). They depend on some parental care even after they have become strong fliers. Paige (1968) has noted young eastern least terns actively foraging for themselves by about 5 weeks of age.

Tomkins (1959) recovered a 5 and a 10-year-old eastern least tern in Georgia. Massey (1973) recovered five banded California least terns ranging from 5 to 15-years-old. Three of these birds were 13-years-old or older. Boyd (1983) recovered two interior least terns in Kansas that were 6 years old. Record longevity is 24 years for a least tern banded in Massachusetts and recovered in New Jersey (Klimiewicz and Futcher 1989).

Movements/Dispersal Patterns - Breeding site fidelity of coastal and California least terns is very high (Atwood et al. 1984, Burger 1984). While this has also been suggested of the interior least tern in its riverine environment, the ephemeral nature of that habitat prevents some sites from being used in subsequent years. Hardy (1957) hypothesized that the localized shifts in least tern distribution are the result of the interplay of several related ecological factors. Those include the presence of suitable sandbars, the existence of favorable water conditions during the nesting season, and the availability of food. Changes in the microhabitat and social structure within the breeding areas often leads to birds changing sites if suitable habitat of higher quality is available elsewhere (Prindiville 1986).

Band resightings to indicate least tern movements or lack thereof are sparse. An interior least tern banded in 1988 as a breeding adult on the Missouri River in North Dakota returned in 1989 to breed on a Missouri River sandbar in North Dakota (Mayer and Dryer 1990). In the Mississippi River valley, a bird banded as a breeding adult in 1987 was observed nesting at the same site in 1989, and three others banded as breeding adults in 1988 returned to nest within the same stretch of the

Mississippi River in 1989 (Smith and Renken 1990). Two of those birds had returned to within 4.8 km of their former nesting site. One least tern captured in 1987 as a breeding adult at a Mississippi River colony in Missouri had been banded as a chick in 1980; this bird was nesting at a site 131 km upriver from its natal Tennessee colony (Smith 1987, Smith and Renken 1990). Chick dispersal may be as far as that reported by Boyd and Thompson (1985) for a breeding Kansas bird that had been banded as a chick on the Texas coast.
Annual and seasonal movements of interior least terns between breeding sites are poorly understood, but they are known to occur frequently over significant distances and may occur quickly based on abrupt changes in habitat conditions. Interchange between coastal least terns and interior populations may explain the positive population trends on the lower Mississippi River that have not been accounted for through local reproduction (Kirsch and Sidle 1999).

Population Status and Trends

The interior least tern was proposed for listing as an endangered species on May 29, 1984 (49 FR 22444-22447). The species was listed as endangered on June 27, 1985 (50 FR 21784-21792). According to the recovery plan (USFWS 1990b), the least tern has been a species of concern for many years because of its perceived low numbers and the vast transformation of its riverine habitat. Barren sandbars, the most common least tern nesting habitat, were once a common feature of the Mississippi, Missouri, Arkansas, Ohio, Red, Rio Grande, Platte, and other river systems of the central United States. Sandbars generally are not stable features of the natural river landscape, but are formed, enlarged, eroded, moved, or destroyed, depending on the dynamic forces of the river. However, stabilization of major rivers for navigation, hydropower, irrigation, and flood control has destroyed the dynamic nature of those processes (Smith and Stucky 1988). Many of the remaining sandbars are unsuitable for nesting because of vegetation encroachment or are too low and subject to frequent inundation. The number and distribution of least terns probably has declined accordingly.

Kirsch and Sidle (1999) compiled tern population data for 1984-1995 to assess the status of the population. Breeding population estimates were compiled for 35 local areas. Numbers of terns increased during the period 1984 to 1986, probably due to increased survey efforts. However, large population increases along the middle Mississippi River and lower Mississippi River (Cape Girardeau, Missouri, to Vicksburg, Mississippi) between 1989 and 1990 (100 percent) and between 1993 and 1994 (60 percent) cannot be attributed to increased survey effort or improved survey methods (Kirsch and Sidle 1999). Approximately 52 to 79 percent of interior least terns nest along this portion of the Mississippi River. The Platte River, Nebraska, harbors the second largest number of least terns [438-635 terns (6.2-13.6 percent)]. Two stretches of the Missouri River (Garrison Dam to Lake Oahe, North Dakota, and Gavins Point Dam, South Dakota to Ponca, Nebraska); Salt Plains National Wildlife Refuge; Oklahoma, Cimarron and Canadian Rivers, Oklahoma; and Falcon Reservoir on the Rio Grande River, Texas, all typically harbor more than 100 least terns annually (Kirsch and Sidle 1999). Although recent counts of least terns (approximately 8,800 terns in 1995) exceed the overall recovery objective of 7,000 birds, the mean number of least terns in 12 of 19 local areas designated in the recovery plan (USFWS 1990b) do not reach corresponding objectives (Kirsch and Sidle 1999) and thus, do not meet recovery objectives for downlisting..

Overall population trends from 1986 to 1995 are positive. However, this positive trend is primarily due to increases in numbers of least terns on the lower Mississippi River (Kirsch and Sidle 1999). Annual change for the entire population was approximately 9 percent. However, when data from the lower Mississippi River was excluded, the annual change was 2.4 percent (Kirsch and Sidle 1999). At the scale of drainage basins, trends were positive for the Lower Mississippi River (13 percent), Platte River (2.6 percent) and the Missouri River (1.8 percent). However, only the trend for the Lower Mississippi River was significant (Kirsch and Sidle 1999).

Interior least tern numbers at local breeding areas fluctuate substantially. This is perhaps due to changes in local and regional habitat availability or differences in emigration, immigration or local recruitment (Kirsch and Sidle 1999). Kirsch and Sidle (1999) detected significant population trends in 7 of 31 local areas. Trends in 5 of these areas were significantly positive (Garrison Dam to Lake Oahe on the Missouri River, North Dakota; Elkhorn River, Nebraska; reservoirs in the Arkansas River watershed, Colorado; Gibson Lake on the Wabash River, Indiana; and the Lower Mississippi River). Two areas had significant negative trends. These were Council Bluffs, Iowa, near the Missouri River, and Optima National Wildlife Refuge, Oklahoma (Kirsch and Sidle 1999). Both of those areas support low numbers of least terns.

Kirsch and Sidle (1999) found fledging success estimates to be highly variable among colonies, river reaches and drainages, both within and among years. Fledging success estimates for the lower Mississippi River do not support the positive population trend for that area (Kirsch and Sidle1999). In addition, available data do not indicate high productivity in years prior to large population increases (Kirsch and Sidle 1999). Also, fledging success in many local areas was found to be below the 0.51 fledglings/pair thought to be required for population maintenance (Kirsch 1996). Kirsch and Sidle (1999) speculated that the most plausible explanation for the recent increase of interior least terns is surges of immigration from the least tern population along the Gulf of Mexico which is large and stable or increasing (Thompson 1982, Jackson and Jackson 1985, Thompson et al. 1997). Further, they state that regular immigration for the Gulf Coast population may be an important influence on the dynamics of the interior population of least terns. However, movement data are limited, with only one published report of a least tern moving between the Gulf Coast and interior breeding areas (Boyd and Thompson 1985).

Habitat and Food Requirements

Habitat Characteristics - Interior least terns physical habitat requirements are difficult to describe and are often confused by regional variation. Lack of vegetative cover (Dirks 1990, Ziewitz et al. 1992), substrate composition and homogeneity (Adolf 1998), and proximity to stable food sources (Faanes 1983, Dugger 1997, Adolf 1998), have been identified as important physical components of least tern habitat. Sandbar geophysiology and associated hydrology are integral components of suitable habitat. Bacon (1996) found channel bars chosen for nesting sites by least terns on the Yellowstone River were exposed above river level longer throughout the breeding season than non-nesting habitats. Similarly, Smith and Renken (1991) found that least tern colonies along the lower Mississippi River were located on sand islands and sandbars that differed from unused sand islands by the length of time sites were continuously exposed above the river. Most nest colonies on the Yellowstone occurred in a section of the river where channel sinuosity began to increase and there was a higher incidence of channel bars and overlapping islands surrounded by irregular channel activity. Recent habitat investigations by the Corps (C. Kruse, pers. comm. 2000) support Ziewitz et al. (1992) that large habitat blocks occurring in complexes or "hemi" bars are selected for at rates exceeding their random availability.

Least tern colony sites are usually located in open expanses of sand or pebble beach within the river channel or reservoir shoreline. They prefer sites that are well-drained and well back from the water line. Least terns usually nest on sites totally devoid of vegetation, but have been found on sites with up to 30 percent vegetative cover (Schulenberg and Placek 1984, Dryer and Dryer 1985, Landin et al. 1985, Rumancik 1985). Vegetation, if present, is usually located well away from the colony (Hardy 1957, Anderson 1983, Rumancik 1985, Smith and Shepard 1985). However, widely dispersed annual vegetation or young saplings may commonly be found within or near some interior least tern colonies (Wycoff 1950, Faanes 1983, Evans 1984, Dryer and Dryer 1985).

The interior least tern also nests in dike fields along the Mississippi River (Smith and Stuckey 1988, Smith and Renken 1990); at sand and gravel pits (Kirsch 1987-89); ash disposal areas of power plants (Wilson 1984, Johnson 1987, Dinsmore and Dinsmore 1988); along the shores of reservoirs (Chase and Loeffler 1978, Neck and Riskind 1981, Boyd 1987, Schwalbach 1988); and at other manmade sites (Shomo 1988). It is unknown to what extent those alternative habitats have replaced productive natural habitat.

Foraging habitat for least terns includes side channels, sloughs, tributaries, shallow-water habitats adjacent to sand islands and the main channel (Dugger 1997). To successfully reproduce, productive foraging habitat must be located within a short distance of a colony (Dugger 1997). In a study of eastern least terns in North Carolina, all 61 of the colonies observed were within 820 ft (250 m) of a large expanse of shallow water (Jernigan et al. 1978). In Georgia, eastern least terns foraged a maximum distance of 1,345 ft (410 m) from the colony (Tomkins 1959). Least terns in Nebraska generally were observed foraging within 328 ft (100 m) of the colony (Faanes 1983). Armbruster (1986) recommends that feeding areas for terns be present within 1,312 ft (400 m) of the nesting colony.

Food and Feeding Habits - The interior least tern is piscivorous, feeding on small fish in shallow waters of rivers, streams, and lakes (USFWS 1990a). Moseley (1976) believed least terns to be opportunistic feeders, exploiting any fish within a certain size range. Important prey genera include *Fundulus*, *Notropis*, *Campostoma*, *Pimephales*, *Gambusia*, *Blonesox*, *Morone*, *Dorosoma*, *Lepomis*, and *Carpiodes* (Hardy 1957, Grover 1979, Schulenberg et al. 1980, Rumancik 1988, 1989, Wilson et al. 1989, Smith and Renken 1990). Fishing behavior involves hovering and shallow dives over standing or flowing water.

Range Wide Distribution and Abundance of Habitat

Remnants of least tern habitat remain distributed across much of the species' historic range, although at much reduced levels. Beach habitats are increasingly used for human recreation and residential development; river sandbars have been destroyed by channelization, water diversions, impoundments, and by changes in vegetation resulting from controlled water flow below dams.

At a minimum, over 9,500 ac (3,847 ha) of sandbar (excluding vegetated areas) existed prior to impoundment of main stem dams above Gavins Point Dam (USFWS 1984). While the reach of river below Gavins Point Dam still exhibits its somewhat free-flowing state, approximately 7,800 ac (3,159 ha) of sandbar habitat has been lost between 1956 and 1975 (Schmulbach et al. 1981). Gavins Point Dam closed in 1955. Schmulbach et al. (1981) reported 2,200 ac (891 ha) of sandbar remaining along the 50-mi (80 km) stretch of river below Gavins Point Dam that is designated as the Missouri National Recreation Area. In the lower Mississippi River, 158,074 ac (64,019 ha) of bare sandbar habitat occurred above the Low Water Reference Plane (LWRP) in 1948. By 1994, the amount of bare sandbar habitat above the LWRP had declined to 105,797 acres (USACE 1999b). This represents a 33 percent decline in bare sandbar habitat. That decline is attributable to the river's response to a series of bendway cutoffs, sandbar accretion, and colonization by woody vegetation (USACE 1999b). Much of the sandbar habitat that remains on the Mississippi River is associated with wingdam systems, which may not provide optimal breeding habitat for least terns.

Alternatively, agricultural fields, parking lots, and flat, graveled roof tops are providing occasional opportunistic nesting sites. In Nebraska, where the central Platte River no longer provides suitable habitat because of upstream diversion, least terns are nesting at commercial sand and gravel pits within 0.9 mi (1.5 km) of the Platte (Sidle and Kirsch 1993). In Iowa, least terns have nested on fly ash effluent at power plants (Huser 1996).

Factors Affecting the Species Range Wide

Habitat Loss and Degradation - Channelization, irrigation, construction of reservoirs and pools, and managed river flows have contributed to the elimination of much of the least tern's sandbar nesting habitat (Funk and Robinson 1974, Hallberg et al. 1979, Sandheinrich and Atchison 1986). For example, Ducey (1985), describes the changes in channel characteristics of the Missouri River since the early 1900's under the Missouri River BSNP. The wide, braided character of the Missouri River was engineered into a single, narrow navigation channel. Most sandbars virtually disappeared between Sioux City, IA, and St. Louis, MO (Sandheinrich and Atchison 1986, Smith and Stucky 1988). The middle Mississippi River and the lower Mississippi River have experienced similar effects due to channelization. Interior least terns along the Arkansas River in Oklahoma and Arkansas contend with dam discharges and altered hydrographs, similar to on the Missouri River (USFWS 1990a).

Reservoir storage and irrigation depletions of flows responsible for scouring sandbars has resulted in encroachment of vegetation onto sandbars along many rivers, further reducing least tern nesting habitat (Eschner et al. 1981, Currier et al. 1985, O'Brien and Currier 1987, Stinnett et al. 1987, Lyons and Randle 1988, Sidle et al. 1989). According to Smith and Stucky (1988), the process of dike field terrestrialization is also well underway at several least tern colony sites in the lower Mississippi River. In addition, river main stem reservoirs now trap much of the sediment load resulting in less aggradation and more degradation of the river bed, reducing formation of suitable sandbar nesting habitat.

With the loss of much least tern nesting habitat, predation has become a significant factor affecting least tern productivity in many locations (Massey and Atwood 1979, Jenks-Jay 1982), including the Missouri River (Dirks and Higgins 1988, Kruse et al. in review).

Human Disturbance - Human disturbance affects tern productivity in many locations, including the Missouri River (Massey and Atwood 1979, Goodrich 1982, Burger 1984, Dryer and Dryer 1985, Schwalbach et al. 1986, Dirks and Higgins 1988, Schwalbach 1988, Mayer and Dryer 1990). Many rivers have become the focus of recreational activities, and sandbars, where they exist, are fast becoming the recreational counterpart of coastal beaches. Human presence reduces reproductive success (Mayer and Dryer 1988, Smith and Renken 1990). Domestic pet disturbance and trampling by grazing cattle are other factors that have contributed to the population decline.

Pollution/Contaminants - Pollutants entering the waterways within and upstream of breeding areas can negatively impact water quality and fish populations in nearby foraging areas. Strip mining, urban and industrial pollutants, and sediments from non-point sources can all degrade water quality and fish habitat, thereby impacting small-fish populations on which least terns depend (Wilbur 1974, Erwin 1983). In addition, because least terns are relatively high on the food chain, they are in a position to accumulate contaminants which may render eggs infertile or otherwise affect reproduction and chick survival (USFWS 1983, Dryer and Dryer 1985). The extent of this impact, however, is undocumented. Mercury residues have been found in least terns from the Cheyenne River watershed in South Dakota. DDEs and PCBs have also been found in the two coastal subspecies in South Carolina and California (USFWS 1983). Elevated selenium and PCB concentrations were noted in least tern eggs collected on the Missouri River in South Dakota (Ruelle 1991). Allen and Blackford (1997) found 81 percent of 104 least tern eggs collected from the Missouri River exceeded 3µg/g dry weight selenium concentration, the level currently considered safe for avian reproductive success.

Summary

Throughout its range, least tern distribution and abundance have been affected by channelization and impoundment projects. Although this species is still widely distributed, it is generally restricted to less altered river segments. Overall population trends from 1986 to 1995 are positive. However, this positive trend is due to increases in numbers of least terns on the lower Mississippi River. Fledging success rates for the lower Mississippi River do not support the positive population trend for this area, indicating possible immigration from Gulf Coast populations. Although recent counts of least terns (approximately 8,800 terns in 1995) exceed the overall recovery objective of 7,000 birds, the mean number of least terns in 12 of 19 local areas identified in the recovery plan (USFWS 1990a) do not reach corresponding objectives (Kirsch and Sidle 1999).

The remaining suitable least tern nesting habitat is anticipated to decline in quantity and suitability as sandbar habitat converts to woody vegetation and river system manipulation continues to degrade aquatic habitats.

PIPING PLOVER

Species Description

The piping plover is a migratory shorebird of the family Charadriidae. Adult piping plovers have an average body length of 17 cm (Palmer 1967) and generally weigh from 46 to 64 g (Haig 1992). Throughout the year, adults have a sand-colored upper body, white undersides, and orange legs. During the breeding season, adults develop orange bills and single black bands on the forehead and breast. 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 (Haig and Oring 1987). Juvenile plumage is similar to adult nonbreeding plumage (USFWS 1988b).
Juveniles acquire adult plumage the spring after they fledge (Prater et al. 1977).

First considered a separate species by Ord (1824), the piping plover binomial was recorded by the American Ornithologist's Union (AOU) Checklist as *Charadrius melodus* in 1931. There has been debate for years over the validity of the designation of two subspecies, *C. m. melodus* (Atlantic birds), and *C. m. circumcintus* (inland birds), which the AOU adopted in 1957. In 1998, the AOU returned to the single species designation after genetics were reported similar between the groups (Haig 1988a, AOU 1998). Ongoing research, using more sophisticated genetic techniques, will better answer this question in the near future.

Historic and Current Range Wide Distribution

Piping plovers historically bred in three areas of North America: (1) Atlantic coastal beaches from Newfoundland to South Carolina; (2) beaches of the Great Lakes; and (3) the northern Great Plains/Prairie region from Alberta to Ontario and south to Nebraska (USFWS 1988b) (Figure 4).

Winter sites were not well described although piping plovers were generally seen along the Gulf of Mexico, on southern Atlantic coastal beaches from North Carolina to Florida, in eastern Mexico and on scattered Caribbean Islands (Haig and Oring 1985).

Currently, the species' range remains similar to historic range accounts, except that plovers nesting in the Great Lakes have almost disappeared (Haig and Oring 1988a). In 1996, northern Michigan had the only viable nesting population of plovers in the Great Lakes area. Wintering grounds have received less attention than breeding grounds in the past, so all possible wintering areas may not have yet been surveyed (USFWS 1988).

Life History

Reproductive Biology - Piping plovers are territorial shorebirds that spend 3 to 4 months on northern U.S. and southern Canada breeding sites. 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 1992). 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).

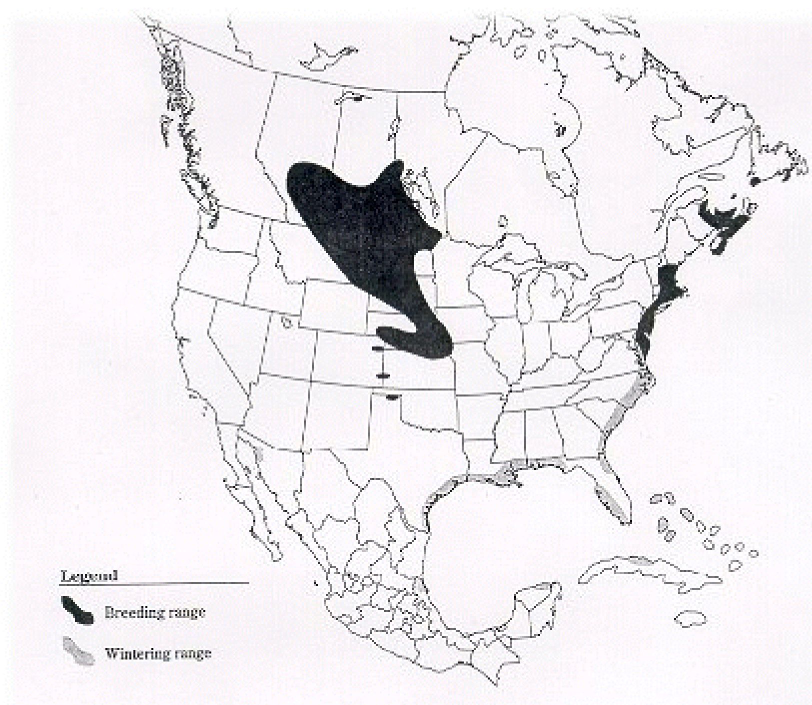

Figure 4: Approximate breeding and wintering range of the piping plover in North America (developed from www.mmiusa.com/ookpik/plover/range.html).

Nest initiation may begin by late April and continue until early July (USACE 1998a). Finished nest scrapes or bowls are shallow depressions approximately 2 cm deep and 6 cm in diameter, frequently lined with small pebbles or shell fragments (USFWS 1988). Both adults actively defend the nesting territory. Egg laying typically commences the second or third week of May. Females lay an egg every other day until a 4-egg clutch is complete. Both sexes share incubation, which can last for 25 to 31 days (Wilcox 1959, Cairns 1977, Prindiville 1986, Wiens 1986, Haig and Oring 1988a).

On the Missouri River system, eggs begin to hatch from late May to mid-June (USACE 1993a, 1994a, 1995a, 1996, 1997). Clutches hatch within one-half to one day and chicks are precocial, being able to feed themselves within hours (USFWS 1988). Males and females share brooding duties, although females in Manitoba deserted broods as early as the first week after hatch (Haig 1987). Broods generally remain on nesting territories but may expand their movements as they mature or are disturbed. On average, pairs fledge 0.3 to 2.1 chicks per year (Haig and Oring 1985). During a single year, most adults raise one brood of up to four chicks, although one pair in Nebraska raised two broods (Lingle 1990). When nests are destroyed, adults may renest up to four times (Dyer et al. 1987). Young plovers are able to breed the year after fledging, but little information indicating reproduction by first-year birds on the Great Plains is available (C. Kruse pers. comm.).

By July and August, piping plovers flock on undefended feeding areas and 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).

Growth and Longevity - Piping plover chicks may be observed in short, hop-flights several days before sustained flights are possible. Age of fledging varies with 21 days in Manitoba (Haig and Oring 1988a), 21 to 28 days in North Dakota (Prindiville-Gaines and Ryan 1988), and 30 to 35 days on Long Island, New York (Wilcox 1959).

Current estimates of piping plover survival rates are limited. Root et al. (1992) estimated a mean annual survival rate of 0.664 for adults in the Great Plains population from 1984-1990 using recapture and re-sighting data from plovers in North Dakota. Most plover mortality was thought to occur during migration or on wintering grounds (Root et al. 1992), but 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 to11 years (Wilcox 1959).

Movements/Dispersal Patterns - Breeding site fidelity for piping plovers ranged from 4.5 percent in two studies combined in South Dakota (Schwalbach 1988, Dirks 1990) to 92.3 percent in Lake of the Woods, Minnesota (Haig and Oring 1987). From 1986 to 1989, 22 adults were banded along the Missouri River in South Dakota and one resighting was reported during that time (Schwalbach 1988, Dirks 1990, Schwalbach et al. 1993). Six other banded plovers were also seen during that time, but may have been banded as chicks. On the Atlantic Coast, almost all observations of plovers have occurred within the same, or adjacent, state of banding (USFWS 1996). In New York, Wilcox (1959) recaptured 288 of 744 (38.9 percent) banded adults and all but three were recaptured in the same nesting area. Little is known about current site fidelity along the Missouri River, as few adults have been banded in this area since the late 1980s.

Return patterns do not differ significantly between males and females (Haig and Oring 1988a). Furthermore, return patterns to specific breeding sites do not seem influenced by previous reproductive success (Wiens 1986, Haig and Oring 1988a). In Manitoba, adults exhibited 2 patterns: (1) those that hatched chicks the year before returned to the same breeding site but changed territories; (2) adults that experienced nest failure the year before generally changed sites (Haig and Oring 1988a). Adults have been known to use breeding sites as far as 546 km apart in consecutive years (Haig 1987).

The percentage of chicks returning to fledging sites ranges from 4.7 percent in New York (Wilcox 1959) to 1.3 to 50 percent in South Dakota (Schwalbach et al. 1993; R. Niver, pers. comm. 2000). From 1986 to 1989, 160 chicks were banded along the Missouri River in South Dakota and two resightings (1.3 percent) were reported during that time (Schwalbach et al. 1993). Six other banded plovers were also observed, but may have been banded as adults. In 1998, 14 juvenile plovers were banded along Lewis and Clark Lake and below Gavins Point and 7 (50 percent) returned in 1999 to the same river reaches (Niver unpublished data). In Manitoba, first year males and females return in equal numbers (Haig 1987). Chick dispersal is difficult to characterize, although long-range dispersal distances have been documented.

Piping plovers winter along the Gulf and southern Atlantic Coast, as well as in eastern Mexico and some Caribbean Islands. While banded plovers from the northern Great Plains and Canada Prairie have been observed in virtually all the southern states, most have been reported along the Gulf Coast (Haig and Oring 1988b). Also, most Atlantic Coast breeders winter along the southern Atlantic Coast (Haig and Plissner 1993, Haig and Oring 1998b,).

Winter site fidelity has not been widely studied for piping plovers. In Alabama, Johnson (1987) observed 63 percent of plovers banded in the previous year. Various birders have also observed banded plovers in areas for more than one winter (Plissner and Haig 1997, pers. comm. with Ted Belows, 1999).

Population Status and Trends

The Service identified the piping plover as a candidate species for addition to the list of threatened and endangered wildlife in December 1982 (47 FR 58454). On January 10, 1986, the Service listed piping plovers on the Great Lakes as endangered, while the remaining Atlantic and Northern Great Plains birds were listed as threatened (50 FR 50726-34). Plovers on migration and in wintering areas were classified as threatened. Historic references on population trends of the piping plover are largely qualitative or lacking altogether for some geographical regions. However, there is enough available information to indicate a substantial decline in population numbers. Around 1900, naturalists described the piping plover as common. Since that time, the population has decreased over most of its range, and has vanished as a nesting species in many local areas. Early 20th century accounts report that shorebird hunting caused the first known major decline of the piping plover primarily along the Atlantic coast (Bent 1929, Hall 1960). Populations recovered with the passing of the Migratory Bird Treaty Act in 1918. More recently, populations have declined substantially as a result of habitat loss due to recreation, commercial development, dam construction and other human disturbance.

There are no estimates of historic piping plover population sizes (i.e., populations prior to the initiation of surveys in the early 1980s) (USFWS 1988). Breeding surveys in the early 1980s reported 2,137 to 2,684 adult plovers in the Northern Great Plains/Prairie region, 28 adults in the Great Lakes region, and 1,370 to 1,435 adults along the Atlantic Coast (Haig and Oring 1985). Surveys on the wintering grounds during the same time recorded only 25 percent of the population counted on the breeding grounds. No explanation was offered for the difference between wintering and breeding population sizes, but it seemed apparent that several wintering areas remained unknown.

In 1991, the first International Piping Plover Census was conducted by the Great Lakes & Northern Great Plains and the Atlantic Coast Piping Plover Recovery Teams (U.S.) and the Prairie and Atlantic Canada Piping Plover Recovery Teams (Canada) (Haig and Plissner 1993). That was an important step for surveying piping plovers on breeding and wintering grounds because census methods and timing were similar in all areas. Results of the 1991 breeding ground surveys were: 1,975 adults in the Atlantic Coast region, 40 adults in the Great Lakes region, and 3,467 adults in the northern Great Plains/Prairie region (Haig and Plissner 1993). On the wintering grounds 3,451 plovers were recorded, with the majority in Texas (Haig and Plissner 1993). A second International Census took place in 1996. Results of the 1996 breeding ground surveys were: 2,581 adults in the Atlantic Coast region, 48 adults in the Great Lakes region, and 3,284 adults in the northern Great Plains region (Plissner and Haig 1997). On the wintering grounds, 2,515 plovers were counted (Plissner and Haig 1997).

Ryan et al. (1993) developed a stochastic population growth model using empirical, demographic data, and that model indicated that the Great Plains plover population was declining 7 percent annually. Unchecked, that decline would result in extirpation in approximately 80 years. They also used the simulation model to predict reproductive and survival rates necessary to stabilize and increase the population. Ryan et al. (1993) stated that if adult (0.66) and immature (0.60) survival rates were held constant, a 31 percent increase, from 0.86 to 1.13 chicks fledged per pair, was needed to stabilize the population. Annual population increases of 1 percent and 2 percent required 1.16 and 1.19 chicks per pair, respectively. Such growth would result in the Great Plains population reaching the level--(2,550) pairs--needed for delisting from the ESA protection in 53 and 30 years, respectively. One- and five-year delays in the initiation of 1 percent population growth caused 13- and 67-year delays respectively in reaching recovery. The model results indicated that the Great Plains plover population was undergoing a substantial decline.

Habitat and Food Requirements

Habitat Characteristics - Piping plover breeding habitat is comprised of open, sparsely vegetated areas with alkali or unconsolidated substrate. In north-central North America, piping plovers nest on the barren sand and gravel beaches of the Great Lakes and on alkali wetlands, gravel shorelines and river sandbars in the Great Plains. In times of drought or other adverse conditions, the birds have used less than optimal habitat but productivity suffers (Weber and Martin 1991). Although the preference of piping plovers for open areas has been repeatedly noted in the literature, quantitative data on habitat characteristics, evidence of habitat selection, and information on the relative quality of inland habitats remain scarce.

Several studies have suggested that beach width may affect habitat use by piping plovers breeding on inland lakes. Whyte (1985) recorded minimum nest-to-water distances of 40 m at his Saskatchewan study area and suggested that beaches less than 20-30 m in width were not likely to be used by piping plovers. In Alberta, however, Weseloh and Weseloh (1983) calculated a mean beach width of only 11.7 m at nest sites. But they noted that these seemed to be the widest beaches available. Prindiville-Gaines and Ryan (1988) reported mean beach width to be larger in occupied territories (x = 33 m) than in unoccupied beaches (x = 13.6 m) North Dakota.

The amount and distribution of beach vegetation affects piping plover habitat selection and reproductive success. Prindiville-Gaines and Ryan (1988) found no difference in vegetative cover between territories (x = 3.4 percent) and unoccupied sites (x = 3.8 percent). However, vegetation was more clumped in territories than in unoccupied areas. Furthermore, territories in which piping plover nests were successful had either less vegetation or more clumped vegetation than territories with unsuccessful nests (Prindiville 1986).

Substrate composition may also affect habitat selection by piping plovers and influence nest success. Cairns (1977) found 31 of 38 nests in Nova Scotia on mixed sand and gravel and stated that those nests were less conspicuous than those on sand alone. Whyte (1985) reported that piping plovers were more likely to establish nests on gravel than was expected by chance alone. In North Dakota, gravel was generally more evenly distributed and in greater concentration on piping plover territories than at unoccupied sites (Prindiville 1986).

Piping plovers nesting on the Missouri, Platte, Niobrara, Yellowstone and other rivers use reservoir beaches and large dry, barren sandbars in wide, open channel beds. Vegetative cover on nesting islands is usually less than 25 percent (Ziewitz et al. 1992). Twenty-eight Platte River sandbars, occupied by nesting piping plovers, averaged 938 ft (286 m) in length and 180 ft (55 m) in width (Faanes 1983). Vegetative cover on those sandbars averaged 25.4 percent. The optimum range for vegetative cover on nesting habitat has been estimated at 0 to 10 percent (Armbruster 1986). Schwalbach (1988) found 89 percent of the plovers nesting in areas of less than 5 percent vegetative cover. On the Missouri River, average vegetation height ranged from 2-11 in (6 cm to 29 cm) (Schwalbach 1988; P. Mayer, pers. comm.). Schwalbach (1988) found that the majority of the plovers (63 percent) nested in areas where vegetation height was less than 4 in (10 cm). Average elevation of nests (terns and plovers) above river level range from 7.4 in (19 cm) below Gavins Point Dam to 12 in (30 cm) below Garrison Dam (Schwalbach 1988, Dirks 1990, and P. Mayer, pers. comm. 1994). Schwalbach (1988) and Ziewitz et al. (1992) suggest that birds select a higher nest site when available and sites 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 sufficient protection from rises in river levels.

Open, wet, sandy areas provide feeding habitat for plovers on river systems and throughout most of the birds' nesting range. Piping plovers feed primarily on exposed substrates by pecking for invertebrates at or just below the surface (Cairns 1977, Whyte 1985). In Saskatchewan, Whyte (1985) noted that adults concentrated foraging efforts within 5 m of the water's edge. He found broods also fed most often near the shore, but their use of upland beach habitats was greater than that of adults. Cairns (1977) reported that chicks tended to feed on firmer sand at greater distances from the shoreline than adults. At Lake of the Woods, MN, and on Long Island-Chequamegon Point, WS, adult piping plovers seemed to prefer shoreline or beach pool edges (wet sand) over open beach (dry sand) as feeding sites (Wiens 1986; S. Matteson, Wisconsin Department of Natural Resources). Studies suggest that forage areas include the nesting island itself, as well as adjacent sandbar flats (Cairns 1977, Whyte 1985, Corn and Armbruster 1993).

Food and Feeding Habits - Little is known about the diet of piping plovers or their foraging behavior during any phase of the annual cycle (breeding, migration, wintering), largely because the species' status and sensitivity to disturbance have precluded the collection of birds for stomach contents analysis. Bent (1929) reported the stomach contents of four piping plovers from Alabama as containing marine worms, insects (fly larvae and beetles), crustaceans, mollusks, and other small marine animals (and their eggs). Similarly, in Nova Scotia, Cairns (1977) observed piping plovers feeding on marine worms averaging 1-3 in (2.5-7.5 cm) in length. She suggested their diet consisted of marine worms, minute worms, and crustaceans. Whyte (1985), at Big Quill Lake in Saskatchewan, found the following families present on piping plover territories *Carabidae, Dytiscidae, Corixidae, Saldidae, Chironomidae*, and *Ephidridae*. Nordstrom (1990) found prey items available on piping plover territories at the John E. Williams Nature Preserve in North Dakota to include *Ephidridae, Chironomidae, Dolechopodidae* and *Muscidae*. Along the Platte River in central Nebraska, piping plovers prey primarily on beetles and small soft-bodied invertebrates from dry substrates and from along the waterline (Lingle 1988). Piping plovers forage by picking food items off of the surface or by probing in soft substrates.

Range Wide Distribution and Abundance of Habitat

Piping plover habitat remains distributed across much of the species' historic range, although in a much reduced and fragmented condition. Coastal beach habitat in the wintering areas, and Great Lakes and Atlantic Coast nesting sites, have been reduced to small, mostly protected refugia by intensive recreation, and residential and commercial development. Northern Great Plains piping plover habitat along the Missouri River has been reduced by over 80 percent by the construction of dams and the creation and maintenance of a commercial shipping channel. At a minimum, over 9,500 ac (3,847 ha) of sandbar (excluding vegetated areas) existed prior to impoundment of main stem dams above Gavins Point Dam (USFWS 1984). While the reach of river below Gavins Point Dam still exhibits its somewhat free-flowing state, approximately 7,800 ac (3,159 ha) of sandbar has been lost between 1956 and 1975 (Schmulbach et al. 1981). Gavins Point Dam closed in 1955. In 1981, Schmulbach et al. (1981) reported 2,200 ac (891 ha) of sandbar remaining along the 50-mile (80 km) stretch of river below Gavins Point Dam that is designated as the Missouri National Recreation Area.

Factors Affecting the Species Range Wide

The piping plover is a species with highly variable annual reproductive success that uses freshwater and saline wetland habitats throughout the annual cycle. Those ephemeral habitats render birds susceptible to frequent nest destruction, and consequently, large population fluctuations.

Habitat Loss and Degradation - Loss of sandy beaches and other littoral habitats due to recreational/commercial developments and dune stabilization on the Great Lakes, Atlantic Coast, and Gulf of Mexico are partially responsible for the decline of the species (Bent 1929, Cairns 1977, Haig and Oring 1985, USFWS 1985, Flemming et al. 1988, and others). Also in the Great Lakes, historic nesting sites have been destroyed by high water levels, flooding, or eroding beaches (Russell 1983). Reservoirs, river channelization, and modified river flows have eliminated sandbar nesting habitat along hundreds of kilometers of the Missouri and Platte rivers in the Dakotas, Iowa, and Nebraska. Diversion of peak flows that scour river sandbars has resulted in vegetation encroachment. Consequently, piping plovers are often faced with finding a nest site outside the channel or not nesting at all. In addition, river main stem reservoirs now trap much of the sediment load resulting in less aggradation and more degradation of the river bed and subsequently less sandbar nesting habitat. Commercial sand and gravel mining operations along river banks have created sandy spoil piles that are used for nest sites.

Although some saline wetlands in the northern Great Plains have been drained or modified, the impact of that activity has not been specifically investigated. Freshening of water on saline wetlands in central North Dakota decreased their quality as vegetation encroached on nesting habitat (Prindiville 1986).

Winter habitats are threatened by coastal erosion, beach stabilization, navigation dredging and disposal, and industrial or urban expansion that could result in wholesale destruction of sites. Site quality may be threatened by increased human use of beaches for recreational purposes. Habitat quality may be substantially lowered, at least in the short-term, by oil spills. Wintering sites near existing oil trans-shipment facilities and oil tanker shipping lanes should be identified and regularly monitored for spills. Stabilization of barrier island sand flats also has been identified as a potential threat to piping plover habitat. Stabilization may result in encroachment of vegetation that reduces the quality of, or eliminates altogether, wintering sites.

With habitat loss, predation has become a major factor on piping plover recruitment. Increased urbanization and use of beaches has brought an increase in the number of unleashed pets and unnaturally high densities of gulls and other predators such as skunks (*Mephitis* spp.) and foxes (*Vulpes* spp.). Cattle trampling nesting habitat may also affect site use (Smith et al. 1993), nest success, and chick survival (Prindiville 1986).

Human Disturbance - Where breeding does occur on coastal beaches, inland lakes and river sites, reproductive success can be reduced by human and pet disturbance. Vehicular and foot traffic destroys chicks and eggs. The presence of people on beaches can inhibit incubation and other breeding behavior, further decreasing reproductive success (e.g., Cairns 1977, Flemming et al. 1988). Human disturbance can vary from stepping on eggs or being close enough to nests to preclude incubation, to drawing predators into an area by dropping litter near a clutch or brood. Piping plover response to direct human disturbance varies considerably across the breeding range (Flemming et al. 1988, MacIvor et al. 1990, Strauss 1990, Patterson et al. 1991).

Pollution/Contaminants - Pollutants entering the waterways within and upstream of breeding areas can negatively impact water quality and forage resources in adjacent foraging areas. Piping plover tolerances to elements in the environment are poorly understood, but given their position on the food chain, they are likely to accumulate contaminants. No evidence of reproductive failure in plovers has been directly linked to elevated contaminant concentrations.
Fannin and Esmoil (1993) found elevated levels of selenium and mercury in piping plover eggs collected from the Platte River in Nebraska, and that selenium in particular may be causing embryo mortality without gross embryological defects. Ruelle (1993) found selenium concentrations in piping plover eggs collected from the Missouri River in South Dakota similar to concentrations known to be embryotoxic in other birds. Selenium concentrations were slightly elevated in unsuccessful eggs of piping plovers collected from nesting areas along the Missouri River in North Dakota, but were below concentrations associated with toxicity (Welsh and Mayer 1993). All those projects indicate that the impacts of contaminants combined with the physical degradation of habitat can accelerate population declines for piping plovers.

Summary

Piping plover abundance has most recently been affected by habitat loss. Urbanization and development of beach habitats along the Atlantic Coast and Great Lakes has significantly reduced nesting sites and remaining habitats are greatly fragmented. Agricultural conversion and intense livestock use of wetland habitats, as well as the impoundment, containment and operation of the Missouri River have greatly reduced piping plover habitat in the Northern Great Plains. Piping plovers remain distributed across much of their historic range except along the Great Lakes. Recruitment rates recorded from many breeding sites are not meeting those necessary to provide population growth and populations appear to be declining. Exchange of birds between the three regional breeding populations and movements of birds on the wintering grounds is not well understood.

PALLID STURGEON

Species Description

The pallid sturgeon, *Scaphirhynchus albus*, also known as white sturgeon, white shovelnose, white hackleback (Kallemeyn 1983), and rock sturgeon (Bailey and Cross 1954) is endemic to the Yellowstone, Missouri, middle and lower Mississippi Rivers, and the lower reaches of their major tributaries (Bailey and Cross 1954). The specimens for species identification were collected at or near Grafton, Illinois on the lower Illinois and Mississippi Rivers (Forbes and Richardson 1905). The pallid sturgeon grows to lengths of over 6 ft (1.8 m), can weigh in excess of 80 lbs (36 kg), and can be described as having a flattened, shovel-shaped snout, a long and completely armored caudal peduncle, and lacks a spiracle (Smith 1979). The mouth is toothless, protrusible, and ventrally positioned under the snout, as with other sturgeon.

Pallid sturgeon are similar in appearance to the more common and darker shovelnose sturgeon (*Scaphirhynchus platyrhynchus*) and have five rows of scutes that run the entire length of the body. Pflieger (1975) reported the principal features distinguishing pallid sturgeon from shovelnose as the paucity of dermal ossifications on the belly, 24 or more anal fin rays, and 37 or more dorsal fin rays. Forbes and Richardson (1905) noted that pallid sturgeon contained 20 to 22 ribs while the shovelnose sturgeon had only 10 to 11 ribs. The air bladder was also noted as being relatively smaller in the pallid sturgeon. Those authors recorded differences between the pallid and shovelnose sturgeon in the number of ventral radials, relative depth of lateral scutes, orbital space size, proportional lengths of inner and outer barbels, mouth width, proportion of head width to head length, and proportion of head length to body length. Prior to the listing of the pallid sturgeon as an endangered species, very little was known about this freshwater sturgeon and much of what is currently known about the life history is from recent studies conducted on the Missouri River and its largest tributary, the Yellowstone River.

Genetics

The issue of species status for the pallid sturgeon has been often debated since the pallid sturgeon was petitioned for endangered status. The pallid sturgeon's similar appearance to the more common shovelnose sturgeon has led some to conclude that they are members of the same species. Since the pallid sturgeon was listed in 1990, however, geneticists and ichthyologists have worked to refine testing procedures and develop the materials to definitively determine the status of these two fish species.

Several earlier studies, including work completed by Forbes and Richardson (1905), Bailey and Cross (1954) and Carlson and Pflieger (1981), attempted to use various meristic, morphological and physical characteristics to identify the distinguishing characteristics of the pallid sturgeon. Forbes and Richardson (1905) first identified the characteristics of the pallid sturgeon from eight specimens from the Mississippi River at the mouth of the Illinois River. Local fisherman had noticed that some sturgeon, locally called white sturgeon or switch-tail, appeared to be different from the more common shovelnose sturgeon. Bailey and Cross (1954) compared 35 measurements and seven plate and fin-ray counts for the pallid and shovelnose sturgeon and found:

> "Although the album and platorynchus are readily separable and are well-marked species, it is clear that they are closely related and share several fundamental distinctions from the other recent acipenserids."

Carlson and Pflieger (1981) developed a character index using four counts and ten measurements to differentiate between the pallid, shovelnose, and suspected hybrids. Comparisons were also made using tissue samples from 10 pallid sturgeon, 74 shovelnose sturgeon, and 6 presumed hybrids. Tissue samples were identical at all 52 loci examined using electrophoresis; no statistically significant differences were found at three polymorphic loci examined. They concluded that the similarities suggest a close relationship, but, given the many phenotypic differences, they were still surprised by the similarities .

In less than half the pallid sturgeon range where hybridization has not been observed or is minimal (MT, ND), obvious morphological differences exist between pallid and shovelnose sturgeon. Krentz (1996) developed a character index that uses six morphological characteristics to differentiate between the two species and makes field identification easy in the North Dakota/Montana range of the population. Sheehan et al. (1999) also developed a character index that was applied to Mississippi River pallid sturgeon and found the populations of pallid sturgeon in the lower Missouri River and the Mississippi River appear to have much hybridization, thus complicating identities. Campton (1987) stated that detecting hybrids through use of morphological and meristic characteristics has many shortcomings and can only provide circumstantial evidence of hybridization. He also stated that if hybridization has proceeded beyond the first generation, distinguishing individuals of mixed ancestry is often impossible.

By 1994, several studies had been conducted which attempted to differentiate the pallid and shovelnose sturgeon using genetic analyses. Phelps and Allendorf (1983) and Genetic Analyses, Inc. (1994) compared sequences of segments of the mitochondrial DNA (mtDNA) cytochrome b gene. None of the studies detected significant genetic differences between pallid and shovelnose sturgeon, but suffered from a lack of complete understanding of the genetics of the *Scaphirhynchus* species. Since then, other studies have found that the cytochrome b locus was not useful for discriminating among some congeneric fish species (Campton et al. 1995). Fain et al. (2000) found that the mitochondrial cytochome b gene was not useful to distinguish species with *Scaphirhynchus* as well as two other species groups within the sturgeon genus *Acipenser*.

Campton et al. (1995, 1999) conducted a comparative study of the mtDNA d-loop of the *Schaphirhynchus* species. The d-loop is considered to be a rapidly evolving part of the genome. The results support previous conclusions that a very close evolutionary relationship exists between the pallid and the shovelnose sturgeon. However, the mtDNA markers utilized for this study were not useful as a stand-alone tool for addressing hybridization questions because the mtDNA is inherited from the female parent only (Campton et al. 1995).

Sloss et al. (in press) conducted microsatellite analyses of the *Scaphirhynchus* sturgeon and found that the *Scaphirhynchus* species do not randomly select mates from throughout the whole population of *Scaphirhynchus*. The data show that the shovelnose and pallid sturgeon are statistically different and that significant allelic frequency differences exist between pallid sturgeon and shovelnose sturgeon populations, thus further supporting the validity and protective status of the pallid sturgeon as a separate species.

Most recently, Campton et al. (2000) conducted further studies on mtDNA, which indicate significant reproduction isolation between pallid and shovelnose sturgeon. They concluded that the mtDNA results provide the first molecular genetic evidence for distinguishing the *Scaphirhynchus* species, and, coupled with current morphological and biogeographic data, indicate that pallid sturgeon should be evaluated as a separate species under the ESA.

Historic and Current Range Wide Distribution

The historic range of pallid sturgeon as described by Bailey and Cross (1954) encompassed the middle and lower Mississippi River, the Missouri River, and the lower reaches of the Platte, Kansas, and Yellowstone Rivers (Figure 5). Bailey and Cross (1954) noted a pallid sturgeon was captured at Keokuk, IA, at the Iowa and Missouri state border. Duffy et al. (1996) stated

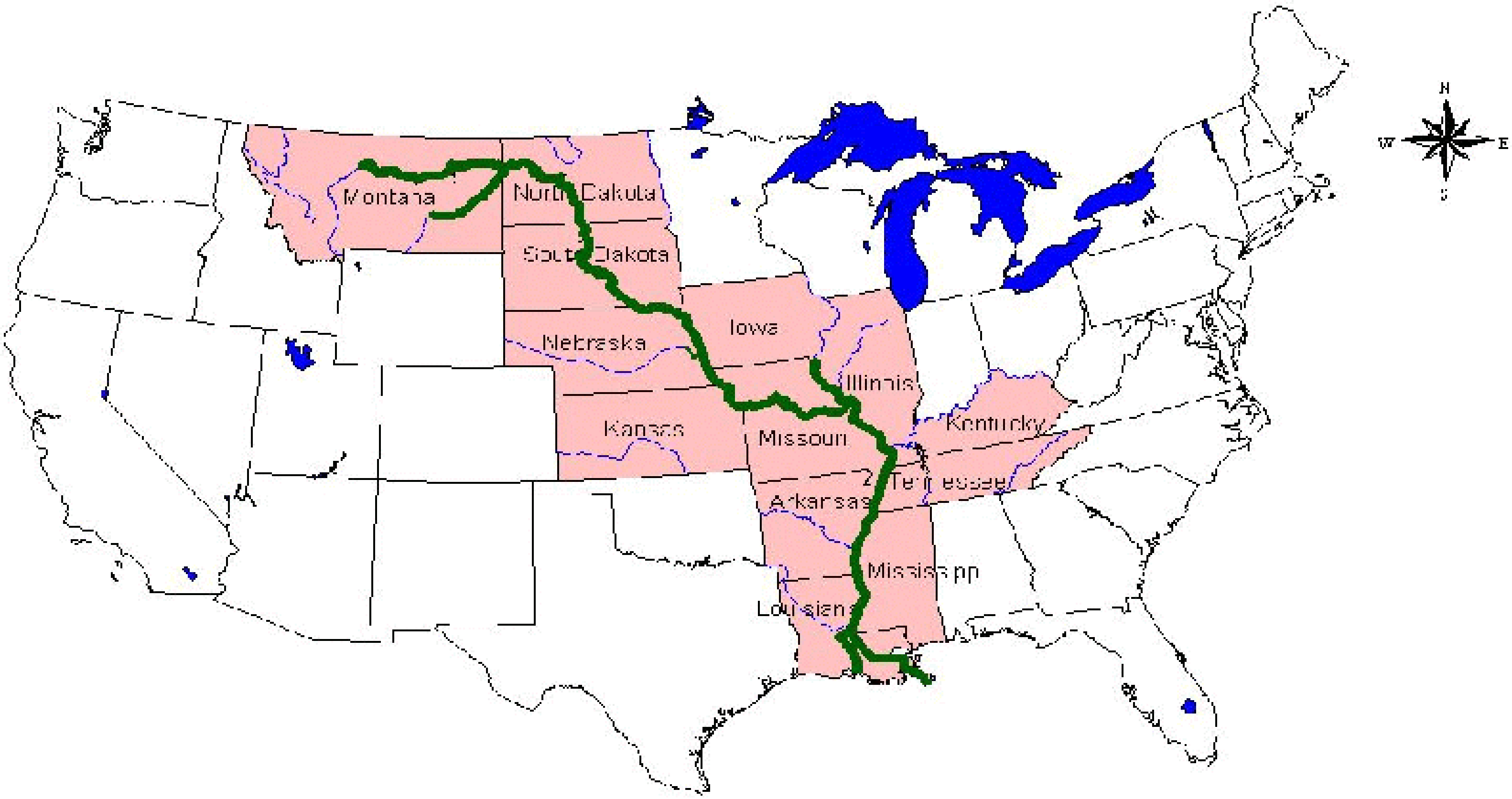

Figure 5. Pallid sturgeon historic range.

that the historic range of pallid sturgeon once included the Mississippi River upstream to Keokuk, IA, before the river was converted into a series of locks and dams for commercial navigation (Coker 1930).

Carlson and Pflieger (1981) stated that pallid sturgeon are rare, but widely distributed in the Missouri River and in the Mississippi River downstream from the mouth of the Missouri River.

The pallid sturgeon appears nearly extirpated from large segments of its former range. In 1991, pallid sturgeon were discovered in the Atachafalya River in Louisiana (Reed, Louisiana Dept. Wildlife and Fisheries, pers. comm. 1991).

Today, they are only occasionally found in a few selected areas. Since 1980, reports of most frequent occurrence are from the Missouri River: 1) between the Marias River and Ft. Peck Reservoir in Montana; 2) between Ft. Peck Dam and Lake Sakakawea (near Williston, North Dakota); 3) within the lower 70 mi (113 km) of the Yellowstone River downstream of Fallon, Montana; 4) in the headwaters of Lake Sharpe in South Dakota; 5) near the mouth of the Platte River near Plattsmouth, NE; and 6) below river mile 218 to the mouth in the State of Missouri. Areas of most recent and frequent occurrence on the Mississippi River are 6) near Chester, IL; 7) Caruthersville, MO; and 8) in the Atchafalaya River in Louisiana at the Old River Control Structure, where the Atchafalaya diverges from the Mississippi River (USFWS 1993). Of 872 pallid sturgeon records prior to 1998, 70 percent were reported from the Missouri River. Approximately 10 percent of the Missouri River records were from below Gavins Point Dam; the majority of records were from intensive sampling efforts in Montana, North and South Dakota, and include recaptures. In addition, 9 percent of the total records came from the Yellowstone River, 5 percent from the Mississippi River, 14 percent from the Atchafalaya River, and less than 2 percent from the St. Francis, Platte, Ohio, Kansas, and Big Sunflower Rivers (Steve Krentz, USFWS, pers. comm. 2000).

Keenlyne (1989) updated previously published and unpublished information on distribution and abundance of pallid sturgeon. He reported pre-1980 catch records for the Mississippi River from its mouth upstream to its confluence with the Missouri River, a length of 1,153 mi (1,857 km); in the lower 35 mi (56 km) of the Yazoo/Big Sunflower and St. Francis Rivers (tributaries to the Mississippi); in the Missouri River from its mouth to Fort Benton, MT, a length of 2,063 mi (3,323 km); and in the lower 64 km of the Kansas River, the lower 21 mi (34 km) of the Platte River, and the lower 200 mi (322 km) of the Yellowstone River (tributaries to the Missouri River). The total range is approximately 3,500 mi (5,635 km) of river. States within or bordering this range are Montana, North Dakota, South Dakota, Nebraska, Iowa, Kansas, Missouri, Illinois, Kentucky, Tennessee, Arkansas, Mississippi, and Louisiana.

Life History

Reproductive Biology - The knowledge base regarding reproduction or spawning activities of pallid sturgeon has been rapidly improving during the past 5 years. Even basic parameters such as the microhabitat characteristics of spawning locations, substrate preference, water temperature, or time of year are now beginning to be documented. Spawning occurs between March through July depending on location (Forbes and Richardson 1905, Gilbraith et al. 1988;). Keenlyne and Jenkins (1993) estimate that spawning probably begins in March in the lower Mississippi and Atchafalaya Rivers; in late April or early May in the lower Missouri and middle Mississippi Rivers; and in late May or early June in the upper Missouri River. Sexually mature pallid sturgeon have been observed in the Yellowstone River in western North Dakota during late May and early June when water temperatures ranged from 60-65ºF (15.5?-18.5?C) (Steve Krentz, USFWS, pers comm.). Sandvol (USFWS, pers. comm., 1992) observed a male pallid sturgeon captured from the Missouri River near Williston, ND, running milt in late May 1991.

While no spawning beds have been located, Bramblett (1996) described probable spawning areas in the Yellowstone River from about river km 6 to river km 14. Breder and Rosen (1966) report that as a group, sturgeon exhibit uniform spawning behavior; and thus, such information can be used to make inferences about pallid sturgeon behavior. All sturgeon species spawn in the spring or early summer, are multiple spawners, and release their eggs at intervals. Spawning behavior was observed in 1998 during propagation attempts at Garrison Dam National Fish Hatchery. Following the luteinizing hormone injection, spawning behavior was observed between sexually mature male and female pallid sturgeon within 20-ft (6.1 m) circular tanks (Rob Holm, USFWS, pers comm.). In the wild, the adhesive eggs are released in deep channels or rapids and are left unattended (Gilbraith et al. 1988). The larvae of Acipenserids are generally pelagic, becoming buoyant or active immediately after hatching (Moyle and Cech 1982). Although the behavior of young pallid sturgeon is poorly understood, recent work by Kynard et al. (1998a) indicates that a downstream migration period for larval pallid sturgeon begins day-0 at hatching and continues up to day-13, with a decline after day-8. With this information it has been possible to use water velocities to roughly estimate that larval pallid sturgeon may drift in the water column for a distance of 40 to over 400 mi (64-643 km) (Steve Krentz, USFWS, pers. comm.).

Females collected in June and July in the upper end of Lake Sharpe, a reservoir on the Missouri River in South Dakota, contained mature ova and presumably were ready to spawn. However, during 10 years of sampling for young-of-the-year fish in Lake Sharpe (Kallemeyn 1983) or in the 17 years since then, no evidence of successful reproduction has been found.

Kallemeyn (1983) reported that pallid sturgeon males reach sexual maturity at 21-23 in (53.3-58.4 cm), however, size and age of females at sexual maturity were unknown at that time. Conte et al. (1988) indicated that females of most sturgeon in North America do not mature until at least age 7 and typically require several years for eggs to mature between spawnings. The age of sexual maturity and intervals between spawning were estimated for nine pallid sturgeon by recording what were interpreted to be spawning events from pectoral fin ray cross sections. Sexual maturity for males was estimated to be 7 to 9 years, with 2 to 3 year intervals between spawning years. Females were estimated to reach sexual maturity in 15 to 20 years, with 3 to 10 year intervals between spawning years (Keenlyne and

Jenkins 1993). Time of sexual maturity and the age intervals between spawning years is likely to be influenced by available forage, environmental conditions and other factors (USFWS 1993), and thus, likely varies to some degree between river reaches.

Keenlyne et al. (1992) estimated fecundity for a female pallid sturgeon taken from the upper Missouri River. The authors found the mass of mature eggs weighed 69 oz (1,952 g), which represented 11.4 percent of total body weight. Total fecundity was estimated at 170,000 eggs for this female. Females may take up to 10 years between spawnings depending on the quality and quantity of food available in their natural habitat (Keenlyne and Jenkins 1993). The food availability is in turn dictated by habitat factors such as flow, water temperatures, substrate, and structure. Therefore, fecundity of a female may vary considerably, with an individual female spawning only a few times during her normal life span (Duffy et al. 1996).

Henry and Ruelle (1992) calculated the gonadosomatic index (GSI) and fecundity for one female pallid/shovelnose sturgeon hybrid and three female pallid sturgeon captured on the Mississippi River. The fecundity of the hybrid was estimated at 61,992 eggs. This fish had the highest GSI (23.9) of the other sturgeon measured. The eggs of the pallid sturgeon were not as mature and had GSI's of 7.2, 9.0, and 10.5.

While subtle differences likely exist in the spawning requirements of the pallid sturgeon and shovelnose sturgeon, the shovelnose sturgeon is believed to provide a good indication of spawning requirements for pallid sturgeon. The two species are reported to hybridize (Carlson et al. 1985). Shovelnose sturgeon spawn over substrates of rock, rubble, or gravel in the main channel of the Missouri/Mississippi Rivers and major tributaries, or on wing dams in the main stem of larger rivers (Helms 1974, Elser et al. 1977, Moos 1978,). Spawning was suspected to occur in the relatively swift water in or near the main channel of the unchannelized Missouri River near Vermillion, South Dakota, when water temperatures reach 64? to 66?F (18? to19?C), which can be from late May through June (Moos 1978). Shovelnose sturgeon spawning occurs in the Tongue River, Montana, a Yellowstone River tributary, from early June until mid-July at water temperatures of 62.4? to 70.7?F (16.9? to 21.5?C) (Elser et al. 1977). Pallid sturgeon have been spawned on three different occasions at both Gavins Point NFH and Garrison Dam NFH. Water temperatures and egg quality were monitored prior to and during spawning and analysis has shown that the optimum spawning temperature ranged from 60? to 65?F (15.5? to 18.5?C) immediately prior to the spawning (Steve Krentz, USFWS, pers. comm.).

Without increased flows in June and July, and warmer water temperatures during that period, the cues for pallid sturgeon to spawn probably are no longer present under existing main stem dam operations, throughout much of the Missouri River.

Age and Growth - Little is known about age and growth of pallid sturgeon. This is primarily due to lack of sturgeon tissues that allow age determination. Use of the leading ray of the pectoral spine has provided age estimates; however, the Pallid Sturgeon Recovery Team does not support the collection of this tissue due to uncertainties of the overall effects to the fish. To date, most ages have been collected from mortalities.

It should be noted that recent efforts to validate pallid sturgeon age estimates from pectoral fin rays have questioned the accuracy and precision of this aging technique. Using hatchery raised fish, Hurley (1999) documented that the majority of pallid sturgeon age estimates, based on pectoral fin rays, were incorrect, with the most frequent error being 3 years. He noted a tendency to underage, rather than overage pallid sturgeon samples. Large variations between first and second age estimates for the same fish by each reader (within reader variation) were noted. Hurley (1999) found only 28 percent accuracy and up to 4 years variation using pectoral fin rays for aging. However, a 3 to 4 year variation in age estimates may not be significant given on older pallid sturgeon (40-50 years).

The total length of pallid sturgeon was significantly greater than that of shovelnose in the lower Missouri and Mississippi Rivers for each age group in which comparable data were available (Carlson et al. 1985). Fogle (1963) estimated growth rates using cross sections of pectoral fin rays from six pallid sturgeon from Lake Oahe in South Dakota. He estimated that growth of those fish was relatively rapid during the first 4 years, but that growth decreased to approximately 2.8 in (70 mm) per year between ages 5 and 10. Carlson and Pflieger (1981) presented data (n=8) from the Missouri and Mississippi Rivers in Missouri, that showed slightly slower growth than from pallid sturgeon in South Dakota. Keenlyne and Jenkins (1993) found that male pallid sturgeon showed rapid growth from age-5 to age-7 until sexual maturity. Those fish were from Louisiana, Missouri and North Dakota.

In 1998, a 66-lb (30-kg), 63-inch (160-cm), female pallid sturgeon captured from North Dakota was aged following mortality. Dennis Scarneccia (1999, Univ of Idaho, pers comm.) used techniques developed for white sturgeon and estimated the age at over 50 years and possibly as high as 60.

Movements - Pallid sturgeon exhibit seasonal variation in movement patterns based upon temperature and discharge (Bramblett 1996, Constant et al. 1997, Sheehan et al. 1998a, Hurley 1999). Movement patterns also vary between spawning versus non-spawning years (Bramblett 1996). Bramblett (1996) reported an average home range of 48.8 mi (78 km) in the Yellowstone and upper Missouri Rivers while Sheehan et al. (1998a) reported a home range of 21.2 mi (34 km) in the Mississippi River. Sheehan et al. (1998a) speculated that because habitat in the Mississippi River is relatively uniform, large movements and home ranges may not be as beneficial in the Mississippi River, as in the Yellowstone and Upper Missouri Rivers area, because study fish are not likely to encounter new habitats and thus have a smaller home range.

As large river fish, pallid sturgeon are capable of moving long distances in search of favorable habitat. Sheehan et al. (1998a) noted one study fish moving along a 60.3-mi (97 km) stretch of river. Bramblett (1996) noted a maximum home range as large as 198.6 mi (319 km), with pallid sturgeon moving up to 13 mi/day (21 km/day) and shovelnose sturgeon moving up to 9 mi/day (15 km/day).

Erickson (1992) found pallid sturgeon movement greater during the night while Bramblett (1996) observed greater movements during the day. The primary habitat difference suspected in those findings was turbidity. Erickson (1992) had secchi readings as high as 157 in (400 cm) while Bramblett (1996) averaged 8 in (20 cm) and rarely exceeded 39 in (100 cm). Bramblett (1996) modeled the information from his study and found that predictive depth of pallid sturgeon was greater during the hours following sunrise and suggested that pallid sturgeon may be photophobic.

The spawning period for pallid sturgeon, believed to occur from late April into July, historically corresponded with increased flows from runoff, which also has been known to trigger spawning of other ancient big-river fish such as paddlefish (Russell 1986) and shovelnose sturgeon (Berg 1981). Gardner (1995a) radio tracked 14 pallid sturgeon in the upper Missouri River during a low water runoff year and a near-normal year. He found that adult pallid sturgeon moved an average of 3.2, 12.9, and 17.6 mi (5.1, 20.7, 28.3 km) further upriver during May, June, and July of the normal runoff year compared to the low runoff year.

Both shovelnose sturgeon and paddlefish spawning migrations occur in response to increased flows in June (Berg 1981). Although there is limited information on pallid sturgeon spawning migrations, Bramblett (1996) stated that discharge and photoperiod may be important environmental cues for the timing of movements for both shovelnose and pallid sturgeon. He found a typical pattern of movement for pallid sturgeon was to move upstream into the Yellowstone River and out of the Missouri River in the early spring during increasing discharge and photoperiod; reside in the Yellowstone River during high discharge; and move downstream, back into the Missouri River during late summer. A similar pattern has been observed in the paddlefish population (John Firehammer, University of Idaho, pers. comm.).

Erickson (1992) and Bramblett (1996) observed that movement rates of pallid sturgeon were lowest in winter months and a significant positive correlation between water temperatures and movement rate of pallid sturgeon existed.

Juvenile pallid sturgeon from Gavins Point NFH in South Dakota were subjected to swimming stamina tests in 1998. Adams et al. (1999) found sustained and prolonged speeds of juvenile pallid sturgeon were comparable to similar sized lake sturgeon; however, pallid sturgeon exhibited a higher capacity for burst swimming. Adult shovelnose sturgeon, a closely related species, were also tested for swimming endurance. Sturgeon were found to swim volitionally at low speeds (5-30 c/s), but at higher speeds (40-120 c/s), sturgeon alternated between active swimming and appressing themselves to the bottom of the swimming tunnel (USFWS 1999). This second behavior is enhanced by sturgeon morphology - streamlined body shape, flat rostrum, and large pectoral fins. It allows sturgeon to exploit river bottoms as a refugia from current and maintain position in high velocities.

Population Status and Trends

Because the pallid sturgeon was not recognized as a distinct species until 1905, it was not listed in early commercial fishery reports, so little is recorded about its abundance prior to that time. Even as late as the mid-1900s, it was common for pallid sturgeon to be tallied in commercial catch records as either shovelnose or lake sturgeon (Keenlyne 1995). Correspondence and notes of researchers suggest, that the pallid sturgeon was still fairly common in many parts of the Mississippi and Missouri River systems as late as 1967 (Keenlyne 1989). The literature indicates that declines in populations have occurred coincidental with development of the Missouri and Mississippi River systems for flood control and navigation (Deacon et al. 1979, Keenlyne 1989). [Excerpt from Duffy et al. 1996]. Forbes and Richardson (1905) and Bailey and Cross (1954) indicated that the species was never as common as the shovelnose sturgeon.

A comparison of pallid sturgeon and shovelnose sturgeon catch records provides an indication of the rarity of pallid sturgeon. At the time of their original description, pallid sturgeon composed 1 in 500 river sturgeon captured in the Mississippi River at Grafton, Illinois (Forbes and Richardson 1905). Pallid sturgeon were more abundant in the lower Missouri River near West Alton, MO, representing one-fifth of the river sturgeon captured (Forbes and Richardson 1905). Carlson et al. (1985) captured 4,355 river sturgeon in 12 sampling stations on the Missouri and Mississippi Rivers. Field identification revealed 11 (0.25 percent) pallid sturgeon. Grady et al. (in prep) collected 4,435 river sturgeon in the lower 850 mi (1,367 km) of the Missouri River and 100 mi (161 km) of the Middle Mississippi River from November 1997 to April 2000. Field identification revealed nine wild (0.20 percent) and nine hatchery-origin pallid sturgeon. Ongoing field work at the Missouri Department of Transportation Hermann Bridge Replacement site has resulted in two pallid sturgeon (0.17 percent) of 1,192 river sturgeons collected January through September 2000 (J. Grady, pers. comm. 2000).

During systematic sampling on the Missouri and Yellowstone Rivers in 1995, the Montana Department of Game, Fish and Parks collected 10 (2.2 percent) pallid sturgeon compared to 444 shovelnose sturgeon (Liebelt 1995). Reed and Ewing (1993) collected 11 (11 percent) pallid sturgeon, 18 hybrids and 74 shovelnose sturgeon in the vicinity of the Old River Control Complex in Louisiana. Watson and Stewart (1991) noted one (0.29 percent) pallid sturgeon out of 350 sturgeon from the lower Yellowstone River in Montana.

Bailey and Cross (1954) provided information on the proportion of pallid sturgeon in the total commercial catch of river sturgeon from various parts of the species' range as follows: Kansas River at Lawrence, KS (8 percent) (number of species not reported); Missouri River in South Dakota, 3 of 62 specimens (5 percent); and Mississippi River at New Orleans, 3 of 4 specimens (75 percent). Fisher (1962) recorded 4 of 13 river sturgeons (31 percent) from the Missouri River in Missouri as pallid sturgeon. Comparable commercial catch records are not available for the upper river reaches where commercial fishing was light or nonexistent.

The channelized Missouri River downstream from Sioux City, IA, to the mouth and the Mississippi River downstream from the mouth of the Missouri River are rapidly flowing river sections. Thus, sampling in these areas and acquisition of current abundance estimates is difficult. Abundance estimates for these parts of the range by Duffy et al. (1996) were not considered reliable due to the lack of mark/recapture data.

Pallid sturgeon were proposed for listing as an endangered species on August 30, 1989 (54 FR 35901-35904). The species was listed as endangered on October 9, 1990 (55 FR 36641-36647). The reasons for listing were habitat modification, apparent lack of reproduction, commercial harvest and hybridization in parts of its range. Most authors attribute the decline of pallid sturgeon to the massive habitat alterations that have taken place over virtually all of its range (Kallemeyn 1983, Gilbraith et al. 1988, Keenlyne 1989, USFWS 1993).

Since 1988, pallid sturgeon researchers have collaborated on studies to gather information about the species including estimates of fish numbers (Keenlyne 1995). That has allowed workers to identify where populations still remain and to obtain rough estimates of present abundance of the species. Tag and recapture data has allowed researchers to estimate that 50 to 100 pallid sturgeon remain in the Missouri River above Ft. Peck Dam in Montana, and between 200 and 300 pallid sturgeon remain between the Garrison Dam in North Dakota and Fort Peck Dam, including the lower Yellowstone River (Steve Krentz, pers. comm.). One to five sightings per year have been made of pallid sturgeon between the headwaters of Oahe Reservoir in South Dakota to the Garrison Dam and from the riverine reach in the Missouri River above Gavins Dam to Fort Randall Dam suggesting that, perhaps as many as 25 to 50 fish may remain in each of these areas. A small population also exists between Oahe Dam and Big Bend Dam on the Missouri River in South Dakota with perhaps 50 to 100 fish remaining in this riverine section. Unfortunately, no evidence has been obtained that any of the upper Missouri River system populations are successfully reproducing because only large individuals are being reported (Keenlyne 1989, Duffy et al. 1996).

Glen Constant, at Louisiana State University, estimated the pallid sturgeon population in the Atchafalaya River to range from 2750 to 4100 fish. That is based on tag returns and telemetry studies. However, a high incidence of hybridization is occurring in the Atchafalaya River and Mississippi Rivers (Keenlyne et al. 1994) which makes estimation of the number of pure pallid sturgeon in these river systems difficult (Duffy et al. 1996).

In recent years, pallid sturgeon populations have been augmented by release of hatchery reared fish. In 1994, the MDC released approximately 7000 fingerlings in the Missouri and Mississippi Rivers and an additional 3000 fingerlings were stocked in 1997 (Graham 1997, 1999). Since stocking in 1994, approximately 86 pallid sturgeon returns have been reported, mostly in the Mississippi River downstream of St. Louis (Graham 1999). Thirty-five 12 to 14-inch fish raised at Natchitoches NFH were stocked in the lower Mississippi River in 1998 (Kilpatrick 1999). Also in 1998, 745 hatchery-reared yearling pallid sturgeon were released at three sites in the Missouri River above Ft. Peck Reservoir (Gardner 1999) and another 750 yearling sturgeon were released near the confluence of the Yellowstone and Missouri Rivers (Steve Krentz, pers. comm.).

During the summer of 2000, 397 3-year old hatchery-raised pallid sturgeon and 6 adult brood stock pallid sturgeon were taken from the Gavins Point National Fish Hatchery and released into the Fort Randall reach of the Missouri River (Segment 9). All of the pallid sturgeon had tags and transmitters for identification and telemetry purposes, 22 juveniles were fitted with sonic transmitters.

Despite stocking efforts, pallid sturgeon remain rare compared to the shovelnose sturgeon. In 1997 and 1998, the MDC, Long Term Resource Monitoring Station at Cape Girardeau collected 7 pallid sturgeon (0.45 percent) compared to 1549 shovelnose sturgeon in the middle Mississippi River (Petersen 1999). All seven were hatchery-origin pallid sturgeon (J. Grady, pers. comm. 2000). Constant et al. (1997) noted that in surveys of commercial catch, shovelnose sturgeon accounted for between 52 percent and 98 percent of the total sturgeon catch, with the remainder composed of similar portions of hybrids (2 percent to 21 percent) and pallid sturgeon (0 percent to 26 percent).

Evidence of successful pallid sturgeon reproduction and recruitment is rare throughout the range of the species, because of fragmentation and modification of the habitats. In 1998, the MDC collected a young-of-the-year pallid sturgeon at approximate river mile 49.5 south of Cape Girardeau in the middle Mississippi River (Petersen and Herzog 1999). During the summer of 1998 and 1999, several pallid sturgeon larvae were collected from the lower Missouri River in Missouri (Jim Milligan, USFWS, pers. comm. 1999). Those three instances represent the first evidence of successful pallid sturgeon reproduction in recent years and indicate that some suitable spawning habitat and hydrologic conditions remains in the lower Missouri River below Gavins Pont Dam and/or Platte River, and potentially, the middle Mississippi River.

Recent work in the Atchafalaya River has revealed fish of several age groups suggesting that some reproduction and recruitment may occur in the Atchafalaya River. However, the only physical evidence of reproduction were three gravid females (Constant et al. 1997). According to their data, pallid sturgeon collected in the Atchafalaya River and other areas of the Mississippi River have averaged less than 6.6 lbs (3 kg) and length-at-age estimates calculated according to Fogle (1963) indicated that even the smallest fish were over age 6, with the oldest perhaps over age 14. The age of fish in their study indicates the most recent recruitment of pallid sturgeon to be from the 1988 year class (Constant et al. 1997).

Larval sturgeon rarely have been collected from within the range of pallid sturgeon. This may be due to low reproductive success or the inability of standard sampling gear to capture larval sturgeon. Hesse and Mestl (1993) collected two sturgeon larvae from the Missouri River adjacent to Nebraska between 1983 and 1991. Those larvae were among 147,000 fish larvae collected during filtration of 18,340,014 cu ft (519,400 cu m) of river water. Gardner and Stewart (1987) collected no sturgeon larvae in 339 samples from the Missouri River or in 77 samples from tributary streams where 3,124 and 5,526 fish larvae were collected, respectively. In three years of sampling in/near Lisbon Chute on the Missouri River, the Service's Columbia Missouri Fishery Resources Office collected over 10,000 small fish utilizing seines, benthic trawls and fyke nets. In processing 9855 of these fish, 1 confirmed and 2 probable larval pallid sturgeon have been identified (Joanne Grady, USFWS, pers. comm.). Those data suggest that spawning success and larval sturgeon abundance are low.

Habitat and Food Requirements

Habitat Characteristics - Forbes and Richardson (1905), Schmulbach et al. (1975), Kallemeyn (1983), and Gilbraith et al. (1988) describe pallid sturgeon as being a fish well adapted to life on the bottom in swift waters of large, turbid, free-flowing rivers. Pallid sturgeon evolved in the diverse environments of the Missouri and Mississippi Rivers. Floodplains, backwaters, chutes, sloughs, islands, sandbars, and main channel waters formed the large-river ecosystem that provided macrohabitat requirements for pallid sturgeon and other native large-river fish. Those habitats were historically in a constant state of change. Mayden and Kuhajda (1997) describe the natural habitats to which the pallid sturgeon is adapted as: braided channels, irregular flow patterns, flooding of terrestrial habitats, extensive microhabitat diversity and turbid waters. Today, those habitats and much of the once functioning ecosystem of the pallid sturgeon has been changed by human developments.

The historic floodplain habitat of the Missouri and Mississippi Rivers provided important functions for the native large-river fish. When floodflows crested the river's banks, floodplains provided the major source of organic matter, sediments and woody debris for the main stem rivers when floodflows crested the river's banks. The transition zone between the vegetated floodplain and the main channel included habitats with varied depths described as chutes, sloughs, or side channels. The chutes or sloughs between the islands and shore were shallower and had less current than the main channel. Those areas provided valuable diversity to the fish habitat and probably served as nursery and feeding areas for many aquatic species (Funk and Robinson 1974). The still waters in this transition zone allowed organic matter accumulations, important to macroinvertebrate production. Both shovelnose sturgeon and pallid sturgeon have a high incidence of aquatic invertebrates in their diet (Carlson et al. 1985; Gardner and Stewart 1987). Floodflows connected these important habitats and allowed fish from the main channel to use those habitats to exploit available food sources.

Carlson et al. (1985) captured both pallid sturgeon and shovelnose sturgeon in gear-sets along sandbars on the inside of riverbends, and in deeply scoured pools behind wing dams, indicating overlap of habitat use by the two species. However, 4 of 11 pallids were captured in gear-sets in swifter currents where shovelnose sturgeon were less numerous. Although pallid sturgeon and shovelnose sturgeon habitat use and movements are similar in certain aspects, important differences were noted by Bramblett (1996). Pallid sturgeon showed significant preferences during most times of the year for sandy substrates, particularly sand dunes, and avoided gravel and cobble substrate preferred for spawning (Bramblett 1996). In contrast, shovelnose sturgeon significantly preferred gravel and cobble substrates and avoided sand.

Pallid sturgeon were also more specific and restrictive in use of macrohabitat selection than shovelnose sturgeon (Bramblett 1996). According to this study, pallid sturgeon were found most often in sinuous channels with islands or alluvial bars present. Straight channels, and channels with irregular patterns or irregular meanders were only rarely used by pallid sturgeon. Seral stage of islands or bars near pallid sturgeon was most often subclimax (Bramblett 1996).

Bramblett (1996) noted that because macrohabitats used by pallid sturgeon were more specific and restrictive than shovelnose sturgeon, features in these macrohabitats may be more important to pallid sturgeon than to shovelnose sturgeon. Bramblett (1996) found macrohabitats used by pallid sturgeon were diverse and dynamic. For example, pallid sturgeon used river reaches with sinuous channel patterns and islands and alluvial bars which generally have more diversity of depths, current velocities, and substrates than do relatively straight channels without islands or alluvial bars. The diversity of channel features such as backwaters and side channels was also higher. The subclimax riparian vegetational seres in these areas are indicative of a dynamic river channel and riparian zone (Johnson 1993).

In telemetry studies of pallid sturgeon on the middle Mississippi River, Sheehan et al. (1998a) found a positive selection for main channel border and downstream islands tips and also for depositional areas between wingdams and deep holes off wingdam tips. That seems to correlate well with Carlson et al. (1985). Sheehan et al. (1998a) speculated that between wingdam areas and downstream island tips may be used as velocity refugia and/or feeding stations. Study sturgeon were found most often in main channel habitat, however, they exhibited selection against that habitat type. Their occurrence in such habitat was not surprising considering main channel comprised approximately 65 percent of the available habitat in the study reach (Sheehan et al. 1998a).

Constant et al. (1997) reporting on radio-tracked sturgeon, stated that sturgeon were most frequently found in low slope areas and that such areas were used in proportion to their availability. No sturgeon were observed on extremely steep slopes. They found that sand made up over 80 percent of the substrate in low slope areas where over 90 percent of pallid sturgeon were located. Constant et al. (1997) stated that the preference for sand substrates in low slope areas suggests that pallid sturgeon use such areas as current refugia. Sand substrates were found to have lower invertebrate densities than substrates of silt-clay which were generally located on areas of steep slope which were exposed by swift currents. As such, it would have been energetically costly for pallid sturgeon to remain near these substrates for extended periods of time. However, telemetry observations showed 55 percent of sturgeon locations occurred within 10m of steep slopes, suggesting that pallid sturgeon remained near areas of high food abundance (Constant et al. 1997).

Some caution must be used in evaluating the results of habitat preference studies conducted in the highly altered river environments of today as there is no way to measure pallid sturgeon preference for habitats that no longer exist (Dr. Robert Sheehan, SIUC, pers. comm.). The results of studies by Bramblett (1996), Constant (1997), and Sheehan et al. (1998a) are indicative of the habitats being used by pallid sturgeon in the altered environment of today.

Micro-Habitat Characteristics - Microhabitat characteristics of pallid sturgeon are just recently being described. Much of the microhabitat research to date is located in significantly altered environments. That research does not necessarily indicate preferred or required habitats; instead it may only indicate which habitats of those presently available are used by the pallid sturgeon. Also, capture locations may have conditions representing seasonal habitat preferences. Hurley (1996) found that pallid sturgeon were selecting downstream island tips although they were not abundant within the study area.

Current/Velocity: Findings from a study on the Missouri River in South Dakota indicate that pallid sturgeon most frequently occupy river bottoms where velocity ranges from 0 to 0.73 m/s (Erickson 1992). Other studies in Montana found that pallids are most frequently associated with water velocities ranging from 0.46 to 0.96 m/s (Clancey 1990). Bramblett (1996) noted pallid sturgeon occupying bottom velocities ranging from 0.0 to 1.37 m/s. These velocities are commonly found throughout the species' range.

Pallid sturgeon collected from the Missouri River above Garrison Reservoir in North Dakota during spring and fall seasons of 1988 to 1991 were found in deep pools at the downstream end of chutes and sandbars, and in the slower currents of near-shore areas. Those areas may have been providing good habitat for energy conservation and feeding (USFWS 1993). Sheehan et al. (1998a) indicated that there were no shifts in habitat selection and avoidance by middle Mississippi River pallid sturgeon under three different discharge regimes (low, medium and high discharge ranges of 0 - 165 Kcfs, 165 Kcfs to 270 Kcfs and >270 Kcfs). Data collected by Constant et al. (1997) support observations that shovelnose sturgeon tolerate lower current velocities than pallid sturgeon (Carlson et al. 1985, Ruelle and Keenlyne 1994, Bramblett 1996). They found that pallid sturgeon catch-per-unit-effort (CPUE) declined following shutdown of the Old River Control Structure and that no pallid sturgeon were collected when current velocity was reduced to zero, although shovelnose sturgeon CPUE was highest at this time.

Turbidity: Pallid sturgeon historically occupied turbid river systems. Turbidity levels where pallid sturgeon have been found in South Dakota range from 31.3 to 137.6 Nephelometric turbidity units (NTU) (Erickson 1992). Pallid sturgeon avoid areas without turbidity and current (Bailey and Cross 1954, Erickson 1992). That behavior contributes to the reason why pallid sturgeon are no longer found in the Missouri River reservoirs, and have not expanded into other rivers in the Mississippi drainage, even though access is available (Duffy et al. 1996).

Water Depth: Pallid sturgeon were frequently found in water depths of 2 to 6 m in South Dakota (Erickson 1992). In Montana, pallid sturgeon were captured from depths between 1.2 to 3.7 m in the summer, but they were captured in deeper waters during winter (Clancey 1990). Other pallid sturgeon collected in the upper Missouri, Yellowstone and Platte Rivers were captured in depths between 1 to 7.6 m (Watson and Stewart 1991, USFWS 1993). Bramblett (1996) found pallid sturgeon in depths from 0.6 to 14.5 m. That contrasts with Constant et al. (1997) which found pallid sturgeon at mean depths of 15.2 m and observed pallid sturgeon at depths of 7 and 21 m with greater frequency than such areas were available. The range of depth used by pallid sturgeon is likely related to the available habitat within the river segment (Krentz, USFWS, pers. comm.).

Substrate: Pallid sturgeon are most frequently caught over a sand bottom, which is the predominant bottom substrate within the species' range on the Missouri and Mississippi Rivers. Constant et al. (1997) noted that pallid sturgeon spent considerable time associated with sand substrates. They noted that preference for sand substrates in low slope areas suggests that pallid sturgeon use such areas as current refugia (e.g., use sand-wave troughs created as bed-material moves along the river bottom (Gordan et al. 1992)). The pallid sturgeon collected on the Yellowstone River in July 1991 by Watson and Stewart (1991) was over a bottom of mainly gravel and rock, which is the predominant substrate at that capture site. Reed and Ewing (1993) found sturgeon occurring in the man-made rip-rap lined outfall channels of the Old River Control Complex in Louisiana. Bramblett (1996) found that pallid sturgeon preferred sandy substrates, particularly sand dunes and avoided substrates of gravel and cobble. Pallid sturgeon have adhesive eggs. Thus, spawning is thought to occur over hard substrates of gravel or cobble with moderate flow (Dr. Robert Sheehan, SIUC, pers. comm.).

Temperature: Pallid sturgeon inhabit areas where the water temperature ranges from 32? - 86?F (0? C to 30?C), which is the range of water temperature on the Missouri and Mississippi Rivers. Sheehan et al. (1998a) noted that sturgeon habitat use in the Middle Mississippi River did not change with changes in temperature regimes and stated that temperature would not seem to have an affect on either habitat use or habitat selection by Middle Mississippi River pallid sturgeon. Curtiss (1990) found no relation between surface water temperatures and depth used by shovelnose sturgeon on the Mississippi River and no indication that shovelnose sturgeon were moving into deeper, cooler water (if available) as water temperature increased. Current research, however, indicates that pallid sturgeon spawning is directly linked to water temperature. As water temperature increases to 62?-65?F (16.7?C - 18.3?C), pallid sturgeon initiate spawning activity (Steve Krentz, USFWS, pers. comm.).

Sheehan et al. (1990) found that swimming ability decreased and mortality increased for some river species below 39?F (4?C). Hurley (1996) evaluated the habitat associations and movement of pallid sturgeon in the Middle Mississippi River at water temperatures below 39?F (4?C) and above 39?F (4?C) yet below 50?F (10?C). Below 39?F (4?C), study sturgeon were found in association with current-disrupting habitat features such as downstream island tips, wing dams downstream, main channel, and main channel border. Once winter temperatures rose above 39?F (4?C), habitat use became more restricted with main channel border and main channel comprising 87 percent of all relocations. When water temperatures rose to above 50?F (10?C) but below 68?F (20?C) during the spring, relocations in habitats between wing dams increased to 40 percent of the contacts.

Food and Feeding Habits - Carlson et al. (1985) determined composition of food categories, by volume and frequency of occurrence, in the diet of shovelnose sturgeon (n=234), pallid sturgeon (n=9), and presumed hybrids (n=9). Although benthic macroinvertebrates characteristic of river habitats are important dietary components (Modde and Schmulbach 1977, Carlson et al. 1985), the occurrence of lake and terrestrial invertebrates in sturgeon stomachs suggest that drifting invertebrates may also be important forage organisms (Modde and Schmulbach 1977, Contant et al. 1997). Aquatic invertebrates (principally the immature stages of insects) compose most of the diet of shovelnose sturgeon, while adult pallid sturgeon and presumed hybrids consume a greater proportion of fish (mostly cyprinids). Other researchers also reported a higher incidence of fish in the diet of adult pallid sturgeon than in the diet of shovelnose sturgeon (Cross 1967; Held 1969). Most piscivorous Missouri River species eat large quantities of aquatic insect larvae in early life and even as adults (Modde and Schmulbach 1977).

A large pallid sturgeon adult and numerous shovelnose sturgeon were observed on video tape feeding in relatively clear water in the tailrace of Ft. Peck Dam on the Missouri River in Montana. The large adult pallid sturgeon "stood on its fins" in a stationary position. That would allow food organisms to wash into its mouth with the current beneath it (Steve Krentz, pers. comm. 1994). During April of 1999, adult pallid sturgeon were collected near the mouth of the Yellowstone River. Several adult pallid sturgeon were observed with larger (>6 in)(15 cm) food items distending the abdomen. Upon closer examination, one of the pallid sturgeon was observed with a 9-in (22 cm) goldeye protruding into the mouth (Krentz, pers. comm. 1999).

Range Wide Distribution and Abundance of Habitat

The historic habitat of the pallid sturgeon extended from Montana throughout the Missouri River downstream to the Mississippi River and downstream to the Gulf of Mexico. The lower ends of the larger tributaries also provided suitable habitat for certain times of the season. The total length of the pallid sturgeon range was 3,515 mi (5,656 km).

Currently, the Missouri River (1,154 mi) (1,857 km) has been modified significantly with approximately 36 percent of the riverine habitat inundated by reservoirs, 40 percent channelized, and the remaining 24 percent altered due to dam operations (USFWS 1993). Most of the major tributaries of the Missouri and Mississippi Rivers have also been altered to various degrees by dams, water depletions, channelization and riparian corridor modifications.

The middle Mississippi River from the mouth of the Missouri River to the mouth of the Ohio River is principally channelized with few remaining secondary channels, sandbars, islands and abandoned channels. The middle Mississippi River has been extensively diked to maintain a 9 ft (2.7 m) (navigation channel and flood control levees have reduced the size of the floodplain by 39 percent.

The lower Mississippi from the Ohio River to near the Gulf have eliminated major natural floodways and reduced the land area of the floodplain by more than 90 percent (Fremling et al. 1989). Fremling et al. (1989) also reports that levee construction isolated many floodplain lakes and raised river banks. As a result of levee construction, 15 meander loops were severed between 1933 and 1942.

Factors Affecting the Species Range Wide

Habitat Loss and Degradation - Destruction and alteration of big-river ecologic functions and habitat once provided by the Missouri and Mississippi Rivers is believed to be the primary cause of declines in reproduction, growth, and survival of pallid sturgeon (USFWS 1993). The physical and chemical elements of channel morphology, flow regime, water temperature, sediment transport, turbidity and nutrient inputs once functioned within the big-river ecosystem to provide habitat for pallid sturgeon and other native species. Today on the main stem of the Missouri River, approximately 36 percent of riverine habitat within the pallid sturgeon's range has been transformed from river to lake by construction of six massive earthen dams by the Corps between 1926 and 1952 (USFWS 1993). Another 40 percent of the river downstream of dams has been channelized. The remaining 24 percent of river habitat has been altered by changes in water temperature and flow caused by dam operations.

The channelized reach of the Missouri River downstream of Ponca, Nebraska, once a diverse assembledge of braided channels, sandbars, and backwaters, is now confined within a narrow channel of rather uniform width and swift current. Morris et al. (1968) found that channelization of the Missouri River reduced the surface area by approximately 67 percent. Funk and Robinson (1974) calculated that the length of the Missouri River between Rulo, NE, and its mouth (~500 RM) (310 km) had been reduced by 8 percent, and the water surface area had been reduced by 50 percent following channelization.

Missouri River aquatic habitat between and downstream of main stem dams has been altered by reductions in sediment and organic matter transport/deposition, flow modification, hypolimnetic releases, and narrowing of the river through channel degradation. Those activities have adversely impacted the natural river dynamics by reducing the diversity of bottom contours and substrate, slowing accumulation of organic matter, reducing overbank flooding, changing seasonal flow patterns, severing flows to backwater areas, and reducing turbidity and water temperature (Hesse 1987). The Missouri River dams also are believed to have adversely affected pallid sturgeon by blocking migration routes and fragmenting habitats (USFWS 1993).

Levee construction on the lower Mississippi River from the Ohio River to near the Gulf of Mexico has eliminated the river's major natural floodway and reduced the area of the floodplain connected to the river by more than 90 percent (Fremling et al. 1989). Fremling et al. (1989) also report that levee construction isolated many floodplain lakes and raised river banks. As a result of levee construction, 15 meander loops were severed between 1933 and 1942.

The pattern of flow velocity, volume, and timing of the pre-development rivers provided the essential life requirements of native large-river fish like the pallid sturgeon and paddlefish. Hesse and Mestl (1993b) found a significant relationship between the density of paddlefish larvae and two indices (timing and volume) of discharge from Fort Randall Dam. They concluded that when dam operations caused discharge to fluctuate widely during spring spawning, the density of drifting larvae was lower, and when annual runoff volume was highest, paddlefish larval density was highest. Hesse and Mestl (1987) also modeled these same two indices of discharge from Fort Randall Dam with an index of year-class strength. They demonstrated significant negative relationships between artificial flow fluctuations in the spring and poor year-class development for several native and introduced fish species; river carpsucker (*Carpiodes carpio*), shorthead redhorse (*Moxostoma macrolepidotum*), channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictis olivaris*), sauger (*Stizostedion canadense*), smallmouth buffalo (*Ictiobus bubalus*), and bigmouth buffalo (*I. cyprinellus*). The sample size of sturgeon was too small to model in that study; however, a clear relationship existed between poor year-class development in most native species studied and the artificial hydrograph.

Modde and Schmulbach (1973) found that during periods of low dam releases, the secondary subsidiary channels, which normally feed into the river channel, become exposed to the atmosphere and thus cease to contribute littoral benthic organisms into the drift. Schmulbach (1974) states that use of sandbar habitats were second only to cattail marsh habitats as nursery grounds for immature fishes of many species.

In spite of efforts to constrict and control the Missouri and Mississippi Rivers with reservoirs, stabilized banks, jetties, dikes, levees and revetments, remnant reaches of the Missouri River and the Mississippi River from the Missouri River confluence to the Gulf of Mexico still provide habitat usable by pallid sturgeon.

The upper ends of the reservoirs in the upper basin may be influencing the recruitment of larval sturgeon. Both the shovelnose and pallid sturgeon larvaes have a propensity to drift after hatching (Kynard et al. 1998a,b). Bramblett (1996) found that the pallid sturgeon may be spawning in the Yellowstone River between RM 9 and 20 upriver and that from historic catch records, there is some evidence to indicate that the occurrence of pallid sturgeon catches coincide with the spring spawning at the mouth of the Tongue River (Krentz, pers. comm.). Shovelnose sturgeon have been found to spawn in the tributaries of the Yellowstone River as well as such areas as the Marias, Teton, Powder and Tongue Rivers (Gardner, Montana Fish, Wildlife and Parks, pers. comm.) (Annear, Wyoming Fish and Game Department, pers. comm.). Shovelnose sturgeon are successfully recruiting and reproducing in the river stretches in the upper basin and this may be directly related to the amount of larval and juvenile habitat they have available downstream of the spawning sites. Early indications in culturing pallid sturgeon indicate that sturgeon larvae will not survive in a silty substrate. In 1998, most of the larval sturgeon held in tanks at Gavins Point NFH in Yankton, SD, experienced a high mortality when the water supply contained a large amount of silt which settled on the bottom of the tanks. Migration routes to spawning sites on the lower Yellowstone River have been fragmented by low head dams used for water supply intakes. This has forced pallid sturgeon to spawn closer to reservoir habitats and reduced the distance larval sturgeon can drift after hatching.

Commercial Harvest - Historically, pallid, shovelnose, and lake sturgeon were commercially harvested in all states on the Missouri and Mississippi Rivers (Helms 1974). The larger lake and pallid sturgeon were sought for their eggs which were sold as caviar, whereas shovelnose sturgeon were historically destroyed as bycatch. Commercial harvest of all sturgeon has declined substantially since record keeping began in the late 1800s. Most commercial catch records for sturgeon have not differentiated between species and combined harvests as high as 430,889 lb. (195,450 kg) were recorded in the Mississippi River in the early 1890s, but had declined to less than 20,061 lb. (9,100 kg) by 1950 (Carlander 1954). Lower harvests reflected a decline in shovelnose sturgeon abundance since the early 1900s (Pflieger 1975). Today, commercial harvest of shovelnose sturgeon is still allowed in 5 of the 13 states where pallid sturgeon occur.

Mortality of pallid sturgeon occurs as a result of illegal and incidental harvest from both sport and commercial fishing activities (Bob Sheehan, Southern Illinois University, pers. comm.). Sturgeon species, in general, are highly vulnerable to impacts from fishing mortality due to unusual combinations of morphology, habits and life history characteristics (Boreman 1997). In 1990, the head of a pallid sturgeon was found at a sport-fish cleaning station in South Dakota, and in 1992 a pallid sturgeon was found dead in a commercial fisherman’s hoop net in Louisiana. In 1997, four pallid sturgeon were found in an Illinois fish market (Sheehan et al. 1997b). It is probable that pallid sturgeon are affected by the illegal take of eggs for the caviar market. In 1999, a pallid sturgeon that was part of a movement and habitat study on the lower Platte River was harvested by a recreational angler (Dr. Ed Peters, University of Nebraska-Lincoln, pers. comm. 1999). In addition, such illegal and incidental harvest may skew pallid sturgeon sex ratios such that hybridization with shovelnose sturgeon is exacerbated.

Currently, only a sport and/or aboriginal fishery exists for lake sturgeon due to such low population levels (Todd 1998). Shovelnose sturgeon is commercially harvested in eight states, including Illinois and Missouri, and a sport fishing season exists in a number of states (Mosher 1998). Although information on the commercial harvest of shovelnose sturgeon is limited, Illinois reported the commercial harvest of shovelnose sturgeon was 43,406 lb. (19,689 kg) of flesh and 233 lb. (106 kg) of eggs in 1997 and Missouri reported a 52-year mean annual harvest of 8,157 lb. (3,700 kg) of flesh (Todd 1998) and an unknown quantity of eggs for 1998. Missouri also has a sport fishery for shovelnose sturgeon but has limited data on the quantities harvested (Mosher 1998).

Pollution/Contaminants - Although more information is needed, pollution is likely an exacerbating threat to the species over much of its range. Pollution of the Missouri River by organic wastes from towns, packing houses, and stockyards was evident by the early 1900s and continued to increase as populations grew and additional industries were established along the river (Whitley and Campbell 1974). Due to the presence of a variety of pollutants, numerous fish-harvest and consumption advisories have been issued over the last decade or two from Kansas City, MO, to the mouth of the Mississippi River. That represents about 45 percent of the pallid sturgeon's total range.

PCBs, cadmium, mercury, and selenium have been detected at elevated, but far below lethal, concentrations in tissue of three pallid sturgeon collected from the Missouri River in North Dakota and

Nebraska. Detectable concentrations of chlordane, DDE, DDT, and dieldrin also were found (Ruelle and Keenlyne 1994). Prolonged egg maturation cycle of pallid sturgeon, combined with a bioaccumulation of certain contaminants in eggs, could make contaminants a likely agent adversely affecting eggs and embryo, development or survival of fry, thereby reducing reproductive success.

Further investigations are needed to identify sources of contaminants in the Missouri and Mississippi Rivers and to assess the role of contaminants in the decline of pallid sturgeon populations.

Hybridization - The previous lack of genetic information on the pallid and shovelnose sturgeon, has led to a hybridization debate. In recent years, however, several studies have increased our knowledge of the genetic, morphologic, and habitat differences of those two species. Campton et al. (1995) collected data that support the hypothesis that pallid and shovelnose sturgeon are reproductively isolated in less-altered habitats, such as the upper Missouri River. Campton (2000, in press) suggested that natural hybridization, backcrossing, and genetic introgression between pallid and shovelnose sturgeon may be reducing the genetic divergence between those species. Sheehan (2000, pers comm) has identified 86 separate loci for microsatellite analysis that are being used to differentiate between pallid, shovelnose and suspected hybrid sturgeon.

Bramblett (1996) found substantial differences in habitat use and movements between adult pallid and shovelnose sturgeon in less altered habitats of the Yellowstone River. Presumably, the loss of habitat diversity caused by human-induced environmental changes inhibits naturally occurring reproductive isolating mechanisms. Campton et al. (1995), and Sheehan et al. (1997b) note that hybridization suggests that similar areas are currently being used by both species for spawning.

Carlson et al. (1985) studied morphological characteristics of 4,332 sturgeon from the Missouri and middle Mississippi Rivers. Of that group, he identified 11 pallid sturgeon and 12 pallid/shovelnose sturgeon hybrids. Suspected hybrids recently have been observed in commercial fish catches on the lower Missouri and the middle and lower Mississippi Rivers (K. Graham, Missouri Department of Conservation, pers. comm. 1992; B. Reed, Louisiana Dept. of Wildlife and Fisheries, pers. comm. 1992). Bailey and Cross (1954) did not report hybrids, which may indicate that hybridization is a recent phenomenon resulting from environmental changes caused by human-induced reductions in habitat diversity and measurable changes in environmental variables such as turbidity, flow regimes, and substrate types (Carlson et al. 1985). A study by Keenlyne et al. (1994) concluded that hybridization may be occurring in half the river reaches within the range of pallid sturgeon and that hybrids may represent a high proportion of remaining sturgeon stocks. Hybridization could present a threat to the survival of pallid sturgeon through genetic swamping if the hybrids are fertile, and through competition for limited habitat (Carlson et al. 1985). Keenlyne et al. (1994) noted few hybrids showing intermediacy in all characteristics as would be expected in a first generation cross, indicating the hybrids are fertile and reproducing.

Hubbs (1955) indicated that the frequency of natural hybridization in fish was a function of the environment, and the seriousness of consequences of hybridization depend on hybrid viability. Hybridization can occur in fish if spawning habitat is limited; if many individuals of one potential parent species lives in proximity to a limited number of the other parent species; if spawning habitat is modified and rendered intermediate; if spawning seasons overlap; or where movement to reach suitable spawning habitat is limited (Hubbs 1955). All those conditions exist to some extent within the range of pallid and shovelnose sturgeon. Any of those conditions, or a combination of them, could be causing the apparent breakdown of isolating mechanisms that prevented hybridization between these species in the past (Keenlyne 1994).

Although Mayden and Kuhajda (1997) contend there is no empirical evidence indicating that hybridization between shovelnose sturgeon and pallid sturgeon is common, they present no evidence to support this contention. Based on meristic and morphological characters, Carlson et al. (1985) noted hybrids prevalent in their samples, suggesting that hybridization between the species of *Scaphirhynchus* may occur frequently. Field surveys of *Scaphirhynchus* stocks suggest a relatively high incidence of hybridization between shovelnose sturgeon and pallid sturgeon in the middle Mississippi River (Sheehan et al. 1997a, 1997b, 1998). Hybridization in the Lower Missouri and Middle Mississippi Rivers increased from 1 in 361 river sturgeons (0.27 percent) in the late 1970s to 1 in 145 river sturgeons (0.69 percent) in the late 1990s (Carlson et al. 1985, Grady et al. in prep). Sheehan et al. (1997b) and Carlson and Pflieger (1981) noted a 3:2 ratio of hybrid sturgeon to pallid sturgeon on both the Missouri and Mississippi Rivers. Sheehan et al. (1997b) speculated that if that is representative of the sturgeon population in the middle Mississippi River, hybridization may pose a significant threat to pallid sturgeon as the species continues to introgress with shovelnose sturgeon.

Summary

Sturgeons exhibit unusual combinations of morphology, habits, and life history characteristics, which make them highly vulnerable to impacts from human activities (Boreman 1997). Sturgeons generally have low mortality rates, long life spans, and relatively low capacities for population increases (Boreman 1997). As such, pallid sturgeon are well adapted to living in large rivers, where fluctuating environmental conditions, such as discharge, can affect reproductive success. However, those characteristics also make sturgeon species more sensitive to additional mortality factors, particularly human activities. Many anthropogenic impacts, such as those that diminish spawning and nursery habitat, primarily affect reproduction and survival of age-0 fish (Dr. Robert Sheehan, Southern Illinois University at Carbondale (SIUC), pers. comm.). Sturgeon populations worldwide have declined because of anthropogenic influences. The structure and magnitude of genetic diversity of natural populations of sturgeon serves to buffer those fish against environmental variation and should be maintained (Wirgin et al. 1997).
The loss of genetic variability can result in depressed fitness of the population (Spearman et al. 1994).

Pallid sturgeon distribution and abundance have drastically declined. In various studies, pallid sturgeon have represented from 0.29 percent to 11 percent of total sturgeon collected. In commercial catch surveys, pallid sturgeon have composed 0 to 26 percent of sturgeon collected. Habitat modification is considered the primary factor affecting pallid sturgeon populations. Approximately 49 percent of the pallid sturgeon's historic range has been modified to the extent that it is no longer suitable. Much of the remaining habitat has been substantially impacted by channelization. The species is now relegated to four genetically isolated sub-populations (upper Missouri River, Missouri/Yellowstone River, lower Missouri River-middle Mississippi River-lower Mississippi River, Atchafalaya River). The populations have little opportunity for genetic exchange. Evidence of successful reproduction is rare and documentation of recent recruitment is non-existent.

As habitat loss continues, other factors affecting pallid sturgeon, such as incidental/illegal harvest and hybridization, become more problematic. Further, habitat modification exacerbates the effects of such factors, such as hybridization.

Although microhabitat use data for the pallid sturgeon are limited, the general habitat needs of the species is known. Those include braided channels, seasonal flow patterns, turbidity, and extensive microhabitat diversity. Further, it is reasonable to draw inferences from data collected for other large river fish, such as the paddlefish and shovelnose sturgeon, which evolved under similar river conditions.

ENVIRONMENTAL BASELINE WITHIN THE ACTION AREA

The section 7 environmental baseline is an analysis of the effects of past and ongoing human and natural factors leading to the current status and condition of the listed species, their habitats and ecosystem within the action area. The environmental baseline is a "snapshot" of a species' health at a specified point in time that reflects the current condition of the species, and that sets the "context" for the jeopardy analysis. The baseline for this biological opinion includes: 1) the past and present impacts of all Federal, State, or private actions and other human activities in the action area; 2) the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation; and 3) the impact of State or private actions occurring simultaneously with this consultation.

Although the baseline includes the past and present impacts of activities in the action area (e.g., annual operations and maintenance), it does not include the future impacts of the action under review in this consultation. Therefore, the baseline does not include the anticipated effects of the continued operation of the Missouri and Kansas River projects.

STATUS OF THE SPECIES WITHIN THE ACTION AREA AND THE ECOSYSTEMS UPON WHICH THEY DEPEND

The status and condition of the bald eagle, least tern, piping plover, and pallid sturgeon and the

Missouri and Kansas River ecosystems on which they depend is summarized in the following pages. The information is based on the Service's 1990 Biological Opinion on Missouri River Operations and 1994 Draft Biological Opinion on the Missouri River Master Manual, the Corps' 1994 and 1998 DEIS on the Master Manual, the Corps Biological Assessments on the MR Projects, and numerous Service correspondence to the Corps over the last 10 years.

Missouri River System

Historical Perspective - The Missouri River originates on the eastern slope of the Rocky Mountains near Three Forks, MT, and today flows approximately 2,321 mi (3,734 km) through Montana, North Dakota, South Dakota, Iowa, Nebraska, Kansas, and Missouri to its confluence with the Mississippi River near St. Louis, Missouri. The Missouri River is the second longest river in the United States and its basin drains approximately 529,350 mi^2 (1,371,016 km^2), including 9,700 mi^2 (25,123 km^2) in Canada; all of Nebraska; most of Montana, Wyoming, North Dakota, and South Dakota; about half of Kansas and Missouri; and smaller parts of Iowa, Colorado, and Minnesota. The primary tributaries are the Yellowstone, Platte, and Kansas Rivers.

Historically, the Missouri River was a diverse, unaltered, 2,551 mi (4,104 km)-long (Missouri River Commission 1898) riverine/floodplain ecosystem of braided channels, riparian lands, chutes, sloughs, islands, sandbars, backwater areas, and natural floodplain communities (Figure 6 adopted from Hesse and Sheets 1993). That ecosystem supported diverse and abundant populations of native river fishes, furbearers, shorebirds, and waterfowl (Funk and Robinson 1974).

Survey maps from the late 19th century show extensive stands of floodplain forest throughout the basin (Missouri River Commission 1898). Bragg and Tatschl (1977) described the presettlement floodplain in Missouri as consisting of extensive stands of mature floodplain forest; in 1826, 76 percent of the floodplain vegetation was forest. Wetland, prairie, and sandbar habitats also were extensive in the pre-development floodplain and river channel. In the now channelized reach of the river between Ponca, NE, and St. Louis, MO, 18,600 ac (7,533 ha) (16 percent) of wetlands, 8,400 ac (3,402 ha) (7 percent) of prairie, and 34,200 ac (13,851 ha) (30 percent) of sandbars occurred in the main channel and the immediate floodplain (50 percent of the floodplain was not classified in the 1890s survey maps that were used) (Hesse et al. 1988).

At least 160 species of wildlife were resident or migrant visitors to the Missouri River ecosystem, and 156 native fish species lived in the main stem and tributaries (Hesse et al. 1988, **(NOTE: Insert Figure 6 from 1994 BO)**Hesse et al. 1989). Reliable historic data on the composition and abundance of the pre-development fish community are not available, but reports of early settlers and commercial fishing records (Funk and Robinson 1974) suggest an immense and productive fish community in the main stem river. The river was and continues to be a significant pathway for migratory birds. Records from the fur trade and waterfowl and shorebird market-hunting era indicate the importance of the historic river ecosystem to highly productive and valuable wildlife populations.

Riverine and floodplain habitats were maintained by dynamic processes of continuous bank erosion and deposition, that constantly reshaped the channel and floodplain, and created unvegetated sandbars and islands. As late as 1923, high bank to high bank channel widths ranged from 1500 to 6500 ft (457-1893 m) with prevalent meandering (Johnson et al. 1976). Depths and velocity distributions, which are a product of both the flow regime and channel morphology, were very different from the distributions found in much of today's altered channel. Latka et al. (1993) found that historically in late summer and fall, 98 percent of the Missouri River main channel was less than 10 ft (3 m) deep with velocities between 1 and 2.5 fps (30 and 76 cm/s) occurring most frequently.

The Missouri River valley formed on an highly erodible alluvial plain composed of sand, silt, gravel, and clay to a depth of nearly 100 ft (130.5 m) (Whitely and Campbell 1974). The creation and maintenance of channel morphology and the formation of the floodplain depend largely on discharge and sediment (Kellerhals and Church 1989). Maps adopted from Hesse (1987) (Figure 7) of the Corps' first Missouri River survey, completed between 1892 and 1895 (Missouri River Commission 1898) illustrate the braided channel configuration, abundant sandbars, and vegetated floodplain communities of the pre-control Missouri River. Aquatic habitat diversity and variability in the distributions of the pre-control Missouri River channel depths and widths are documented in cross-section width and discharge data from a 1923 Corps' hydrographic survey of the lower river (Gee and Parker 1923) and reflected in color maps generated by the Corps during the Master Manual Study for Volume 7D-S2 of the 1998 Revised Draft EIS (USACE 1998b).

Historically, the river carried a high sediment and nutrient load from overbank flooding, thus earning the nickname "Big Muddy." The average annual suspended sediment load in the historic river ranged from 125 million metric tons at Yankton, SD, to 318 million tons at Boonville, MO (Galat et al. 1994 citing others). Since then, the suspended sediment load has decreased by 69 to 99 percent depending on location and proximity to the main stem dams.

The natural hydrograph was very dynamic and highly variable from year to year as well as from one segment of the river to another. In general, the typical hydrologic pattern on average water years was characterized by a peak in March/April from snowmelt in the plains and ice melt on the river and tributaries, a decline in May, a higher peak in June (Hesse et al. 1989; Galat and Lipkin 1999) from snowmelt in the Rocky Mountains and rainfall throughout the basin, and declining flows throughout the summer and fall. An exception to the declining flow pattern throughout the fall and into the winter occurred in the lower basin which had a small peak in October/November from fall rains throughout the basin (Figure 8, adopted from Hesse and Mestl

(NOTE: Insert Figure 7 from 1994 Draft BO)(NOTE: Insert Figure 8 from 1994 Draft BO) 1993a). Although the general hydrologic pattern was evident in most years, the magnitude of the highs and lows varied tremendously by year and provided the dynamics that were so important to the creation and maintenance of the form and function of the river.

Historic accounts of the river note its notorious propensity to flood throughout its length. "Dominant discharge" (bankfull) flows or "flushing flows," which occurred approximately every 1.5 years (Hesse and Mestl 1993a) maintained the dynamic processes of the pre-control channel and floodplain characteristics. Hesse and Mestl (1993a) estimated the pre-development dominant discharge to be 100,000 cfs at Omaha.

Riverine aquatic habitat, floodplain habitat, biodiversity, and the health of the Missouri River ecosystem was primarily shaped by the timing, variability, and amplitude of the natural hydrograph, and the interaction between the river and its floodplain. The natural hydrograph defined the biological values and the pre-control channel morphology and floodplain characteristics of the Missouri River which supported a diverse flora and fauna.

Description of Existing Missouri River System - Modification of the Missouri River aquatic and terrestrial ecosystem from the presettlement era has been thoroughly documented (Funk and Robinson 1974, Bragg and Tatschl 1977, Hallberg et al. 1979, Johnson et al. 1982, Hesse 1987, Pfleiger and Grace 1987, Hesse et al. 1988, Hesse et al. 1989, Hesse and Sheets 1993, Keenlyne 1993, Latka et al. 1993). The Service also has addressed past impacts to the system in considerable detail in various planning documents and technical assistance reports on the Master Manual Study (e.g., October 24, 1990, Planning Aid Letter; December 18, 1992, endangered species/environmental quality alternatives letter; March 1993 Fish and Wildlife Report; and August 1994 Draft Biological Opinion on the Missouri River Master Water Control Manual Review and Study and Operations of the Missouri River Main Stem System) and reports to the Corps on the BSNP (USFWS 1980).

Clearing and snagging activities and Federal construction and operation programs such as the Pick/Sloan Plan (1944 Flood Control Act) and the Missouri River BSNP significantly altered fish and wildlife values of the Missouri River ecosystem. Those programs, administered by the Corps and Reclamation, transformed the free-flowing natural river system into a system of seven large main stem reservoirs, and riverine reaches highly altered by regulated flows, river-training structures, and bank stabilization. In addition to main stem modifications, Federal development programs impounded many river tributaries, especially in the large subbasins of the Platte, Kansas, and Osage Rivers. The river ecosystem is also impacted by channelization of floodplain tributaries and an extensive network of levees along the lower river and major tributaries. Approximately one-third of the river is impounded by dams and reservoirs, one-third is channelized or stabilized, and one-third is regulated by releases from the main stem dams.

Initial work to improve the river began in 1838 with snag removal to aid in commercial navigation of shallow-draft steamboats (Hesse 1989, Schneideres 1999). Snag removal projects increased and spot bank protection was initiated in the late 1800s (USFWS 1980a). Congress authorized the Missouri

River BSNP in 1912 to provide a 6-ft (1.8 m) deep navigation channel from Kansas City, MO, to the mouth north of St. Louis. In 1927, Congress extended the navigation channel upstream to Sioux City, IA. In 1945, the project was further expanded to include a 9-ft (91.5 m) deep by 300-ft wide navigation channel, from Sioux City to the mouth. Channelization shortened the river by about 72 mi (115 km); eliminated 168,000 ac (68,040 ha) of riverine habitat including 100,300 ac (40,621 ha) of aquatic habitat and most island and sandbar habitat (65,300 ac) (26,446 ha); and eliminated 354,000 ac (143,370 ha) of meander belt habitat including 309,000 ac (125,145 ha) of riparian timber, sandbars, and other habitat types (USFWS 1980). For each linear mile of channel, 1 mi^2 (259 ha) of wetland, oxbow lakes, meandering river, islands, and mudflats was lost (Keenlyne 1988). The BSNP alone reduced channel widths by 72 to 78 percent, reduced shallow water habitats (0-5 ft deep) (0-1.5 m) by 90 percent, eliminated 50 percent of the river's surface area, reduced suspended sediment transport by 67 to 99 percent, and converted nearly 168,000 ac (68,040 ha) of riverine habitat into, primarily, privately owned and leveed agricultural land. Floodplain forest in Missouri was reduced from 76 percent of floodplain vegetation in the 19th century to 13 percent by 1972.

While the Corps modified the lower river for navigation, over one third of the river's total length was inundated by reservoirs in the upper basin, converting free-flowing river, bottomland timber, marshes, grasslands, and sandbars to deep water. The first of the Corps' six main stem dams to close was Fort Peck Dam in 1938. Fort Peck is the uppermost dam in the System and its original purpose was to supply water for the downstream navigation project and control floods. The second dam to close was the Fort Randall Dam in 1952, followed by Garrison Dam in 1953, Gavins Point Dam in 1955, Oahe Dam in 1958, and Big Bend Dam in 1963.

Construction of the reservoir system has completely changed the character of the Missouri River. Construction of reservoirs alone was responsible for the flooding or elimination of what was once a rich, abundant ecosystem. For example, the main stem reservoirs in South Dakota and Nebraska alone inundated approximately 171,400 ac (69,417 ha) of grassland, 3,030 ac (1,227 ha) of marsh, 116,520 ac (47,190 ha) of bottomland timber and brush, 9,530 ac (3,859 ha) of sandbar, and 84,130 ac (34,072 ha) of free-flowing river (USFWS 1984).

Construction of the multi-purpose dams on the Missouri River essentially impounded almost a third of the river. Effects from impoundment are and will continue to adversely affect pallid sturgeon by (1) converting river habitats to lake habitats; (2) blocking migration routes; (3) reducing substrate diversity by the sedimentation of the reservoirs (4) increasing hybridization with shovelnose sturgeon (through reduced spawning habitat and access to historical spawning sites); (5) increasing the risk of predation by other fish; (6) increasing competition with other fish; and (7) decreasing pallid sturgeon foraging capability.

Impoundment of the Missouri River effectively converted much of the free-flowing, river habitat to a lake, pool condition which is unsuitable for pallid sturgeon. The dams are physical barriers which inhibit upstream migration of riverine fish, including pallid and/or shovelnose sturgeon, as well as paddlefish and lake sturgeon. Gravel bars and other habitats within the reservoirs have filled with sediment. The main stem dams and reservoirs will continue to occupy much of the pallid sturgeon's historic habitat, providing conditions unsuitable for successful reproduction and recruitment of the fish, while blocking sturgeon migrations to suitable habitat and reducing (in some cases eliminating) sturgeon genetic exchange between river reaches. Using work by Kynard et al. (1998a) on the downstream migration period for larval pallid sturgeon and river water velocities, it is estimated that pallid sturgeon larvae may drift downstream from 40 to over 400 mi (64-643 km) from the spawning site (Steve Krentz, USFWS, pers. comm.). In the upper river, even if sturgeon spawning occurs, several reaches may not provide enough suitable riverine habitat between the dams and the headwaters of the next downstream reservoir to meet the pallid sturgeon larval requirements, significantly affecting recruitment into the adult population. In addition, not only has there been a change in substrate composition in the reservoirs, but changes in the turbidity (see below) and predator species composition greatly decreases survival of young-of-the-year pallid sturgeon.

Impoundment of the Missouri River also affects the sediment transport and turbidity in the river. Erosion is a natural function of the Missouri River ecosystem and through erosion, inorganic sediments, organic matter, and large woody debris were introduced into the river. That material import was essential to the habitat dynamics, nutrient cycling, and forage base of the river system. Such sediment and nutrient discharge are the raw materials for riverine productivity and habitat development in the Missouri River.

Before the Missouri River was channelized and impounded, it annually eroded 12.3 acres/mile of the floodplain (USACE 1981b). Fremling et al. (1989) reported that the sediment load of the middle Mississippi River has declined 66 percent, mainly due to sediment entrapment in Missouri River impoundments. Reduced sediment transport greatly affects natural channel dynamics, and has led to hydraulic sorting and bed paving which has reduced bed roughness and substrate diversity. Those changes in channel sediment dynamics have reduced the reproductive success of substrate spawners, such as sauger, sturgeon, and paddlefish (Hesse et al. 1993).

In addition to affecting the bedload of the river, impoundment (as well as channelization) has also led to changes in turbidity. Turbidity caused by suspended sediment provided the pallid sturgeon and other native fish, adapted to living in a nearly sightless world, with cover. Today, water clarity has increased (Neel et al. 1963) as a result of sediment accumulating behind the main stem dams. That can affect the pallid by increasing predation, reducing food availability, and increasing competition with fish better adapted to less turbid environments. As turbidity decreases, predation by a sight-feeding predators, such as northern pike (*Esox lucius*), walleye (*Stizostedion vitreum*), and smallmouth bass (*Micropterus dolomieui*), are expected to significantly impact native species, including the pallid sturgeon, that are adapted to highly turbid systems. In the Missouri River, pelagic planktivores and sight-feeding carnivores have increased in abundance, whereas species specialized for life in the turbid, predevelopment river (like the pallid sturgeon) have decreased in abundance (Pflieger and Grace 1987). That change in community structure is less apparent where changes in the natural hydrograph, temperature regime, and turbidity are less pronounced. Reduced turbidity may also affect food availability by changing species composition that favor fishes better able to forage in clearer water, leading to greater competition with pallid sturgeon and other native fishes for available food resources.

As previously mentioned, sediment accumulation behind the main stem dams has led to significant bed degradation below them. Channel degradation has affected the pattern of overbank flooding and wetland recharge and riverine floodplain connectivity. Water level regulation contributes to water level fluctuations in aquatic habitats in the Missouri River. That can affect the availability of larval and juvenile rearing habitat and the availability of seasonal refugia. In addition, loss of aquatic habitat reduces the nutrient cycling ability of the Missouri River, therefore, reducing the natural forage base of pallid sturgeon.

Flows have been modified primarily to meet flood control, navigation, and hydropower objectives. Consequently, the normal flow pattern has been reversed near the dams, with spring high flows suppressed (sometimes drastically during flood control operations) and low summer and fall flows augmented. Downstream of Kansas City, the effect of dam operations on flows is somewhat buffered by large tributary inflows.

Operation of the Corps' six main stem reservoir dams compounded the impacts and significantly altered the river's natural processes. Cold water releases from the dams altered the natural hydrograph and temperature regime of the river. The sediment transport dynamics were disrupted by the dams and caused river bed degradation in the tailrace reaches. River meandering or the lateral movement of the river across the floodplain ceased. The flood pulse and riverine/floodplain connection were nearly eliminated and adversely affected the nutrient transport cycle and floodplain communities. The dams became effective barriers to fish migration. Thus, many of the impacts to Missouri River resources (i.e., floodplain, riparian, wetland, and aquatic habitats; indigenous fish species; other endemic life forms; threatened and endangered species) can be directly and/or indirectly attributed to project-related alterations of the natural hydrograph and physical habitats.

Habitat losses and flow regime changes have led the Service to list four species dependent on the river as endangered or threatened and two species as candidates for listing. Many fish species native to the river have had serious population declines; six are of special concern. Empirical data from certain river reaches verifies long-term declines and changes in benthic invertebrate production, commercial sturgeon fisheries, and certain tailwater sport fisheries (Ward and Stanford 1979, Mestl and Hesse 1992, Williamson et al. 1998).

Appendix III, adopted from Galat et al. (1994) is a comprehensive summary of the past impacts to the Missouri River ecosystem from channelization, and construction and operation of the main stem dams. These past impacts continue to have ongoing effects today.

Operation of the reservoir system has reduced floods and collects incoming sediments that are essential to natural hydraulic river processes. Furthermore, bank erosion in system reservoirs does not result in island and sandbar formation as it does in the more natural river reaches (i.e., below Fort Peck, Garrison, and Gavins Point Dams).

Bank stabilization has occurred over the years as authorized by Section 14 of the Flood Control Act of 1946 and Public Law 88-253, as amended by the Flood Control Act of 1968. In addition, Section 32 of the Water Resources Development Act (WRDA) of 1974 (amended 1976) and Section 33 of WRDA of 1988 provide for erosion control at critical erosion problem areas in the upper river; however, such erosion control may threaten the natural river processes that result in island and sandbar formation. From the time the dams were closed until 1975, the Corps estimated that 14,058 ac (5,693 ha) (6.83 acres per river mile per year) have been lost to erosion (USACE 1978). The Corps (1978) estimated future losses at 6.59 acres per river mile per year. Impacts of completed Missouri River bank stabilization projects and future bank stabilization projects have yet to be fully evaluated for their impacts on island and sandbar formation.

Upper basin depletions for developments affect natural stream flows within the upper basin which in turn affect System storage in the upper basin reservoirs. These developments include surface water irrigation, ground water irrigation and its effects on surface water supplies, municipal and industrial supplies, watershed treatment, rural domestic and livestock uses, tributary reservoirs, recreation lakes, stock ponds, and evaporation. The estimated average annual depletions in the System are 4.9 MAF based on development from 1949 to 1970 (USACE 1979). The largest water use is irrigation which is estimated to deplete average annual flows by 2.1 MAF. The Corps will address this issue with updated information in the Master Manual Draft EIS due for completion in the spring of 2000.

In general, the effects of past and present construction projects and flow alterations on Missouri River habitats are summarized as follows:

? **Construction of main stem dams and reservoirs** has converted riverine and floodplain aquatic and wetland habitats to deep water habitats.

? **Construction of dams** has interrupted sediment and organic material transport, resulting in reduced turbidity, increased bed degradation, and reduced sandbar formation downstream of dams.

? **Channelization, construction of river training structures, and bank stabilization** of free-flowing reaches of the lower river for bank stabilization and commercial navigation has resulted in the loss of over 100 mi (161 km) of river shoreline, loss of shallow-water habitat, sandbars, oxbows and backwaters, and has contributed to bed degradation in some reaches.

? **Construction and repair of floodplain levees** in the lower river has led to the clearing and loss of floodplain forests and wetlands, isolated remaining wetlands from the river, and reduced organic matter inputs.

? **Construction of dams** has blocked upstream and downstream fish movements to spawning or foraging areas and/or adversely affected larval survival.

? **Bottom releases from some dams** has resulted in cooler water temperatures which is for native warmwater fish spawning and development.

? **Suppression of spring flows has caused:** (1) loss of spawning cues (i.e., warm water coupled with river stage increases) which triggered spawning activity in native river fish, (2) loss of productivity in upper river reaches due to altered nutrient transport and cycling. Those flows introduced detritus and other carbon sources produced on the floodplain and in off-channel wetlands to the river. Such materials are the basis of the food chain and energy flow in large, temperate rivers. (3) lack of seasonal fish and wildlife access to remaining off-channel backwaters and wetlands. Seasonally inundated backwaters and wetlands provide spawning, nursery, and feeding areas for fish, and important feeding and breeding habitat for numerous migratory birds and furbearers.

? **River bed degradation** in the tailwaters below dams has compounded the effects of the loss of high spring flows for recharging wetlands and other off-channel habitats by lowering the riverbed, river elevation, and opportunity for connection to off channel aquatic and terrestrial habitats.

? **Reduced formation of high elevation sandbar habitat in unchannelized reaches below dams, and vegetation encroachment of remaining high elevation bars** has resulted from loss of sediment and scouring or flushing flows associated with the natural spring flood pulse.

Importance of the Missouri River Ecosystem - Since the settlement by European man in the Missouri River basin, the river has been intensively used or managed for transportation, irrigation, municipal and industrial water supply, recreation, commercial fisheries, cooling of thermoelectric power plants, flood control, hydroelectric power generation, and fish and wildlife resources. Most of those uses are addressed in the Corps' Master Manual operational priorities or authorized project purposes for operation and management of the Missouri River system and the BSNP.

River ecologists and managers have only recently begun to understand the complex relationships between biota and the physical system of large rivers (Hesse and Sheets 1993) and gain a full appreciation of impacts from alterations to natural systems (Keenlyne 1993). Consequently, the States, Federal agencies, Indian tribes, private industry, conservation organizations, and others are focusing considerable attention on these issues. The Corps considered fish and wildlife resources subservient to other authorized project purposes in the Master Manual until a General Accounting Office report (USGAO 1992) indicated that no legal justification existed for such low prioritization. The Corps has now taken the position that fish and wildlife resources are co-equal with all other authorized project purposes.

To focus additional attention to the importance of the Missouri River ecosystem, American Rivers, a national conservation organization, placed the Missouri River on its list of the Nation's 10 most endangered rivers in April 1994. American Rivers has designated the Missouri River as first or second most endangered river every year since 1997.

To further highlight the degradation of the Missouri River ecosystem and the plight of other species, in June 1994, American Rivers, the Environmental Defense Fund, the National Audubon Society, the Nebraska Audubon Council and the Mni Sose Intertribal Water Rights Coalition filed a petition with the Service to list two Category 2 species native to the Missouri River system, the sicklefin chub and sturgeon chub, as endangered, under the ESA. In June 2000, Montana Rivers Coalition sued the Secretary of the Interior and the Service to force a finding on the petition which is nearly 5 years overdue.

Furthermore, in March 2000, two conservation groups, American Rivers and Environmental Defense, filed Notices of Intent to Sue the Department of the Army and the Department of the Interior. Environmental Defense filed a *60-day Notice of Intent to Sue Under the Endangered Species Act for Operation of the Missouri River Main Stem System and Related Activities* and American Rivers filed a *60-day Notice of Intent to Sue for Violations of the Endangered Species Act and the Administrative Procedure Act Caused by Missouri River Dam Operations.*

In June 2000, the State of Missouri informed the Secretary of the Interior that they reserved the right to file suite for longstanding violations of the Endangered Species Act related to the Secretary's failure to designate critical habitat for the pallid sturgeon, interior least tern, and piping plover. The State of Missouri filed suite in August 2000.

Kansas River System

Historical Perspective - Historically, the Kansas River ecosystem was very similar to that previously described for the Missouri River, though on a smaller scale. The main stem river arises at the confluence of its two primary tributaries, the Republican and Smoky Hill Rivers, near present-day Junction City, Geary County. From here it flows easterly 170 mi (273 km) to its confluence with the Missouri River. The entire Kansas River Basin, including all tributaries, extends 480 mi (772 km) from east to west, and drains 98,908 mi^2 (256,171 km^2) of northern Kansas, southern Nebraska and northeastern Colorado (Sanders et al. 1993). The Kansas River valley cuts through Pennsylvanian and Permian rock, with layers of soft shale, sandstone, and hard limestone. The river valley ranges from 1.75 to 5.0 mi (2.8-8 km) in width, and is essentially flat with some dissected terraces (Kansas Forestry, Fish and Game Commission 1977).

The Kansas River near present-day Topeka, Shawnee County, was reported in the mid-1840s to be approximately 750 ft (228 m) wide during high runoff events (Smucker 1856, Thwaites 1905a). Naturalist Thomas Say (Thwaites 1905b) reported the river near Topeka in 1819 to be "so shoal as to almost any point to admit of being forded without difficulty." In August 1853, J.L. Tidball conducted a navigability survey of the Kansas River main stem for a distance of about 50 mi (80 km) downstream from Fort Riley, and reported the water depth to vary from 2 to 7 ft (.6-2.1 m), "more frequently exceeding the greater than falling below the less..." (Langsdorf 1950). In this survey, there were nine areas between Fort Riley and the mouth of the Blue River (approximately 22 mi [35 km]) that averaged less than 2 ft (.6 m) deep. That stretch of river averaged 240 to 360 ft (73-109 m) wide. From the Blue River mouth to the mouth of Soldier Creek (66 mi) (106 km) the river widened, and from Soldier Creek to the mouth of the Kansas River it narrowed again.

Tidball's survey (Langsdorf 1950) also reported large sandbars, behind some of which the water depth was frequently 6 or 7 ft (1.8-2.1 m). He mentioned another area near the location of present-day St. Marys, Pottawatomie County, in which "shoals" sometimes no more than 12 in (30 cm) deep were dominant for approximately a mile of river. He reported the bottom substrate to be predominantly "easily yielding quicksand," with the river banks likewise primarily consisting of sand with occasional seams of clay. Tidball's survey was conducted at low water, as riparian residents indicated that the river stage had been 5 to 8 ft (1.5-2.4 m) higher earlier in the year.

Thomas Say (Thwaites 1905b) reported on the riparian vegetation: "Willow islands, moving sandbars, and falling-in banks, are as frequent as in the Missouri. The line of forest which skirts the banks, including the bed of the river, is about half a mile wide, but not entirely uninterrupted. The course of the river is remarkably serpentine, forming woodland points alternately on both sides." S.H. Long (Thwaites 1905b) wrote that the Kansas River valley contained "similar forests of cottonwood, sycamore, etc., interspersed with meadows; but, in ascending, trees become more and more scattered, and at length disappear almost entirely, the country, at its sources, being one immense prairie." Further downstream, near present-day Lawrence, Douglas County, Fitch and McGregor (1956) reported from early accounts that the floodplain contained "rich mesophytic forest of predominantly oak-hickory type."

The river channel within the high banks was reportedly exposed to a continuous pattern of bank erosion and deposition, creating a shifting channel configuration and development of unvegetated sandbars and islands. Yet the channel was relatively stable within the confines of its floodplain. Dort et al. (1981) reports that only 12 percent of the river main stem shifted laterally greater than channel width between 1936 and 1976. Reduction of overbank flows has further reduced that lateral channel migration (Simons, Li & Associates 1984). Since 1951, less than 10 percent of the main stem has actively migrated (USACE 1988), indicating that channel movement has declined since impoundment of tributary reservoirs.

Wedel (1941) used archaeological and sedimentation records to conclude that severe droughts had occurred repeatedly in the Kansas River basin prehistorically. Some of these were probably of sufficient severity to depopulate the western plains. Other early accounts by explorers such as Lewis and Clark, Fremont, Zebulon Pike, and Major S.H. Long (Metcalf 1966) report a widely fluctuating streamflow in the Kansas River, reflecting seasonal precipitation patterns across a large watershed, similar to what is observed today, though then totally unregulated.

Description of Existing Kansas River System - The Kansas River, confluence of the Republican and Smoky Hill Rivers to the mouth of the Kansas River at Kansas City, has experienced significant effects of reservoir impoundments on tributaries. This is due to a complete lack of main stem reservoirs on the Kansas River, although every major tributary has been impounded. Beginning in 1949, 18 large Federal reservoirs have been constructed in the Kansas River basin and, along with over 13,000 smaller impoundments, control over 80 percent of the drainage area (Mundorff and Scott 1964; Simons, Li & Associates 1984). Operation of the Federal reservoirs has reduced the peak flows in the Kansas River, increased the intermediate flows, and decreased the moderate and low flows. It is estimated that discharge at DeSoto, Johnson County, would have exceeded 100 Kcfs ten times between 1935 and 1973 under natural conditions; however, with reservoir regulation that discharge has been exceeded only once during this same time period (Simons, Li & Associates 1984).

Construction and operation of the Federal reservoirs on the Kansas River trapped tributary sediment, precluding its introduction into the main stem. Reservoir surveys by the Corps of Engineers estimate 95 to 98 percent of the suspended sediment flowing into reservoirs is trapped, with the trap efficiency for sand-sized particles being 100 percent (Simons, Li & Associates 1984). The proportion of total sediment load consisting of silt and fine sand was much greater at Wamego during 1970-1977 than it was during 1957-1967, due to a reduction in coarse sediment being transported (Osterkamp et al. 1982). Bed degradation immediately downstream of the three reservoirs nearest the main stem (Milford, Tuttle Creek, and Perry) is nearly 10 ft (3 m), but decreases to less than 2 ft (.6 m) at the tributary mouths (Simons, Li & Associates 1984).

The annual average sediment yield in the lower Kansas River declined from nearly 235 metric tons during 1958-1961, to 77 metric tons during 1978-1980, even though water yields were similar for both periods (Cross and Moss 1987; Sanders et al. 1993). The natural response of the river to this reduced sediment load it to reduce its gradient, through either channel lengthening (increasing meanders) or bed degradation (Osterkamp et al. 1982). There is little evidence of increasing sinuosity, as the channel has been constricted through development and encroachment into a narrower floodplain over time. There is evidence of bed degradation, though the length of time since development of the reservoir system has not been sufficient to adequately assess the full impact (Osterkamp et al. 1982).

Continuing bank erosion, coupled with floodplain encroachment, have reduced the perennial riparian vegetation native to the Kansas River channel. Though accurate data are not available for pre- and post-construction periods, it is obvious that there is very little riparian forest which meets naturalist Thomas Say's (Thwaites 1905b) 0.5-mi (.8 km) wide description. Not all this can be attributed to reservoir operation; however, much of the agricultural and municipal floodplain development would not have been feasible without flood protection afforded by the reservoirs. Additionally, bank stabilization projects, some of which may be detrimental to aquatic habitats and channel hydraulics, could be reduced or eliminated if suitable riparian vegetation were maintained (Sanders et al. 1993). Similarly, with a restricted floodplain, degraded bed, and increased human use and encroachment, the amount of off-channel wetland habitats have likely declined along the Kansas River, though accurate data are not available.

Fish fauna of the lower Kansas River (Lawrence to the mouth) has changed since construction of the system of Federal reservoirs (Cross and Moss 1987). Ten species of fish decreased in abundance or disappeared altogether from this reach between 1950 and 1980, including pallid sturgeon, sturgeon chub, and sicklefin chub. Thirteen species increased in abundance during this same time period; species which primarily are widespread in the eastern Mississippi basin, as well as westward. Many are reportedly pelagic, and are relatively large-eyed (visual feeders). The species that have decreased are species adapted to shallow, turbid stream conditions; benthic feeders which rely on chemosensory organs for food detection. Cross and Moss (1987) concluded that these reported faunal changes accelerated after completion of reservoir construction, which led to moderation of discharge, decreased turbidity, and a tenfold increase in phytoplankton. "The character of the substrate has changed from loose and "quick" to firm and stable. Shoals formed by long, transverse dunes no longer occur, and shallow bars seldom develop ripples of slowly moving sand (Cross, unpub. data, cited in Cross and Moss 1987)."

About 13 species of freshwater mussels occurred in the Kansas River historically (Call 1885, 1887). Presently, only four of these species still occur in the main stem, although 11 of the 13 still occur in its tributaries (Murray and Leonard 1962, Sanders et al. 1993). While the reasons for this decline in mussel diversity are not completely understood, the effects of impoundments and the increase in toxics have been implicated (Murray and Leonard 1962, Oesch 1984).

Importance of the Kansas River Ecosystem - Since the Kansas River basin was settled by European immigrants, the river has been intensively used or managed for commerce and transportation, irrigation of farmland, municipal and industrial water supply, recreation, commercial fisheries, flood control, hydroelectric power generation, and fish and wildlife resources. In 1991, the Kansas Fish and Game Commission designated the stretch of the Kansas River in Riley, Pottawatomie, Wabaunsee, Jefferson and Shawnee counties as a High-Priority Fishery Resource (Moss and Brunson 1981). Six evaluation factors are used to determine fishery resource value: fishery characteristics, angling use, water quality, stream uniqueness, riparian association, and habitat restoration, reclamation, or mitigation potential.

The Kansas River channel and riparian corridor provide crucial habitat for many species which are of biological, cultural, or commercial importance. Thousands of waterfowl use the Kansas River channel and floodplain during migration and wintering. Several species of commercially valuable furbearers occur in the riparian habitats, including muskrat, mink, beaver, raccoon, and both red and grey fox. The riparian forests and meadows provide migration and nesting habitat for many species of birds, including many that are declining neotropical migratory songbirds.

Five of the nine aquatic or riparian species that are federally-listed as threatened or endangered and known to occur in Kansas have been documented as using Kansas River habitats. A sixth species occurs in smaller tributary streams to the Kansas River. Two of the three aquatic Federal candidate species in Kansas are known to have historically occupied the Kansas River, although both may be extirpated or are extremely rare today. And eight of the 20 aquatic species of concern (formerly federally designated category 2 candidate species) in Kansas are known from the Kansas River.

Missouri and Kansas River Sections and Segments

As referenced throughout the previous discussions, the Missouri River system of today is vastly different from when Lewis and Clark made their epic journey up the “Big Muddy.” The physical, chemical, and biological characteristics of the Missouri River today vary significantly throughout its 2,300 mi (3,700 km) length. Consequently, the status of listed threatened and endangered species, candidate species, and their respective habitats within the ecosystem upon which they depend, impacts to these species and habitats, and opportunities to implement actions necessary to conserve, restore, or recover these species and their habitats may differ by river reach or reservoir for the Missouri River, as well as the Kansas River.

The Service has divided the Missouri River into four characteristic sections to focus discussions on the “environmental baseline” of the listed species and the river ecosystems upon which they depend, the “effects of the Federal action,” the analysis of impacts, and the recommendations/opportunities to further the conservation and recovery of listed and candidate species. Those sections are unchannelized (UC), reservoir and headwaters (R&H), inter-reservoir (IR), and channelized (C). We have further divided the river into 15 segments based on unique morphological characteristics. The Kansas River is affected by operation of the tributary reservoirs and is considered a separate segment. Thus, a total of 16 segments on the Missouri and Kansas Rivers are identified (Table 7, Figure 9).

The Service developed the sections and segments for the Missouri River by adapting basin-wide study designs for the recently completed Missouri River Benthic Fishes Study (Dieterman et al. 1997) and the Missouri River Natural Resource Committee’s proposed Missouri River Environmental Assessment Program (MRNRC undated, circa 1999). Use of reasonably compatible designations for various sections and segments of the river will provide a consistent and logical basis of reference for information on species, habitats, impacts, and conservation or recovery actions.

Table 7. Missouri and Kansas River Sections and Segments Referred to in the Biological Opinion

River Sections

Unchannelized (UC)
Reservoirs & Headwaters (R&H)
Inter-reservoir (IR)
Channelized (C)

River Segments

	Missouri River	River Mile
1.	Fort Peck Lake (R&H)	RM 1882.7 - RM 1771.5
2.	Fort Peck Dam to Lake Sakakawea Headwaters near Williston, ND (IR)	RM 1771.5 - RM 1568.0
3.	Lake Sakakawea (R&H)	RM 1568.0 - RM 1389.9
4.	Garrison Dam to Lake Oahe Headwaters near Bismarck, ND (IR)	RM 1389.9 - RM 1304.0
5.	Lake Oahe (R&H)	RM 1304.0 - RM 1072.3
6.	Oahe Dam to Big Bend Dam (IR, Lake Sharpe - R&H)	RM 1072.3 - RM 987.4
7.	Lake Francis Case (R&H)	RM 987.4 - RM 880.0
8.	Fort Randall Dam to Niobrara River (IR)	RM 880.0 - RM 845.0
9.	Niobrara River to Lewis & Clark Lake, and Lewis & Clark Lake (R&H)	RM 845.0 - RM 811.1
10.	Gavins Point Dam to Ponca, NE (UC)	RM 811.1 - RM 753.0
11.	Ponca, NE to Sioux City, IA (C)	RM 753.0 - RM 735.0
12.	Sioux City, IA to Platte River (C)	RM 735.0 - RM 595.5
13.	Platte River to Kansas City, MO (C)	RM 595.5 - RM 367.5
14.	Kansas City, MO to Osage River (C)	RM 367.5 - RM 130.4
15.	Osage River to the mouth of the Missouri River (C)	RM 130.4 - RM 0.0
	Kansas River	**River Mile**
16.	Confluence of Republican and Smoky Hill Rivers to mouth of the Kansas River (UC)	RM 170.0 - RM 0.0

INSERT RIVER SEGMENT MAP

Bald Eagle

Historic and Current Distribution in the Action Area - During the 1800s, breeding populations were a regular occurrence along the Missouri River (Stewart 1975). Lewis and Clark documented the first recorded observations. As the expedition traveled up the Missouri River during spring, bald eagles became plentiful enough to command attention. In the vicinity of the Milk River in Montana, on April 28, 1805, Lewis noted in his journal that "the bald eagle are more abundant than I ever observed them in any part of the country" (Montana Bald Eagle Working Group 1986).

Today on the Missouri River, bald eagles use the river habitat for nesting, non-breeding, and wintering. Above Ft. Peck Dam in Montana, bald eagles use forested floodplain habitat. In the upper Missouri River from below Ft Peck Dam to the channelized reach (Segments 2-10), historic habitat for the bald eagle has changed dramatically with a series of six dams and reservoirs. Much of the bottomland cottonwood habitats used for nesting and roosting have been eliminated either by reservoir inundation or agricultural and community development adjacent to river reaches below the dams. Eagles take advantage of remnant cottonwood forests near available forage, particularly in tailrace areas where crippled fish are readily available and river and reservoir areas can support abundant waterfowl from October through March. On the lower Missouri River (Segments 11-15), remnant floodplain forests are more abundant than along the upper river because of its wider floodplain, different biographic zones, and rainfall.

Historic records indicate that wintering bald eagles commonly roosted along the Kansas River (Segment 16) in the late 1800s, and that so many bald eagles were known to nest in the vicinity of present-day Lecompton, that the original name of the town was Bald Eagle (Sherar 1934, cited in Levenson and Bee 1980). Growth in human population and activity in that area, including active steamboat navigation from 1854 to 1865, resulted in decreased bald eagle use and available habitat of the area. Eagle surveys conducted along a 10.2-mi (16 km) reach of the Kansas River in the Lecompton-Lawrence vicinity reported peak winter numbers of from 10 to 37 individuals (Levenson and Bee 1980).

Today in Kansas the bald eagle occurs primarily as a winter resident and transient species. Winter surveys conducted by the State have reported totals approaching 1,000 bald eagles in some years (Jerry Horak, KDWP, pers. comm.). In 1989, the bald eagle reestablished itself as a nesting species (Schwilling et al. 1989), with five to ten active nests per year since then. Both wintering and nesting bald eagles use similar habitat in Kansas, seeking out the tallest trees in the canopy, with access to nearby open water.

Population Status and Trends in the Action Area - Refer to Appendix IV for wintering and breeding bald eagle population distribution on the Missouri River. Present-day breeding occurs above Fort Peck Reservoir in Montana, between Garrison Dam and Lake Oahe in North Dakota (Segment 4), and below Fort Randall (Segment 8) and Gavins Point Dams (Segment 10) in South

Dakota/Nebraska. As nationwide populations increase, so have nesting occurrence in the remaining suitable habitats.

In Montana, more than 170 bald eagle nesting territories occur in the State. Of these, at least 29 nesting territories occur along the river above Fort Peck Reservoir. However, breeding records below Fort Peck (Segment 2) are scarce, although much of the floodplain has suitable habitat. The Montana Bald Eagle Management Plan identifies a potential need for three additional territories in this area. The only bald eagle management zone in Montana that has not met recovery goals established in the Pacific Bald Eagle Recovery Plan encompasses the Missouri River. Montana ranks in the top 15 States in total number of wintering eagles. On the Missouri River, numbers of wintering eagles have increased as a result of general population increases. The number of non-breeding eagles using the Missouri River also has increased. Wintering populations on the Missouri River in Montana between 1993 and 1989 have ranged from a low of 54 in 1987 to a high of 171 in 1989.

In North Dakota, the Missouri River floodplain forest upstream of Lake Sakakawea and between Garrison Dam and Lake Oahe provides suitable nesting habitat for bald eagles. Until 1988, no attempts at nesting had been documented since 1975 and 1976 when one pair nested below Garrison Dam. The pair fledged one young in 1975 which was later found dead near the nest tree. In 1988, two nesting attempts (one active) below Garrison Dam resulted in the fledging of one young. Each year from 1988 to 1995 a pair successfully fledged young from a nest site below Garrison Dam. In 1996, two nesting pairs raised one young each. The Service expected that young eaglets from the earlier successful nests would develop an affinity to the area where raised and nest in the area once they reached sexual maturity. In 1997, the Service conducted an aerial survey of this reach of the Missouri River and documented eight active nests which fledged 12 young. No survey was conducted in 1998; however, eight active nests were documented again in 1999.

Bald eagles winter along ice-free river reaches near Williston, North Dakota, and below Garrison Dam. Wintering populations on the Missouri River in North Dakota between 1986 and 2000 have fluctuated from a low of 2 to a high of 59 individuals. The wintering populations are highly dependent on the severity of the winter conditions and the availability of ice-free conditions on the river.

In South Dakota, breeding bald eagles were documented for the first time in more than 100 years in 1993 when two birds were fledged from a nest on the Missouri River at Karl Mundt National Wildlife Refuge. Nesting has continued at Karl Mundt and two nests have been documented every year since 1997. Additional nests have been found below Karl Mundt with a high of 8 nests in 2000. Three major areas of mature cottonwood timber remaining on the Missouri River in South Dakota are known to support wintering populations of bald eagles. They are the Pierre/Oahe Dam area, Karl Mundt National Wildlife Refuge/Fort Randall Dam area, and portions of the Missouri National Recreational River, particularly in the Yankton/James River Island area. Bald eagle wintering habitat on the Missouri National Recreational River (i.e., Gavins Point Dam to Ponca, Nebraska) also was identified in a 1986 report USFWS 1986b). Nineteen areas were identified in this report as known wintering areas or having potential as wintering areas. Statewide, annual, midwinter surveys conducted in January for the years 1963-1985 in South Dakota averaged 287 bald eagles per year. Since 1986, surveys have been limited to the Missouri River where bald eagle numbers have averaged 178 birds per year (1986-1999 average). In many areas throughout the State, they presently appear to be increasing in numbers. From 1986 to 1999, wintering populations along the Missouri River in South Dakota have ranged from 113 in 1986 to 327 individuals in 1998.

On the Nebraska/Iowa river reach, one active nest exists on the Iowa side of the river. That nest fledged two young in both 1992 and 1993. That reach also may attract large numbers of wintering bald eagles. In some years, when the river remains open, more than 200 eagles may occur.

On the Kansas reach of the Missouri River, no confirmed records of nesting bald eagles exist, although some potential breeding habitat is present. Better quality habitat can be found along the Kansas River and its tributary reservoirs. The Clinton Reservoir on the Wakarusa River (a Kansas River tributary), the Hillsdale Reservoir on Big Bull Creek (a Marais des Cygnes tributary; the Marais des Cygnes becomes the Osage River), and the Perry Reservoir on the Delaware River (a Kansas River tributary) all currently support bald eagle nests. The first nest on the Kansas River in modern times was not observed until 1997, and has been active every year since. Overstory along the Kansas River riparian corridor primarily consists of cottonwood *(Populus deltoides*), American sycamore (*Platanus occidentalis*), and willow (*Salix* spp.) (Levenson and Bee 1980). Large trees in close proximity to open or flowing water are typically selected for perching and nesting. In general, trees of at least 24 in (61 cm) diameter at breast height and/or 50 ft (15.2 m) tall within 100 ft (30.5 m) of water are considered prime bald eagle habitat, particularly in areas which remain relatively ice-free late into the winter.

Along the State of Missouri reach of the river, two active bald eagle nests currently exist. Over the past 4 years, nesting attempts on the river and elsewhere in Missouri have increased steadily. Throughout the state in 1999, there were 53 nesting territories that produced 80 to 90 fledglings. Over the past several years, the number of eagles wintering on the Missouri reach of the river has increased significantly, and the state provides important wintering habitat to hundreds of birds along the Missouri and Mississippi rivers. During midwinter surveys in 2000, almost 300 eagles wintered on the Missouri River in Missouri, out of a state-wide total of 1,970. The lower ends of major river tributaries, such as the Grand and Osage Rivers, also support large wintering populations.

Distribution and Abundance of Habitat in the Action Area - Available habitat areas are the remnant forested flood plain habitats. Significant areas are noted above in discussions of Current Distribution in the Action Area and in Population Status and Trends in the Action Area.

Productivity and Recovery Objective in the Action Area - The Northern States Bald Eagle Recovery Plan (USFWS 1983) reports that changes in survival have more impact on the population of bald eagles than similar changes in reproductive rates. Depending on adult survival, populations with lower reproduction can do better than others with higher reproduction (Grier 1980). According to the Northern States Bald Eagle Recovery Plan, the Service has to rely on information about numbers of nesting birds and maintain an assessment of the reproductive side of the population equation.

The initial goal for recovery is to have 1,200 occupied breeding areas distributed over a minimum of 16 states within the Northern States Region by the year 2000, with an average annual productivity of at least 1.0 young per occupied nest. Delisting goals were met in 1991, with 1,349 occupied breeding areas distributed over more than 20 states and an estimated average productivity since 1991 of greater than 1.0. In 1998, the estimated number of occupied breeding areas for the Northern States Recovery Region exceeded 2,200. Distribution of a recovered population within the Missouri River Basin States is given in pairs as follows (USFWS 1983; Montana Bald Eagle Working Group 1986):

Montana	99
North Dakota	10
South Dakota	0
Nebraska	10
Iowa	10
Kansas	0
Missouri	50

By 2000, these objectives have been met or exceeded for all states. On July 6, 1999 (64 FR 36454), the Service proposed to delist the species in the 48 conterminous states. A final decision is expected by October 2000.

Importance of the Missouri River and Kansas River to the Bald Eagle - In northern states where natural lakes and smaller rivers freeze during winter, the Missouri River provides the only open water for wintering eagles. Those open water areas also concentrate wintering waterfowl populations. The eagles concentrate below main stem dams where food is most plentiful and easily available. Tailrace areas also provide other forage opportunities for eagles to feed on disabled fish that pass through the turbines.

Although most of the mature floodplain forest has been dramatically reduced since settlement (Bragg and Tatschl 1977), the Missouri River floodplain along most of the flowing reaches has sufficiently large cottonwood trees for nesting, winter roosting, and migratory staging. Recovery goals for the Northern States population have been met in part because of the contribution of Missouri River remnant forests. Nesting and wintering habitat are both critical to the continued survival of the bald eagle.

The 170 mi (274 km) of the Kansas River vary widely in the quality of bald eagle habitat provided, with much of the riparian forest removed from large sections. Where the cottonwood forest remains intact, wintering eagles congregate during cold months, preying on fish and waterfowl, especially in river stretches near large reservoirs.

Least Tern

Historic and Current Distribution in the Action Area - The least tern was formerly a common breeder on the Missouri River and many of its tributaries from St. Louis, MO, to Montana (USFWS 1990). The explorers, Lewis and Clark, observed terns along the Missouri River in 1804 and believed them to be "a native of this country and probably a constant resident" (Burroughs 1961). They noted an increasing presence of the species above what is now called Plattsmouth, NE (Moulton 1986). Coues (1874) recorded least terns on the Loup Fork and Yellowstone Rivers in Montana during the Warren Expedition. Hardy (1957) recounts various qualitative records on the distribution of the tern indicating the tern's former presence along most of the Missouri River. The least tern is now entirely absent as a breeding bird on the Missouri River from St. Louis, MO, to Sioux City, IA.

Today least terns are found scattered along 696 mi (1,119 km) of the 2,300 mi (3,700 km) Missouri River and on several of its major tributaries including the Kansas, Platte, Niobrara, Cheyenne and Yellowstone rivers. During the 15-year period from 1986 to the present, a total of 8,195 adult least terns have been censussed on the Missouri River and its major tributaries. The majority of these birds, 72.6 percent or 6,245 birds occurred on the free-flowing stretches of the river below Ft. Peck, Garrison, Ft. Randall, and Gavins Point Dams (C. Kruse, pers. comm. 2000). Additionally, 24.5 percent of the censussed terns were located at the confluence of the Niobrara and Missouri Rivers (683 adults) and on Lake Oahe reservoir (1325 adults).

Distribution of least terns on the Missouri River continues to be influenced by the relation of sandbar habitats to water levels as noted by Schwalbach et al. (1986). Reservoir storage and release patterns determine least tern habitat use and reproductive success by affecting habitat and forage availability. The current distribution of least terns on the Missouri and Kansas River segments follows:

Fort Peck Lake, Segment 1, RM 1882.7 - 1771.5: The reservoir is at the northwestern limit of the tern's breeding range and contains little suitable habitat for breeding terns. During years of poor habitat conditions in the heart of the breeding range, a handful of tern nests usually may be observed along the lower portion of the reservoir. That area has been surveyed annually since 1987 (Pavelka and Kruse 1999). The most nests located were four in 1991.

Fort Peck Dam to Lake Sakakawea Headwaters near Williston, ND, Segment 2, RM 1771.5 - 1568.0: That reach also lies within the northwestern fringes of the least terns breeding range. Populations of terns on that reach fluctuate with habitat conditions elsewhere in the range. Numbers peaked in 1997 when other habitat along the Missouri River was inundated. That reach has been censussed annually since 1987 (Pavelka and Kruse 1999).

Lake Sakakawea and Lake Audubon, Segment 3, RM 1568.0 - 1389.9: Despite the length of the reservoir shoreline, there is regular, albeit, little use by terns on that reach. Although low reservoir levels expose extensive gravel-sand beaches, rising levels inundate most habitat. Furthermore, with few exceptions terns throughout their breeding range nest primarily on sandbars in rivers.

Garrison Dam to Lake Oahe Headwaters near Bismarck, ND, Segment 4, RM 1389.9 - 1304.0: This reach provides the first stretch of river with extensive areas of sandbars suitable for nesting terns. This area has been an important reach for nesting terns. Numbers, reproductive success, and habitat conditions are detailed by Mayer and Dryer (1989, 1990) and Pavelka and Kruse (1999). Over the last 13 years, an average of 160 least terns have been recorded along this section of the river.

Lake Oahe, Segment 5, RM 1304.0 - 1072.3: The hundreds of miles of reservoir shoreline of Lake Oahe harbor over 100 terns (Pavelka and Kruse 1999). Few nests are found in the middle of the lake, but terns use the shoreline along the Cheyenne River arm of the reservoir. The most important nesting site on Lake Oahe is Dredge Island at RM 1270.0, which accounts for nearly 50 percent of all nests found on the lake since surveys began. Lake Oahe supports substantial numbers of terns, however, nesting success has been below average with only 23 percent of nests successful.

Oahe Dam to Fort Randall Dam (Lake Sharpe and Lake Francis Case), Segments 6 and 7, RM 1072.3 - 880.0: Although terns historically nested along the river between Lake Oahe and Fort Randall Dam, they no longer occur in that reach.

Fort Randall Dam to Niobrara River; Niobrara River to Lewis and Clark Lake, Segments 8 and part of 9, RM 880.0 - 811.1: Various studies and survey reports provide substantial data on the numbers, density, reproductive success, and distribution of terns as well as habitat conditions and management actions and needs below Fort Randall (Schwalbach 1988, Dirks 1990, Kruse 1993, Pavelka and Kruse 1999). Terns continue to nest along this reach which supported an all-time high of 200 terns in 1999.

Gavins Point Dam to Ponca, NE, Segment 10, RM 811.1 - 753.0: The largest number of terns along the Missouri River occur below Gavins and have been the subject of much research and management by the Service and Corps (Schwalbach 1988, Dirks 1990, Kruse 1993, Pavelka and Kruse 1999).

Channelized reach, Ponca, NE, to St. Louis, MO, Segments 11, 12, 13, 14 and 15, RM 753.0 - 0.0: Least terns historically nested along this reach. As recently as the 1960s, between 20 and 70 terns would regularly use DeSoto National Wildlife Refuge (NWR) in Iowa, with the last nesting record in 1972. Continued habitat loss throughout this reach, however, has eliminated tern nesting (with the exception of the one or two nests associated with floodplain ash pits in Iowa).

Kansas River, confluence of Republican and Smoky Hill Rivers to mouth of Kansas River, Segment 16, RM 130.4-0.0: No historic records of least terns nesting on the main stem Kansas River exist. The species was first observed nesting on the river in 1996 at about RM 131. Colonies or individual pairs have continued nesting each year in the middle river, RM 65 to 140, most frequently from RM 75 to 130. Birds have relocated and used different sandbars throughout this time period in response to revegetation of sandbar habitats.

Population Status and Trends in the Action Area - The most recent, relatively complete survey of interior least tern documented approximately 5,500 terns scattered throughout the interior United States (Kirsch and Sidle 1999; Erika Wilson, FWS, pers. comm. 2000)(Table 8). That compares with a high count of 9,000 terns in 1994, and underscores the variability of tern

Table 8. Least Tern Numbers Throughout the Range

Location	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Yellowstone River, MT to L. Sakakawea	16	14	19	40	21	19	21		
Missouri River, MT Ft. Peck Reservoir	10	0	7	9	2	0	2	4	0
Missouri River, MT Ft. Peck Dam to L. Sakakawea	66	110	31	58	95	128	162	25	40
Missouri River, ND L. Sakakawea	8	29	14	35	7	27	2	23	9
Missouri River, ND/SD Garrison to Oahe Dams	338	322	258	377	368	179	142	231	162
Missouri River, SD Ft. Randall to Gavins Pt.	87	42	114	87	26	30	60	154	200
Missouri River,SD/NE Gavins Pt. to Ponca	193	186	272	211	93	82	115	144	161
Missouri River, IA Sioux City	0	12			12	13	16		
Missouri River, IA Council Bluffs	20	9	0	0	4	8	5		
Cheyenne River, SD					32	32	30		
Niobrara River, NE	291					321	103		
Loup River, NE	117	188	46		150	139			
North Loup River, NE						17			
South Platte River, NE	0	0	5	0	0	2			
North Platte River and Lake McConaughty, NE	16	24	10	12	8	10	10		
Platte River, NE (central reach)	19	191	178	169	119	157	120		
Platte River, NE (lower reach)	487	427	451	426	180	290	377		
Elkhorn River, NE	30	35	38	24	35	86	62		
Lower Ark. River Valley lakes, CO	46	42	30	22		64			
Arkansas River (J.M. Res.) and adjacent col, CO									
Quivira NWR, KS	54		48	46	50	66	56		
Jeffery Energy Center, Pottawatomie Co, KS	0	0	0	16	20	20	15		
Cimmarron River, KS/OK	67	452	16	22	16	14	14		
Optima Reservoir, OK	15	16							
Salt Plains NWR, OK	82	136	168	90	200	200	200		
Red River, OK/TX	333								700
Arkansas River, OK Kaw Dam to Muskogee	304	315	447	471	339	381	277		
Arkansas River, AR		68							
Canadian River, OK (Newcastle to Purcell)	38		80	78	122	86	110		
Canadian River, OK (Sequoyah NWR)					54	77	41		
Canadian River ,TX									
Prairie Dog Town Fork of Red River TX									
Mississippi River, C. Girardeau to Vksbrg	4297	3653	4589	6776	6971	3067	3428	5538	6159
Ohio River, KY/TN	0			44		138	91		
Gibson Lake, IN	12	9	34	30	24	68			

Bitter Lake NWR, NM	10	12	14	11	14	14	12		
Rio Grande River, Falcon Reservoir, TX			655						
Rio Grande River, Lake Casa Blanca, TX									
Rio Grands River, Armistad Reservoir, TX									
Dallas county , TX, Waster water treatment plant		15	24	20	20	27	25		
Totals	**6956**	**6307**	**7548**	**9074**	**8982**	**5762**	**5496**	**6119**	**7431**

Sources: Kirsch and Sidle 1999, Wilson pers. comm. 1999, Pavelka and Kruse 1999, Jones 1998 and 1999, and Kruse pers. comm. 1999.

numbers between years. As previously mentioned, tern movements among breeding areas and large year to year population fluctuations, make analysis of long-term tern numbers difficult. Kirsch and Sidle (1999) found that long-term trends in least tern numbers in the Missouri River drainage was positive (1.3 percent), but was not statistically significant. Although recent censuses of least tern numbers along the upper Missouri River have ranged from 817 in 1994 to 504 in 1997, tern reproductive success (i.e., fledge ratio goals) met the recommendations in the Service's 1990 biological opinion of 0.7 chicks/pair only three times in the last ten years, 1998 and 1999 (Table 9, Figure 10) and 2000 (1.22 chicks per pair). Those highly productive years are believed to be a result of record basin runoff and subsequently high discharges during the period from 1995 to 1997. Those flows created extensive least tern nesting and foraging habitat below Garrison, Fort Randall, and Gavins Point Dams (Segments 4, 8, and 10). Without periodic high discharges to maintain and reconfigure this habitat, least tern recruitment likely will decline in the future.

Nesting least tern populations on the Kansas River have remained relatively small since their discovery in 1996. The high count was 18 pairs in 1998. Nest success has varied a great deal, including 1999 when not a single chick was fledged due to uncontrolled runoff from rainfall events which destroyed all nests. Since 1994, a small (less than 10 pairs) nesting colony has been established at the Jeffrey Energy Center, located 7 mi (11 km) north of RM 113 in Pottawatomie County. Interchange likely occurs between that colony and those on the river, as indicated by the 2000 recapture of an adult least tern which had been banded as a nesting adult in 1999 at the Jeffrey Energy Center (R. Boyd, unpublished data).

Table 9. Least Tern Adult Census and Fledging Data by Missouri River Segment, 1986-1999.

Missouri River Segments	Adult Terns	Percent System Total	Yearly Adult Avg.	Fledged Terns	Percent Fledged Total	Yearly Fledge Average
Fort Peck Lake* (Segment 1)	49	0.6	3.8	10	0.4	0.8
Fort Peck River**	873	10.7	72.8	255	10.4	21.3

(Segment 2)						
Lake Sakakawea* (Segment 3)	185	2.3	15.4	30	1.2	2.5
Garrison River (Segment 4)	2181	26.6	155.8	671	27.4	47.9
Lake Oahe (Segment 5)	1325	16.2	94.6	167	6.8	11.9
Fort Randall River (Segment 8)	399	4.9	28.5	117	4.8	8.4
Lewis and Clark Lake (Segment 9)	683	8.3	48.8	291	11.9	20.8
Gavins Point River (Segment 10)	2500	30.5	178.6	909	37.1	64.9
River Reaches	6013	73.4	429.5	1999	81.2	142.8
Lake Reaches	2182	26.6	155.9	451	18.8	32.2
Total	8195	100	585.4	2450	100	175.0

*No data collected in 1986
**No data collected in 1986 and 1987

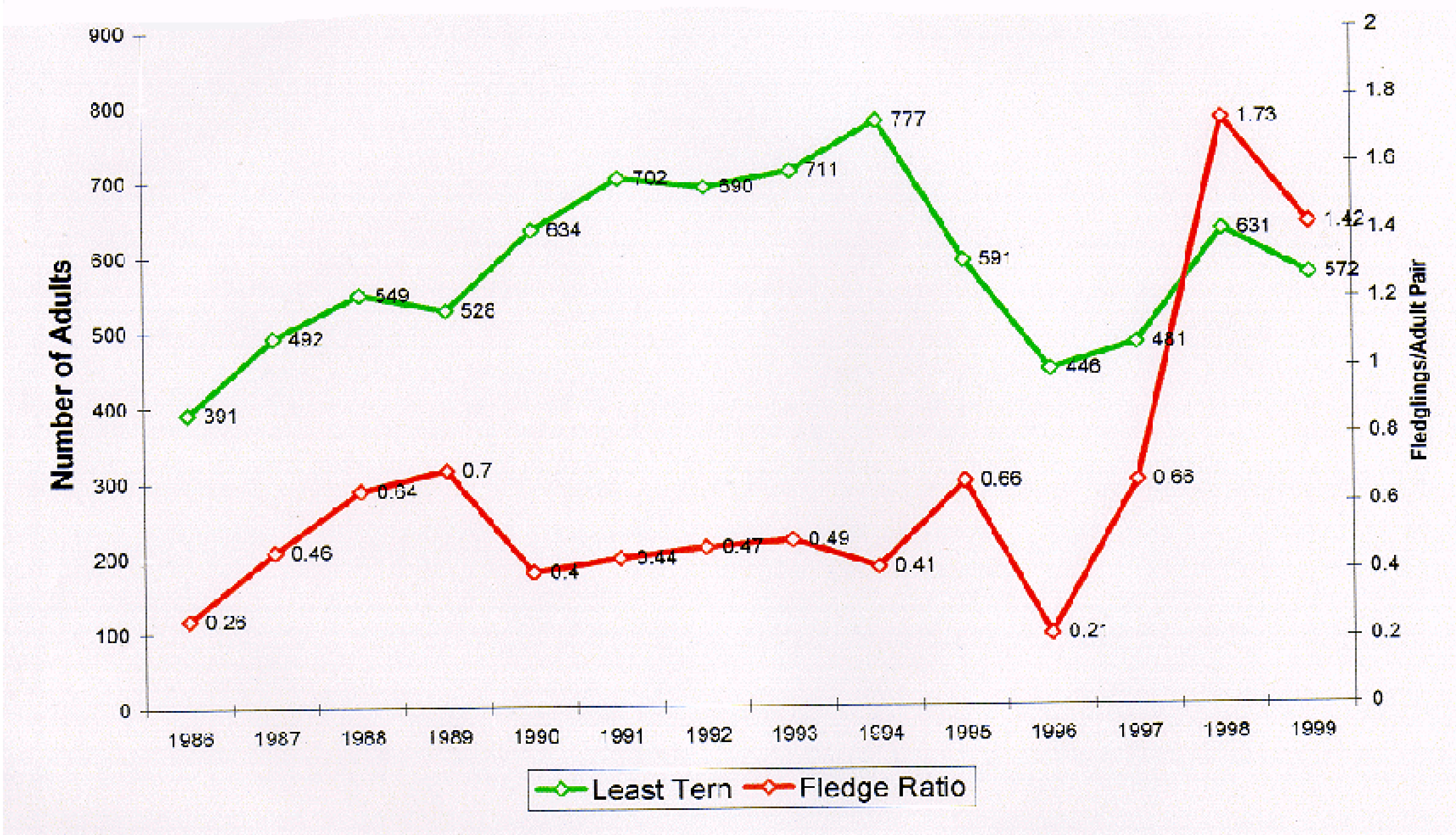

Figure 10. Least tern adult census and fledge ratios 1986 to 1999.

Distribution and Abundance of Habitat in the Action Area - Depending on the annual runoff, habitat distribution and abundance will vary considerably from reach to reach and year to year on the Missouri River. Below normal runoff will lead to low lake elevations and low releases from the dams resulting in exposure of thousands of acres of potential habitat. Conversely, above normal runoff will inundate lake habitat as the reservoirs capture the spring runoff and higher releases from the dams will flood downriver habitat.

However high runoff is not necessarily detrimental, as periodic high runoff is needed to retard vegetation encroachment on sandbars and beaches. Another factor influencing the quality of habitat is the presence of residential development along the river. Otherwise good tern habitat may not be used if there is heavy recreational use of the habitat. Below is a reach by reach description of habitat distribution and abundance.

Fort Peck Lake, Segment 1: Habitat is widely scattered across beaches along the eastern part of Fort Peck Lake. The relative abundance of habitat varies annually with the amount of water captured in the reservoir during the spring runoff. The average maximum elevation of the lake in the summer is 2239.1 feet mean sea level (msl) which generally leaves an adequate amount of beach habitat for the terns. The highest elevation recorded on the lake has been 2251.6 feet msl. The lowest annual maximum recorded on the lake has been 2214.0 feet msl. Generally when the lake rises to its normal maximum operating pool of 2246.0 feet msl, virtually all tern beach habitat is inundated. Over the past 33 years (1967 to 1999) this has occurred 21 percent of the time (7/33) (Corps Reservoir Control Center). This is not necessarily a negative as a high lake elevation does have the benefit of inundating encroaching vegetation and thus restoring beach habitat.

Fort Peck Dam to Lake Sakakawea Headwaters, Segment 2: Least tern habitat on the Missouri River is created by scouring vegetation off sandbars and the building of sandbars by sediment deposition. Construction of Fort Peck Dam has altered habitat creation by reducing the frequency of flooding downriver and eliminating a substantial amount of sediment deposition. Over the past 33 years (1967 to 1999) releases from Fort Peck Dam during the nesting season (May through August) has averaged 10.4 Kcfs. Upper decile releases of 15 Kcfs or greater have occurred three times (1975, 1976, & 1996) over the past 33 years (1967 to1999). These upper decile releases have been effective in reducing vegetation encroachment on the sandbars.

Sediment deposition does occur within the reach through erosion and inflows from the Milk and Poplar Rivers. Sandbars especially have built up below the Milk River confluence as a result of river’s relatively high contribution of suspended particulate matter. The Poplar River also transports a considerable amount of suspended fine sediments.

Lake Sakakawea, Segment 3, and Lake Audubon: The amount of habitat available on Lake Sakakawea can vary considerably from year to year. Habitat availability depends two factors: runoff into the Missouri River watershed and vegetation encroachment from the previous year. High runoff means less habitat as beaches flood when the reservoir fills to capture the spring rise. However, habitat quality and quantity will also decline as vegetation encroaches on beaches that are not periodically inundated.

The average maximum elevation of the lake in the summer is 1843.9 feet msl. This generally leaves a sufficient amount of beach habitat for the terns. The highest elevation recorded on Lake Sakakawea has been 1854.8 feet msl. The lowest annual maximum recorded on the lake has been 1823.4 feet msl (Corps' Reservoir Control Center). Generally when the lake rises above its normal maximum operating pool of 1850.0 feet msl, virtually all plover beach habitat is inundated. Over the past 33 years (1967 to 1999) this has occurred 9 percent of the time (3/33) (Corps Reservoir Control Center). These high lake elevations do have the benefit of inundating encroaching vegetation and thus restoring beach habitat.

Garrison Dam to Lake Oahe Headwaters, Segment 4: Habitat first becomes available on the Missouri 9 mi (14 km) below Garrison Dam at RM 1380.0. Historically this reach contains the largest amount of habitat but several factors influence the quality and quantity of the habitat. The lack of a flood pulse has reduced the ability of the river to prevent encroachment of vegetation on the sandbars. Over the past 33 years (1967 to 1999) releases from Garrison Dam during the nesting season (May through August) has averaged 27,300 cfs (Corps Reservoir Control Center). Upper decile releases of 37 Kcfs or greater have occurred just twice (1975 and 1997) over the past 33 years (1967 to 1999) (Corps Reservoir Control Center).

Sediment deposition within the reach has been severely reduced by the construction of Garrison Dam and the armoring of the shoreline. Approximately 35 percent of the shoreline from the dam to the headwaters of Lake Oahe has been protected by bank stabilization projects. The Knife and Heart Rivers contribute some sediment load but this generally is insignificant beyond the confluences.

Habitat is further affected by human recreation use. The cities of Bismarck and Mandan lie adjacent to the Missouri from RM 1320 to RM 1312 with new residential developments springing up both above and below the metropolitan area on the river. The Bismarck/Mandan metropolitan area brings heavy human use to the sandbars including such activities as picnicking, volleyball, golf, hiking, swimming, pet use, and boating.

Lake Oahe, Segment 5: As with Fort Peck Lake and Lake Sakakawea above it, the amount of habitat available to least terns on Lake Oahe varies annually and depends how high the lake rises during the spring runoff. The average maximum elevation of the lake in the summer is 1609.2 feet msl. At this elevation normally there is a sufficient amount of habitat available to the plovers. The highest elevation recorded on Lake Oahe has been 1618.7 feet msl. The lowest annual maximum recorded on the lake has been 1589.3 feet msl (Corps Reservoir Control Center). When the lake rises above the normal maximum operating pool of 1617.0 ft msl, most of the plover habitat is inundated. Over the past 33 years (1967 to 1999) this has occurred 18 percent of the time (6/33) (Corps Reservoir Control

Center).

Oahe Dam to Fort Randall Dam (Lake Sharpe and Lake Francis Case), Segments 6 and 7: Little, if any, habitat has been found on these two lakes.

Fort Randall Dam to Niobrara River, Segment 8: Habitat first becomes available on the Missouri 7½ mi (12 km) below Fort Randall Dam at RM 871.5. Over the past 33 years (1967 to 1999) releases from Fort Randall Dam during the nesting season (May through August) have averaged 30,900 cfs. Upper decile releases of 45,800 cfs or greater has occurred just once (1997) over the past 33 years (1967 to 1999) (Corps Reservoir Control Center). Habitat is quite limited within the reach occurring from only RM 871.5 to RM 865.0 and from RM 852.5 to RM 848.0. Extensive summer home developments have occurred along the river, especially on the Nebraska side. These occur at RM 869, RM 865 and from RM 853 to RM 851. All of these developments are adjacent to nesting areas and present a potential conflict between the birds and recreationists.

Niobrara River to Headwaters of Lewis & Clark Lake, part of Segment 9: Habitat on Lewis & Clark Lake is limited to the headwaters of the lake from RM 844.0 to RM 828.0. This part of the lake is dominated by a sedimentation zone caused by inflows of the Niobrara River at RM 844.0. Just below the confluence with the Niobrara numerous sandbar complexes are available for the terns and plovers from RM 843 to RM 838. Farther down the lake, small pockets of sandy beaches are available within the sedimentation zone, but the majority of islands here are dominated by cattails and other aquatic vegetation. High releases from Fort Randall Dam and high inflows from the Niobrara River can scour vegetation off of sandbars in the uppermost part of the lake. However, Lewis & Clark Lake is maintained at a constant elevation around 1206 feet msl during the nesting season. This allows little opportunity for flooding of vegetation once it becomes established in the lower part of the sedimentation zone.

Gavins Point Dam to Ponca, NE, Segment 10: Habitat first becomes available on the Missouri River 3 mi (5 km) below Gavins Point Dam at RM 807.0. Over the past 33 years (1967-1999) releases from Gavins Point Dam during the nesting season (May through August) have averaged 33,500 cfs. Upper decile releases of 51,000 cfs or greater have occurred just once (1997) over the past 33 years (1967-1999). The high flows in 1997 have significantly improved both the quality and quantity of habitat that had become degraded through vegetation encroachment.

Sediment deposition has been greatly reduced by Gavins Point Dam. Some sediment replenishment occurs from inflows of the James River, the Vermillion River and bank shore sloughing. The latter has been reduced by numerous bank stabilization projects in the reach. Several summer home developments occur on both sides of the Missouri. For the most part however these sites are not adjacent to current nesting areas.

Ponca, NE to St. Louis, MO, Segments 11, 12, 13, 14, and 15: Because of the channelization of the

Missouri River in the 1930s, 1950s, 1960s, and 1970s virtually no habitat is available for nesting least terns on the river.

Kansas River, Segment 16, RM 170-RM 0: Sparsely vegetated sandbar/island habitat is widely distributed throughout the Kansas River, varying in quantity and quality from one reach to another. Least terns have demonstrated a preference for the middle Kansas River (RM 75 to 130). Aerial photography indicates that this section averages two to three large sandbars every mile of river, with some sandbars extending a mile or more in length, and often located on opposite banks directly across from one another. Upstream from the mouth of the Blue River (RM 148), sandbars are much smaller and less suitable, sometimes farther apart. Downstream from Lawrence (RM 50), the river contains very few large sandbars, probably a result of a history of sand and gravel dredging in this stretch.

Several sandbars were scoured free of vegetation on the Kansas River between Manhattan and Wamego following the large and prolonged flood flows of 1993. Least terns were first noted to nest on several of these sites in 1996. Potential nesting habitat for the birds has been recorded upstream of Wabaunsee and as far downstream as St. Mary's.

The sandbars in the middle, preferred, section of river have been observed to change over the short period of time in which terns have been nesting here. For example, Franks Island (RM 73) was successfully used by a nesting colony in 1998, but in July 2000 was observed to be virtually unusable due to vegetation encroachment and siltation (D. Mulhern, FWS, pers. comm. 2000). This phenomenon is being observed at many sandbars and islands throughout the Kansas River, as stabilized flows preclude sandbar scouring and development.

Productivity and Recovery Objective in the Action Area - In 1990, the Service published the *Interior Population of the Least Tern Recovery Plan* (USFWS 1990a). That plan includes recovery goals for the least tern along major river systems throughout their range. Major recovery steps outlined in the plan include: (1) determine population trend and habitat requirements; (2) protect, enhance, and increase populations during breeding; (3) manage reservoir and river water levels to the benefit of the species; (4) develop public awareness and implement educational programs about the least tern; (5) implement law enforcement actions at nesting areas in conflict with high public use.

The tern recovery plan recommends the removal of the tern from the endangered species list if essential habitat throughout its range is properly protected and managed, and species distribution and populations goals are reached and maintained for 10 years. Recovery goals for the project area, which is in the Missouri River system, are habitat protection and population levels of 2,000 adults. Specifically, the recovery plan recommends the following population levels and distribution be maintained for 10 years (distribution and population goals have been similarly described for the Mississippi, Ohio, Arkansas, Red, and Rio Grande Rivers systems within the tern's range):

Montana- 50 adults

North Dakota- 250 adults
South Dakota- 580 adults (includes 400 adults shared with NE on the MR)
Missouri River below Gavins Point Dam-400 adults
Other Missouri River sites- 100 adults
Cheyenne River- 80 adults

Nebraska- 1,520 adults (includes 400 adults shared with SD on the MR)
Missouri River- 400 adults
Niobrara- 200 adults
Loup River- 170 adults
Platte River- 750 adults

Kansas - No population goals have been established for the Kansas River.

As previously mentioned, increasing range-wide population trends from 1986 to 1995 are believed to be a result of immigration of least terns to the lower Mississippi River (Kirsch and Sidle 1999). Fledging success is variable across the tern's range, and in many local areas Kirsch (1996) found fledging success to be below a very conservative 0.51 fledglings/pair thought to be required for population maintenance. More recently, Dugger developed another fledging estimate of 1.0 chick/pair required to maintain stable tern populations. The Service's 1990 biological opinion (USFWS 1990b) on the Corps annual operating plan called for the maintenance of 0.70 fledgling success. Given the population analysis by Kirsch and Sidle (1999) and Smith and Renken (1993), maintaining an annual fledgling success of 0.70/pair on the Missouri River (suggested by USFWS 1990b) may not be necessary, or even possible given the great variation of fledgling success among sites and years that is typical for this species (Kirsch 1992, Smith and Renken 1993). A multi-year average of 0.70/pair fledgling success may be appropriate for the Missouri River.

In addition to seemingly low fledging success on the Missouri River, Kirsch and Sidle (1999) noted that low individual site fidelity and substantial fluctuations in local tern numbers suggest considerable movement among breeding areas. Those factors can further confound the understanding of the species status based on short-term trends. Therefore, long-term information on the reproductive success of interior least terns, as well as tern numbers and distribution, are important factors in determining when the least tern has successfully achieved its recovery goals.

Importance of the Missouri River to the Least Tern - Missouri River least terns account for approximately 10 percent of the total interior least tern population. In 1999, 572 terns were found along the Missouri River, most nesting on sandbars, but a few nesting along reservoir shorelines. Over the last ten years, terns along Missouri River accounted for between 6.8 and 10.3 percent of the total interior least tern population (Table 8). In addition to its importance as nesting habitat for the least tern, the Missouri River is a migration corridor, and may play an important role in the species movements to and among other significant nesting areas along the river and its major tributaries (i.e., Platte River, Elkhorn River, Loup River, Niobrara River, and the Yellowstone River) (Hardy 1957).

Importance of the Kansas River to the Least Tern - The least tern is not known to nest on the Kansas River historically, although historic records exist of nesting terns on some of the larger tributaries in the western part of the basin. The first records of nesting least terns on the main stem Kansas River occurred in 1996 near Wabaunsee. Their occurrence is believed to be due to available suitable habitat resulting from floods in 1993 and 1995, and because other habitats were unavailable during nest initiation due to prolonged flooding on the Missouri, Platte, and lower Mississippi Rivers. Nesting terns have returned every year since.

Because the number of nesting least terns on the Kansas River is small, determinating of the potential importance of the river to the interior least tern is difficult. At times, the river does provide suitable nesting habitat for the tern. River operations, however, may limit the overall reproductive success of the birds depending on flood control constraints and water supply obligations. Further research is needed to better evaluate potential management opportunities to operate the river to improve conditions for the least tern while meeting other project purposes.

Piping Plover

Historic and Current Distribution in the Action Area - Though not cited specifically in their journals, members of the Lewis & Clark Expedition undoubtedly saw piping plovers on the Missouri River. The first scientific exploration of the Missouri, the Lewis & Clark Expedition passed up the river in 1804 and 1805 and journeyed back down the river in 1806 on their return to St. Louis. On September 21, 1804 the Expedition reached the Big Bend of the Missouri (now beneath the waters of Lake Sharpe) in present day central South Dakota. On that date William Clark wrote, "… we observed an immense number of Plover of Different kind Collecting and taking their flight Southerly…" (Moulton 1987). Historically, on the Missouri River piping plovers have been recorded nesting as far south as Plattsmouth, NE (RM 595) (Heinemann 1944). The westernmost record of piping plovers nesting on the Missouri has been Fort Peck Lake in eastern Montana (RM 1776)(USFWS 1988). Much of the riverine sandbar habitat used by the piping plovers was eliminated in the 1950s and 1960s. Over 620 mi (997 km) of the river were inundated following the construction of Garrison Dam in North Dakota and Oahe, Big Bend, Fort Randall, and Gavins Point Dams in South Dakota. The channelization of the Missouri from Sioux City, IA, to Plattsmouth, NE, removed an additional 55 mi (88 km) of plover habitat. The current distribution of piping plovers on Missouri and Kansas River Segments follows.

Fort Peck Lake, Segment 1, RM 1882.7 - 1771.5: This reach defines the western edge of piping plover habitat and traditionally contains few piping plovers. An average of fifteen plovers are seen during the adult census or 3.1 percent of the Missouri River System total. Populations of plovers on the lake are typically inversely proportional to amount of habitat available on the rest of system. Plovers have been found primarily along Bear Creek Bay and the Dry Arm of the lake. The plovers arrive at the lake in early May with the majority of nests initiated in the middle of the month.

Fort Peck Dam to Lake Sakakawea Headwaters near Williston, ND, Segment 2, RM 1771.5 - 1568.0: Since censussing began in 1988, very few piping plovers have been found on this reach, averaging just 12 plovers per year or 2.3 percent of the Missouri River System total. In contrast to the plovers farther west on Fort Peck Lake, most of the piping plover nests on the river are not initiated until late May and early June. Plovers using this reach are often found near the confluence of the Milk River and near the mouth of the Yellowstone River.

Lake Sakakawea and Lake Audubon, Segment 3, RM 1568.0 - 1389.9: These two reservoirs represent the first significant areas for piping plovers on the Missouri River System. The average adult census for piping plovers over the last twelve years has been 79 birds or 16.2 percent of the System total, the third highest of the Missouri River segments supporting plovers. While piping plovers are widely distributed over much of the reservoir, important nesting areas on Lake Sakakawea include Steinke Bay, Douglas Creek Bay, the Van Hook Arm, Little Egypt, and Tobacco Garden Bay. Piping plover nest initiation is similar to that observed on the adjacent prairie couteau wetlands with the birds initiating nests in early to mid-May.

Garrison Dam to Lake Oahe Headwaters near Bismarck, ND, Segment 4, RM 1389.9 - 1304.0: This reach is second only to the reach below Gavins Point Dam in adult census numbers. The reach averages 116 plovers yearly. This is 26.1 percent of the System total for piping plovers. In contrast to early arriving plovers on Lake Sakakawea, the majority of plover nest initiations on the Garrison River Reach do not occur until the first three weeks in June.

Lake Oahe, Segment 5, RM 1304.0 - 1072.3: The lake is host to large numbers of piping plovers with an average of 71 adult plovers (15.8 percent of the system total) counted annually. The plovers begin arriving as early as late April, with the majority of nest initiations during the last three weeks in May. Important nesting sites for the plovers include the upper part of the lake from RM 1295.0 to 1299.0, Dredge Island at RM 1270, Swiftbird Bay, Kenel Flats, Little Bend and the Cheyenne River Arm.

Oahe Dam to Fort Randall Dam (Lake Sharpe and Lake Francis Case), Segments 6 and 7, RM 1072.3 - 880.0: Only a few records of piping plover use along the 192 miles of the Missouri inundated by these dams have been recorded since dam closure.

Fort Randall Dam to Niobrara River, Segment 8, RM 880.0 - 845.0: Traditionally this reach has seen few plovers, however in the late 1990s significant numbers of plovers have been found on sandbars at RM 866 and RM 851. Annually, an average of 13 adult plovers are found on the reach during the adult census. This represents 2.9 percent of the Missouri River System total. The majority of the plover nests are initiated during the first two weeks in June.

Niobrara River to Headwaters of Lewis and Clark Lake, part of Segment 9, RM 845.0 - 828.0: The yearly average for the adult census on this reach is 29 piping plovers or 6.4 percent of the system total. The plovers arrive on the lake in mid-May with the majority of the nest initiations occurring during the last 2 weeks of the month. The plovers concentrate in the upper reach of Lewis & Clark Lake with the majority on sites located three miles above and below Chief Standing Bear Bridge (RM 841.0).

Gavins Point Dam to Ponca, NE, Segment 10, RM 811.1 - 753.0: Annually, an average of 121 adult plovers are found on the reach during the adult census. This is the highest of any reach and represents 27.2 percent of plover total on the system. Piping plovers begin arriving on the reach as early as the last week in April. The highest number of nest initiations occurs during the last 2 weeks in May.

Ponca State Park, NE, to St. Louis, MO, Segments 11, 12, 13, 14, and 15, RM 753.0 - 0.0: In the 1980s piping plovers were recorded as nesting on power plant ash ponds near the Missouri River in Woodbury and Pottawattamie Counties, Iowa (USFWS 1988).

Kansas River, Segment 16, RM 170 - 0.0: No historic records exist of piping plovers nesting on the Kansas River, nor anywhere else in the state. The species was first observed nesting on the river in 1996 at about RM 131. Individual pairs have continued nesting each year in the middle river, RM 105 to 140, nearly always in association with or very near an active least tern colony. An adult pair was observed in July 2000 at RM 66 (D. Mulhern, FWS, pers. comm.). These birds were not behaving territorially, nor were they accompanied by young, so it is unknown whether they attempted to breed in this area of the river in which they were observed.

Population Status and Trends in the Action Area - Since being listed as threatened in 1985, annual adult censuses for piping plovers have been conducted on the Missouri River (Table 10, Figure 11). It should be noted that the Missouri below Fort Peck Dam and Lake Sakakawea were not censussed in 1986 and 1987.

Piping plover populations on the System showed a general upward trend from 1986 through 1991, with a peak of 623 adult plovers in 1991. This was followed by a downward trend of adult piping plovers on the Missouri during most of the 1990s. From a high of 623 adult birds in 1991 the low point was reached in 1997 when only 117 adults were counted The precipitous decline in plover numbers in 1996 and 1997 can be attributed to a lack of habitat caused by high runoff on the Missouri in those years. By contrast, piping plover numbers and fledge ratios rebounded in 1998 and 1999 following a return to normal runoff and the availability of extensive habitat created by the high flows in 1996 and 1997.

Distribution and Abundance of Habitat in the Action Area - Piping plovers and least terns are sympatric nesters on the Missouri and Kansas Rivers. Habitat distribution and use are similar. See Distribution and Abundance of Habitat in the Action Area under Least Terns.

Table 10. Piping Plover Adult Census and Fledging Data by Missouri River Segment, 1986-1999.

	Adult Plovers	Percent System Total	Yearly Adult Avg.	Fledged Plovers	Percent Fledged Total	Yearly Fledge Average
Fort Peck Lake* (Segment 1)	178	3.1	14.8	106	5.4	8.8
Fort Peck River** (Segment 2)	135	2.3	12.3	60	3.1	5.5
Lake Sakakawea** (Segment 3)	942	16.2	85.6	290	14.9	26.4
Garrison River (Segment 4)	1516	26.1	116.6	581	29.8	44.7
Lake Oahe (Segment 5)	920	15.8	70.8	188	9.6	14.5
Fort Randall River (Segment 8)	169	2.9	13.0	60	3.1	4.6
Lewis and Clark Lake (Segment 9)	374	6.4	28.8	154	7.9	11.8
Gavins Point River (Segment 10)	1578	27.2	121.4	510	26.2	39.2
River Reaches	3398	58.5	261.4	1211	62.1	93.2
Reservoir Reaches	2414	41.5	185.7	738	37.9	56.2
Total	5812	100	447.1	1949	100	149.9

* No data collected in 1986
** No data collected in 1986 & 1987

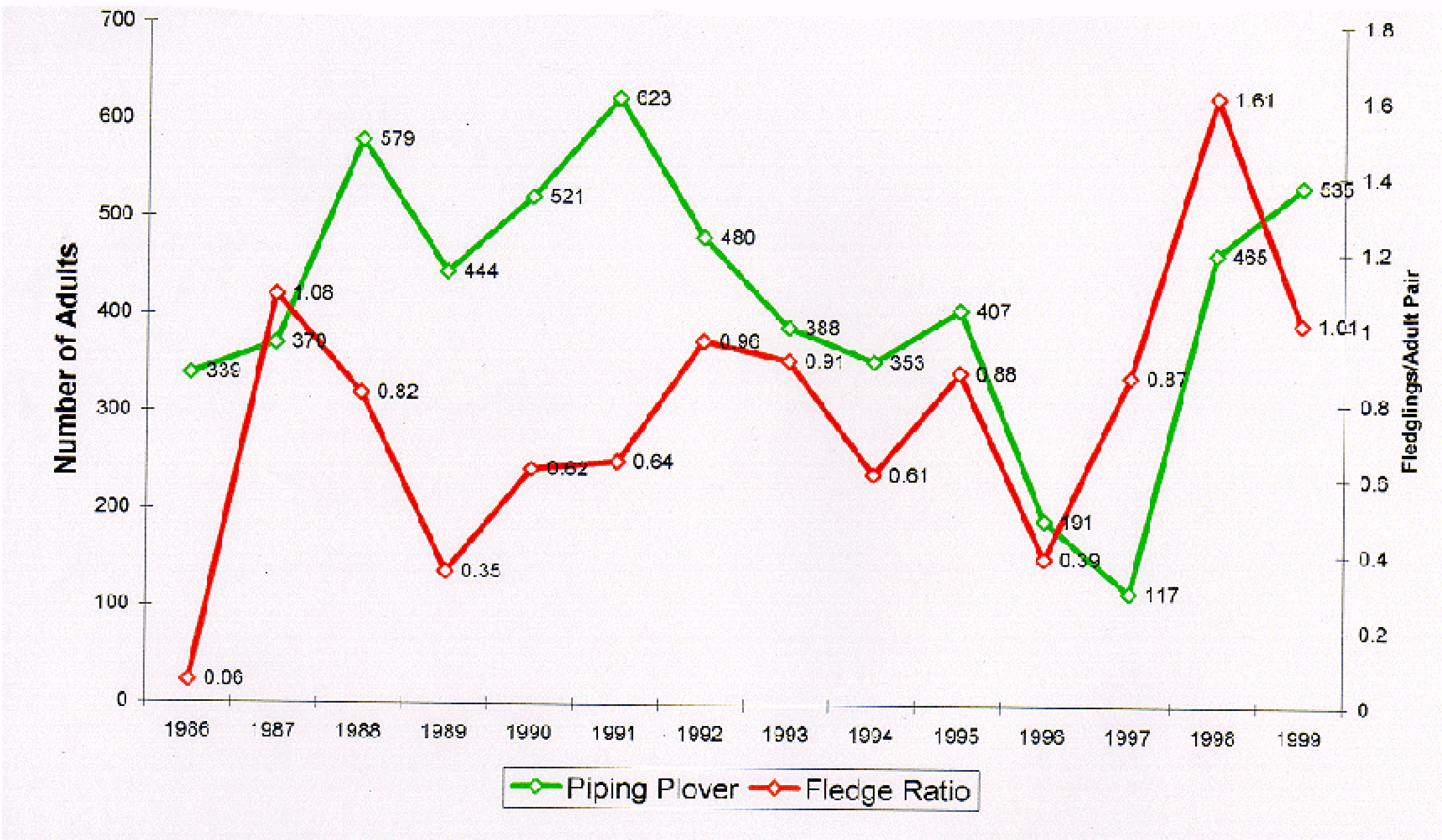

Figure 11. Piping plover adult census and fledge ratios 1986 to 1999.

Productivity and Recovery Objective in the Action Area - The Service published the *Great Lakes and Northern Great Plains Recovery Plan* in 1988 (USFWS 1988). That plan includes recovery goals for the piping plover by state and includes goals for the Missouri River. In 1994, the Service released a revised plan as a technical/agency review draft. The 1994 plan revised the recovery objective from 1,300 breeding pairs in the 1988 plan to 2,300 breeding pairs. The revised recovery objective was increased based on (1) distribution and abundance data collected from 1988 to 91; (2) knowledge of how thoroughly each state had been previously surveyed; (3) historic population data; (4) assessment of the potential to increase breeding pairs at unoccupied sites; and (5) results of population viability analysis for the recovery of the Northern Great Plains population (Ryan et al. 1993). More recently, the Service decided that recovery of the two populations addressed in the recovery plan would benefit from separate recovery plans that would direct separate recovery programs. Separate revised recovery plans for the Great Lakes and Northern Great Plains populations are presently under development.

Although the 1994 draft plan was never finalized, the Service will base recovery objectives for this opinion on numbers from the 1994 plan as it incorporates the most recent population information and trend data available. The Northern Great Plains Piping Plover Recovery Plan (USFWS 1988) states that recovery of the plover will be substantially affected by the ability to protect essential habitat, including the Missouri River, and to intensively manage that habitat to maximize productivity and survival. For the plover to be considered for delisting, populations in the U.S. Northern Great Plains will have attained a level of 2,300 pairs (4,600 individuals) in the following distribution for 15 years:

- Montana - 300 pairs
- North Dakota - 750 pairs
  - Missouri River - 150 pairs
  - Missouri Coteau - 600 pairs
- South Dakota - 400 pairs (300 pairs shared with NE on MR below Gavins Point)
  - Other Missouri River Sites - 75 pairs
  - Other sites - 25 pairs
- Nebraska - 525 pairs (including 300 pairs on Missouri River shared with SD)
  - Platte River - 150 pairs
  - Niobrara River - 50 pairs
  - Missouri River - 300 pairs
  - Loup River System - 25 pairs
- Minnesota - 25 pairs (Lake of the Woods)
- Iowa - 5 pairs
- Colorado - 20 pairs
- Other Northern Great Plains Sites, including Kansas River - 575 pairs

Two range wide population surveys have been conducted for the piping plover, the 1991 (Haig 1992) and 1996 International Piping Plover Censuses (Plissner and Haig 1997). These surveys were completed to help determine the species distribution and to monitor progress toward recovery. From 1991 to 1996, Northern Great Plains piping plover numbers declined by 5 percent. On the Missouri River, piping plovers were down 72 percent between census years. However, 1996 and 1997 were record high water years on the Missouri River and plover populations dipped to their lowest recorded to date, 191 and 117 respectively. Those record flows (1995 to 1997) affected river morphology that created an abundance of habitat complexes in the succeeding normal flow period. By 1998, with a return to normal flows and with an abundance of habitat, the declining trend (4 out of the previous 5 years) was reversed and plover numbers began recovering. The 268 pairs of piping plovers on the System in 1999 represent a population only 50 percent of the recovery goal.

The reproductive success of piping plovers or the productivity of the species is usually reported by fledge ratios (number of flighted chicks per breeding pair). In the Northern Great Plains from 1980 to 1985, reproductive success was studied by Wiens and Cuthbert (1984), Whyte (1985), Wiens (1986), Haig (1987), and Prindiville-Gaines, and Ryan (1988). From those study data, Prindiville-Gaines and Ryan (1988) calculated the mean annual fledging ratio for piping plovers in the Northern Great Plains to be 1.12 chicks/pair. Prindiville-Gaines and Ryan (1988) went on to estimate that an annual fledging rate of between 1.15 and 1.44 chicks/pair is necessary to maintain a stable population in the Northern Great Plains. The Service's 1990 biological opinion (USFWS 1990b) on the Corps' annual operations called for the maintenance of a 1.44 fledge ratio. Ryan et al. (1993) constructed a stochastic population growth model to predict changes in the Northern Great Plains piping plover population. Based on that modeling effort it was found that substantial increases in reproductive success or survival would be necessary to stabilize the Northern Great Plains population. Holding adult and immature survival rates constant at a mean annual reproductive rate of 1.13 chicks/pair was necessary to stabilize the population. Annual population increases of 1 percent and 2 percent requires 1.16 to 1.19 chicks/pair respectively. Ryan et al. (1993) also found that all available evidence points to a substantial decline in the Northern Great Plains piping plover population and emphasized the importance of applying management techniques such as predator control and river operations to increase reproductive rates.

Further population viability modeling was conducted by Plissner and Haig (2000) using a metapopulation viability analysis package, VORTEX. Plissner and Haig (2000) found a mean productivity level of 2.0 fledglings/pair was required to maintain the current population size with a significant probability of persisting for the next 100 years.

Population modeling by Melvin and Gibbs (1994) with Atlantic Coast population data, estimated 1.24 chicks/pair was needed to maintain a stationary population and that extinction probabilities were very sensitive to changes in productivity.

All the modeling efforts above were sensitive to changes in survival rates. Long term declines in survival rates could occur due to continuing declines in availability or quality of breeding, wintering or migration habitat; increased human disturbance and predation on wintering and breeding sites and/or reduced longevity or fitness due to unforseen genetic factors.

Productivity estimates for plovers on the Missouri River from 1986 to 2000 ranged from a low of 0.09 chicks/pair in 1986 to a high of 1.61 chicks/pair in 1998. Three years of record flows (1995 to 1997) on the Missouri River affected river morphology such that in the succeeding normal flow period an abundance of habitat complexes were created on the river. These complexes provided the necessary conditions that resulted in the highest fledge ratios to date; 1.61 chicks/pair in 1998 and 1.58 chicks/pair in 2000. These fledge ratios are either recognized as sufficient to meet population stability (Ryan et. al. 1993, Melvin and Gibbs 1994, and Prindiville-Gaines and Ryan 1988) or are just shy of that mark (Haig and Plissner 2000). The average productivity for plovers on the Missouri River from 1986 to 1999 is 0.735 fledged chicks/pair which is far below that which has been estimated to provide population stability.

Importance of the Missouri River to the Piping Plover - During the 1991 and 1996 International Piping Plover Census, the number of adult plovers nesting on the Missouri River accounted for approximately 31 percent and 12 percent respectively, of the Northern Great Plains population. Nesting has been documented on the Missouri River main stem from Valley County, Montana, to Dixon County, Nebraska. Most nesting occurs along the flowing reaches between Garrison Dam and Lake Oahe in North Dakota (26.1 percent) and between Gavins Point Dam and Ponca, NE (27.2 percent). Plovers also nest along beach shorelines of the reservoirs when habitat is available. The Missouri River is extremely important for providing nesting habitats during droughts when most of the ephemeral alkali wetland nesting habitats in the prairie pothole region are dry. The importance of the Missouri River to piping plovers as a migratory corridor is unknown. Plovers have been seen staging on the river in the fall and large flocks of plovers have been seen at tributary deltas during spring migration

Importance of the Kansas River to the Piping Plover - The first known breeding record for the piping plover on the Kansas River occurred in 1996 when two pairs of plovers nested on sandbar habitat. This habitat was on a new channel created by the high water in 1993. Success of piping plovers since the initial 1996 nesting has been tenuous. Because much of the flow in the Kansas River has been controlled since the 1950s, sandbar habitat is usually not available for the plovers. The importance of the Kansas River to piping plovers is virtually unknown.

Pallid Sturgeon

Historic and Current Distribution in the Action Area - Today, pallid sturgeon only are occasionally found in a few selected areas. Since 1980, reports of most frequent occurrence are from the Missouri River: (1) between the Marias River and Ft. Peck Reservoir in Montana; (2) between Ft. Peck Dam and Lake Sakakawea (near Williston, North Dakota); (3) within the lower 70 mi (113 km) of the Yellowstone River downstream of Fallon, Montana; (4) in the headwaters of Lake Sharpe in South Dakota; and (5) near the mouth of the Platte River near Plattsmouth, Nebraska; and (6) from the lower

Missouri River below rivermile 218 in the state of Missouri. Of 872 pallid sturgeon rangewide records prior to 1998, 70 percent were reported from the Missouri River, 9 percent from the Yellowstone River, and less than 2 percent from the St. Francis, Platte, Ohio, Kansas, and Big Sunflower Rivers (Steve Krentz, pers. comm. 2000). Approximately 10 percent of the Missouri River records were from below Gavins Pont Dam; the majority of records were from intensive sampling efforts in Montana, North and South Dakota, and include recaptures.

Early life stages of sturgeon rarely have been collected historically from within the range of the pallid sturgeon. Since 1990, only three occurrences of pallid sturgeon larvae or young-of-the-year have been documented. In 1998, one young-of-the-year pallid sturgeon was captured in the Mississippi River by personnel from the Long Term Resource Monitoring Station near Cape Girardeau, MO (Mike Peterson, MDC, pers. comm. 1999). During the summer of 1998 and 1999, several larval pallid sturgeon, were captured in the lower Missouri River below a restored side-channel area near Columbia, MO (Jim Milligan, USFWS, pers. comm. 1999). The low incidence of larval sturgeon is likely due to low reproductive success of sturgeon or the inability of standard sampling gear to capture young sturgeon. Hesse and Mestl (1993b) collected two sturgeon larvae from the Missouri River adjacent to Nebraska between 1983 and 1991. These larvae were among 147,000 fish larvae collected during filtration of 18,340,014 ft^3 (519,400 cu m) of river water. Gardner and Stewart (1987) collected no sturgeon larvae in 339 samples from the Missouri River or in 77 samples from tributary streams where 3,124 and 5,526 fish larvae were collected, respectively. Since 1994, additional work by Gardner (1995b) has found young of the year and juvenile sturgeon. Liebelt (1998) has also documented sturgeon reproduction in the Yellowstone drainage in eastern Montana. Liebelt (MTFWP, pers. comm.) sampled over 120 young-of the year shovelnose sturgeon in the Missouri River below the Yellowstone River during the fall of 1999. Although the larval and juvenile sturgeon that were sampled were ultimately identified as the shovelnose species, sampling efficiency for larval and juvenile sturgeon has improved.

Population Status and Trends in the Action Area - Duffy et al. (1996) reported that tag and recapture data has allowed researchers to estimate that approximately 50 to 100 pallid sturgeon remain in the Missouri River above Fort Peck Dam in Montana and between 200 and 300 pallid sturgeon remain between Garrison Dam in North Dakota and Fort Peck Dam which also includes the lower Yellowstone River. One to five sightings per year have been made on pallid sturgeon between the headwaters of Oahe Reservoir in North Dakota to the Garrison Dam and from the riverine reach in the Missouri River above Gavins Point Dam to the Fort Randall Dam, suggesting that, perhaps, as many as 25 to 50 fish remain in each of these areas. A small population also exists between Oahe Dam and the Big Bend Dam on the Missouri River in South Dakota with perhaps 50 to 100 fish remaining in the upper few miles of riverine section above the headwaters of Lake Sharpe.

Very little is known about the current status of the pallid sturgeon population of the Missouri River below Gavins Point Dam. Capture/recapture data is non existent and based on frequency of reports, rough estimates of one to five pallid sturgeon per kilometer of river in the channelized lower Missouri

River provide an estimate of between 1,303 to 6,516 pallid sturgeon in this river section (Duffy et al, 1996). Those estimates are considered subjective due to the lack of mark/recapture data.

In response to obvious declines in pallid sturgeon numbers and the notable lack of recruitment, MDC began an augmentation effort by releasing fingerlings raised at Blind Pony State Fish Hatchery. Approximately 7,000 fingerlings were released in the Missouri and Mississippi Rivers in 1994 and an additional 3,000 fingerlings were released in 1997 (Graham 1997, 1999). Since the release, approximately 127 tagged pallid sturgeon have been reported (Graham, pers. comm. 2000). Most of these fish are being reported below St. Louis likely due to higher numbers of commercial fisherman in the Mississippi River (Graham 1999).

Eleven experimental stockings and population augmentation efforts within the six separate recovery priority management areas (USFWS 1993a) have occurred over the last 7 years (Table 11). These efforts have temporarily boosted total population numbers. The effects of mortality and subsequent rates of survival are currently unknown.

Field surveys of *Scaphirhynchus* stocks suggest a relatively high incidence of hybridization between shovelnose sturgeon and pallid sturgeon in the middle Mississippi River (Sheehan 1997a, 1997b, 1998). Sheehan et al. (1997b) and Carlson and Pflieger (1981) noted a 3:2 ratio of hybrid sturgeon to pallid sturgeon. Sheehan et al. (1997b) speculated that if this is representative of the sturgeon populations in the middle Mississippi River, hybridization may pose a significant threat to pallid sturgeon as the species continues to introgress with shovelnose sturgeon.

Table 11. Pallid sturgeon stockings from 1994 to 2000.

Recovery Priority Areas	Year	River	Number Stocked
4 & 5	1994	Missouri and Mississippi Rivers	7,000
4 & 5	1997	Missouri and Mississippi Rivers	3,000
4	1997	Platte River	412
6	1998	Atchafalya River	35
2	1998	Missouri and Yellowstone Rivers	750
4	1998	Platte River	84
1	1998	Missouri River	750
4	1999	Platte River	15

2	2000	Missouri/Yellowstone Rivers	200
2	2000	Missouri/Yellowstone Rivers	480
3	2000	Missouri River	400
		TOTAL	13,126

Refer to the Effects Section for abundance of shallow water habitat within the channelized section of the Missouri River.

Distribution and Abundance of Habitat in the Action Area - The distribution, abundance and quality of habitat have been severely altered throughout the action area. As mentioned in the Range Wide Distribution and Abundance of Habitat Section for the pallid sturgeon, suitable habitat for the pallid sturgeon has been inundated by reservoirs, modified by dam operations and the amount of riverine habitat has been reduced through stabilization of the bankline and reduction of the top width. The remaining fragments of riverine habitats within the Missouri River Basin are:

Missouri River above Fort Peck Lake (outside action area)
Segment 2 - Fort Peck Dam to Lake Sakakawea Headwaters (includes Yellowstone River)
Segment 4 - Garrison Dam to Lake Oahe Headwaters
Segment 8 - Fort Randall Dam to Niobrara River
Segments 10 - 15 - Gavins Point Dam to mouth of the Missouri River
Segment 16 - Kansas River

Productivity and Recovery Objective in the Action Area -The short-term recovery objective for the pallid sturgeon is to prevent species extinction with the use of artificial propagation and population augmentation. The long-term objective is to downlist and delist the species through protection, habitat restoration, and propagation activities by the year 2040. Downlisting and delisting will be initiated when pallid sturgeon are reproducing naturally, juveniles are recruiting into the population, and populations are self-sustaining within designated river reaches. Under the current preliminary criteria, downlisting may be considered when (1) a population structure with at least 10 percent sexually mature females occurring within each recovery-priority management area has been achieved, and when (2) sufficient population numbers are present to maintain stability. Those criteria will be further quantified as additional information becomes available and may be modified or expanded in the future.

Recovery objectives, as described in the Recovery Plan for the pallid sturgeon, will not be achieved without restoring the ecosystem functions of the Missouri and Mississippi Rivers associated with the natural hydrograph and temperature regime, sediment (suspended and bedload) transport, and energy cycling. The Missouri River and it's tributaries that are used by pallid sturgeon represent 66 percent 2,317 mi (3732 km) of the total range of the pallid sturgeon (Keenlyne 1989). More than half of the 2,317 mi (3,732 km) has been impounded by 6 hydroelectric dams and most of the remaining habitat is affected by cold water releases from the reservoirs or the habitat has been severely modified by BSNP training structures. The Missouri River downstream of Gavins Point is the longest unfragmented segment of the Missouri River, however it is also the most severely modified by BSNP training structures.

Importance of the Missouri River to the Pallid Sturgeon - The Pallid Sturgeon Recovery Plan (USFWS 1993) has identified four recovery priority management areas on the Missouri River for priority implementation of recovery actions. Those river reaches exhibit remnant elements of what is believed to be suitable pallid sturgeon physical habitat, provided that the hydrology and chemical elements of the aquatic ecosystem, such as temperature and turbidity, are restored. The recovery priority areas are listed as follows from the headwaters to the Mississippi River; (1) from the mouth of the Marias River to the headwaters of Ft. Peck Reservoir, (2) from Ft. Peck Dam to the headwaters of Lake Sakakawea, including the Yellowstone River (Segment 2), (3) from 20 mi (32 km) upstream of the mouth of the Niobrara River to the headwaters of Lewis and Clark Lake (portions of Segment 9), and (4) from Gavins Point Dam to the Mississippi River (Segments 10-15). Recovery priority management areas 2, 3, and 4 are most affected by main stem dams.

The length of the Missouri River affected by the 6 main stem dams (Fort Peck Reservoir and downstream) represents more than one-half of the existing range of the pallid sturgeon. To date, 75 percent of pallid sturgeon observations recorded in the pallid sturgeon catch record database maintained by the Service have come from the Missouri River (S. Krentz, pers. comm. 2000).

The incidence of hybridization also is lower on the Missouri River than on the Mississippi River, and increases in frequency from the headwaters to the mouth (Carlson et al. 1985, Keenlyne et al. 1994).

Importance of the Kansas River to the Pallid Sturgeon - Historic catch records for pallid sturgeon are scarce for the Kansas River. Since 1950s, only five documented pallid sturgeon have been sampled from the lower 40 mi (65 km) of the Kansas River, all during late March and early April in 1952. Little sampling for pallid sturgeon has occurred on the Kansas River.

In general, pallid sturgeon researchers assume at this time that tributaries are used primarily for foraging and/or spawning. Pallid sturgeon use of tributaries such as the Kansas, Platte, and Niobrara Rivers needs to be better evaluated to identify their role in pallid sturgeon recovery. They are undoubtedly important to the ecosystem, but the full extent of pallid sturgeon use of those habitats is unclear.

Pallid sturgeon inhabit the main stem Missouri River, and have entered the lower Kansas River during floods, with the furthest upstream records from Douglas County (Cross and Collins 1995). It is highly unlikely that this species currently occurs in the Kansas River due to habitat modifications and physical barriers (e.g., Johnson County Wier), except under conditions of high flows.

FACTORS AFFECTING THE SPECIES WITHIN THE ACTION AREA

This analysis describes factors affecting the environment of the listed species in the action area. In addition to the effects from factors associated with the past operations and maintenance of the Missouri and Kansas River projects, the environmental baseline includes unrelated Federal actions that have completed formal or informal consultation, as well as Federal actions within the action area that may benefit listed species. The baseline also includes non-Federal (i.e., State, Tribal, local, and private) actions already affecting the species or that will occur contemporaneously with this consultation.

The Service is not aware of any proposed Federal projects in the action area that have undergone formal or early Section 7 consultation (50 CFR 402.11) on the tern, plover, pallid sturgeon, and/or bald eagle whose hydrologic effects are not already incorporated into the baseline.
Formal consultations addressing the impacts of water development projects on terns, plovers, pallid sturgeon, and whooping cranes have been abundant in the Platte River basin in Nebraska, Colorado, and Wyoming. Since July 1, 1997, biological opinions have been completed on 14 projects with water depletions greater than 25 acre-feet in the Platte River basin. In addition, a programmatic intra-Service section 7 consultation was completed by the Service to consider water depletions of 25 acre-feet or less on the Platte River. This biological opinion assumed jeopardy from 25 acre-feet or less depletions on least terns, piping plovers, and whooping cranes in the central Platte River, and the pallid sturgeon in the lower Platte River. A reasonable and prudent alternative to offset impacts was provided in the programmatic opinion. Additional projects may be evaluated in the future under this programmatic biological opinion but any cumulative impacts should be offset by implementation of the reasonable and prudent alternative.

Within the action area, a number of Federal, State, and private actions have various effects on the Missouri River ecosystem and the listed species considered in this opinion. To the best of the Service's knowledge, the Federal projects have undergone informal consultation with the Service on potential effects on listed species. The negative effects are limited in scope; however, several habitat restoration initiatives are underway in the lower channelized river in Nebraska, Iowa, Kansas, and Missouri, that will cumulatively provide short-term and long-term benefits to certain components of the Missouri River ecosystem.

Unrelated Federal Projects

Recent Flood Initiatives - A major impetus for new river and floodplain initiatives was a major flood of record that occurred throughout major portions of the middle and lower Missouri River basin during the summer of 1993. The extent of flooding in 1993 (stage and duration) in the main stem Missouri River and it major tributaries above Kansas City, Missouri, was one of the largest on record; below Kansas City new flow and stage records were set.

In 1993, in the reach of the Missouri River downstream of Rulo, Nebraska (Segments 13, 14 and 15), the flood created numerous scour lakes, blue holes, and temporary and seasonal wetlands on the floodplain, widened the channel in some locations, breached or overtopped almost 1,000 levees, and deposited large amounts of sand on agricultural lands. About 1,170 ac (473 ha) of connected scour lakes and wetlands, and 2,052 ac (831 ha) of unconnected scour lakes and wetlands resulted from the flood in the lower 492 mi (791 km) of the river. The size of those areas range from 5 to 116 ac (2-47 ha) with some of the scour lakes having depths up to 60 ft (18 m).

Many of these scour lakes remain connected to flows in the main stem river, and have significantly increased the amount of quiet, off-channel aquatic habitat for river fishes. Limited sampling of the connected scour lakes has detected use by sauger, shovelnose sturgeon, paddlefish, flathead catfish, and other native river fishes (J. Robinson, MDC, pers. comm., as cited in USFWS 1994). Near Brownville, Nebraska, preliminary seining data in the main channel suggests an increase in the relative abundance of plains minnows, speckled chubs, flathead chubs, silver chubs, and sturgeon chubs (L. Hesse, pers. comm., as cited in USFWS 1994), native cyprinids with declining populations (Hesse et al. 1993).

In Missouri, the Service and MDC are working with the Corps and Natural Resources Conservation Service (NRCS) to retain connected scour lakes during levee reconstruction and repairs to bank stabilization and navigation training structures (blown-out revetments and wing dikes). Notched revetments and wing dikes and ring levees are being used to prolong the availability of the newly created floodplain habitats. However, the Corps expects that over time these habitats will accrete sediment and slowly lose their aquatic and wetland habitat values.

Emergency Wetland Reserve Program and Wetland Reserve Program - The Service and States of Missouri, Kansas, Nebraska, and Iowa also are working with Natural Resources Conservation Service (NRCS) and the Agricultural Stabilization and Conservation Service to protect flood-created habitats and floodplain wetlands through the Emergency Wetland Reserve Program (EWRP) and the Wetland Reserve Program (WRP) which provide a one-time payment to landowners for a perpetual easement on these areas. As of 1994, about 13,503 ac (5,468 ha) of floodplain lands in Missouri, Kansas, Iowa, and Nebraska have been determined eligible for the EWRP and WRP programs. Roughly 83 percent of these lands are in the State of Missouri and 15 percent in Iowa (USFWS 1994).

Most of the EWRP lands are concentrated in three contiguous tracts in central Missouri. Those areas (i.e., Jameson Island/Lisbon Bottoms, Cambridge Bend Levee and Drainage District, and Diana Bend) total roughly 7,000 ac (2,835 ha) of floodplain lands. The remainder of the EWRP lands in Missouri and other lower river States occur in small, isolated tracts which may or not be landward of a levee, pending final levee repairs by the NRCS, Corps, and private landowners. Two of the three large EWRP tracts have been acquired by the Service and MDC. Those tracts will be managed as riverine/floodplain areas open to the river (i.e., breached levees will not be repaired).

Federal Levee Projects - A number of Federal levee projects are under construction or development. They include the Missouri River Levee Unit L_385 project in Riverside, MO; the Kansas City, Missouri and Kansas City, Kansas Flood Protection Project; the Missouri River Levee Unit L_142, across from Jefferson City, MO; and the Monarch-Chesterfield Levee Upgrade just west of St. Louis. Although most of those projects are designed to provide 500-year flood protection to urban areas, several levee units are designed to protect what is now largely agricultural land. The proposed L_142 levee is designed to protect against a 1,100-year flood. The Corps based that level of protection on the historic trend of rising river stages (up to 5 ft [1.5 m]) for a given discharge. They attributed much of that trend to sediment deposition on berms, channel cut-offs, and levee construction (USACE 1999c). The effects of levee building are many. Not only do levees reduce connectivity between the river and floodplain (e.g., reduce riverine recharge and fisheries access to floodplain wetlands and other habitats, reduce nutrient and organic material exchange, etc.), but they also lead to additional levee projects to address higher river stages, and induce development in the adjacent floodplain. Levees and floodplain encroachment also reduce the Corps' flexibility to operate the river for flood control and limit habitat restoration opportunities to compensate for past and ongoing project-related effects to both Federally listed species and native river species of special concern.

Through Public Law 84-99, the Corps is also involved in repairing eligible Federal and non-Federal levees (most prevalent below Gavins Point Dam). That law authorizes emergency funds to be spent to prepare for, or repair and restore, any flood control work threatened or destroyed by flood, including strengthening or other modification necessary for adequate flood control (USACE 1995b). After the 1993 and 1995 floods on the Missouri River, the Corps repaired hundreds of levees, many of which had been previously repaired repeatedly. Repair of those levees result in effects similar to Federal levees. Although non-Federal levees generally provide lower flood protection (and thus are often over-topped at higher river stages), cumulatively they effect a far greater portion of the floodplain.

Federal Emergency Management Agency - On the Missouri River floodplain in Missouri, 47 communities decided to relocate off the floodplain under the Federal Emergency Management Agency's (FEMA) floodplain buy-out program. After residents are relocated, floodplain structures were demolished, and purchased lands dedicated to open-space uses such as parks and agricultural lands. Because of those land use restrictions and the limited amount of open space gained, this program will have limited benefit in addressing floodplain ecosystem needs such as restoration of bottomland forests and forested and emergent wetlands. To the degree that the absence of homes, businesses, and other improved property in the floodplain reduces the need for substantial levee protection, then some river ecosystem benefits may result. Nonetheless, the Corps' proposed L_142 levee project in central Missouri will go through a portion of the Cedar City buy-out area. The proposed mitigation would not compensate lost flood storage because of the alignment. That project may establish a disturbing precedent, bringing to question the permanence of FEMA's control over buy-out areas and the value of the program in encouraging floodplain-compatible land use.

Refuge Land Acquisition and Management - The Floods of 1993 and 1995 caused extensive damage on the lower Missouri River, but also provided the opportunity to purchase tracts with high potential habitat value. Consequently, the Service initiated an acquisition program to purchase flood-damaged lands from willing sellers. The purpose of the Service's acquisition program is to restore fish and wildlife habitat, restore natural flood plain functions, and where compatible, provide increased public access to the river and riverine habitat. The Service currently has the authority to use Land and Water Conservation Funds and emergency appropriations related to the flood to pursue acquisition in Missouri. Funds are leveraged when possible by acquisition of lands enrolled in the Wetland Reserve or Emergency Wetland Reserve Program. High priority areas have been identified from Plattsmouth, Nebraska, to St. Louis, Missouri.

<u>Big Muddy National Fish and Wildlife Refuge:</u> The Big Muddy National Fish and Wildlife Refuge is authorized to acquire up to 60,000 ac (24,300 ha) of the Missouri River flood plain between Kansas City and St. Louis. To date, the Service has acquired 5,833 ac (2,362 ha) in six units and manages an additional 1,301 ac (527 ha) of Corps mitigation lands. Acquisition of additional refuge lands is contingent on adequate funding and willing sellers, and may take 20 to 50 years to complete. The Service has already begun habitat restoration (reforestation through plant succession and planting, chutes, wet prairies, etc.). Adjacent to Jameson Island in central Missouri, the Service and the Corps have modified channel training structures to increase shallow-water and sandbar habitat. The Corps and the Service are also working to maintain a navigation grade control structure at a chute created at Lisbon Bottoms during the 1993 and 1995 floods. The Corps has modified repairs to a revetment to allow continued flow through the chute. Habitat improvements have already shown positive biologic results as documented in the fish use of those areas. A wide variety of fish species, including several of special concern and the pallid sturgeon, have been documented in and around those habitats. Taking full advantage of the restoration opportunities of the Refuge is expected to take many years. The long-term benefits of those areas should be evaluated to better refine potential restoration work.

<u>Desoto National Wildlife Refuge:</u> In the channelized lower river, the Service also owns another 8,000 acres of refuge lands adjacent to the Missouri River main channel. Practically all of these lands occur within the Desoto NWR near RM 643. The principal feature of Desoto NWR is a large oxbow lake that was formed when the Corps cut off a large river meander for the bank stabilization and navigation channel in the early 1960s. The refuge is isolated from the main channel because of a levee, bed degradation, and an electric fish barrier that prevents interchange of river fish with the cut-off lake. The Desoto NWR represents an opportunity to reconnect the river to its floodplain and substantially increase off-channel habitat in the Sioux City-Omaha reach of the channelized river. No plans have been developed to implement that idea, therefore, there is no assurance that these benefits could be attained in the near future.

Desoto NWR also manages the nearby Boyer Chute NWR near Blair, NE. The refuge is a joint Federal and local conservation partnership to restore a portion of Missouri River habitat that flows through the 2.5-mi (4 km) chute paralleling the river. Currently, the refuge covers approximately 2,000 ac (810 ha).

Karl Mundt National Wildlife Refuge: Although a portion of the wintering bald eagle flock roosted in woodlands managed by the Corps, the main roosting areas were on private lands below Fort Randall Dam. To preserve this national treasure, a project was launched by the 7-Eleven Food Stores Division of the Southland Corporation and the National Wildlife Federation. Receipts generated by the sale of endangered species drinking cups were set aside in the "Save A Living Thing" Project Corporation which raised $250,000 which was transferred to the National Wildlife Federation. With these funds, the Federation purchased 780 ac (316 ha) of river bottom and obtained a perpetual easement which guaranteed the preservation of an additional 300 ac (122 ha) of important woodlands. Administration of the land was turned over to the Service on December 19, 1974. The new refuge was named after the late Karl E. Mundt, a South Dakota Senator who was a strong supporter of the ESA of 1966. The refuge contains one of the last stretches of truly natural Missouri River bottomland. A wide variety of wildlife use this unique habitat. Operations of the Missouri River over the years have led to the decline of the cottonwood riparian forest along the bank in this segment and many others. Flood control operations have prevented periodic overbanking flooding necessary for the regeneration and maintenance of cottonwoods. Consequently, loss of trees to bank erosion is no longer compensated by regeneration. Cottonwoods are planted periodically by the Service to provide future cottonwood forest.

Audubon National Wildlife Refuge: This refuge is superimposed on Lake Audubon, an isolated eastern arm of Lake Sakakawea in central North Dakota. Under agreement with the Corps, the Service administers a portion of the reservoir area as a wildlife project. Lake Audubon is maintained primarily by water from Lake Sakakawea. Sparsely vegetated island beaches on the 14,738-ac (5,968 ha) refuge, alkali wetlands, waterfowl production areas, wildlife development areas and nearby private lands have been popular nesting areas for the threatened piping plover. Refuge personnel monitor the nests and place wire cages over them, to protect the chicks from predators. More than 100 islands provide safe nesting habitat for many waterfowl species. The refuge and WPAs/WDAs are frequent stop-over points for migrating whooping cranes, and one of the ten bald eagle nests in North Dakota is just a few miles away below Garrison Dam.

Charles M. Russell National Wildlife Refuge: The 1.1 million-acre (445,500 ha) refuge is recognized for encompassing the Fort Peck Reservoir, but also adjoins 25 to 30 mi (40-48 km) of free-flowing and meandering Missouri River. This reach of the river is still subject to spring flooding and silt deposition, and is probably one of the few remaining portion of the upper Missouri River with naturally reproducing cottonwood riparian habitat. This reach is not grazed, hayed, or farmed and continues to function as it did thousands of years ago. Scenic vistas like those viewed by Lewis and Clark remain. The transition from the cottonwood and willow seedlings on the muddy banks, through poles and saplings, to the gallery forests reveals an abundance of wildlife, including most of the species seen by Lewis and Clark. Pallid sturgeon and paddlefish still swim in the murky waters, while extirpated from most of their previous range. This wild, scenic, and free-flowing section of the Missouri River is a natural treasure and glimpse of our past.

Sand and Gravel Dredging - In 1996, the Service completed informal consultation with the KCD of the Corps on the effects of reissuing commercial sand and gravel dredging permits in the main stem river between Rulo, NE, and St. Louis, MO. As a result of the consultation, permit conditions restrict dredging operations to defined river reaches within the rectified channel lines to avoid impacts to dike fields, tributary confluences, backwaters, point bars and other shallow water spawning and nursery areas important to pallid sturgeon and other river fishes. The Corps provided the Service with annual dredging data between 1974 and 1998 (Ken Starck, KCD, pers. comm.). Record keeping was not mandatory until 1991, so early numbers are exceedingly conservative/incomplete. In addition, they do not include material dredged for federal projects (i.e., flood control levees and bridge work). Nonetheless, those data indicate that the amount of sand dredged annually has steadily increased from approximately 1.7 metric tons in the late 1970s, to 3.0 metric tons in the early 1990s, to 6.6 metric tons in 1998.

Unfortunately, there has been no monitoring of the dredged reaches to evaluate whether permit conditions are sufficient to avoid adverse direct or indirect impacts to shallow water habitats landward of the rectified channel line. Such impacts could degrade potential off-channel pallid sturgeon habitat. In addition, there has been concern regarding the long-term effects of dredging on bed elevations in the lower river. The1993 flood deposited large amounts of sand, presumably from floodplain scour and levee breaching, but perhaps also from transport of river bedload onto the floodplain. Prior to the flood, commercial dredging in the Kansas City area had caused localized bed degradation and anecdotal information suggested the same could be happening in the lower river near St. Louis. The middle Mississippi River below St. Louis has already undergone significant bed degradation.

Given the known impacts to upper river tailwater reaches and the Sioux City-Omaha reach of the channelized river from bed degradation, similar impacts could be occurring to wetlands, oxbow lakes, side channels, sloughs, and plant succession (cottonwood forest regeneration), in portions of the lower river if dredging is removing sand faster than it is being replenished. Although the KCD has been monitoring the amount of material removed and the amount of bedload transported annually by the Kansas River, those results may have limited applicability to the Missouri River which is entirely stabilized, thus having a limited source of bedload material.

Since the initiation of the Farm Bill in 1985, the control of sediment and erosion across the land has become a priority for land managing agencies like the U.S. Department of Agriculture (USDA). Through the implementation of the Sodbuster portions and Conservation Reserve Programs of the Farm Bill and Best Management Practices, these and other USDA programs have helped control sediment runoff across the land and thus sediment input into the Missouri River is unknown. However, the North-Central Resource Conservation and Development Association (1997) reported that 11.6 million tons of sediment per year flow from the Cheyenne River into the Missouri River. During a USDA sediment control program at Foster Creek, a tributary to the Cheyenne River, the restored tributary showed a 174-fold reduction in sediment loading (North-Central Resource Conservation and Development Association 1997) indicating these programs are having some impact.

Federal Highway Administration Bridge Projects - The Service is aware of four new bridges which will span the lower Missouri River in Iowa/Nebraska and Missouri. The respective Departments of Transportation have begun planning and environmental compliance work for the U.S. Highway 34 Bridge at Plattsmouth, NE (RM 591); US Highway 59 at Atchison, KS; Missouri State Highway 13 Bridge at Lexington, MO (RM 317); U.S. Highway 65 Bridge at Waverly, MO (RM 299);and Missouri Highway 19 Bridge at Hermann (RM 98). The Missouri Department of Transportation is also in the very preliminary stages of evaluating potential alignments for an expansion/addition to Interstate Highway 70 across Missouri. Regardless of the final route chosen, construction will likely involve an additional crossing of the Missouri River. In South Dakota, planning is underway for replacement of the Highway 81 bridge across the Missouri River at Yankton. In Kansas, three highway projects to replace or expand existing bridges over the Kansas River are currently under consideration; the Kansas Highway 4 (Oakland Expressway) at Topeka; and US Highway 75, also at Topeka; and the Kansas Highway 32 in Kansas City, KS.

The Service does not expect construction of these projects to cause direct adverse effects to the bald eagle. Bridge construction and removal, however, could potentially affect both the pallid sturgeon and its habitat. Dredging and or blasting to construct or remove bridge pilings can affect fish within the immediate project areas, as well as alter water quality (i.e., suspended sediments) and bottom conditions (i.e., depths and substrate). Indirect effects of the bridge include altered hydrographic conditions adjacent and downstream of the structure, and, oftentimes, constrictions of the river "floodway," further reducing the Corps flexibility to operate the river. In addition, placement of the bridge and approach rights-of-way and stabilization of the riverbank for some distance up and downstream of the bridge limit opportunities for restoring river top width and shallow water habitat. Fill needed for bridge embankments may destroy wetlands or interfere with river flow patterns during high flows. Depending on design criteria, levees parallel to the riverbank may be used to protect the approach embankments, and would isolate the river from the floodplain. Cumulatively, these projects would affect a small percentage of the total floodplain and channel area of the Missouri River.

Any federally authorized/financed bridge projects that may effect the species must undergo separate ESA consultation at which time their effects will be considered. The Service has completed section 7 consultation with the Nebraska Department of Roads and the South Dakota Department of Highways regarding the impacts of two new bridges over the Missouri River at Vermillion and Springfield, South Dakota. The bridge at Springfield is completed and construction on the Vermillion bridge is underway.

Corps of Engineers Section 1135 Projects - Section 1135 of the Water Resources Development Act of 1986 authorized the Corps to modify existing projects to improve fish and wildlife habitat. Such projects require a non-Federal cost-share. The Boyer Chute restoration project is the only completed section 1135 project adjacent to the river. The Omaha District of the Corps, in cooperation with the Papio-Missouri River Natural Resources District, Service and Nebraska Game and Parks Commission, completed restoration of Boyer Chute (RM 633-638) in the spring of 1993 (Harberg et al. 1993). The project re-opened a 7-mile long historic chute of the Missouri River that had lost most of its habitat value due to a closing structure at its upstream end and a road with a culvert at the midpoint of the chute.

The goal of the project was to recreate the depths and velocities (shallow water and lower velocities) that most frequently occurred in the pre-development Missouri River channel, and to allow erosion and deposition processes to further enhance the chute habitat. Initial monitoring efforts indicate that those goals have been met. The relative abundance and species composition of the chute fish community has changed and now favors native species normally dependent on braided channel habitats. Use of the chute by native river species such as the shovelnose sturgeon, sauger, plains minnow (*Chybognathus placitus*), silver chub (*Macrhybopsis storeriana*), and burbot (*Lota lota*) increased post-construction (Hesse 1994).

Several more riverine and wetlands restoration projects that could be funded through section 1135 are either in the initial planning stages or under development.

Recreational Rivers and National Wild and Scenic Rivers Act - The Upper Missouri River from Fort Benton downriver to the Fred Robinson Bridge (U.S. Highway 191) was designated as a “wild and scenic river” component of the National Wild and Scenic River System in October 1976. This 149-mi (240 km) segment of the Missouri River upstream of Charles M. Russell National Wildlife Refuge is the only major portion of the Missouri to be protected and preserved in its natural, free-flowing state. This reach is administered by the Bureau of Land Management. It is also the premier segment of the Lewis and Clark National Historic Trail.

Two segments of the Missouri River have been designated as “recreational rivers” in the National Wild and Scenic Rivers System. A 39-mi (63 km) portion of the Missouri River between Fort Randall Dam and the headwaters of Lewis and Clark Lake (Segment 9) was designated in 1991 (PL 102-50). A General Management Plan (GMP) for the reach was prepared by the National Park Service (NPS) (the agency with administrative authority over the reach) in July 1997. This GMP emphasizes management for conserving, protecting, and restoring riverine biological diversity on public land and neither encourages nor discourages increased visitor use nor additional or expanded agricultural practices. It strongly discourages construction of residences or other private development.

A 59-mi (95 km) portion of the Missouri River between Gavins Point Dam and Ponca, Nebraska (Segment 10) was designated in 1978 (PL 95-625). While the National Park Service is the overall administrating agency for this reach as well, the legislation also provided a significant management role for the Corps of Engineers. The Corps is to “...provide for the construction...of recreational river features and streambank stabilization structures as the Secretary of the Army...deems necessary.” Construction is to be conditioned upon the availability of “...such land and interests in land...to carry out such construction...and to protect and enhance the river in accordance with this Act.” Clarification of the Corps’ management responsibilities was written into a Cooperative Agreement between the Department of the Army and the Department of Interior, signed in 1980.

In 1999, the Corps and the NPS jointly finalized an updated version of the GMP for the Missouri National Recreational River (MNRR). A final record of decision on the GMP was made May 8, 2000. The GMP provides for the maintenance and restoration of biologic values within the reach and will protect and enhance the values for which the river was designated. The NPS and the Corps will manage the MNRR through a cooperative agreement with the NPS generally administering land-related resources and the Corps generally managing water-related resources. Limited developments such as boat and canoe accesses and trails are allowed and site specific environmental compliance would be done when and if construction occurs.

Bank stabilization is authorized by the enabling legislation and will be undertaken as needed so long as all actions are in conformance with appropriate and required environmental compliance laws, and a Federal interest is established and funds allocated for such construction. The Corps has prepared a habitat erosion protection analysis which addresses erosion of forested habitat within the MNRR (USACE 2000a). Based on the review of forest losses, erosion rates, and habitat within the MNRR, the Corps is recommending construction of bank stabilization to protect forested habitat at five sites within the MNRR. Without bank protection the five sites combined may lose 3,595 habitat units due to erosion over the next 25 years based on Habitat Evaluation Procedure analyses conducted by the Corps. Those sites include RM 779.5 R (Point on North Alabama Bend), RM 779 L (North Alabama Bend), RM 773.5 R (Vermillion Reach), RM787.5 L (Myron Grove GPA), and RM781 L (Clay County Park).

Title VI Projects - Cheyenne River Sioux Tribe, Lower Brule Sioux Tribe, and State of South Dakota Terrestrial Wildlife Habitat Restoration (Public Law 105-277, October 21, 1998) and the Water Resources Development Act (WRDA) (Public Law 106-53, August 17, 1999) - Title VI and WRDA will transfer much of the Corps' land and recreation areas in South Dakota to the State and the Bureau of Indian Affairs (for the Cheyenne River and Lower Brule Sioux Tribes). The Corps is preparing the NEPA documentation for those land transfers. In accordance with the ESA, the Service is in informal section 7 consultation with the Corps on those land transfers.

State of South Dakota Recreation Sites Lease Proposal - The Corps is reviewing a proposal by the State of South Dakota to lease 23 recreation sites along the Missouri River. That lease request also included plans for recreational facility enhancement and expansion. The Corps is preparing NEPA documentation and is in informal consultation under section 7 of the ESA with the Service. The Service has notified the Corps that expanded recreational facilities may exacerbate human disturbance of nesting Missouri River least terns and piping plovers.

Corps of Engineers Pierre/Fort Pierre Sedimentation Study - Under Section 441 of the Water Resources Act of 1996 "Oahe Dam, Lake Sharpe, South Dakota," the Corps is investigating potential solutions to recurring flooding and related problems in the vicinity of Pierre and Ft. Pierre, SD, caused by sedimentation in Lake Sharpe. The potential solutions investigated are lowering the lake level, sediment bypass/removal, and sediment agitation to allow resuspension and movement of sediment.

The Corps is also investigating development of a comprehensive solution that includes consideration of structural and nonstructural measures upstream from the lake consisting of land treatment, sediment retention structures, and other such measures as the Corps determines appropriate.

Corps of Engineers Pierre/Fort Pierre Relocation Effort - The Corps is moving forward with a buy-out plan for homes located in the Pierre/Fort Pierre area floodplain of the Missouri River. No agreements have been made on the rate of the lands abandoned by homeowners.

Section 32/33 Bank Stabilization Program - The Corps has constructed a number of streambank erosion control or bank stabilization projects along the Fort Peck, Garrison, Fort Randall, and Gavins Point reaches of the Missouri River since the 1960s. These measures have been authorized by several means including Section 14 of the Flood Control Act of 1946, Section 32 of the Water Resources Development Act (WRDA) of 1974, Public Law 93-251, and Section 33 of the Water Resource Development Act of 1988. Additional stabilization measures have also been installed by landowners, developers, and other local interests.

Construction of extensive stream bank protection projects were authorized and completed under Section 32 of the Water Resources Development Act of 1974, as amended by Section 161 of the Water Resources Development Act of 1976. This construction was a demonstration program to evaluate stream bank stabilization methods. Construction work occurred at nine locations on the Missouri National Recreational River (Segment 10) where bank loss was taking place at a rate of several acres annually. This work was intended to protect about 25 mi (40 km) of bank length, or 21 percent of the total bank length within the Missouri National Recreational River (Segment 10)(Corps 1991). Since completion of these structures, yearly maintenance checks are done and required repairs are made to maintain the original project purpose. On the reach below Ft. Randall Dam (Segments 8 and 9), two Section 32 bank stabilization projects have been completed. Seventeen Section 32 bank stabilization projects were constructed in North Dakota (Reach segments 3 and 4). We are not aware on any additional Section 32 projects on the Missouri River.

Bank stabilization activities and sloughing easements on the upper Missouri River were also authorized by Section 33 of the Water Resources Development Act (WRDA) of 1988 (Public Law 100-676), which modified Section 9 of the Flood Control Act of 1944 (Public Law 534, 78th Congress). Section 9 was further modified by WRDA of 1990 (Public Law 101-640), Title I, Section 102 (u). This legislation, as modified, states:

> Section 9 of the Flood Control Act of 1944, entitled "An Act authorizing the construction of certain public works on rivers and harbors for flood control, and for other purposes" approved December 22, 1944 (58 Stat 891), is amended by adding at the end thereof the following new subsection:
>
> (f) The Secretary of the Army is directed to undertake such measures, including maintenance

and rehabilitation of existing structures, acquisition of real property and associated improvements from willing sellers, and monetary compensation to affected landowners which the Secretary determines are needed to alleviate bank erosion and related problems associated with reservoir releases along the Missouri River between Fort Peck Dam, Montana, and a point 58 mi (93 km) downstream of Gavins Point Dam, South Dakota and Nebraska. The cost of these measures may not exceed $3,000,000 per fiscal year. Not withstanding other provision of the law, the costs of these measures, including the costs of necessary real estate interests and structural features, shall be appointed among project purposes as a joint-use operation and maintenance expense. In lieu of structural measures, the Secretary may acquire interests in the affected areas, as the Secretary deems appropriate, from willing sellers."

Section 33 funds have been used to purchase five sloughing easements covering 297 ac (120 ha) adjacent to the upper Missouri River below Garrison, Fort Randall, and Gavins Point Dams. The sloughing easement estate provides the Government the right to allow the bank to erode or slough to the ultimate erosion line, as determined by the Corps. The landowner retains use of the area; however, alterations of the easement area require written approval of the Corps. Land having a sloughing easement will not be considered for any Government streambank erosion prevention program. Permission for landowner bank stabilization at a later date may or may not be granted. The Corps must consider the cost of bank stabilization as compared to the erosion control benefits it provides. In most instances, acquisition of sloughing easements is the most cost effective method available.

In 1996, the Corps constructed two non-traditional bank stabilization projects on the upper Missouri River under Section 33 of the Water Resource Development Act of 1988. The projects, which combine vegetative techniques and hardened components, are located 10 mi (16 km) southwest of Wolf Point, Montana, and approximately 20 mi (32 km) upstream of Williston, North Dakota. The purpose of these projects was to identify and demonstrate alternative methods to the traditional riprap methods that are commonly used along the Missouri River.

Other bank stabilization has occurred over the years through Section 14 of the Flood Control Act of 1946, which authorized the Corps to construct streambank stabilization to prevent damage to highways, bridges, roads, and other nonprofit public facilities in imminent danger of failure.

Seven streambank stabilization projects between Garrison Dam and Lake Oahe were constructed under Public Law 88-253 as amended by the Flood Control Act of 1968. Two erosion control projects were separately authorized by Congress. One project was constructed at Wolf Point, Montana, in conjunction with the Bureau of Indian Affairs under Section 2 of Public Law 92-222. The second project was in Gregory County, South Dakota, on the Karl Mundt National Wildlife Refuge.

A total of 36 Section 32 projects, some consisting of multiple structures, have been constructed by the Corps on the upper Missouri River (USACE 1993). In 1991, the Corps (1991) estimated that approximately 32 mi (51 km) or 27 percent of the Gavins Point reach (Segment 10) has been stabilized. This includes 25 mi (40 km) of stabilization measures constructed by the Corps and 7 mi (11 km) of private stabilization. Existing Federal bank stabilization projects below Fort Randall Dam (Segment 8) include 7 sites, totaling 7 linear mi (11 km); another 2 mi (3 km) of erosion control measures have been constructed by individual landowners and local interests. The Corps estimates that approximately 15 percent of the Fort Randall reach has been stabilized. Seventeen stabilization projects using a variety of techniques have been designed and installed by the Corps in North Dakota (Segments 3 and 4). These projects, totaling about 32.3 mi (52 km), were constructed during the 17 year period from 1965 to 1981. The Corps' North Dakota Regulatory Office has authorized an additional 8.3 mi (13 km) of stabilization measures by individual, nationwide, or emergency general permits. By comparison to the other reaches, a relatively small amount of stabilization has occurred on the Fort Peck reach (Segment 2). The Corps estimated that 1.6 mi (2.6 km) or less than 1 percent of this reach was stabilized. These estimates have likely increased and are currently being measured by the Corps' Waterways Experiment Station as part of the Programmatic Environmental Impact Statement to evaluate the cumulative effects of bank stabilization activities along the upper Missouri River. In part, this study will "determine the existing condition of the river channel, project future conditions, and determine the impacts that additional stabilization might have on alluvial processes and channel form" (taken from USACE 2000a).

Section 10/404 Permit Program - The Corps administers Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act permit programs on the Missouri and Kansas Rivers. These permit programs regulate the placement of fill material and construction activities in aquatic resources and navigable waters of the United States. Construction activities regulated by the permit programs include: irrigation, municipal, rural, and industrial water intakes; residential, marina, and recreational developments; storm water and waste water treatment facility outlets; cable, pipeline, and transmission line crossings; bridges; piers; docks; navigational aids; platforms; sand and gravel operations, and bank stabilization projects.

In the lower Missouri River, permits for private bank stabilization projects account for a small percentage of the Section 404 permits because most stabilization is conducted through the BSNP. Sand and gravel dredging, ditch repair and clean out, private levee construction, and boat docks and ramps account for a large portion of the permitted activities. Although numerous wetland permits for development activities are associated with urban sprawl, most of those sites are located in areas that are, or will soon be protected by Federal levees. A notable exception is dredging and fill to accommodate casino "boats" along the Missouri River. Along the Garrison reach of the upper Missouri River, commonly authorized activities include boat docks, boat ramps, irrigation intakes for residential and agricultural uses, and bank stabilization projects for individual home sites, residential areas, and recreational facilities.

In November 1998, the Corps announced plans to prepare a Programmatic Environmental Impact Statement (PEIS) to evaluate the cumulative effects of past, present, and reasonably foreseeable future bank stabilization activities. The PEIS will evaluate the free-flowing reaches of the upper Missouri

River, including the Fort Peck, Garrison, Fort Randall, and Gavins Point reaches (Segments 2, 4, 8, and 10). A scoping meeting was held in February 1999 and the Corps' Waterways Experiment Station has initiated efforts to collect hydrogeomorphic data along the upper Missouri River. Progress on the PEIS in FY-00 has been limited due to Corps funding constraints.

Impacts of Contemporaneous Non-Federal Actions

Tribal Water Rights and Natural Resource Management - In United States v. Winters, 207 U.S. 564 (1908), the United States Supreme Court recognized the doctrine of reserved water rights, which assures that Native American lands (and other public lands set aside by the government for a particular purpose) will receive sufficient water to fulfill the purposes of the reservation. Most water rights in the western United States (which includes all Missouri River Basin states, except Minnesota, Iowa and Missouri) have priority based on when water was first put to a beneficial use such as agriculture. However, Federal reserved water rights for Native American reservations and other federally-reserved lands have priorities dating back to at least as early as when the reservations were established (and, in the case of Native American reserved water rights, possibly earlier), even if water use on the reserved lands begins at a much later date. As many as twenty-eight tribes claim water rights to the Missouri River, and in most cases these claims precede the water rights of any non-Indians. Although Congress has consented to the adjudication of Native American reserved water rights in state courts in general stream adjudications, reserved rights are not subject to state law and can be adjudicated in Federal court.

Many reservations along the Missouri River now use or have plans to use Missouri River water for drinking water and irrigation. The Fort Peck tribes have applied for a Federal appropriation for a municipal, rural, and industrial project in Montana that will extract approximately 4,000 acre-feet of water annually from the Missouri River. The Indian Nations of the Missouri River Basin have told the United States to stop using tribal land and water for hydroelectricity, navigation traffic, and irrigation unless the Tribes are adequately compensated for the use and degradation of tribal resources (Mni Sose Intertribal Water Rights Coalition, Inc. 1997). Tribal water rights will certainly need to be addressed by the Corps during the Master Manual revision process. As these tribal water right issues are resolved, the management of federally listed species may need reconsideration. Any tribal water development that requires Federal authorizations or funding may be subject to ESA section 7 compliance.

The Cheyenne River Sioux Tribe is already involved with the management of federally listed species through their involvement with monitoring terns and plovers on the Missouri and Cheyenne Rivers. The Cheyenne River Sioux Tribe and the Lower Brule Sioux Tribe have also developed terrestrial mitigation projects under Title VI - Cheyenne River Sioux Tribe, Lower Brule Sioux Tribe, and State of South Dakota Terrestrial Wildlife Habitat Restoration (Public Law 105-277, October 21, 1998) and the Water Resources Development Act (WRDA) (Public Law 106-53, August 17, 1999). The Cheyenne River Sioux and Lower Brule Sioux Tribes have designed their mitigation efforts to restore riparian, ecological and cultural significance to their land adjacent to the Missouri River. Other Missouri River Tribes (in North Dakota, South Dakota, and Nebraska) are also seeking the return of land adjacent to the Missouri River through Congress (see WRDA 2000 proposal; Section 423 of S. 2796, June 27, 2000).

The Tribes in the Missouri River Basin are involved with natural resource management and several are already involved with the management of federally listed species. Tribes have participated in both the Missouri River Basin Association and the Missouri River Natural Resource Committee and many are actively involved with the Mni Sose Coalition. The Mni Sose Intertribal Water Rights Coalition assists 2 member Tribes in the protection of their rights to the use of Missouri River water, tributaries, and groundwater located on, near, and under their respective reservations. The Coalition has launched a training effort in environmental protection directed toward tribal leaders and natural resource staff members. This training includes analysis of existing environmental laws, pending environmental legislation, and training in environmental protection strategies.

Land Acquisition - MDC has programmed at least $5 million for acquisition of Missouri River riverine and floodplain habitats created by the 1993 flood. Almost 8,000 ac (3,240 ha) could be acquired assuming land prices of $637/acre. Additional land could be obtained if these funds are leveraged with EWRP payments or supplemented by other acquisition funds earmarked for flood-damaged lands in other areas.

Roughly 75 percent of the lands acquired by MDC (6,000 ac [2,430 ha]) would be open to the river and in general, passively managed (i.e., reforestation projects would be the most intensive management practiced on these lands). The remaining lands would be managed more intensively for wetland wildlife, similar to the management provided on existing State conservation areas on the river floodplain. Pumps, water control structures, cross-dikes, and flood-protection levees could be structural features of those areas, which probably would remain isolated from the river proper except during large flood events.

The MDC currently manages about 16,000 ac (6,480 ha) of wetland wildlife areas (termed Conservation Areas) in the lower 500 mi (805 km) of the river. Most of those areas are concentrated above Jefferson City, managed intensively for wetland wildlife, and isolated from the river by levees.

Above Missouri, the Iowa Department of Natural Resources and Nebraska Game and Parks Commission manage about 20,700 ac (8,383 ha) of floodplain wildlife areas. About 70 percent of the total land area (14,312 ac [5,796 ha]) border the main river channel. Those areas contain riparian forests and emergent wetlands and may or may not be leveed. Most lands are concentrated in Iowa, especially between Sioux City and Omaha, where the State claimed ownership of former public domain river channel areas that were cut off by the BSNP or accreted to land. Management of the areas above Omaha is complicated by bed degradation which has dewatered backwater areas, oxbow lakes, and wetlands.

Floodplain Development - Much of the development of the Missouri and lower Kansas River floodplains followed completion of the BSNP and construction of the major dams along those systems. Flood protection and a reliable source of water and power stimulated agricultural, industrial, and urban development of the floodplain. For example, 85 percent of the floodplain between Sioux City and the mouth of the Missouri River was intensively cropped by the mid-1970s (Bragg and Tatschl 1977). However, agriculture is increasingly succumbing to urban sprawl. This is most common near metropolitan areas such as Kansas City and St. Louis. In many cases, development since the 1993 flood has accelerated with the promise of new or upgraded Federal levees. That development not only involves dredging the river for fill, but also includes filling floodplain wetlands, clearing floodplain forests, and further constricts the floodplain's capacity to accommodate high river discharges (i.e., major floods). Such development entails both public and private expenditures in the millions of dollars to underwrite infrastructure (e.g., shopping malls, subdivision, interstate highways, etc.) that will be at risk during major floods in the future.

During the past 10 years, urban floodplain development has steadily increased along the unchannelized, upper Missouri River as well. Riverfront development for marinas and private residences has blossomed, often accompanied by bank stabilization projects. In some cases, encroachment of low-lying developments and localized operations for flood protection has reduced the Corps' flexibility to manage the system for other authorized project purposes. The lowest elevation of buildings in a development can and has dictated specific water management operations to eliminate the threat of flooding (e.g., at Fox Island south of Bismarck, ND, in 1997).

Recreational Development - The six reservoirs of the Missouri River Main Stem Reservoir system and the reaches between and below these reservoirs provide recreational opportunities to many people in the states the river flows through as well as adjacent states. Many Federal, state, county, municipal and private recreation areas exist. The Corps operates 170 recreation areas along the Missouri River Main Stem Reservoir system (http://www.nwo.usace.army.mil/html/Lake_Proj/pklakepr.htm). Half of these recreation areas are found on Lakes Oahe (30 percent) and Sakakawea (20 percent). In South Dakota, 92 boating access sites are located on the Missouri River (K. McPhillips pers. comm. 2000). Of these access sites, 39 are Corps sites, 26 are State sites, and 17 are other including city, county and private sites. In North Dakota, 52 boating access locations are located on the Missouri River (http://www.state.nd.us/gnf.boatramps.html). In Nebraska, 9 boating access areas are located on the Missouri River (http://www.ngpc.state.ne.us/gpland/showramps.ihtml).

Under current Missouri River operations, the reservoirs provide $60.4 million in recreation benefits while the other reaches provide $24.2 million (USACE August 1998 Fact Sheet - Recreation). These recreation benefits include boating, boating-related activities, hunting, fishing, camping, swimming and other recreational pursuits which occur on more than 80,000 ac (32,400 ha) of recreational lands along nearly 6,000 mi (9.654 km) of reservoir shoreline. Recreational development along the Missouri River includes public as well as private development.

During times of limited sandbar habitat on river reaches below Garrison (Segment 4), Fort Randall (Segment 8), and Gavins Point Dams (Segment 10), conflicts may occur between nesting terns and plovers and humans using the sandbars for recreation. Eggs and nests may be inadvertently destroyed or birds and chicks harassed. Impacts can be significant to individual colonies of birds; however, with a proactive public information program and signs on sandbars to warn recreators of nesting birds, impacts can be adequately addressed.

Lewis and Clark Initiative - As the bicentennial commemoration of the Lewis and Clark Voyage of Discovery approaches, a significant increase in Missouri River tourism is expected. Many of these visitors will recreate on the river during the breeding seasons for least terns and piping plovers. An increase in human disturbance on the sandbars would be detrimental to the nesting and fledging success of both species. Also, water-based tourists will increase the risk of spreading non-native species into areas of the river that are currently void of these species. Of specific concern is the zebra mussel and the Asian carp guild. An increased outreach and education effort between the Corps, NPS., Service, and states will decrease the likelihood of the Lewis and Clark visitor impacting the habitat of threatened and endangered species.

Commercial Fish Harvest - As mentioned in the species status section for the pallid sturgeon, commercial harvest of the closely related shovelnose sturgeon occurs within the range of the pallid sturgeon. Identifying the effects of commercial harvest to both species is a priority for the pallid sturgeon recovery team. Sturgeon species, in general, are highly vulnerable to impacts from fishing mortality due to unusual combinations of morphology, habits and life history characteristics (Boreman 1997). Because pallid sturgeon have been found within commercial catches, a more detailed analysis of the effects of commercial harvest on sturgeon populations within the range of the pallid sturgeon needs to completed.

EFFECTS (DIRECT AND INDIRECT) OF THE FEDERAL ACTION

As referenced earlier, the effects of all past activities, including effects of the past operations of the Missouri and Kansas River Systems and the BSNP, current non-Federal activities, and Federal projects with completed section 7 consultations, form the environmental baseline. To this baseline, future direct and indirect impacts of the continued operations of the Missouri and Kansas River Systems and the BSNP, 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 most consultations, the Service typically evaluates projects that have not been constructed or implemented. However, in this consultation, the Service is evaluating the effects of projects that have already been implemented and, thus, effects that are already occurring. Therefore, the Service must first establish the environmental baseline using the current status and condition of the listed species and their habitats; the Service does not go back in time and set the baseline at the species' condition prior to dam construction and operation or prior to construction and implementation of the BSNP (See Section entitled Environmental Baseline Within the Action Area). The environmental conditions that would result from project implementation (i.e., continued operations) is then projected and evaluated against the projected environmental conditions that would result if operations were not continued. The difference between the those environmental conditions is the effect of continued operations of the System.

In this consultation, the effects of the action are already impacting listed species. The Service expects that the nature of those effects under future conditions with current operations will be similar to current effects, but that future conditions will reflect further degradation of the system. Over time, the effects may be much more significant, especially for a species like the pallid sturgeon with an aging population. The probability that the pallid sturgeon will go extinct increases every year without habitat improvements resulting in reproduction and recruitment of new year classes. However, due to analytical limitations, we are forced to use a more conservative or simplistic approach and accept an assumption that the environmental conditions that would result from continued operations of the system will be at the same "level" as the current environmental baseline. Therefore, the Corps' current water control plan (CWCP) and associated modeling data from the 1994 and 1998 DEISs on the Master Manual can represent the "future with the project" for Missouri River Dam Operations, but not for Kansas River Operations or the BSNP. The incremental effects cannot be isolated unless the river system is examined hypothetically without project operations. The "future without the project," or removal of operations, can be represented by a modified run-of-river scenario. Therefore, the Service and the Corps developed an environmental water plan during the Master Manual Study as a "comparative alternative" to aid the analysis during the NEPA study, as well as the section 7 analysis of the environmental baseline and the assessment of the effects of the Federal action (i.e., continued operation of the dams) on listed species. For purposes of this consultation, the "future without the project" will be referenced as FWOP. (Note: In the 1994 Draft Biological Opinion, the CWCP was identified as ABAA10 and the FWOP equated to EVQ2.)

FWOP represents a "future without the project" hydrologic condition and is characterized as one of the better environmental hydrographs that could be expected with dams and reservoirs in place, pools full at the top of the carryover multiple use zone with 57.1 MAF of system storage, present depletions in place, existing river channel morphology, no flow regulation (i.e., inflow equals outflow), evaporation, and levees and river training structures in place. It is commonly referred to as a "modified run-of-river" simulation. Continued operation of the river under the current operations criteria represents a "future with the project" environmental condition. The difference in the flow regimes between the "future with the project" condition (i.e., operations under the CWCP) and the "future without the project" condition (i.e., without operations, FWOP) represents the effects of the Federal action (i.e., continued operation of the system) on listed species and their habitats.

Likewise, to determine effects of the continued operations of the Kansas River and the BSNP, the current environmental conditions with the projects must be evaluated against the projected environmental conditions if the projects were suspended, i.e., run-of-river operations on the Kansas River tributary reservoirs and discontinuation of operation and maintenance of the river training structures associated with the BSNP.

The quality, quantity, and seasonal availability of Missouri and Kansas Rivers channel and floodplain habitats is dictated, in large part, by the rivers' channel morphology and annual flow regimes. Riverine and floodplain habitats, and human influences on those habitats, are a product of the shape, magnitude, and timing of the rivers' hydrograph within/over the active meander zone. In the Lower Missouri River, however, much of the natural meander zone has been stabilized to form the project channel.

The hydrologic and sediment transport processes that shaped the pre-development Missouri River ecosystem have been interrupted or modified by Missouri River main stem dam construction and operation, and other actions which have profoundly altered the river's channel and floodplain morphology (e.g., bank stabilization and navigation training structures, tributary channelization, levee development).

In both the impounded and channelized reaches of the Missouri River, differences in the shape and magnitude of the hydrograph, water temperatures, wetland habitat, seasonal flooding, unvegetated sandbars, native fish habitat, and off-channel and main channel shallow water area reflect the effects of the hydrograph within a highly altered river. Changes in those parameters between the current environmental baseline condition and the projected environmental condition without the projects (i.e., run-of-river flow regime and no operation and maintenance) are the principal means to determine the continuing direct and indirect effects to the Missouri and Kansas Rivers ecosystems and federally-listed species.

In general, effects of Operations of the Missouri River Main Stem System, Operations of the Kansas River System, and Operation and Maintenance of the BSNP have been addressed in a number of documents. The most prominent include the Corps' inventory for the Kansas River bank stabilization study (USACE 1980), an analysis of bank erosion in the lower Kansas River (Simons, Li & Associates 1984), Corps' Feasibility Report and EIS on fish and wildlife mitigation for the BSNP (USACE 1981b), the Service's Fish and Wildlife Coordination Act Report on the BSNP (USFWS 1980), the Corps' Draft EIS (USACE 1994b) and Preliminary Revised Draft EIS on the Master Manual (USACE 1998a), the Corps' biological assessments on the projects (USACE 1998a, 1999a), the Service's 1990 biological opinion on Missouri River Operations (USFWS 1990b), and the Service's 1994 draft biological opinion on the Master Manual (USFWS 1994).

MISSOURI RIVER SYSTEM

The effects of current Missouri River Operations (CWCP) versus FWOP are best characterized on pages 71-99 of the Service's 1994 draft biological opinion. The Service presented data from the Corps models on the various resource values. In general, habitat values projected under the "future with the project" (i.e., continued operations under the CWCP) are considerably less than the habitat values that would be expected to occur in the "future without the project," i.e., FWOP. However, the Corps' models have limitations and cannot exclude the effects of the BSNP. Thus, the FWOP alternative does not consider the interaction between a more natural hydrograph and long-term changes in the lower river without maintenance of bank stabilization and navigation structures. Therefore, if the BSNP effects could be excluded, the habitat values would likely be higher. The difference in values reflects the continued degradation of the system and adverse effect of continued operation of the system. Highlights are provided below.

Unchannelized River/Reservoir Reaches

Hydrology - In the unchannelized/reservoir sections of the river above Ponca, Nebraska, the hydrograph of FWOP somewhat mimics the natural hydrograph and, thus, is a noticeable improvement over the CWCPs in the shape and magnitude of the hydrograph in all segments. Plots of monthly median discharges below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams (Figures 12-15) indicate higher flows will occur in the spring and lower flows from July through February. Continuation of operations under the CWCP does not provide the necessary components of a more natural hydrograph such as FWOP, or under which the listed species evolved.

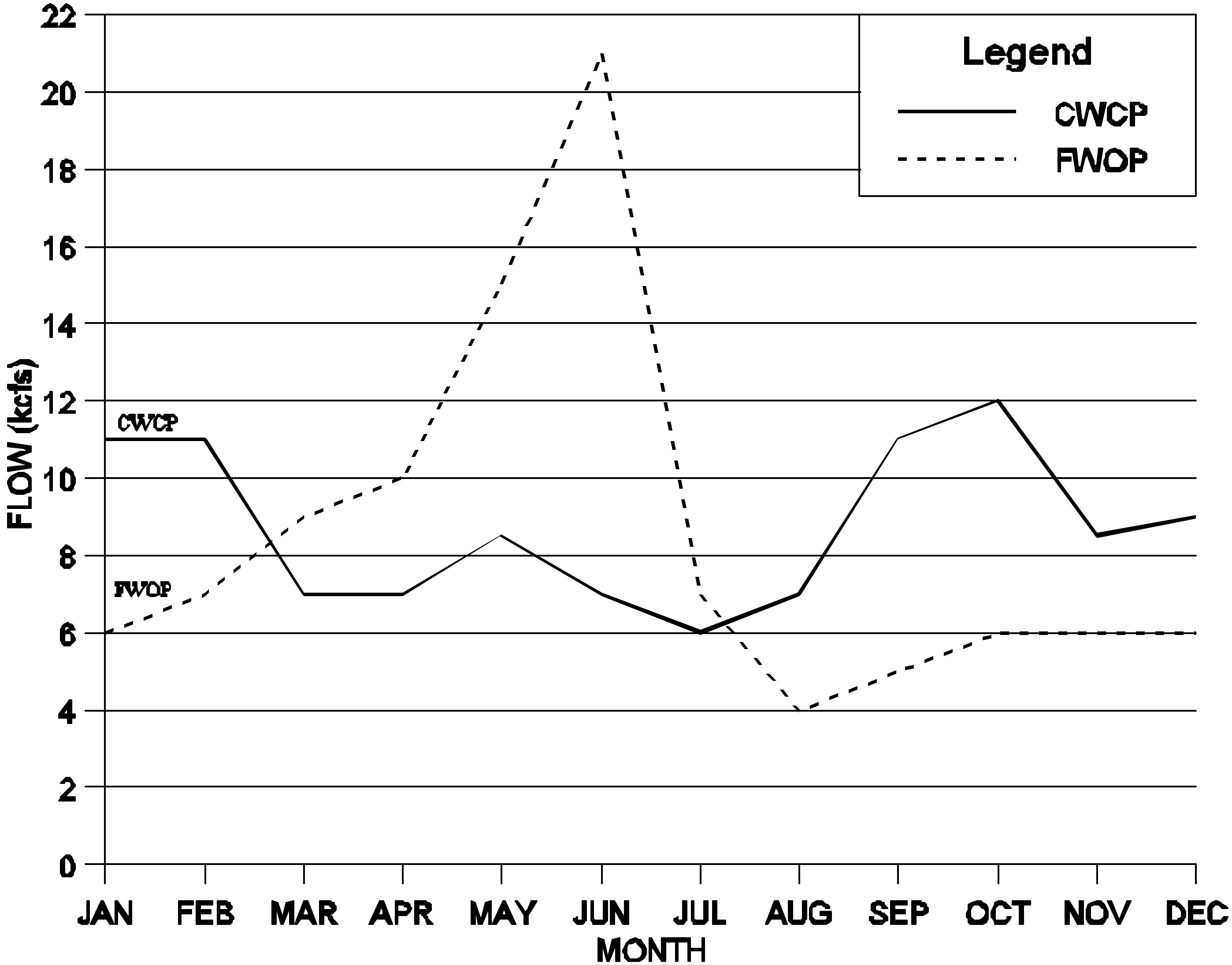

Figure 12. Simulated median monthly discharge, Fort Peck reach (1898-1993).

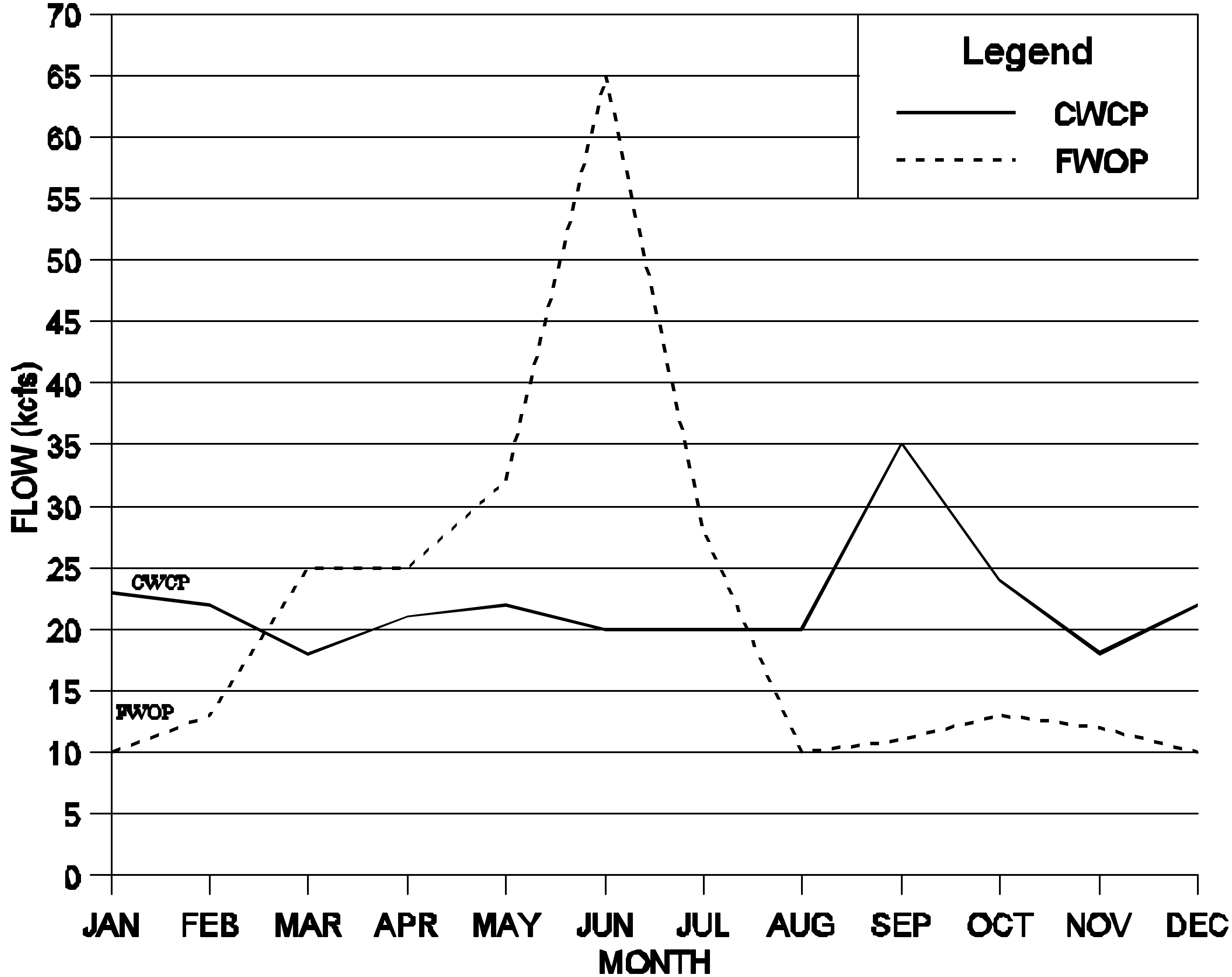

Figure 13. Simulated median monthly discharge, Garrison reach (1898-1993).

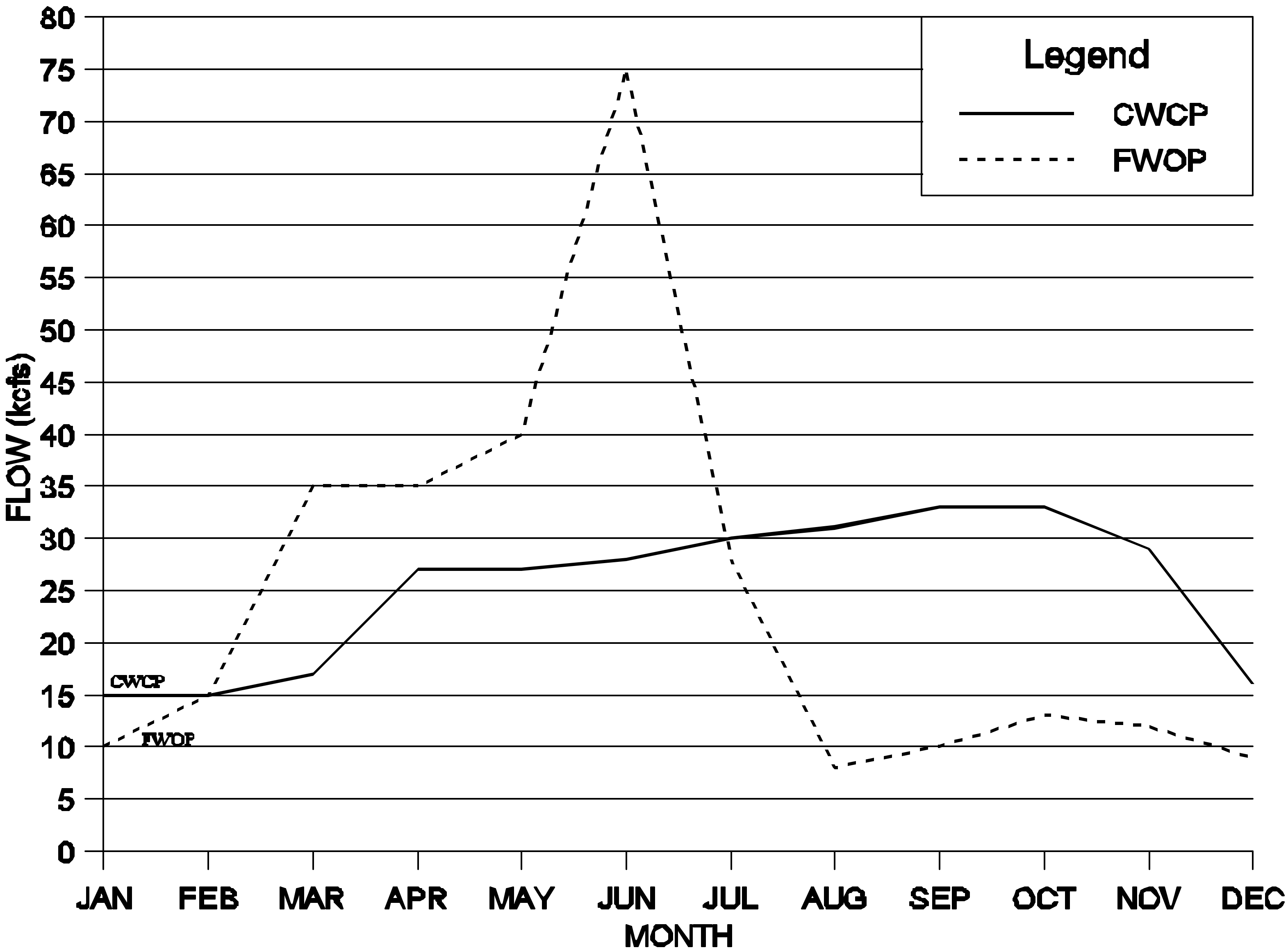

Figure 14. Simulated median monthly discharge, Fort Randall reach (1898-1993)

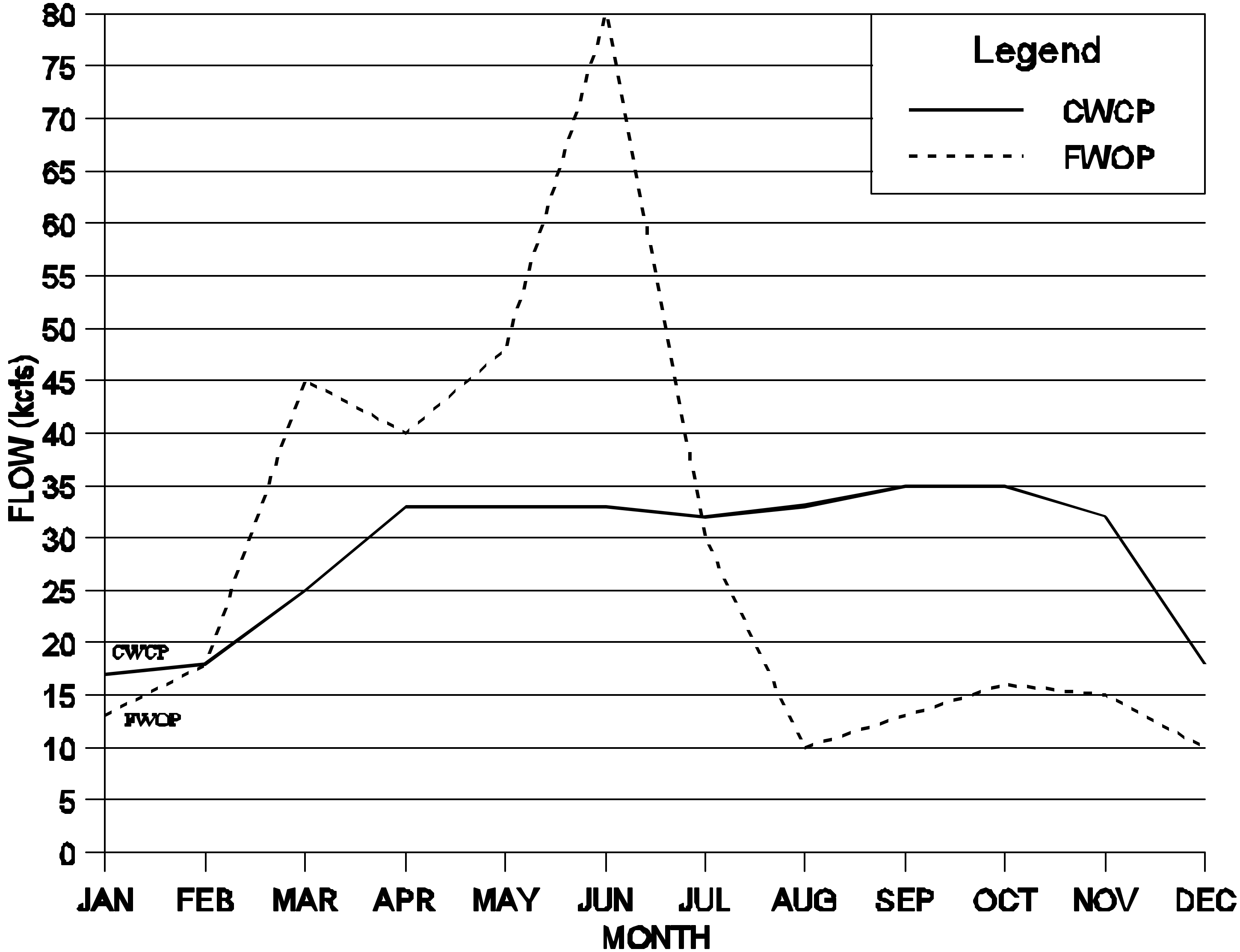

Figure 15. Simulated median monthly discharge, Gavins Point Dam - Sioux City reach (1898-1993).

Wetlands - Table 12 shows that the mean, median, and the 90 percent exceedence value (the amount of wetland habitat available 90 percent of the time) of palustrine forested, emergent, and shrub/scrub wetlands without continued operations (FWOP) ranges between 7 and 17 percent higher than acreages computed under continued operation (CWCP) for the upper river and reservoir deltas. Over 5,000 more ac (2,025 ha) of wetlands in the upper river and reservoir deltas, and an additional 32,000 ac (12,960 ha) in the lower river are estimated to be available 90 percent of the time with the "future without the project" (FWOP) than with the current condition (CWCP). This represents a significant effect on the health of the river ecosystem.

Table 12. Median, 90% exceedence and mean acres of total wetland habitat[1] (USACE, unpublished data, November 2000.

River Reach[2]	Alternative	Median (50%)	90% Exceedence	Mean
Upper River	FWOP	45,881	44,686	46,087
(Segments 2,4,8, part 9)	CWCP	43,228	39,344	44,189
Reservoir Deltas	FWOP	37,660	35,770	38,646
(Segments 3,5, part 9)	CWCP	34,199	30,509	35,060
Lower River	FWOP	95,435	93,279	95,031
(Segments 10-15)	CWCP	74,628	61,558	76,843
Total	FWOP	179,368	176,772	179,764
	CWCP	156,037	135,622	156,092

1 Sum of palustrine forested, emergent, and shrub/scrub wetlands.

2 Upper River = free flowing river reaches above Gavins Point Dam; Reservoir Deltas = deltas above Gavins Point Dam; Lower River = Free flowing reaches from Gavins Point Dam to St. Louis, MO.

Sandbar Habitat - Large expanses of shifting, open, unvegetated sandbar habitat characterized the pre-development channel of the river during the summer. This habitat was valuable not only to nesting and foraging terns and plovers but other shorebird, wading bird, and mammalian species. The amount of open, unvegetated sandbar habitat in the summer is due to high spring pulse flows and declining river stages in the summer. These processes also create mudflats and shallow water areas used as feeding and nursery areas for birds and fish.

The utility of the tern/plover nesting habitat model is limited because it only addresses scouring of vegetation on sandbars to create habitat and does not account for the creation of new sandbars by high flows such as occurred with the high flows in the mid-90s. In spite of its limitations, the bird nesting habitat model may be used to compare gross trends in suitable habitat and is the only quantitative predictive tool available. The habitat model estimates total sandbar nesting habitat (median) in the upper river for current operations (CWCP) is considerably less than FWOP, the projected future without the project (Table 13). Without operations, close to a 200 percent increase in habitat over current conditions is projected for the future environmental condition. The Service believes this increase is very conservative in light of the high elevation sandbar habitat documented by the Corps in 1998 and 1999 resulting from the high flows of 1995-97.

Table 13. Summary of interior least tern and piping plover habitat in the upper Missouri River (USACE, unpublished data, November 2000).

River Reach	Segment	Alternative	Median[1] (50%)	Percent of years With no habitat	Mean[1]
Fort Peck	2	FWOP	140.4	19	125.4
		CWCP	0.0	61	50.4
Garrison	4	FWOP	238.4	22	328.0
		CWCP	26.7	31	97.9
Fort Randall	8, 9	FWOP	26.8	28	57.1
		CWCP	4.3	46	32.7
Gavins Point	10	FWOP	0.0	54	74.2
		CWCP	18.5	28	39.5
Total		FWOP	458.6	14	584.7
		CWCP	177.7	8	220.5

[1] Acres

Spring Flood Pulse and Seasonal Flooding - The amount of floodplain seasonally inundated under differing operating regimes normally parallels the amount of wetland habitat created and maintained by river hydrology (i.e., surface flow and groundwater effects). In the upper river, most of the river is impounded and free-flowing reaches are heavily influenced by intrasystem regulation and river bed degradation.

Based on analysis of data provided by the Corps for the 1994 Draft Biological Opinion on the Master Manual, limited overbank flooding (i.e., flooding lands above the high bank) would occur in the upper basin in the future conditions with the CWCP. An inconsequential amount of floodplain (74 ac [30 ha]) would be inundated on an average annual basis in the Garrison reach; no lands would be inundated elsewhere. Data indicate the FWOP scenario would only flood an additional 362 ac (147 ha) in the upper basin compared to the CWCP. Until recently, no model was available to relate flooded areas to hydrology.

The apparent discrepancy between the predicted amount of wetland habitat and seasonal flooding probably reflects seasonal inundation of within bank riverine and reservoir wetlands, such as side channels, sloughs, timbered islands, and marshes, that still exist on the upper river. Because of current operations and the lack of overbank flooding, senescence of riparian floodplain forests will probably continue, especially in reaches with bed degradation, and little natural regeneration of early floodplain forest seral stages (e.g., cottonwood and willow) will occur. Lack of floodplain forest regeneration has long-term negative implications for bald eagles, which prefer large cottonwood trees for roosting, perching, and nesting.

Little flooding of overbank lands is projected in the unchannelized reach from Gavins Point Dam to Ponca, NE, (Table 14) under the CWCP. However, the FWOP condition is a significant improvement for listed species over the CWCP in meeting spring and early summer stage rise biological targets. Based on data provided by the Corps to support analyses for the 1994 Draft Biological Opinion, conditions conducive to spawning movements and reproduction by sturgeon, paddlefish, and other big river fish species would occur 57 percent more often during March/April, and 58 percent more often in May/June under FWOP than with CWCP.

Warm River Habitat - The productivity of the Missouri River ecosystem and reproductive success of riverine organisms depends not only on the hydrograph and appropriate habitat, but also suitable water temperatures. Even if flow regime and physical habitat requirements are met, suitable water temperatures must exist for successful fish reproduction, and production of periphyton, plankton, aquatic invertebrates, and other aquatic and wetland organisms vital to the food and energy supply of the riverine ecosystem.

Continued operation of the system under CWCP with hypolimnetic hydropower releases at Fort Peck, Garrison, and Fort Randall Dams will continue to provide unsuitable water temperatures below main stem dams that will negatively impact spawning by native river fishes and production at all trophic levels (Table 15). That will continue to limit pallid sturgeon recruitment and food supplies for bald eagles, terns, plovers, and pallid sturgeons. Current operations will not provide adequate temperatures in pallid sturgeon priority recovery reaches of the river below Fort Peck and Fort Randall Dams. More suitable water temperatures for native fish spawning and invertebrate production will continue in the free-flowing river below Gavins Point Dam.

Table 14. Comparison of percent exceedence (percent of time recommended flows are equaled or exceeded) for recommended spring/early summer flows in the unchannelized and

channelized Missouri River below Gavins Point Dam. Adapted from the Service's 1994 Draft Biological Opinion (USFWS 1994) and (USACE, unpublished data, 1994). Updated data may be forthcoming in the Corps' Revised Draft EIS on the Master Water Control Manual Review and Study scheduled for spring 2001.

River Reach[2]	Alternatives[3]	Time Period[1] March/April Stage Rise	Time Period[1] May/June Overbank Flooding
Segment 10			
Gavins Point Dam-	FWOP	60	70
Ponca, NE (Unchannelized)	CWCP	3	12
Segments 12-15			
Sioux City-Omaha	FWOP	63	42
(Channelized)	CWCP	14	1
Omaha-Rulo	FWOP	49	41
(Channelized)	CWCP	16	4
Rulo-Kansas City	FWOP	36	49
(Channelized)	CWCP	9	12
Kansas City-Jefferson City	FWOP	45	39
(Channelized)	CWCP	30	17
Jefferson City-St. Louis	FWOP	63	32
(Channelized)	CWCP	49	18

1 Recommended flows for unchannelized Gavins Point Dam-Ponca reach are from value function curves developed from correlation with pre-development depth and velocity distributions by a State and Federal interagency team of biologists. For modeling purposes, optimum flows were estimated to be 28 Kcfs in March; 40 Kcfs in April; 38 Kcfs in May; and 45 Kcfs in June. Recommended flows for channelized reaches from volume 7D, Draft Environmental Studies, Appendix C, Riverine Fisheries, Missouri River Master Manual Control Manual, May 1993.

2 As measured at Omaha gage (Sioux City-Omaha), Nebraska City gage (Omaha-Rulo), St. Joseph, Missouri gage (Rulo-Kansas City), Boonville gage (Kansas City-Jefferson City), and Hermann gage (Jefferson City-St. Louis).

3 FWOP = modified run-of-river with reservoirs and outlet constraints in place; CWCP = existing Master Manual Current Water Control Plan criteria.

Table 15. Miles of warm river aquatic habitat during April-August in riverine reaches below dams in the upper Missouri River (USACE, unpublished data, November 2000).

Reservoir/ Tailwater Reach	Existing Reach Length	Alternative	Median	90% Exceedence	Mean
Fort Peck	186	FWOP	21.7	10.4	26.5
(Segment 2)		CWCP	26.4	18.0	32.8
Garrison	85	FWOP	16.2	4.8	14.5
(Segment 4)		CWCP	5.3	0.0	6.1
Fort Randall	52	FWOP	16.5	6.6	16.6
(Segment 8)		CWCP	11.6	9.2	13.9
Total	323	FWOP	47.6	33.1	57.6
		CWCP	46.7	36.3	52.9

The Corps' simulation of water temperatures in open river reaches below main stem dams indicates that the FWOP also would not result in any meaningful temperature benefits. Regardless of the future operation plan for the river, an appreciable increase in the number of miles of warm river habitat will only be realized by warm-water spillway releases or modifications of reservoir structures to provide multiple release outlets.

Physical Habitat/Channel Morphology - Physical fish habitat in the Missouri River is primarily a function of the river's flow regime, channel morphology, sediment transport, and substrate composition. To assess the effects of flow scenarios on existing channel morphology, the Corps simulated such changes in a composite physical fish habitat model over the period of record in unchannelized and channelized reaches of the river. Models were initially developed and documented in Volume 7D: Environmental Studies - Riverine Fisheries, Appendix B - Physical Habitat Analyses Upstream of Sioux City and Appendix C - Physical Habitat Analysis Downstream of Sioux City of the Corps' 1994 Draft EIS on the Master Manual (USACE 1994b). The model for the area downstream of Sioux City has been revised to be consistent with the analytical approach for upstream and is reflected in Volumes 7D-S1 and 7D-S2: Environmental Studies - Riverine Fisheries (Supplement), Appendix C - Physical Habitat Analysis Downstream of Sioux City (revised) of the Corps' 1998 Revised Preliminary Draft EIS (USACE 1998b).

The models use the Riverine Community Habitat Assessment and Restoration Concept which correlates the distribution of depths and velocities for a range of flows to a standard reference condition with fish habitat significance. In general the physical habitat index for native fish is the correlation value (maximum per reach is 12.0) between the depth and velocity distributions at various cross-sections computed for the pre- and post-development conditions. Pre-development conditions reflect flow and channel conditions prior to dam construction. Data have been normalized to be comparable between reaches of river.

The model predicts an increase of 7-20 percent from the CWCP to the FWOP conditions in physical habitat (depth and velocity) for native riverine fishes in unchannelized reservoir tailwaters above Sioux City (Table 16). The summed physical habitat index for these reaches for FWOP increases about 12-13 percent over existing conditions. The relatively large difference in physical habitat among the two future conditions is probably a reflection of the wider channels and more diverse depths and velocities found in the unchannelized, remnant reaches of the upper main stem that can be enhanced through flow management. The greatest difference occurs in the Garrison reach, which is not surprising, given the poor flow regime of the current operations. These data reflect the value and contribution that an improved hydrograph can provide to native fish and physical habitat.

Implicit in predictions of future physical habitat is the assumption that altered hydrology associated with alternative water control plans will not affect channel morphology. The Corps has stated that sediment transport, channel bed degradation, reservoir sedimentation, and channel depths throughout the system will not be significantly affected by a change in the water control plan. However, variation in the amounts of annual runoff can affect channel morphology as evidenced by the Upper Decile runoff year and prolonged high releases (60 to 70 Kcfs) in 1997 from Gavins Point Dam which lowered the bed downstream by several feet. Therefore, a change in a water control plan with moderately higher spring flows likely would not accelerate bed degradation and channel incision in reservoir tailwaters. With adequate sediment supply, higher spring flows combined with lower summer flows likely would promote braided channel characteristics and help maintain sandbar and shallow water habitat for nesting terns and plovers and pallid sturgeon.

Regardless of whether the altered flow regime would exacerbate bed degradation, the ongoing negative effects of past bed degradation (i.e., loss of water supply to adjacent wetlands, dewatering of side channels and sloughs, loss of shallow water areas, loss of unvegetated sandbars, and lack of regeneration of forested wetlands) will not be reversed unless sediment is resupplied to the system.

Likewise, predictions of how an altered hydrology will affect sedimentation in reservoir delta areas is difficult. Effects on biologic attributes can be either positive or negative. Sediment aggradation in reservoir delta areas checks the downstream migration of bed degradation, but also may promote the conversion of open river habitat to lacustrine conditions, and eventually foster riparian forest growth. Sedimentation in reservoir headwaters also may smother substrates (e.g., gravel, cobble, rubble, sand) used by some river and reservoir fishes for spawning, but also may promote invertebrate production and provide fish nursery habitat for other species.

Channelized River Reaches

Hydrology - Below Ponca, Nebraska, the remaining 753 mi (1,211 km) of the Missouri River is free-flowing, but channelized for bank stabilization and commercial navigation. As illustrated **Table 16. Median, 90 percent exceedence and mean physical habitat index for native Missouri River fishes (USACE, unpublished data, November 2000).**

River Reach	Alternative	Median (50%)	90% Exceedence	Mean
Unchannelized				
Fort Peck	FWOP	10.2	9.7	10.2
(Segment 2)	CWCP	9.1	8.5	9.0
Garrison	FWOP	9.5	8.3	9.3
(Segment 4)	CWCP	7.9	7.1	7.9
Fort Randall	FWOP	9.3	8.6	9.3
(Segment 8)	CWCP	8.7	8.0	8.6
Gavins Point	FWOP	10.5	9.6	10.5
(Segment 10)	CWCP	9.3	8.6	9.3
Channelized				
(Segments 12-14)				
Sioux City-Platte R.	FWOP	11.0	10.2	10.9
	CWCP	10.2	9.9	10.2
Platte R. - Nebraska	FWOP	9.3	8.3	9.2
City	CWCP	7.9	7.2	8.0
Nebraska City -Kansas	FWOP	9.4	8.6	9.4
City	CWCP	7.8	7.2	7.9
Kansas City-	FWOP	10.8	9.7	10.7
Grand River	CWCP	10.0	9.4	10.0
Grand River-Osage R.	FWOP	11.5	9.7	11.1
	CWCP	10.7	9.3	10.5

Totals	FWOP	91.0	85.7	90.5
	CWCP	81.2	78.6	81.5

by Figures 16-20, the CWCP hydrograph correlates poorly with the pre-dam era hydrograph (Refer to Figure 8), but improves in the river segments downstream of Kansas City because of
tributary inflow. The simulated median monthly discharges under the FWOP correlates much closer with the natural hydrograph in all river segments downstream of Ponca than does CWCP.

The Corps' models computed peak flows for the CWCP to be as much as 50 Kcfs less than the FWOP in the spring and nearly 20 Kcfs higher during July-October in the upper river segments. The difference in peak flow between the CWCP and the FWOP decreases downstream as the distance from Gavins Point Dam (main stem reservoir regulation) increases. Consequently, the adverse effects of the CWCP hydrograph are most prominent in the segments above Kansas City.

The CWCP does not provide spawning cues and timely flow changes for most native river fishes in the lower channelized river, including the pallid sturgeon (Figure 21). In the channelized river, Harrow and Schlesinger (1980) reported drifting cyprinid, catostomid, *Stizostedion* spp., *Scaphirhynchus* spp. and paddlefish larvae from late April/early May to mid-August between Gavins Point Dam and Leavenworth, KS. Except for cyprinids and catostomids, peak larval densities generally occurred from mid-May to late June. Peak densities of sauger occurred earlier than other species; paddlefish and sturgeon densities were generally highest in June. Nearer Gavins Point Dam, however, the trend was toward later peaks, based on limited collections of sturgeon and paddlefish. Above Fort Calhoun, NE, upstream peak densities occurred from late June into mid-July.

Median navigation support flows at Sioux City from August through October under the CWCP are 2-3 times higher than would occur with the FWOP operations. The magnitude of late summer flows below Gavins Point Dam has a major effect on successful recruitment by recently spawned river fishes and the nesting and fledging success (in the unchannelized Gavins Point reach) by terns and plovers. FWOP supplies more shallow water habitat. Higher flows of the CWCP in late summer and early fall generally are about 20 Kcfs higher than the FWOP environmental baseline condition at all downstream gages in the channelized river. Galat and Lipkin (1999) have suggested that elevated water releases during the natural low-flow season cause protracted flooding that may be as damaging to fish and birds as reduced spring flows.

With practically all the lower river's former braided channel characteristics and shallow water habitat eliminated by the BSNP, continuation of artificially high flows under the CWCP and maintenance of the BSNP to support bank stabilization and navigation magnifies the adverse effects to existing marginal physical habitat conditions for larval, young-of-the-year, and juvenile fishes including pallid sturgeon. Few low-velocity, slackwater areas exist in either the main channel or off-channel areas of the channelized river. Those areas and tributary confluences are critical nursery areas for some river fishes like the pallid sturgeon (Hergenrader et.al. 1982, Harrow and Schlesinger 1980, Kallemeyn and Novotny 1977). Lack of nursery areas for recently spawned fishes like pallid sturgeon may be a major limiting factor for fish reproduction and recruitment in the river. Harrow and Schlesinger (1980) reported that drifting fish larvae greater than 8-12 mm in length were not collected in the channelized river. They speculated that a catastrophic die-off of larger larvae was occurring or larvae were leaving the drift and inhabiting protected habitats. Other than tributary confluences, few protected habitats occur in the channelized river.

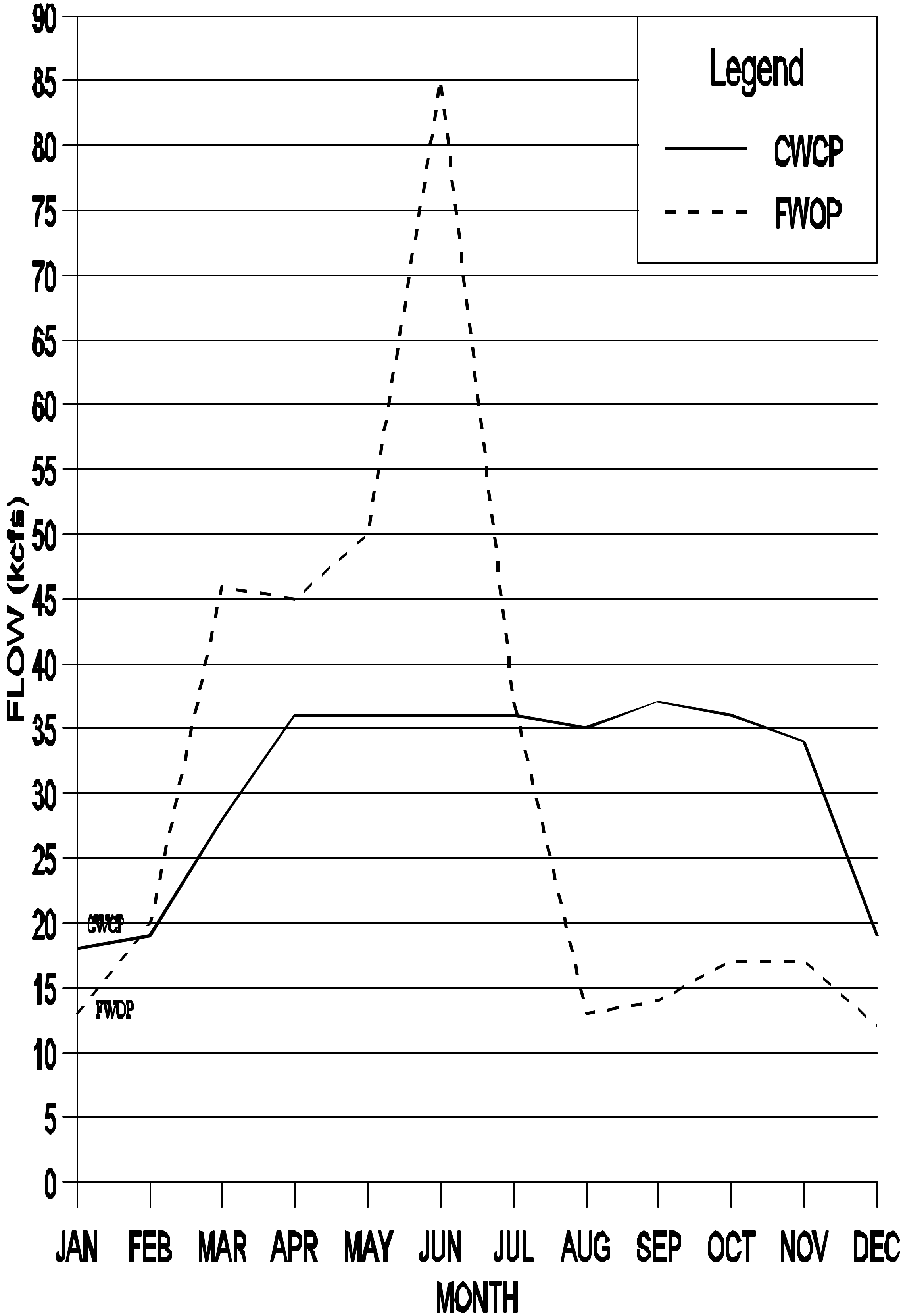

Figure 16. Simulated median monthly discharge, Sioux City - Omaha reach (1898-1993).

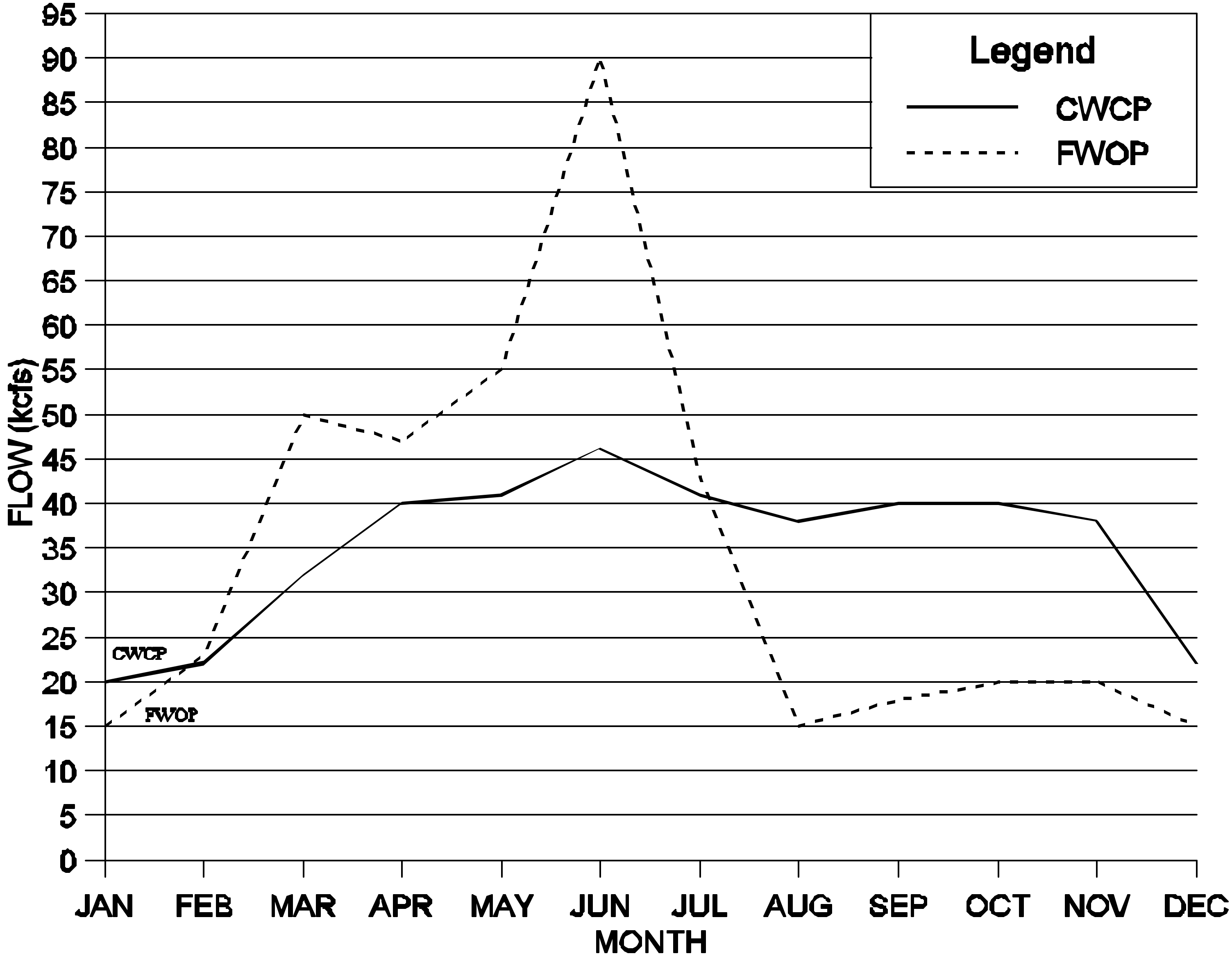

Figure 17. Simulated median monthly discharge, Omaha - Rulo reach (1898-1993).

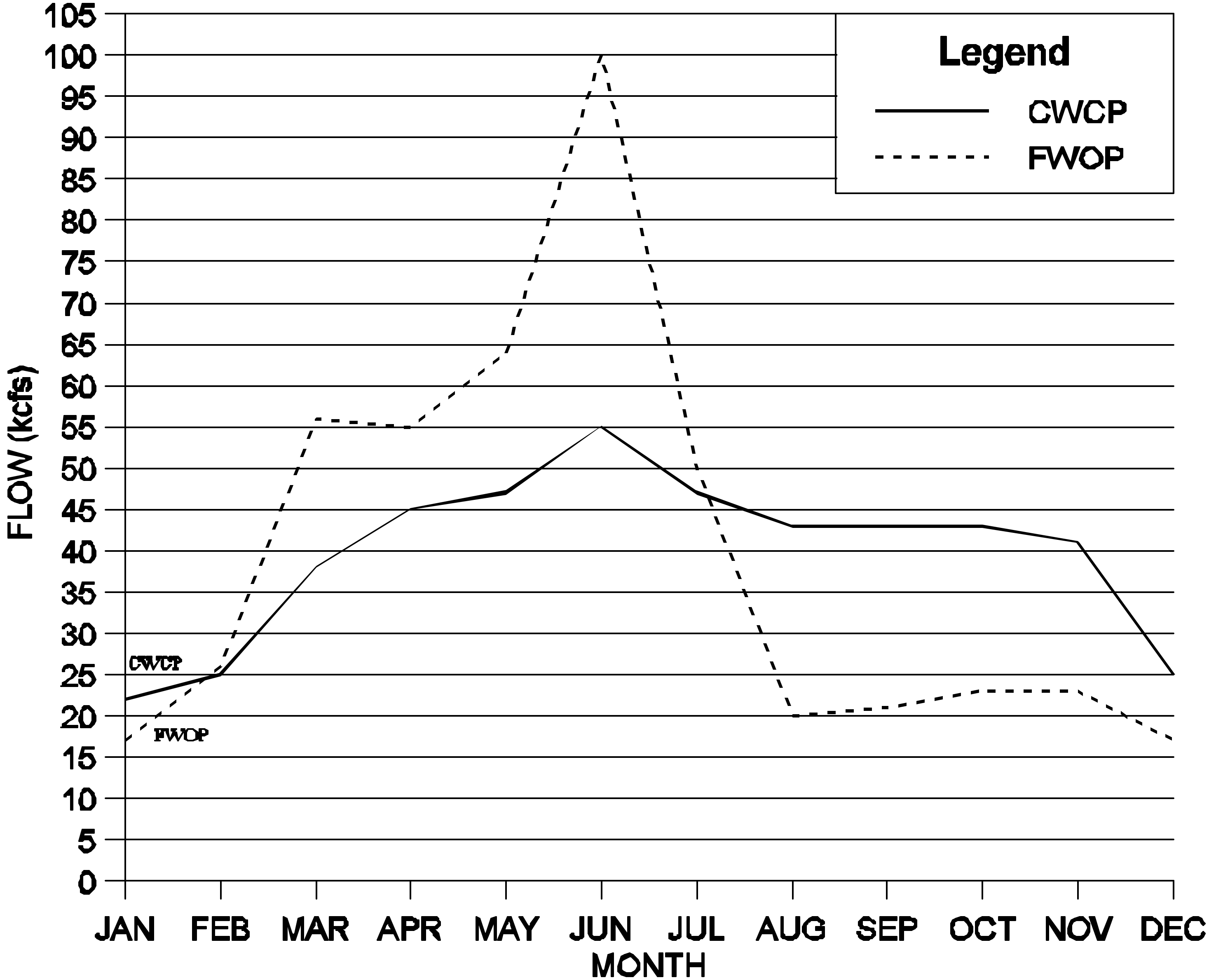

Figure 18. Simulated median monthly discharge, Rulo - Kansas City reach (1898-1993).

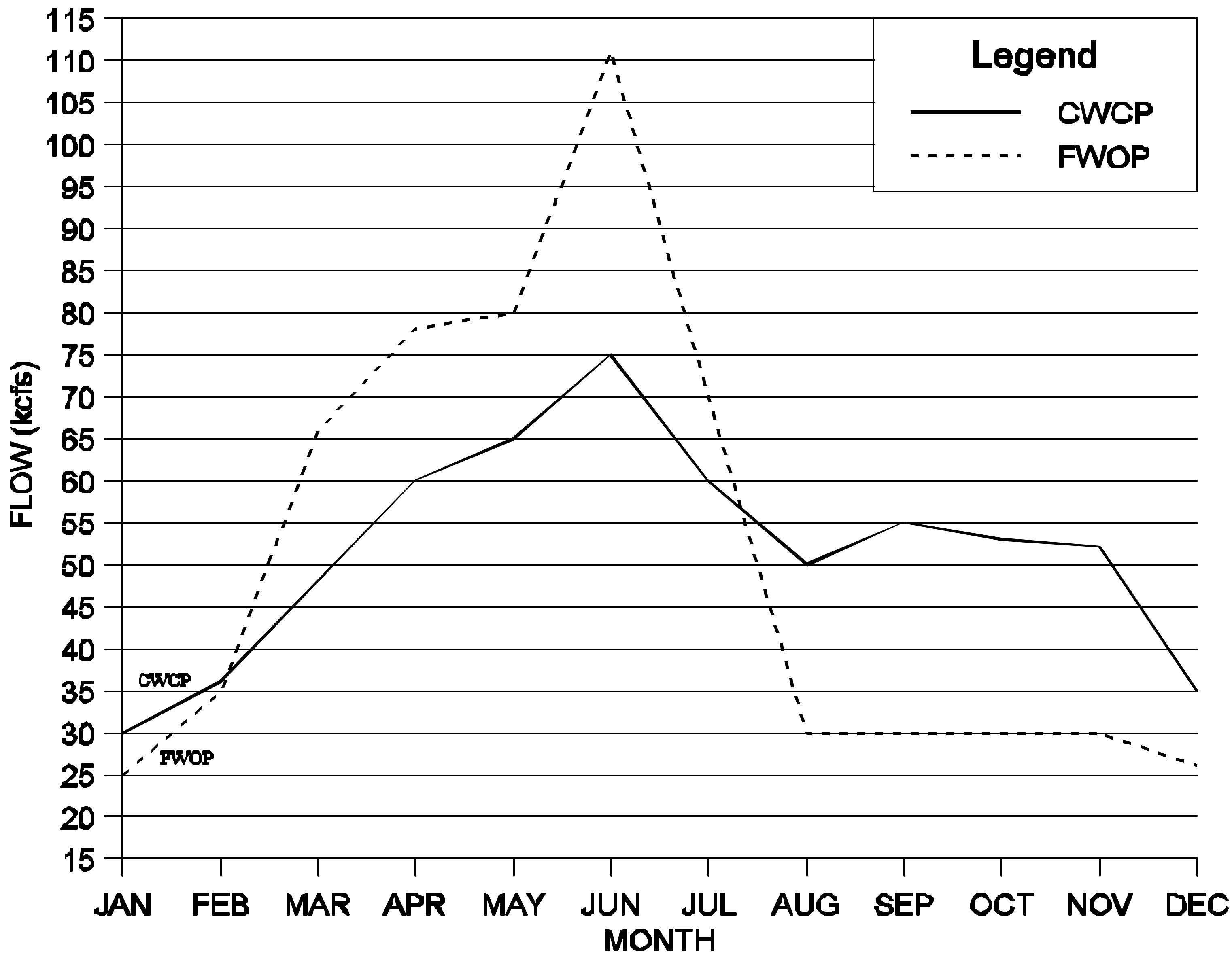

Figure 19. Simulated median monthly discharge, Kansas City - Jefferson City reach (1898-1993).

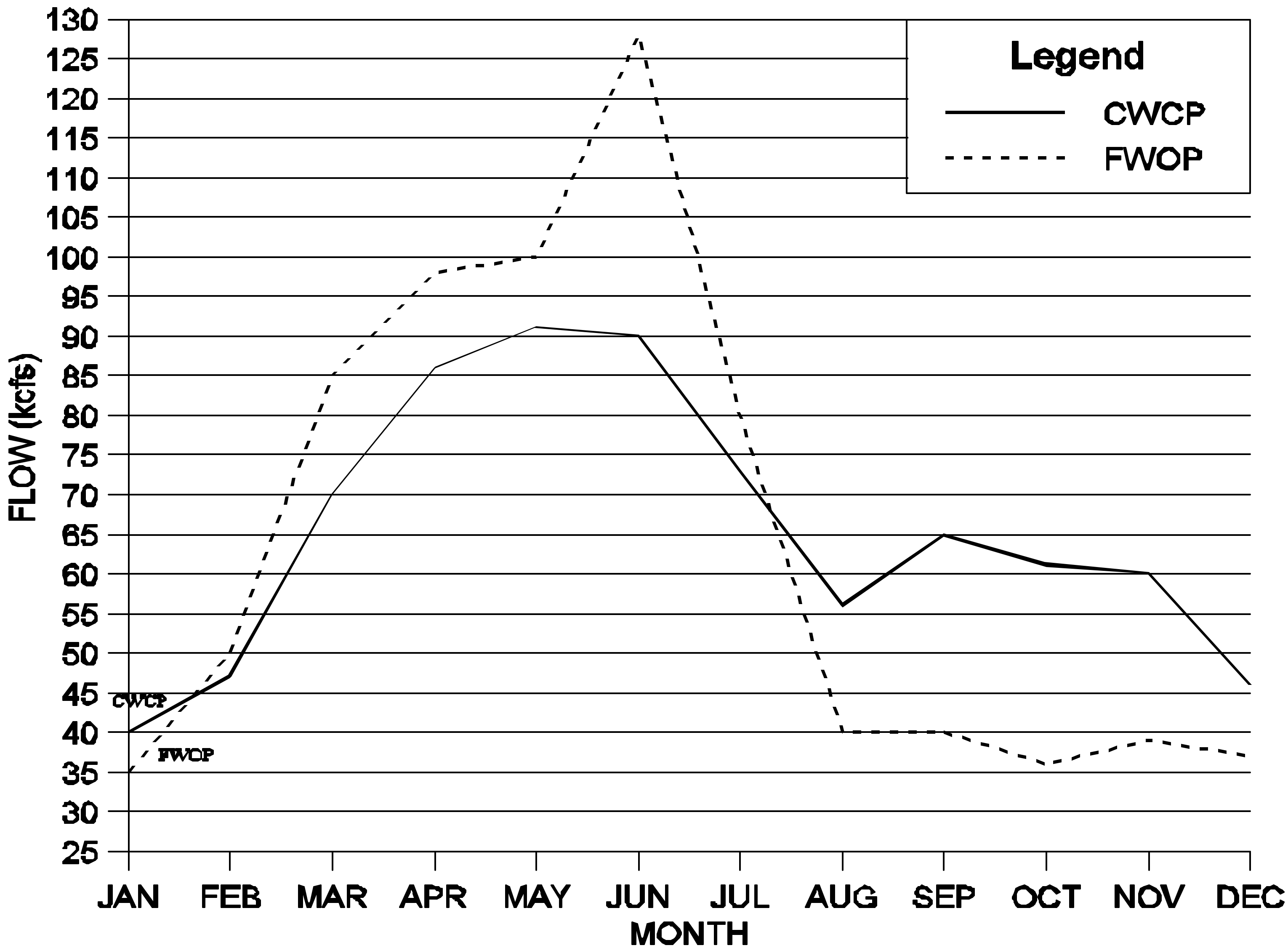

Figure 20. Simulated median monthly discharge, Jefferson City - St. Louis reach (1898-1993).

Figure 21Figure 21

Studies by Latka (1994) provide evidence that the high flows of the summer navigation season may be detrimental to adult fishes as well. Latka found that shovelnose sturgeon, a congener of the pallid sturgeon, switched habitat use based on changes in velocity and bottom topography. During the summer navigation season, sturgeon moved to tributary confluences and dike fields, which had lower velocities and pool habitat on the upstream face of sandbars. After cessation of navigation flows, lower winter flows provided velocity and topographic features in the main channel attractive to sturgeon. Latka noted, however, that the winter flows encountered during his study were lower than normal winter flows because of water conservation operations during the drought of 1988 to 1993.

Latka (1994) speculated that seasonal shifts in habitat use may be related to food availability. Lower velocities and pool areas trap detritus and organic matter, provide colonization sites for benthic invertebrates, and collect drifting invertebrates. Modde and Schmulbach (1977) also suggested that the river's summer flow regime may be limiting the availability of invertebrates to sturgeon. Speculation that lower velocities and bottom topography are important to sturgeon and other unique big river fishes is supported by habitat use in the unchannelized river. Kallemeyn and Novotny (1977) found shovelnose sturgeon and paddlefish almost exclusively in sandbar pools in the unchannelized river. Berry (1996) found that diet weight for shovelnose sturgeon in South Dakota was negatively related to flow in 1993 and 1994 with the highest diet weight in March, but also found no significant differences in diet weight among years of low, medium, and high flow. For shovelnose sturgeon in the Missouri River of Montana, Megargle and White (1997) found a significant positive relationship among the monthly sturgeon ration biomass and the average monthly discharge. Sturgeon from Montana and South Dakota had similar diets, but different relative diet composition. In South Dakota, Chironomidae were foraged upon at rates not in proportion with their availability (Megargle and White 1997).

Floodplain Connectivity - Floodplain connectivity refers to seasonal flooding of areas adjacent to the river. The spring flood pulse often provides connectivity between the floodplain to the river. For native river fish like the pallid sturgeon, this floodplain connectivity, especially during May/June, provided spawning areas for forage species, increased phytoplankton production, and redistribution of carbon to the river.

During development of the 1994 Draft Biological Opinion on the Master Manual, no model was available to specifically relate flooded acres to hydrology. However, at that time the Service analyzed Corps data and concluded that an alternative equivalent to FWOP would provide 98 percent more flooded acreage than the CWCP and nearly 200 percent more flooded acreage in June, the peak flow period in the pre-development hydrograph. Galat and Lipkin (1999) note that the CWCP also eliminates the historic fall flood pulse in the lower river. That pulse was important in providing floodplain access to fish, recharged moist-soil vegetation, and wetlands for wintering migrating waterfowl and shorebirds.

Now, the Corps has a model to address flooded acres and hydrology. Based on this model, in the lower 753 mi (1,211 km) of the channelized river below Ponca, NE, the average annual acres flooded for no more than 10 days in the spring/early summer (May/June) spawning period of native Missouri River fishes for the CWCP is 1,183 ac (479 ha) (Table 17). The FWOP scenario would result in 2,917 ac (1,181 ha) flooded, an increase of 1,734 ac (702 ha) (146 percent) compared to the CWCP. Although data analysis and modeling criteria have changed since the 1994 Draft Biological Opinion, current data continue to reveal environmentally beneficial increases in floodplain connectivity in May/June with FWOP.

Overbank flooding under FWOP would not be equally distributed throughout the lower river. Two-thirds of the flooding would occur in the reaches below St Joseph, MO. That reflects the decreasing flood control effects of the main stem reservoir system as distance from Gavins Point Dam increases. Above St. Joseph, about 33 percent of the average annual flooding would occur

Table 17. Summary of annual average acres flooded for no more than 2 days and 10 days by river reach, during the spring/early summer (May/June) spawning period of native Missouri River fishes in the channelized river (Sioux City, IA - St. Louis, MO) (USACE, unpublished data, November 2000).

River Reach (Segments 12-15)	Alternatives	2 Days Average Annual Acreage	10 Days Average Annual Acreage
Sioux City-Omaha	FWOP	575	513
	CWCP	147	147
Omaha-Nebraska City	FWOP	385	363
	CWCP	142	107
Nebraska City-St. Joseph	FWOP	121	108
	CWCP	58	28
St. Joseph-Kansas City	FWOP	251	234
	CWCP	146	75
Kansas City-Boonville	FWOP	225	190
	CWCP	123	69
Boonville-Hermann	FWOP	596	454
	CWCP	355	201
Hermann-St. Louis	FWOP	977	762

	CWCP	695	438
Totals (All Reaches)	FWOP	3129	2625
	CWCP	1667	1065

in the Sioux City-Omaha and Omaha to Nebraska City reaches. Only 4 percent would occur in the Nebraska City-St. Joseph reach.

Reduced acres of flooded lands under CWCP are due to fewer higher frequency, lower stage floods (i.e., 2-year, 5-year, 10-year events) that occur under CWCP. The number of acres flooded under FWOP and CWCP become similar for the lower frequency, higher stage floods (i.e., 50-year, 100-year, and 500-year).

Comparing exceedence frequencies for spring flows between FWOP and CWCP also illustrates the effects of the action. At four gage stations between Sioux City and Kansas City, the CWCP meets the March/April stage rise criteria only 1-16 percent of the time (Table 14). However, under FWOP, depths and velocities closest to the pre-development conditions would be met 36-60 percent more frequently. Under FWOP, the March/April stage rises occur with sufficient frequency (generally 1 out of every 2 years) in most river reaches to initiate spawning movements and trigger reproduction by native river fishes such as the pallid sturgeon, sicklefin and sturgeon chub, and paddlefish.

Table 14 and 17 summarizes the effects of the continued operation of the CWCP on the spring pulse and connectivity of the river to the floodplain. The greatest negative effect of continuing operations occurs in the Sioux City to Kansas City reach. Although below Kansas City the river is influenced by warmer, more turbid tributary inflows that contribute to a somewhat more natural hydrograph, the connectivity of the floodplain is limited by extensive private and Federal levees adjacent to the river.

Based on the current knowledge of pallid sturgeon breeding biology, the Service believes that adequate spring flows (March through June) should occur on average once every 3 years or 33 percent of the time to provide the frequency necessary for pallid sturgeon spawning and survival. Except for the river below Kansas City, those conditions are not met under the CWCP (Table 14). In addition, except during drought years, elevated flows in the summer/early fall along the lower river, greatly limit suitable habitat for larval, young-of-the-year, and juvenile fish.

Throughout the channelized river, the CWCP meets the May/June flow needs for later spawning river fishes about once every 10 to 11 years above Kansas City, versus once every 5 to 6 years below Kansas City (Table 14, Figure 21). Under FWOP, they would meet May/June overbank conditions in 2 years out of 5. Therefore, continuation of the CWCP does not provide necessary flows once every 3 years for later spawning pallids in the channelized reach of the Missouri River.

Restoration of higher frequency floods and spring stage rises are important to the pallid sturgeon and other long-lived, late maturing fishes, which may spawn infrequently (as little as once every 10 years for females, 2 to 3 years for males). Annual stage rises of at least 10 feet and floods with a return frequency of 10 years or less have been lost from the Missouri River ecosystem through reservoir and levee construction and operations. Restoration of spring floods through flow management and structural reconnection of the floodplain with the river would contribute to the conditions necessary for native river fish species to successfully reproduce, including the survival of the pallid sturgeon. Restoration also would benefit many other species of special concern (e.g., sicklefin and sturgeon chub) and possibly avoid future listings.

Wetland habitat associated with the channel and floodplain of the lower Missouri River has declined significantly since settlement (Hesse et al. 1986b, USFWS 1980). Forested, emergent, open water, and unconsolidated bottom (i.e., sand and mudflats) wetlands are integral components of the Missouri River ecosystem. Those wetlands meet the seasonal habitat needs of a host of organisms, including migrating birds (waterfowl, shorebirds, colonial wading birds, bald eagles), furbearers, and native fishes. Moreover, those wetlands are a major source of food for river wildlife and fish, especially the pallid sturgeon and piping plover. Wetlands produce as much as 50 percent of the aquatic invertebrates found in the river (Hesse and Schmulbach 1991).
In the lower river, the Corps' model predicts a median value of nearly 75,000 ac (30,415 ha) of wetland habitat under the CWCP (Table 12). However, the model also predicts a 28 percent increase to nearly 95,000 ac (38,475 ha) under FWOP.

Overall, the median area of wetlands throughout the entire project area (i.e., Fort Peck headwaters to St. Louis) is 23,331 ac (9,449 ha) (15 percent) greater under FWOP baseline than with the CWCP. At the 90 percent exceedence level, the difference in wetland acres between FWOP and CWCP is even greater. Over 41,000 (30 percent) more ac (16,605 ha) of wetlands are provided under the FWOP conditions. Given the large historic losses of riverine and floodplain wetlands along the lower river, continued isolation of remaining wetlands from the main channel, and large differences (i.e., effect) in the amount of wetlands between the CWCP and FWOP environmental baseline, shortfalls in organic matter input and seasonal fish and wildlife habitats will continue under the CWCP.

Physical Habitat/Channel Morphology - For the channelized river below Sioux City, FWOP compared to continuation of the current operations (CWCP), increases the median physical habitat index for native fish in the lower river from 7-20 percent (Table 16) and likely provides the highest physical habitat value attainable through only flow management in the lower river. Most of the improved physical habitat would occur in the Sioux City to Kansas City reach of the river and probably reflects the provision of higher spring flows and lower summer flows with the FWOP. While a useful screening tool, the physical habitat index cannot quantify differences in effects between operating scenarios, especially differences in late summer/fall habitat. Historically, much lower flows occurred in a much wider channel between August and February. These hydrological and morphological conditions created diverse depths and velocities throughout the main river channel.

Historically, much lower flows occurred in a much wider channel from August through the following February. Those hydrologic and morphologic conditions created a diversity of depths and velocities throughout the main river channel.

For analytical purposes, the Corps has modeled and graphically displayed the distribution and area of depth classes and velocities for several river reaches at flows varying from 15 Kcfs to 65 Kcfs in both the pre-development and existing channels (Volume 7D-S1 and 7D-S2 of the Revised Draft EIS, USACE 1998b). Historical conditions for comparative purposes were determined in pre-development channels near Omaha, NE (1923), Nebraska City, NE (1923), and Waverly, MO (1920). Existing channel conditions were measured in 1997 at several reaches downstream of Gavins Point Dam. The model does not account for the future without the BSNP, thus, it only shows comparative data for removal of the effect of MR Operations through FWOP.

Several studies from the Missouri and other Midwestern rivers have shown the value of shallow water habitat to all life stages of native big river fishes and other river organisms. In general, the literature reports depths of 0-7 ft (0-2.1 m), and velocities less than 2.5 fps (76 cm/s) over sandbars as being preferred main channel and main channel border habitat of big river species such as sauger, channel catfish, shovelnose sturgeon, and blue sucker during all or some of their life history (Nelson 1984, Stauffer 1991). Pallid sturgeon use similar depths and velocities (Liebelt 1998). Those habitats are especially important in the late summer and fall to larval, young-of-the-year, and juvenile life stages of many species.

Construction, operation, and maintenance of the main stem dams and the BSNP have largely eliminated the 0-7 ft (0-2.1 m) depths and velocities less than 2.5 fps from the channelized river by constriction of the channel and imposition of artificially high flows during the normal late summer/fall low-flow period. Table 18 illustrates little shallow water (0-5 ft [0-1.5 m] depths), slow velocity (0-2.5 fps) habitat remains in the channelized river relative to historic conditions.

The amount of shallow-water habitat in the pre-development river appears to have been equally distributed throughout the lower river reaches. Historically, an average of over 105 acres/mile of shallow water habitat (0-5 ft [0-1.5 m]) consistently occurred over about 500 mi (805 km) of the lower river. A similar amount of habitat probably occurred in the 199-mi (481-km) reach below Waverly based on a comparison of the percent reduction in channel width from 1890 conditions (Missouri River Commission, 1898) at St. Joseph (RM 463), Waverly (RM 299), and Hermann, MO (RM 90). At all these sites, the former high bank to high bank width has been reduced by 72 to78 percent.

Continuation of current operations provides only about 24 percent of the shallow water habitat that existed historically below Sioux City. Within the existing channel configuration, operations under the FWOP would provide 5-8 percent of historical habitat acreage. Although these conditions would not be close to historic conditions, they would represent a 100 percent increase over current acreage, which may be significant to the survival of listed species. Furthermore, the data suggest that over 90 percent of the loss of historical shallow water, slow velocity habitat in the lower river is due to the construction, operation, and maintenance of the BSNP.

Given the importance of shallow water, slow velocity habitat to maintenance of the aquatic ecosystem, and the large disparity between pre-development aquatic habitat conditions and the habitat provided under current operations and maintenance, the summer and fall habitat needs of the pallid sturgeon and other native river fishes are not being adequately met. They will only be met by a combination of improvements in main stem reservoir operation and habitat restoration to help recreate sufficient form and function of the river to benefit listed species.

Table 18. Average daily acres of shallow, slow moving habitat per river mile in unchannelized and channelized reaches of the Missouri River during the young-of-year months for native river fish. Data computed by the Corps from Volumes 7D-S1 and S2, Missouri River Master Water Control Manual Review and Update, August 1998, preliminary Revised Draft EIS (USACE 1998b)[1].

River Reach	Alternatives	July	August	September	October	November	December	Average
Unchannelized								
Gavins Point	FWOP	56.7	70.6	70.9	71.2	72.1	71.1	68.8
(Segment 10)	CWCP	64.7	61.4	60.1	61.7	62.5	71.5	63.7
	Historic	99.1	106.6	105.8	105.1	105.5	105.9	104.7
Channelized								
Sioux City	FWOP	2.4	5.3	6.1	6.5	6.7	7.0	5.7
(Segment 11)	CWCP	2.3	2.0	2.0	2.1	2.4	6.8	2.9
	Historic	98.4	107.0	106.1	105.7	106.4	106.0	104.9
Omaha	FWOP	2.2	4.8	5.5	6.1	6.2	6.8	5.3
(Segment 12)	CWCP	1.9	1.8	1.7	1.8	2.0	6.4	2.6
	Historic	98.0	107.0	106.9	106.1	107.1	106.3	105.2
Nebraska City	FWOP	4.6	5.9	6.2	6.5	6.2	7.1	6.1
(Segment 13)	CWCP	4.4	4.5	4.3	4.3	4.4	6.7	4.8
	Historic	97.3	103.4	105.7	110.8	112.2	117.2	107.8
St. Joseph	FWOP	4.9	7.6	8.4	9.2	8.5	11.1	8.3
(Segment 13)	CWCP	4.7	4.7	4.5	4.4	4.5	9.9	5.5
	Historic	97.2	100.3	102.6	107.2	104.9	113.9	104.4

[1] Comparable data was not available for the Kansas City and Boonville reaches (Segment 14) and Osage to mouth reach (Segment

15).

Bald Eagle

The operation and regulation of the main stem System has affected the food source for wintering bald eagles. Tailrace areas have provided open water areas below dams which concentrate wintering waterfowl. Bald eagles will concentrate in these areas to feed on the waterfowl. Eagles also will follow waterfowl as they migrate to local feeding areas. The tailrace areas also provide opportunities for eagles to feed on disabled fish that pass through turbines. On the lower river, changes in turbidity have increased gizzard shad populations, a major food item for wintering bald eagles.

Dam releases in winter may cause changes in the food base for eagles. Reduced winter flows to meet project purposes can increase freezing of the river water, thus forcing waterfowl to leave or change patterns of use. Decreased releases may also decrease the availability of crippled fish for eagles.

Karl Mundt National Wildlife Refuge was established in 1974 to protect a portion of natural Missouri River bottomland that provided a major winter roost for bald eagles. That bottomland of mature cottonwoods below Fort Randall Dam provided a combination of abundant food and ideal winter roosting habitat.

In 1967, 283 eagles were observed, establishing the Fort Randall population of wintering eagles as the largest in the lower 48 States. However, those numbers have dwindled considerably with only 39 eagles counted in 1992. In 1994, however, wintering numbers increased to 138 eagles. Wintering eagle numbers have continued to increase in recent times to 200 birds in 1999 (Appendix IV). The reason for the apparent decline in wintering populations below Fort Randall and then a return to high concentrations is unknown.

While much of the forested floodplain habitat used by bald eagles was lost due to System and BSNP construction, additional habitat has been lost (and potential habitat has not redeveloped) due to regulation of the System and maintenance of the BSNP. Operating the System to reduce periodic flooding has reduced the productivity of the remaining forest lands in the Missouri River floodplain (Hesse et al. 1988). Studies indicate that dams may be having major long- term effects on the dynamics of remnant forest ecosystems (Johnson 1988). The absence of annual soil profile saturation (Reily and Johnson 1982), lack of nutrient salt deposition (Burgess et al. 1973), and lowering of the water table in spring to reduce downstream flooding during the high water demand for trees (Reily and Johnson 1982) all contribute to decreased productivity.

Although cottonwood trees that compose a majority of forested habitat used by bald eagles can live up to 250 years (Johnson 1992) the species is generally relatively short-lived, reaching maturity in about 45 years and rapidly declining after 70 years (Harlow et al. 1979, cited by Corps 1993). In North Dakota, post-dam cottonwood growth had decreased 25 percent compared to the pre-dam period

(Reily and Johnson 1982). Johnson (1988) has found low seedling recruitment rate in cottonwood trees which are favored as winter roosting habitat for bald eagles along the Missouri River. Cottonwoods require fresh alluvium for germination and establishment, and therefore, their populations have been maintained in the past by rapid lateral accretion of the river. Missouri River meandering has virtually ceased under MR and BSNP Operations.

Less favorable water conditions resulting from reduced spring flooding and/or lowered water table are likely contributing to mortality and loss of vigor of mature trees already stressed by advanced age (USACE 1993). Decadent cottonwood stands are readily invaded by other species such as elm (*Ulmus spp.*), green ash (*Fraxinus pennsylvanica*), Russian olive (*Elaeagnus angustifolia*), box elder (*Acornegundo*), red cedar (*Juniperus virginiana*), and mulberry (*Morus rubra*) (Wilson 1970). Therefore, Missouri River cottonwood forests are quickly being replaced by trees that are not suitable as bald eagle nesting or roosting trees.

In addition to degradation of cottonwood forests, agriculture expansion onto the floodplain, encouraged by construction and operation of the main stem dams (and subsequent flood control), and construction and maintenance of the BSNP, is a major factor contributing to the loss of cottonwood habitat. For example, on the MNRR, more than 5,300 ac (2,146 ha) of cottonwood habitat were lost from 1944 to 1977 (USFWS 1979). Since 1985, the Corps estimates that 315 ac (128 ha) of mature forested habitat have been lost due to erosion into the river (USACE 2000a). This estimate was based on aerial photography from 1985 and 1997, and includes three “upper decile” high-flow years. Other types of economic development adjacent to the river (i.e., housing and recreational development) also contribute to the loss of forested areas.

The loss and degradation of cottonwood forests along the river continues with little effort put forth toward restoration or management of those habitats. That has left those unique habitats vulnerable to natural disaster. A summer hail storm in 1988 just below Oahe Dam eliminated and damaged hundreds of cottonwood trees while another high wind event in summer 1994 eliminated thousands of trees about 5 mi (8 km) downstream of Oahe Dam. Current operation of the Missouri River contributes to the continued decline of cottonwood habitat. Little evidence exists to indicate that the minimal amount of overbank flooding under current operations will do anything to maintain existing stands, much less promote enhancement or restoration of cottonwood habitat. Sedimentation in reservoir headwater areas, such as the headwaters of Lewis and Clark Lake, can also result in the drowning of mature cottonwood trees due to flooding and elevated water tables.

Actions associated with maintenance of the BSNP are usually conducted to avoid impacts with bald eagles and their habitat. Maintenance activities are normally conducted outside the winter roosting season and few if any trees are removed for maintenance activities the rest of the year. The Corps will coordinate annually with the Service on proposed maintenance activities and ensure that those activities avoid adverse impacts to bald eagles.

With the exception of the Fort Randall population of wintering bald eagles, the numbers of wintering bald eagles have remained relatively stable to increasing over the years. Since the mid-late 1980s the numbers of nesting bald eagles has continued to increase. However, as forested habitat continues to degrade with time, the number of nesting and wintering bald eagles may also decline. With continued habitat decline, further expansion of breeding eagles also is less likely to occur. However, when considering the overall amount of habitat available, as well as the improvement, health and adaptability of the species, the Service does not believe that bald eagle populations will be significantly affected provided that no more than 10 percent of the current habitat is lost.

Least Tern and Piping Plover

Current operations of the Missouri River Main Stem reservoirs, as detailed in the Corps' Missouri River Main Stem Reservoir System Regulation Manual or Master Manual dated 1979 and subsequent Annual Operating Plans (AOP) have been the subject of a previous jeopardy biological opinion for interior least terns and piping plovers by the Service (USFWS 1990b). That opinion detailed direct and indirect effects of Missouri River Operations on terns and plovers. Those effects are expected to continue under current project(s) operations. The 1990 biological opinion on operations of the Missouri River Main Stem System detailed measures that the Corps is to use to offset the jeopardy to terns and plovers. Those measures are designed to provide conditions that allow the birds to meet fledge ratios necessary to maintain self-sustaining populations of those species. The high flows of 1995 through 1997 created enough habitat to allow the least tern to meet the fledge ratio goals in 1998, 1999, and 2000, and the piping plover to meet the goals in 1998 and 2000. These years provide a model in terms of habitat goals to achieve fledge ratio targets.

The construction of the BSNP eliminated the Missouri River's ability to create and provide a diversity of sandbar habitats. Although suitable tern and plover nesting habitat in the lower river was, for the most part, eliminated during construction of the navigation channel, maintenance of existing navigation structures prevents potential nesting habitat from redeveloping. Recent modifications to selected structures, however, have shown some promise in creating sandbar/shallow water complexes that are important for tern nesting and foraging (e.g., Jameson Island, MO, RM 214). While the potential exists for habitat creation in the lower river, the availability of that habitat to the birds depends on river stages that expose those areas long enough for successful tern nesting. During most years, most sandbars along the lower Missouri River (Segments 13, 14, 15) are flooded providing very limited habitat that is exposed long enough during the nesting season to support least terns. Twelve potential Missouri River colony sites have been identified on the river bordering the State of Missouri, but only six had elevations high enough to meet the continuous exposure requirement during at least 70 percent of the period 1976 to 1986 (Smith 1988). Flooding of tern habitat in the Missouri reach occurs presumably when flow requirements in that portion of the river are under full to minimum service navigation and there are normal to high tributary inflows.

General Effects - Current MR Operations do not provide pulse flows necessary for channel maintenance, sandbar creation, and vegetation scouring, nor do they alleviate the accumulation of sand and gravel behind the main stem dams. Such sediment and pulse flows are the foundation of sandbar creation, as well as scouring and covering of vegetation. Current operations are not expected to create meaningful amounts of shallow-water, sandbar complexes, and thus will not reverse the decline in river channel habitats important to the tern and plover. Current operations have lead to a significant decrease in habitat on the Missouri River. Below Gavins Point Dam, the Corps data shows that less than 4 ac (4.8 ha) per river mile of suitable nesting sandbar habitat were available to the birds in 1996 (Table 19).

High flows associated with naturally occurring high-water years (e.g. 1995 through 1997) created significant amounts of sandbar complexes and shallow-water habitats (Table 19). The amount of dry sand or suitable nesting tern and plover habitat in the Gavins Point reach (Segment 10) increased over 13-fold between 1996 and 1998 from 3.6 acres/mile to 47.4 acres/mile. Wet sand habitat, important as foraging and brooding habitat for the piping plover increased nearly 50 percent from12.5 acres/mile to 18.6 acres per mile. In 1996, vegetated acres comprised 66.1 percent of the total acreage, but had dropped to 35.5 percent of the total acreage in 1998. These data highlight the importance of higher flows in the creation and maintenance of suitable nesting complexes for the least tern and piping plover.

Table 19. Least tern and piping plover sandbar habitat acreages on selected Missouri River segments during 1996 and 1998.

			Land Cover Category[1]									
	Reach	River Miles	Dry Sand			Wet Sand			Vegetation			
Segment			Total Acres	Acres/RM	%	Total Acres	Acres/RM	%	Total Acres	Acres/RM	%	Total Acres
1996[2]												
10	Gavins Point River	58.0 (811.0-753.0)	211.0	3.6	7.6	724.3	12.5	26.3	1,820.0	31.4	66.1	2,755.3
1998[3]												
4	Garrison River	85.9 (1389.9-1304.0)	2,338.2	27.2	50.8	1,219.0	14.2	26.5	1,044.5	12.2	22.7	4,601.7
8	Ft. Randall River	35.0 (880.0-845.0)	305	8.7	17.9	289	8.3	17.0	1,110	31.7	65.1	1,705.0
9	Lewis and Clark Lake (Headwaters)	19.1 (845.0-825.9)	671.1	35.1	6.4	762.4	39.9	7.2	9,131.8	478.1	86.4	10,565.3
10	Gavins Point River	58.0 (811.1-753.0)	2,749.0	47.4	46.4	1,076.2	18.6	18.1	2,104.4	36.3	35.5	5,929.6

[1] These figures represent all interchannel emergent habitat on the described segments. Habitat accreted to shore is not included nor is any submergent habitat. (Unpublished data, USACE, 2000)

[2] 1996 data: June 1996, 39 Kcfs

[3] 1998 data: May 1998, 26 Kcfs

Missouri River maps of 1890s (Missouri River Commission 1898) illustrate surveyed features of the river valley and show the preponderance of sandbars on the river, including the reaches below today's dams. The Corps and others (USACE 1989a, Schmulbach et al. 1981, USFWS 1990b, Schwalbach et al. 1993) have quantified various changes in sandbar habitat along selected river segments. Corps' studies (1989a) that compared habitat available above river stages for terns and plovers indicated a significant difference between available suitable nesting habitat between 1949 and 1986. (Suitable habitat is considered to be unvegetated sandbars exposed between seasonal high water and seasonal low water, or what may be considered the scour area.) Prior to dam construction (1949 at Garrison), the scour area occurred over 4 ft (1.2 m) of elevation. In 1986 at Garrison, there was less than 2 ft (.6 m) of elevation in that zone. In the Gavins Point reach, the scour zone occurred over 9 ft (2.7 m) of elevation in 1960, but less than 2 ft (.6 m) of elevation by the mid-1990s. The loss of habitat since operations began may be a direct result of reservoir operations, or an indirect result of operational contributions to river degradation and vegetative encroachment. In general, flow conditions can reduce the availability of suitable habitat, thereby contributing to increased nest abandonment, increased renesting attempts, and low fledging rates (Schwalbach et al. 1986), and exacerbating the impacts from predation and human disturbance.

Regulation of the main stem Missouri River, as well as construction and maintenance of the BSNP, have resulted in greatly altered channel hydraulics. Currently in portions of the river (i.e., certain reservoirs and tributary confluences), sediments are building up without the opportunity to be scoured or redeposited downstream (aggradation). Such sediment deposition or delta formation can, in some cases, elevate water levels locally, which can lead to flooding in surrounding areas (e.g., Pierre and Fort Pierre, SD). Elevated water levels can further reduce the Corps' flexibility to operate the system by reducing the amount of water that can be passed downstream without threatening development. In other portions of the river, sediments are scoured faster than they are being replaced by deposition from upstream, significantly lowering the river bed (degradation). Degradation, in combination with sediment loads that are now trapped behind the reservoirs, has reduced formation of suitable sandbar nesting habitat, particularly below Garrison and Gavins Point Dams.

Channel degradation has affected tern and plover habitat in additional ways. Channel incision appears to be responsible, in part, for vegetation encroachment on islands and sandbars. Lowering of the riverbed has created relatively higher islands, thus increasing the flow necessary to overtop those islands (USACE 1989a). In most years, system regulation does not provide flows necessary to scour many of these islands, and encroaching vegetation makes the habitat unsuitable for terns and plovers. That is common below Gavins Point Dam, but also occurs below Garrison Dam. Sandbar acreage has decreased in both of those river reaches (USACE 1989a) which the Corps attributes to channel degradation and vegetative encroachment. That study also noted that a minimum of 500 ac (202 ha) of nesting habitat was eliminated by vegetative encroachment below Gavins Point from 1979 to 1985. Vegetative encroachment also is believed to cause changes in nesting distribution and loss of historic nesting sites in Kansas, and along the Platte River in Nebraska (Currier et al. 1985, Schulenberg and Placek 1984, Ziewitz et al. 1992).

Channel degradation, navigation structures, and bank stabilization have contributed to the loss of sandbars/sandbar complexes, channel chutes, oxbow lakes, and wetlands (USACE 1981b) which affects tern and plover forage base. Those types of habitat produce the fish and benthic invertebrates that terns and plovers, respectively, depend on for food. Hesse et al. (1986a) reported that channel degradation and altered hydrologic conditions in the Missouri River have changed the fish composition in nearly all river reaches. Net recruitment, short-term survival, and instream maturation are poor in channelized reaches of the Missouri River (Hesse and Mestl 1985). On the Mississippi River, Tibbs (1995) studied the relationship between river hydrology, fisheries' productivity, and least terns along a reach of the lower river. He found that small fish were at least an order of magnitude more abundant in shallow-water than deepwater habitats. Peak forage fish abundance throughout the study area occurred during the tern nesting period. Based on the catch data and timing of fish abundance, he suggested that the coupling of forage-fish availability and tern reproduction is strongly regulated by river stage, and underscored the importance of river-floodplain connection.

Dugger (1997) examined the foraging ecology and nesting least tern reproductive success on the Mississippi River adjacent to Missouri. Although Tibbs (1995) found the greatest fish abundances in shallow-water habitats, Dugger (1997) found that prey capture rates and dive rates were significantly higher in deepwater habitats. She suggested that prey abundance and availability to foraging terns are not equivalent on the lower Mississippi River, perhaps because of predator avoidance behaviors of fish in shallow-water habitats. Dugger (1997) examined several tern reproductive parameters (i.e., egg weights, clutch size, and chick weights), and hypothesized that differences in those parameters were related to the availability of small fish, and can influence chick survival and fledgling rates. That tern reproductive parameters vary with the availability of forage indicates that food may limit tern reproduction in some years.

Biologists believe that invertebrate production on the Missouri River has also affected piping plover productivity, particularly in regions affected by hypolimnetic releases [C. Kruse (USACE), J. Fraser (Virginia Tech.), and N. McPhillips (USFWS) pers. comm. 2000]. In comparing plover populations between localized areas on the Missouri River and off-river areas, e.g., Prairie Coteau wetlands and the Atlantic Coast, plover productivity and age-at-fledging can be quite different. Patterson et al. (1991) found that differences in plover chick survival among foraging habitats can be due to differences in availability and/or quality of prey. Elias et al. 1999 found that plover chicks foraging in habitats higher in available forage are likely to have higher survival rates than chicks using other habitats with limited forage potential. Two events in the last few years have plover biologists concerned about forage availability on the Missouri River. One was recent captive rearing research that documented chick weights in captivity and in the wild (C. Kruse, Corps, and R. Niver, University of Wisconsin, pers. comm. 2000). Secondly, when habitat was mechanically created on the Missouri River an entire brood was found to have starved to death due to lack of forage on new mechanically-created habitat (C. Kruse, Corps, pers. comm. 2000). After the floods of 1995 through 1997, hatch rates and fledgling rates significantly increased with the occurrence of sandbar complexes that provided significant amounts of edge habitat. It is those edge habitats where plovers are found foraging for a large percentage of time (R. Niver, pers. comm.).

While substantial habitat was lost to system construction, much habitat continues to be lost to system regulation under the current Missouri River operations. For example, where sandbars still occur below Gavins Point Dam, approximately 7,800 ac (3,159 ha) of sandbar habitat have been lost between 1956 and 1975 (Gavins Point Dam closed in 1955; Schmulbach et al. 1981). Schmulbach et al. (1981) reported 2,200 ac (671 ha) of sandbars remaining (at flows ranging from 26 Kcfs to 35.6 Kcfs) along the river from Gavins Point Dam to Ponca, NE. The Corps (1989a) reported 1,500 ac (457.5 ha) of sandbars (at flows ranging from 26 Kcfs to 35.6 Kcfs) remaining in the same stretch of river in 1985. Recent Corps analyses (C. Kruse, pers. comm. 2000) indicate a greater decline in habitat. In 1996, no suitable natural sandbar habitat existed at flows of 32 Kcfs.

Following the low sandbar habitat acreages that occurred in the early 1990s, 3 years of high flow occurred from 1995 through 1997. The result of those high flows was a loss of tern and plover eggs and initiation of a captive rearing program to offset flood losses. Those high flows were the result of natural precipitation events in the Northern Great Plains that were historic highs. Because of extremely high water levels in the reservoirs in 1997, the Corps evacuated water in the exclusive flood control zones as quickly as possible for flood control. Those high flows also produced a 5 to 10 fold increase in sandbar habitat. Since then, the gains in habitat have been reduced significantly from the 1998 high through erosion or revegetation during years with closer to average flows and operations. The habitat created by the high flows has been reduced by about 30-50 percent (C. Kruse and G. Pavelka, pers. comm. 2000).

Specific Effects - The Corps has adjusted project releases to avoid impacts to terns and plovers since 1986. However, the loss of tern and plover nests and/or chicks have been documented on the Missouri River due to System operations in most years since 1978. Losses for the period 1986 through 1999 are listed in Table 20. Those losses are expected to continue.

In an analysis of Release Regulation Results for Tern and Plover Nesting Support (USACE 1998a) under the CWCP the Corps found that they could only provide water control regulation to benefit the birds 20 percent of the time when looking at the full range of water storage and water supply. In their analyses, the Corps provided some benefits 33 percent of the time and no benefits 47 percent of the time (USACE 1998a). The 1990 Biological Opinion to the Corps details the direct and indirect effects of Missouri River CWCP up to 1990 (USFWS 1990b). Operational increases in releases below dams for flood control, hydropower, and navigation during the nesting season appear to have been largely responsible for nest and/or chick losses. Releases for recreation and maintenance have also resulted in losses.

From 1967 to 1986 at Gavins Point Dam, the average increases in release flows between May and July (peak nesting period) was 5.5 Kcfs. This equates to an 8.25- to 13.75-in (21-35 cm) rise in river levels (based on a 1.5- to 2.5-in [3.8-6.4 cm] rise per 1 Kcfs increased release). The average

elevation for all nests found below Gavins Point (1986 through 1988) is approximately 11.5 in (29 cm) above flow levels. Thus, based on average historical releases (1967 to 1986), at least half the nests below Gavins Point could be lost to flooding because of increases in releases
between June and July. Garrison releases for June and July also show an increase that would

Table 20. Missouri River piping plover and least tern egg and nest fates, 1986 to 1999.

Missouri River Productivity Monitoring (Information from G. Pavelka, Corps, Omaha District)	*Piping plovers*				*Least terns*			
	Eggs Collected	Flood*	Fate* Unknown	Abandoned *	Eggs Collected	Flood*	Fate* Unknown	Abandoned *
1986	0	0	0	2	0	0	0	0
1987	0	0	0	0	0	0	0	0
1988	0	7	51	22	0	11	59	21
1989**	0	2	31	11	0	14	20	1
1990**	0	6	22	12	0	12	41	11
1991**	0	16	35	13	0	23	39	20
1992	0	1	12	2	0	2	9	14
1993	0	54	33	18	0	118	55	7
1994	0	7	12	15	0	35	108	22
1995	197	37	17	12	160	35	53	8
1996	140	10	2	9	204	16	46	13
1997	33	7	7	7	24	14	31	18
1998	24	9	14	7	0	1	36	14
1999	68	66	61	28	35	23	43	13
**Lake Oahe Census only								
TOTAL *nest fates	**462**	**222**	**297**	**158**	**423**	**304**	**540**	**162**

have flooded nests and habitat. Those increased releases between June and July were most likely for navigation and peaking power, but in some years could have been for flood control.

The Corps has considered tern and plover needs in dam operations since 1986. One measure the Corps has used since 1986 is to provide stable flows during the nesting season in reaches where the birds nest (e.g., Gavins Point). The average increases in the average daily outflows between May and July from Gavins Point since 1986 (1986 to 1989) was 2,100 cfs. This equates to a 3.2- to 5.3-inch rise for the 2,000 cfs release (based on a 1.5- to 2.5-inch rise per 1,000 cfs). The maximum daily outflow below Gavins Point for that same period (1986 to 1989) was stable (i.e., no change) for 3 out of 4 years.

The effects of water levels and flow operations on the Missouri River and subsequent impacts to terns and plovers are well documented in Schwalbach et. al. (1993). They document losses of both nests and chicks because of operational flows. Pavelka and Kruse (1999) documented additional operational flooding during 1986 through 1997 in and in 1998 in a Corps Biological Opinion Compliance Report (USACE 1999).

Flow Issues - The CWCP requires the Corps to evacuate flood control storage in a safe and expeditious manner. If flood storage is at the limits of the range cited in the CWCP, flood storage evacuation may occur during the tern and plover nesting season. Record runoff during 1995 through 1997 allowed for flood evacuation during the tern and plover nesting season resulting in the direct loss of eggs and chicks, (see Table 20) but also created significant amounts of sandbar/sandbar complex habitat that resulted in the highest productivity ever recorded for terns and plovers on the Missouri River in 1998 (see Figure 10 and 11).

Flood control measures for the lower river may also cause the loss of eggs or chicks.
When downstream flooding occurs on the lower river, flows may be held back from project dams to minimize flooding impacts downstream. Tern and plover egg (nest inundation) and chick (stranding) losses below the dams may occur when flows are returned to support navigation. While the Corps does take precautions to only reduce flows for 2 days then increase flows to minimize nesting on newly exposed habitats to discourage nest initiation, the Corps has documented nest initiation at newly exposed areas and the stranding of chicks when stable flows are returned (C. Kruse pers. comm.). The spiking or rapid increase or decrease in river stage due to releases can also affect reservoir levels due to varying inflows and flow travel times. Birds may be lost if reservoirs rise in response to reducing releases. Due to water travel time, reduced project releases during short-duration high tributary inflows below dams may not be effective in protecting nesting areas.

During early research efforts on the Missouri River (Schwalbach 1988, Dirks 1990, and Schwalbach et al. 1993), many colony sites and in some cases all colony sites below Fort Randall and Gavins Point Dams had signs of water disturbance (i.e, sandbar flooding, nest wetting and innundation) at some time during the summer. They suspected hydropower peaking was the major source of water disturbance at that time at nesting colonies on the Garrison (Segment 4) and Fort Randall reaches (Segment 8), particularly at the mouth of the Niobrara River. Data collected over the years show a large number of losses labeled as unknown. Peaking fluctuations can be drastic and in combination with weather events or tributary inflows can result in water levels at nesting sites that results in the loss of eggs or the possible stranding of chicks.

Recognizing this as an issue, the Corps made peaking power adjustments to limit adverse impacts to the birds at Garrison, Fort Randall and Gavins Point Dams during the nesting season. Those changes put a cap on the highest peaks, but hydropower operations continue to fluctuate greatly for hydropower production causing water level changes at nesting areas that likely result in the loss of eggs and/or chicks due to sand wetting, flooding or stranding of chicks. Peaks in flows still occur and losses can still be anticipated for peaking power adjustments in combination with other factors like maintenance (Schwalbach et al 1993), tributary inflows, and sudden precipitation events. Power emergencies (full capacity releases to prevent brownouts) and power peaking demand during drought may also contribute to bird losses. Dirks (1990) speculated that small increases in water releases (1 Kcfs) could affect egg survival and viability in nests at low nesting sites (4 in [10.2 cm] or less) due to saturation. Kruse (1990 and 1991) also noted the reported loss of nests due to inundation was conservative since abandonment due to nest bowl saturation or other factors are usually assigned as unknown losses because of uncertainty.

Rapid changes in river stage due to water conservation operations or hydropower peaking (i.e., dropping flows and then raising them again on a 2-3 day cycle or hourly cycle, respectively) is also likely to affect invertebrate production as benthic invertebrates may be left exposed when flows quickly decline causing dessication.

Currently, system operations try to balance water levels in reservoirs. During drought, reservoir water levels are equally distributed as well as during extremely high inflow years. However, some reservoirs (e.g., Lake Sakakawea) rise during the tern and plover nesting season resulting in the loss of nests. Reservoirs with large areas of uncontrolled inflow would require adjusting releases, which might take birds or nests downstream. So opportunities to regulate the reservoir levels for terns and plovers are limited.

The CWCP allows for short-term and long-term adjustments in operations. Often flow adjustments are made based on engineering judgement. Construction or maintenance activities would be an example of short-term adjustments. Occasionally those types of actions have led to losses of birds (Schwalbach et. al. 1993 and Schwalbach 1988). Peaking power adjustments to flat daily average releases to minimize bird impacts is an example of a long-term adjustment and is discussed above.

As nests are inundated, so are the sandbar habitats on which the birds depend. Loss of sandbar habitat can occur in two ways: (1) direct or incomplete inundation of habitat; or (2) saturation of the habitat that makes it too wet for nesting (Dryer and Dryer 1985, Schwalbach 1988). Limiting preferred habitat by inundation or nest site dampness contributes to low productivity. Prior to 1986, sandbars were exposed by low releases in May and June and then flooded by higher releases in late June and July. That operational sequence eliminated sandbar habitat (USACE 1989a) and destroyed nests (Nebraska Game and Parks Commission 1979, 1980, 1982, and 1985) because increased releases correspond to median nest initiation dates (Schwalbach 1988).

Since 1994, dam releases have been increased about 2 Kcfs beginning in May to preclude birds from nesting on areas that will be inundated when System releases are typically increased in June, July, or August for navigation. While providing stable flows for the birds eliminates much of the nest loss caused by increases in releases during the nesting period, that type of management results in considerable loss of habitat when flows are held high for the entire nesting period. That loss of habitat limits the area available for nesting and foraging birds and exacerbates predation and human disturbance problems. Stable flows also inundate habitat that might otherwise be available for young plover chicks and fledged plovers to seek shelter and optimize foraging. That is, if flows gradually declined throughout the nesting season, the wetted perimeter of sandbar habitat would increase, thus providing a greater area and opportunity for young chicks to forage and avoid predators (Bacon 1996 and Adolf 1998). Habitat loss and its associated additive impacts (e.g. predation) affects productivity and may limit population stability and potential recovery. The best water conditions for the terns and plovers are high spring flows during nest initiation followed by declining flows for the remainder of the nesting season.

Fluctuations or bouncing of releases for water conservation and hydropower also has resulted in the loss of sandbar habitat. For example, peaking releases at Fort Randall Dam precluded use of some islands (Schwalbach 1988, USFWS 1989), and the bouncing of releases (2 days low, 1 day high) at Gavins Point Dam during the 1989 nesting season resulted in the taking of some habitat, as well as nests. Peaking and bouncing of releases has occurred after the Service's 1990 biological opinion on the AOP. As recent as the 1994 nesting season, bouncing of releases has caused loss of nests as birds nested on newly exposed sandbars on low flow days. Bouncing of releases also results in chick loss due to stranding on sandbars.

During drought periods, the Corps conserves water for navigation support by cutting back flows at Gavins Point Dam for 2 days before the maximum release on the third day. Spiking releases can put birds at risk particularly when habitat is limiting. Birds may and have initiated nesting during the down days and were subject to flooding when flows return. Also chicks have been stranded on sites when higher flows return. Spiking also negatively impacts the foraging base for both terns (fish) and plovers (invertebrates). Both small fish and invertebrates may experience stranding and subsequent dessication when flows are dropped suddenly. Hesse and Mestl (1985) also implicated operational factors including (1) power peaking during fish spawning, (2) flood control (specifically, dewatering areas), and (3) rapid water replacement.

Missouri River Operations under the CWCP are expected to continue to foster the following conditions that contribute to predation:

1. Increased vegetation or vegetative encroachment on islands has provided habitat that is attractive to predators. Soots and Parnell (1975) found that islands that were sparsely

vegetated were less likely to support mammalian predators. In 1988 and 1989, the Corps partially cleared an island of vegetation on the Missouri River at river mile 801.0. Eleven tern and two plover nests were established on the island, but all nests were destroyed by a predator. Evidence indicates that vegetation left on the island provided habitat for mink. The birds did not attempt to renest at this site.

2. As mentioned previously, sandbar habitat has been reduced due to vegetative encroachment, sediment starvation, and to elevation available above water. Terns and plovers must compete for available space with predators, such as mink (*Mustela vison*), raccoon (*Procyon lotor*), opossum (*Didelphis virginianu*) , coyote (*Canis latrans*), domestic dog (*Canus domesticus*), prairie rattlesnake (*Crotolus virdis viridis*), red-tailed hawk (*Buteo jamuicensis*), crow (*Corvus brachyrhynchos*), black-billed magpie (*Pica pica*), great blue heron (*Ardea herodias*), and ring-billed gull (*Larus delawarensis*) (Schwalbach 1988). In 1986, 1988, and 1989, when flows exceeded 30 Kcfs below Gavins Point Dam (i.e., 35 Kcfs in 1986 and 32 Kcfs in 1988 and 1989), predation adversely affected productivity (Schwalbach 1988, Dirks and Higgins 1988, Dirks 1990). In 1987, when flows averaged 30 Kcfs, no predation was noted. The difference in loss of habitat between 30 Kcfs (1987) and 32 Kcfs (1988 and 1989) by inundation and the continuing problem of vegetative encroachment can force birds and predators to share the same available space to the detriment of terns and plovers. The 35 Kcfs flows in 1986 were due to natural flood conditions, while the 32 Kcfs flows in 1988 and 1989 were to meet navigation needs. In 1996, birds below Gavins Point Dam were limited to man-made islands. Nesting at high densities can leave many birds vulnerable to predation (Kruse 1993). Nesting success at one site was severely reduced by mink predation.

3. Schulenberg and Schulenberg (1982) found that flooding of river sandbars during the nesting season actually increases the incidence of predation. Rising water levels shrink limited habitat causing adult birds to abandon their nests or leaving nests and chicks more vulnerable to predation because of increased loss of habitat. Therefore, while predation may be expected to occur naturally, it may be exacerbated by System operations.

Because System operations limit the sandbar area available, the pressure of recreationists on terns and plovers is increased. Recreational activities and human presence reduce reproductive success. A 1976 study estimated 950,000 recreation days on the Missouri National Recreation River (Heritage Conservation and Recreation Service 1979). Additionally, public use on main stem reservoirs in 1987 amounted to 42,455,775 visitor hours, up more than 1.1 million visitor hours from 1986 (USACE 1988). Many of those visitors compete with the birds for space. Sandbar areas are not only attractive for tern and plover nesting, but also for recreationists who use the areas for picnics, volleyball, golf, sunbathing, swimming, fishing, and artifact hunting. Human disturbance has contributed to tern and plover losses on the Missouri River (Dryer and Dryer 1985, Mayer and Dryer 1988, Schwalbach 1988).

Fluctuation in releases may be additive to extreme weather problems. For example, fluctuation in releases and elevated water levels at Lewis and Clark Lake in 1989 resulted in bird mortality, but mortality increased when cold, rainy weather followed. As discussed previously, birds are forced to nest at lower elevations or closer to the water when habitat is limited by System operations. Such operation does not allow much room for wave and wind action. Any increase in flows during nesting, which brings water levels within a few inches of the nest, subjects the nest to increased pressure by wave or wind action. Wave action was documented by Schwalbach (1988) for nest losses in 1986 and 1987 on the Missouri River.

Sandbar erosion, due at least in part to dam operations (fluctuation extremes and intensity of releases), also has caused the loss of habitat as well as nests on the Missouri River (Dirks and Higgins 1988, Mayer and Dryer 1989). The high number of abandoned nests, numerous renesting attempts, and low fledging success in 1986 was reflective of operational or high-water effects on nesting area suitability and hence low productivity (Schwalbach 1988). Schwalbach (1988) found many sandbars were low profile (less than 18 in [45.7 cm] above surface water) below Gavins Point Dam in 1986 and below Fort Randall in 1986 and 1987 and, therefore, were subject to wave actions or small changes in water levels.

Data collected to look at habitat suitability for terns and plovers on the Gavins Point and Fort Randall reaches indicate that flooding, vegetative encroachment, and recreational activity all affect site selection by the birds (Schwalbach 1988). In comparison with other areas, Schwalbach (1988) found Gavins Point sandbar sites moderately stable (57 percent of the tern sites and 55 percent of the plover sites were either new or abandoned) and Fort Randall sandbar sites highly unstable (78 percent of the tern sites and 100 percent of the plover sites were either new or abandoned).

Pallid Sturgeon

MR and KR Operations and the operations and maintenance of the BSNP will continue to affect pallid sturgeon by decreasing the quantity and quality of aquatic habitat in the Missouri River, thus, (1) reducing larval and juvenile rearing habitat; (2) reducing the availability of seasonal refugia; (3) reducing the forage base of pallid sturgeon by reducing nutrient cycling and habitat diversity in the Missouri River; (4) reducing pallid sturgeon staging and spawning cues and (5) increasing hybridization with the shovelnose sturgeon.

Modified Hydrograph - Missouri River main stem dam operations currently reduce flows from April to July for flood control, and increase flows from July to November for primarily navigation, hydropower, flood control and water supply. Before impoundment behind reservoirs, two periods of peak discharge occurred on much of the Missouri River (above St. Joseph, MO); one in April from spring runoff and snowmelt on the Great Plains and a second higher peak in late May to early June from mountain snowmelt. The spawning period for pallid sturgeon, which is believed to occur from late April into July, corresponds with the historic period of increased runoff, which also has been known to trigger spawning of other ancient big-river fish such as paddlefish (Russell 1986) and shovelnose sturgeon (Berg 1981). Gardner (1995a) radio-tracked 14 pallid sturgeon in the upper Missouri River during a low water year and a near normal water year. He found that adult pallid sturgeon moved an average of 3.2, 12.9, and 17.6 mi (5.2, 20.8, and 28.3 km) further upriver during May, June, and July in the normal run-off year compared to the low run-off year. These upriver movements are associated with spawning runs and reflect the influence of the hydrograph on pallid sturgeon.

Shovelnose sturgeon spawning occurs in the Tongue River, a Yellowstone River tributary, from early June until mid-July (Elser et al. 1977). Female pallid sturgeon collected in June and July in Lake Sharpe contained mature ova and presumably were ready to spawn (Kallemeyn 1983). Krentz (USFWS, pers. comm., 1994) observed male pallid sturgeons on the Yellowstone River in Montana running milt during early June of 1993 and 1994. Sandvol (USFWS, pers. comm., 1992) observed a male pallid sturgeon captured from the Missouri River near Williston, ND, running milt in late May 1991. Keenlyne and Jenkins (1993) estimated pallid sturgeon spawn in late April or early May in the lower Missouri and middle Mississippi Rivers, and in late May or early June in the upper Missouri River. Although sturgeon have been found that appeared ready to spawn, only two records of larval or young sturgeon have been documented in recent years. Without the increased river flows in June and July, combined with the necessary water temperatures (i.e., >60?F or 15.6?C) during that period, the spawning cues for pallid sturgeon probably are no longer present in some upper basin main stem river reaches under existing main stem dam operations.

Conditions may be somewhat better in the lower river. The larval pallid sturgeon collected in Missouri in 1999 suggests a spawning event later than June. Those fish were estimated to be 2 to 3 weeks old (Darrel Snyder, Colorado State University, pers. comm.), beyond the passive drift stage, and able to actively seek out preferred habitat. That indicates that somewhere suitable spawning conditions did occur in 1999 in the lower river when the necessary hydraulic and spatial/temporal habitat conditions coexisted. Nevertheless, in most years the current unnaturally high summer and fall operational flows in the lower river leave few areas suitable for young-of-the-year fish refugia and nursery, reducing potential recruitment into the pallid population.

In addition to seasonal shifts in flow patterns, main stem dams operating for daily hydropower needs cause daily water-levels fluctuations in tailwater areas by as much as 6.5 to 10 ft (2-3 m). Those fluctuations and associated increases in water velocity can disrupt the macroinvertebrate community and larval fish rearing areas for many miles downstream of the dams by alternately flooding and dewatering habitats. Modde and Schmulbach (1973) observed that factors affecting shovelnose sturgeon prey availability within the unchannelized Missouri River include temperature, seasonal recruitment, and changes in density influenced by the timing and discharge rates from Gavins Point Dam. They hypothesized that the reduction in numbers of shovelnose sturgeon may be due to reduced availability of prey species caused by high discharges from Gavins Point Dam.

Flood flows under a natural hydrograph were also essential for the dynamic transport of sediment and the re-arrangement of those sediments into natural morphological channel features (fish habitat). Those flows also served to introduce and transport organic matter from the floodplain and to maintain turbidity. Flood flows were the principle method to introduce large woody debris into the river, and carried nutrients to floodplain plant communities, which influenced floodplain forest composition and structure. In addition, floodplain inundation provided off-channel habitats for invertebrates and forage fish, further increasing floodplain productivity critical to riverine species. Invertebrate reproduction and behavioral migration were closely tied to the natural hydrograph (Hesse and Mestl 1993b).

Modified Temperature - Today, main stem dams discharge hypolimnetic releases from reservoirs that stratify the water column, significantly decreasing water temperatures downstream of those dams during ice-free periods. Outlet works for Fort. Peck, Garrison, and Fort Randall dams are positioned 160 to 200 ft (48-61 m)below the top elevation of the dams. Water temperatures at the tailrace of Garrison Dam, for example, rarely rise much above 50ºF (10ºC) during summer months and warm to only 60ºF (15.6ºC) 100 mi (161 km) downstream. Pallid sturgeon require relatively warm water to successfully spawn. Historically, pallid sturgeon spawned in an environment that gradually warmed in the spring to temperatures above 60? F (15.6ºC). Continued releases of cold water further hampers natural reproduction.

Channel Modifications and Maintenance - Maintenance of the BSNP consists, for the most part, of repairing dike and revetment structures to foster a bank stabilized river with a self-scouring navigation channel. Because of the efficiency of those structures, almost no maintenance dredging occurs in the lower river. Maintenance dredging has only occurred (post-construction) two or three times in the last 30 years, and those events involved relatively small amounts of material (Mark Frazer, KCD, pers. comm.). Nevertheless, the net effect of project maintenance (i.e., prevent development of shallow, slow-water habitats and shoaling) perpetuates unsuitable river conditions that will continue to affect the pallid sturgeon in numerous ways. Continued disruption of natural processes will affect pallid sturgeon by reducing (1) substrate diversity; (2) the availability of larval and juvenile rearing habitat; (3) the availability of seasonal refugia; (4) the nutrient cycling ability of the Missouri River, and (5) the natural forage base of pallid sturgeon.

Because the main stem dams have reduced flooding and the BSNP has eliminated significant bank erosion and promoted a self-scouring channelized river, snags and sawyers, important to the structural complexity of the channel environment, almost have been eliminated from the lower river. In the natural river, snags and log jams would cause scouring and filling that provided a highly variable river bottom.

Bank stabilization has largely arrested meander cuts and bank erosion. Maintaining revetments and structures to stabilize the banks eliminates a major source of sediment and snags to provide diverse aquatic habitats and further support the riverine forage base. In addition, preventing bank erosion and channel migration encourages floodplain development that, in general, results in land changes (i.e., deforestation, wetland drainage) that degrade fish and wildlife habitat in and adjacent to the river.

Channel training structures reduce river width and incise the channel. Closing structures isolate side channels. Those structures lock the river channel in place and reduce the natural meandering by encouraging sedimentation, eliminating most, if not all potential habitat value in those areas. Thus, the river remains constricted and the channel bottom continues to degrade in some areas. River migrations that would naturally create new habitat no longer occur. Channel maintenance prevents the river (except in large floods) from redeveloping the habitats to which the pallid sturgeon is adapted (e.g., braided channels, irregular flow patterns, flood cycles, extensive microhabitat diversity and turbid waters).   That reduces the connectivity of off-channel aquatic habitats with the main channel, reducing the availability of seasonal refugia for young-of-the- year. The only documented occurrence of larval pallid sturgeon on the Missouri River in the last few decades was at the lower end of a reconnected side channel in central Missouri (Joanne Grady, USFWS, pers. comm. 2000). On the Mississippi River, Peterson and Hertzog (1999) collected a young-of-the-year pallid sturgeon in main channel border habitat on an inside bend sandbar in approximately 8.5 ft (2.6 m) of water. In addition, Sheehan et al (1998) noted that pallid sturgeon exhibited a strong preference for downstream island tips, which are typically depositional areas. Maintenance of channel training structures prevent the formation or enlargement of such areas, affecting the quality and quantity of larval/juvenile habitat and hence potential recruitment into the population.

Prohibiting natural channel migrations also reduces the input of organic matter and nutrients (e.g., woody debris), and floodplain productivity to the river, significantly reducing pallid sturgeons forage. A stabilized river also contributes to reduced suspended sediment loads (i.e., turbidity), increasing competition with and predation by species better adapted to less turbid environments (see above).

In the lower river, deep-water scour zones are generally found associated with channel training structures. Those areas have been documented to provide overwintering habitat for pallid sturgeon (Jim Milligan, USFWS, pers. comm. and Tim Grace, MDC, pers. comm.). In addition, recent fish work in the lower Mississippi River suggests that off-bank or L-head revetments may provide some off-channel habitat valuable to a large variety of riverine fishes (Atwood 1996).   More recently, the Corps has used chevron dikes in both the Mississippi and Missouri Rivers to address flow problems associated with developing side-channels, and control/add diversity of depth in the cross section. The dikes divert flow into the main channel by presenting the hydraulic appearance of a solid object without isolating the side channel with a closing structure. Flow between the structures maintains a permanent side channel connection, which provides important off-channel habitat for fishes. Chevron dikes also may replace some of the river's historic habitat/substrate heterogeneity and invertebrate abundance and diversity (Ecological Specialist, Inc. 1997), and potentially provide valuable habitat for a large variety of riverine fishes (Atwood 1997).

Deferred maintenance may lessen the adverse effects of some structures; however, properly designed modifications to channel training structures can improve aquatic habitat for the pallid sturgeon and other native fishes. Depending on the size of rock used, channel structures may replace some of the historic substrate diversity and increase macroinvertebrate production locally (Beckett et al. 1983, Bingham

1982, Nord and Schmulbach 1973, Payne et al. 1989). That in turn attracts fish (Farabee 1986, Pennington et al. 1983). Although channel training structures may increase macroinvertebrate production on a local scale, they do not contribute organic matter or carbon to the riverine system. That loss of nutrient inputs reduces invertebrate and fish production which are the primary forage foods of pallid sturgeon. Strategically notching channel structures can encourage scour holes, smaller side channels, sand shoals, and access to off-channel habitats, all of which can benefit the pallid sturgeon, either directly or indirectly through improved habitats and forage. Notches also can allow fish movement to scarce off-channel habitats, increasing the availability of seasonal refugia along the lower river.

Loss of habitat quality, quantity, and diversity also are believed to be affecting the genetics of pallid sturgeon in the Missouri River. Altered environments are suspected as a major factor in increased pallid sturgeon hybridization with shovelnose sturgeon, thus altering the genetic integrity of the species (Campton et al. 1995). The effects of bank stabilization and navigation structures and habitat alterations on the reproductive success of pallid sturgeon, however, are unclear. Data suggests that pallid and shovelnose sturgeon are reproductively isolated in less-altered habitats such as the upper Missouri River (Campton et al. 1995). That does not appear true for much of the remainder of the pallid's range. Overwintering pallid sturgeon have been found associated with scour holes adjacent to wing dikes. Shovelnose sturgeon are known to spawn on wing dikes in main stems of large rivers (Christiansen 1975, Elser et al. 1977, Moos 1978, Helms 1974). Pallid sturgeon may also use those areas due to the absence of other substrate types, possibly increasing the incidence of hybridization with shovelnose sturgeon. Thus, continued maintenance will maintain the present degraded habitat conditions to the extent that the Service believes the incidence of hybridization will be an increasingly important factor in pallid sturgeon population genetics. Hybridization not only decreases reproductive success, but may also lead to genetic swamping and loss of a genetically distinct Missouri River pallid sturgeon population.

Habitat changes, hybridization, and their effects on pallid sturgeon genetics may also influence pallid sturgeon on the Mississippi River. The sturgeons, as a group, exhibit potadromy and occupy different habitats throughout their life cycle. Adult pallid sturgeon may range over 60 or more miles (Bramblett 1996, Sheehan et al. 1998) in search of suitable habitat. In addition, larval sturgeon may drift for distances of 40 to over 400 mi (64-644 km) depending on current velocity (Steve Krentz, USFWS, pers. comm.). Those particular life history characteristics underscore the importance of the interconnectedness of the Missouri and Mississippi Rivers in terms of pallid sturgeon population biology. The interconnectedness of those river systems may be very important in maintaining the genetic connectivity and continuity of pallid sturgeon by ensuring that genetic material is dispersed throughout the population and genetic diversity is maintained. Recapture information from pallid sturgeon fingerlings stocked in the Missouri River in Missouri documents pallid sturgeon movement between those rivers. Fourteen pallid sturgeon stocked in the Missouri River were recaptured in the Mississippi River below St. Louis following release (Graham 1999). Continued maintenance of the BSNP will perpetuate degraded habitat conditions on the Missouri River, greatly limiting the Missouri

River's suitability to pallid sturgeon. Such conditions may impair the genetic exchange between pallid sturgeon in the Missouri and Mississippi rivers. Furthermore, because the pallid sturgeon population in the Missouri River is interconnected with that in the middle and lower Mississippi river, any adverse impact to the Missouri River population is likely to influence the viability of populations occurring in those river reaches as well.

Aquatic features in rivers and floodplains are transient (Leopold et al. 1964, Shields and Abt 1989, Salo 1990, Amoros 1990). Natural river systems are subject to high and low flow events and biological processes that can cause rapid changes in successional stage of a particular river feature (Theiling et al. 1999). Hydraulic and morphologic variability through space and time determine the different habitats found both within a given river channel and also in the adjacent riparian and floodplain zones (Brookes 1996). Under natural conditions, habitat diversity within the Missouri River fulfilled the habitats requirements of the pallid sturgeon during all its life-stages (i.e., spawning, larval, juvenile, adults) over a variety of river flows.

Current operations and maintenance continue to arrest most of the natural processes that provide dynamic physical change in rivers (Theiling 1999). As explained previously, the dynamic equilibrium of the Missouri River has been interrupted and replaced a variable system with stable, static conditions, and hydraulic and morphologic variability has declined as the result of past operation and maintenance activities. The proposed future MR and BSNP Operations will perpetuate these inhospitable conditions and, thereby, continue to homogenize the river system and degrade the aquatic habitat. Since pallid sturgeon require diverse and dynamic habitats, it is likely that proposed MR and BSNP Operations will cause the extirpation of this species from the Missouri River.

KANSAS RIVER SYSTEM

Proposed KR Operations will perpetuate the current degraded conditions in the Kansas River, which do not meet the needs of listed species. Flows will continue to be more stabilized than during pre-impoundment, with extreme high and low flows minimized, but prolonging the more medium flows. Coupled with sediment trapping behind tributary dams, this will result in minimized sandbar/island development and movement. More stable sandbars are subjected to more rapid revegetation, making them suitable habitat for a number of wildlife species but unusable by least terns and piping plovers. The KCD currently takes terns and plovers into consideration during their summer-time operations, attempting to avoid and minimize direct take of nests and/or young. However, sandbar maintenance may not be adequately addressed, particularly regarding flows of sufficient stage and frequency to remove vegetation during the dormant season.

Bank degradation has been observed at numerous points along the Kansas River, although the literature (Langsdorf 1950, Metcalf 1966) indicates this was always a prevalent phenomenon. As indicated previously, lateral movement of the channel may not have changed significantly from historic periods. However, it is assumed that bank sloughing may be accelerated today and into the future with systems operation, in part due to increased development onto the floodplain, including removal of a great deal of the perennial riparian vegetation, especially the cottonwood forest. With greater flood security, humans have constrained the river into a narrower "natural" floodplain, and have replaced much of the riparian forest with annual crops and cool-season grasses. The results have been an increase in the amount of steep-sided, crumbling banks along many river bends. The loss of riparian vegetation, both as a direct result of human removal and indirectly, through accelerated bank erosion, has been to the detriment of species using this habitat, including the bald eagle. The future with the CWCP will offer little opportunity for regeneration or restoration of this riparian forest.

Relative to operation of the Kansas River system, neither the CWCP nor the FWOP has been modeled by the Corps, but the FWOP would be represented by a modified run-of-river scenario, in which inflow is matched by outflow at all tributary dams. This would approximate as much as possible the pre-impoundment conditions. The biggest difference would be that sediment would still be continuously trapped behind the dams, leaving the floodplain of the main stem and several much smaller uncontrolled tributaries as the only sources for sandbar development. Consequently, sandbars likely would remain relatively stable for longer periods of time than occurred historically. These sandbars would be inundated more frequently than under the current operations scenario, helping to scour and remove vegetation. However, USGS data indicate that the pre-impoundment hydrograph of the Kansas River may not have been very conducive to tern and plover nesting. In addition to an early summer peak discharge, a secondary smaller peak often occurred in mid-summer, probably of sufficient stage to inundate many areas that may have been suitable nesting sites. That could help explain the lack of historic nesting records for these species on the Kansas River.

The floods of 1993 and 1995 created the habitat terns and plovers require along the Kansas River, and Corps operations since then have helped the newly colonizing birds remain. Because both species are now habituated to nesting on the Kansas River, presumably they would continue to attempt to nest with a new flow regimen. Under a modified run-of-river scenario, drought years likely would occur with natural flows conducive to successful reproduction, as well as years of "normal" or high water when nesting would be nearly or completely unsuccessful. Therefore, the future without the project would likely be better for these species than the current conditions, but neither scenario may be as beneficial for terns and plovers as a modified CWCP with tern and plover management given priority.

A modified run of river scenario should result in a benefit for the bald eagle, since human encroachment on the floodplain would be hindered, and some areas of human development may have to be abandoned. Those areas may naturally revert to perennial riparian vegetation, or they may be restored through active management. Additionally, off-channel wetlands and more frequently flooded areas may redevelop, benefitting numerous species of fish and wildlife, including the bald eagle and other wetland/aquatic species. Because Bowersock Dam, located at Lawrence in Douglas County, is an impediment to upstream fish migration, and because sand and gravel dredging has occurred and would continue to occur with any future Corps reservoir operation scenario, it is unlikely that either future condition, without additional measures such as fish bypass structures, would result in any net benefit for the pallid sturgeon in the Kansas River.

Bald Eagle

In general, the operation of the Kansas River System has had similar effects on the bald eagle and its habitat as has occurred on the Missouri River system. Kansas River meandering has been reduced under System operations and thus, KR Operations have adversely affected the maintenance of cottonwoods in the floodplain. Cottonwood forests are quickly being replaced by trees that are not suitable as bald eagle nesting or roosting trees. In addition, the expansion of agriculture onto the floodplain, encouraged by operations and subsequent flood control, is a major factor contributing to the loss of cottonwood habitat. The loss and degradation of cottonwood forests along the Kansas River continues without the implementation of any major restoration projects. The current operation of the system perpetuates the decline of cottonwood habitat.

Least Tern and Piping Plover

Interior least terns and piping plovers were documented nesting for the first time in the Kansas River watershed in July 1996 in River Segment 16 (the Kansas River from the confluence of the Republican and Smoky Hill Rivers to the mouth of the Kansas River) (D. Mulhern, Fish and Wildlife Service, pers. comm. 2000). The Service presume that unvegetated sandbar and island habitat created during extremely high river discharges in 1993 and 1995 attracted these birds to nest. The Kansas River had not experienced such volumes of water since the tributary reservoir system was constructed and a tremendous amount of sediment deposition occurred, very little of which was revegetated by the summer of 1996.

Operation of the Kansas River tributary reservoirs to support operation of the Missouri River main stem reservoirs for navigation or flood control may, at times, noticeably effect the Kansas River discharge. The current operation of those tributary dams may impair or inhibit channel maintenance, creation or maintenance of sandbars and islands, and vegetation scouring. Also, large volumes of sand and gravel are trapped behind the dams, creating a sediment-starved discharge. Timing of water releases from tributary reservoirs is based primarily on maintenance of flood storage capabilities in the reservoirs, or in some cases on navigation or flood storage needs downstream on the main stem Missouri River. In more recent years, consideration has been given to fish and wildlife resource concerns in and around the reservoir pool itself. However, until those two listed species began nesting, little or no consideration was given to the needs of fish and wildlife in and on the river downstream of the reservoirs. In some instances, reservoir releases may be adversely affecting creation and/or maintenance of habitat necessary for reproduction by those listed species.

The artificial regulation of river stage for flood control and downstream navigation has altered the hydraulics of the Kansas River channel. Patterns of sediment transport, aggradation and degradation have been affected. It is not feasible to attempt to compare current river discharge with historic patterns on the basis of terns and plovers, since neither species nested on the river historically. However, the release patterns of the reservoirs, coupled with bank stabilization projects, along with levee construction and maintenance, have served to create more of a feature-less channel. Rapidly fluctuating river stages produce unstable banks, increasing bank erosion and significantly affecting sediment transport and deposition. The channel contains fewer habitat features such as chutes and backwater areas which may be important in production of the birds' prey base.

The channel, which historically was subjected to frequent bank erosion and redeposition, has today been confined to a narrower overall floodplain, resulting in a bed which has degraded through time. The loss of sediment transport through the dams and commercial sand and gravel dredging have exacerbated the bed degradation. The lower bed has resulted in taller banks, with resulting higher sandbars and islands. Those sandy habitats, higher in elevation, become more readily vegetated, and vegetation tends to remain for longer periods. Consequently, it takes a much higher river stage to effectively scour these bars clean so that they are usable for species like terns and plovers. That is why the floods in 1993 and 1995 created so much new habitat which was previously nonexistent on the Kansas River (D. Mulhern, pers. comm. 2000).

The most direct impact reservoirs can have on nesting least terns and piping plovers is by inundating nests or drowning pre-fledged chicks. Releases of large volumes of water to meet flood control or downstream demands, if occurring during the active nesting season, may wipe out nests if they are located at a vulnerable elevation relative to river stage. Both species will re-nest if given suitable opportunity, but research elsewhere in Kansas indicates that least tern nests initiated after July 15 are unlikely to produce young that will successfully complete migration (Roger Boyd, pers. comm. 1997). So the timing of high water releases is critical, and releases designed to protect birds must also be timed with uncontrolled runoff from rainfall events.

Pallid Sturgeon

As stated earlier, the dynamic equilibrium of the Missouri River and it's primary tributaries such as the Kansas River has been interrupted and replaced by processes and modifications that will continue to degrade the hydraulic and morphologic variability of this river. The loss of the environmental factors that the pallid sturgeon evolved with and that are essential to the species' continued survival is a result of past and continuing operation and maintenance activities. That disruption will have continuing, ongoing effects. The result will be continued homogenization of the river system and degradation of aquatic habitat. Since pallid sturgeon require diverse and dynamic habitats, this species likely has been or soon will be extirpated from the Kansas River.

INTERRELATED AND INTERDEPENDENT ACTIONS

Effects of the Missouri and Kansas River projects under consultation are analyzed together with the effects of other activities that are interrelated to, or independent with, those actions. An interrelated action is an activity that is part of the proposed action and depends on the proposed action for its justification. An interdependent action is an activity that has no independent utility apart from the action under consultation. The following sections further address interrelated and interdependent actions.

Power Marketing

The Western Area Power Administration has the responsibility to market power for the System. Detailed explanation of power marketing within the System is found in the Master Manual (USACE 1979) and the Additional Information Report (USACE 1989a). Power is marketed on both an annual and a seasonal basis and is the by-product of the seasonal pattern of releases required for navigation and flood control. In general, power produced in the winter period is more critical with respect to maintaining load requirements than during the remainder of the year (USACE 1989a). However, pressure to meet power contracts is common during the summer period when power demands for air conditioning and other seasonal needs are high. This demand for power during the summer coincides with the tern and plover breeding season. According to the Corps, regulation of the System for terns and plovers has reduced hydropower output and increased the purchase of higher priced power by WAPA (USACE 1989b). Because power demands can only be met by the System if it is operating, power marketing is an interdependent action.

Missouri River Fish and Wildlife Mitigation Project

Congress authorized mitigation for fish and wildlife resources lost due to the construction, operation, and maintenance of the BSNP, within the states of Missouri, Kansas, Iowa, and Nebraska, in Section 601(a) of the Water Resources Development Act of 1986 (WRDA 86, Public Law 99-662). The Corps supported that authorization with the April 24, 1984, Chief of Engineers' report, " Missouri River Fish and Wildlife Mitigation, Iowa, Nebraska, Kansas, and Missouri." That report, based on a May 1981 Feasibility Report and EIS completed by the Missouri River Division, documented the estimated loss of 522,000 ac (211,410 ha) of aquatic and terrestrial habitat in and along the Missouri River between 1912 and 2003 attributable to the BSNP. Based on those losses, the 1984 report also described various measures to compensate for these losses and recommended a plan to restore, preserve, or develop 48,100 ac (19,480 ha) of land (USACE 1984). Project construction is to include land acquisition and habitat development on 29,900 ac (12,109 ha) of land and habitat development on 18,200 ac (7,371 ha) of existing public lands within the four affected States. Although several mitigation alternatives were proposed, the selected alternative, when fully implemented, would compensate only an estimated 3 percent of lost aquatic acres and 7 percent of lost terrestrial acres attributable to the BSNP. Like the BSNP, the Mitigation Project is completely Federally funded, (i.e., construction, operation, and maintenance).

If fully implemented, the Mitigation Project will preserve and restore 3,200 ac (1,296 ha) of aquatic habitat, and 44,900 ac (18,184 ha) of terrestrial habitat through development of habitat on public lands and acquisition and development on private lands. Funding began in Fiscal Year 1992. As of April, 2000, approximately 79 percent of the originally authorized land acquisition acreage has been acquired (23,549 acquired acres out of 29,900 originally authorized). Land acquisition is complete in Kansas and Nebraska, and is likely to be completed in Iowa and Missouri in the next couple of years. Of these acquired lands, approximately 18 percent (4,295 ac [1,739 ha]) have been developed for fish and wildlife. Habitat development of public lands as of April 2000, is 2,504 ac (1,1014 ha) of the 18,200 authorized, or about 14 percent.

Conceptual aquatic habitat objectives for mitigation sites call for reclaiming and reconnecting filled-in chutes and backwaters, and preventing future sedimentation. Terrestrial habitat development will depend on the existing habitat types, and for public land, existing management objectives. Habitat development may involve dredging of filled-in wetlands, enlarging wetlands, side channel openings/closure, bank stabilization, dike and levee construction, pumping, reforestation, timber stand improvement, food plot establishment and native re-vegetation. Restoration of floodplain habitats such as mature bottomland forests will take many years before significant habitat benefits will begin to accrue to the Missouri River ecosystem. Restoration of other habitats like emergent wetlands, shallow water areas, and chutes should result in more immediate benefits to the river ecosystem.

On most existing public lands, terrestrial habitats are likely to remain isolated from the river by levees. On acquired lands, the value of the Mitigation Project to the riverine environment will depend on its potential for restoring main channel and off-channel habitat, and reconnecting floodplain habitats to the river during the spring flood pulse. Areas with extensive levee protection and no connected aquatic and wetland habitats such as chutes, sloughs, side channels, and temporary and seasonal wetlands would have less value to the riverine/floodplain ecosystem.
Most recently, Section 334 of the WRDA of 1999 reauthorizes the Missouri River Bank Stabilization and Navigation Fish and Wildlife Mitigation Project and increases the amount of lands, and interests in land, to be acquired for the project by 118,650 ac (48,053 ha). To determine the cost of this project modification, Section 334 (b)(1) also directs the U.S. Army Corps of Engineers to conduct a study within 180 days in conjunction with the States of Missouri, Kansas, Iowa, and Nebraska. That report was completed in April 2000. The Corps is awaiting Congressional action to implement the expanded mitigation project.

Based on conceptual plans for restoration projects in the four states, the agencies anticipate the expanded project could potentially provide approximately 7,000 ac (2,835 ha) of shallow water, sandbar habitat (under existing hydrologic conditions) which is important to many of the listed and candidate species, as well as other native species of concern. However, the exact benefits of project-related shallow water, sandbar habitat to the listed and candidate endangered species are unknown at this time. The expanded mitigation project is also expected to provide approximately 20,000 ac (8,100 ha) of additional wetland habitat and 92,000 ac (37,260 ha) of additional terrestrial habitat in the Missouri River floodplain.

Water Depletion Projects

Several Federal water projects (Pick-Sloan Program) that are related to the proposed action and some of which are reasonably certain to occur in the future may impact System operations individually or cumulatively. Some of these include proposed or modifications/sales of irrigation projects, such as the lower Yellowstone Irrigation Facilities; Lake Andes/Wagner and Marty II in South Dakota; rural water systems, such as Mni Winconi, WEB Extensions, Mid-Dakota, and Lewis and Clark; and combined hydroelectric/irrigation projects like the Gregory Pump-Storage project. Although these projects will undergo separate section 7 consultation, they are dependent on System storage and thus are dependent on System operations. If these projects initiate changes in System operations not considered during this consultation, this section 7 consultation should be reinitiated. As System operations are adapted to meet water depletions, the impacts to terns, plovers, pallid sturgeons, or bald eagles will be dependent on changes to the operational guidelines or criteria.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action (e.g., future Corps' bank stabilization projects or private bank stabilization projects requiring a Section 404 permit) are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

In the past decade, the interest to develop land adjacent to the river to take advantage of the amenities that the river offers has increased. Several proposals that key into tourism potential have been completed or proposed in South Dakota. The Governor of South Dakota has promoted Missouri River development in his "Missouri River Resource Enhancement Program." While limited Federal involvement exists in this program, it does indicate a renewed interest in economic development along the Missouri River.

Since the November 1990 biological opinion to the Corps on Operations of the Missouri River Main Stem Reservoir System, residential and commercial development has expanded considerably near population centers such as Bismarck, Pierre, Yankton, and Sioux City. These developments include residential homes, townhouses, and condominiums; golf courses; restaurants; motels; boat ramps; and marinas. This trend is expected to continue. A new bridge has been constructed between Nebraska and South Dakota at Springfield and another new bridge is under construction near Vermillion, South Dakota. Another bridge has been proposed for the upper end of Lake Oahe near Fort Rice, North Dakota. Those new connections across the river are expected to boost local economies and encourage development.

Land clearing, of forested areas in particular, for economic or agricultural development is likely to continue with increased developmental pressure. Idle forested areas are more likely to be developed for economic purposes than agricultural land. Agricultural development will be slower until that portion of the economy changes.

Increased development of Missouri River areas will likely increase recreational use days on the river. The 1993 estimated level of recreation use at the six main stem lakes and three open river reaches is 10 million annual recreation days (USACE 1994b). An increase in recreational pressure will exacerbate human disturbance problems on the river, as recreationists tend to use habitat that also is attractive to terns, plovers, and bald eagles. Public information efforts have been increased, but as populations expand and people find more time for recreation as well as additional facilities, we can still anticipate that human disturbance of terns, plovers, and eagles will probably increase.

Using 1979 data, the Corps estimates (USACE 1979) that total depletions to the surface water supply in the Missouri River Basin will increase from 11.7 MAF in 1979 to 27.4 MAF annually by the year 2020. As depletions increase, they can be expected to have significant effects upon the functions served by the main stem reservoir system (USACE 1979). However, depletions are not increasing as originally envisioned (USACE 1990). The Revised Draft EIS on the Master Manual scheduled for Spring of 2000 will address possible future depletions.

CONCLUSION

MR, BSNP, and KR Operations under past and present operating criteria and annual operating plans have severely altered the natural hydrology and the riverine, wetland, and terrestrial flood plain habitats and fish and wildlife resources of the Missouri River and lower Kansas River ecosystem. Those alterations contributed to the subsequent listing of the tern, plover, and pallid sturgeon as federally endangered or threatened species. If the MR, BSNP, and KR Operations continue without significant alterations, the continued existence of these species on the Missouri and Kansas Rivers will be threatened. The Federal listed status of these species under the ESA is a symptom of the degradation of the ecosystem and a direct attempt (section 2(b) of the ESA) to focus attention on the conservation of the ecosystem upon which they depend.

After reviewing the current condition of the bald eagle, least tern, piping plover, and pallid sturgeon, the environmental baseline for the action area, the effects of the Corps' proposed operation of the Missouri River Main Stem Reservoir System, the BSNP, and the Kansas River Reservoir System, and the cumulative effects, it is the Service's biological opinion that these actions, as proposed, are likely to jeopardize the continued existence of the least tern, piping plover, and pallid sturgeon, but are not likely to jeopardize the continued existence of the bald eagle. No critical habitat currently has been designated for these species, therefore, none will be affected.

Current MR, BSNP, and KR Operations, if continued without significant alterations, likely will cause further declines in other native species (e.g., blue sucker, shovelnose sturgeon, and two candidate species - the sturgeon chub and sicklefin chub) and likely result in additional species listed as threatened or endangered. If more Missouri River species are listed in the future, operational conflicts and constraints will increase, while flexibility to manage the system will decrease. Therefore, the Corps should make conservation of Federally listed endangered and threatened species, and the ecosystem upon which they depend, a priority objective in future operations. Such action will help ensure compliance with both sections 7(a)(1) and 2(b) of the Act.

BALD EAGLE

After reviewing the condition of the bald eagle, the environmental baseline for the action area, the direct and indirect effects of the current Operations of the Missouri and Kansas Rivers under the CWCP and the maintenance of the BSNP, and the cumulative effects of non-Federal actions, it is the Service's biological opinion that the actions, as proposed, are not likely to jeopardize the continued existence of the bald eagle. No critical habitat has been designated for this species, therefore, none will be affected.

The Northern States population of the bald eagle has exceeded recovery goals. Missouri River bald eagles have contributed to those recovery goals and continue to grow in numbers despite the adverse effects of operation of the Missouri and Kansas River systems and the BSNP. The long-term impacts of operations of the Missouri River on nesting and wintering habitat will continue unless management of this habitat is improved. The indirect effects of System operations on wintering habitat have yet to be fully realized. Wintering habitat on the Missouri River has and will continue to decline (e.g., loss of roost habitat), unless management is improved. Conservation recommendations are provided in this opinion to assist the Corps in decreasing long term impacts of system operations on the bald eagle and to help carry out programs for the conservation of this species.

LEAST TERN

After reviewing the current condition of the least tern, the environmental baseline for the action area, the direct and indirect effects of current Operations of the Missouri and Kansas Rivers under the current CWCP and the maintenance of the BSNP, and the cumulative effects of non-Federal actions, it is the Service's biological opinion that the actions, as proposed, are likely to appreciably reduce the likelihood of both the survival and recovery of the least tern in the wild by reducing the reproduction and distribution of that species, thus jeopardizing the continued existence of the least tern. To date, no critical habitat has been designated for this species, therefore, none will be affected.

The main stem of the Missouri River harbors between 7 and 11 percent of the interior population of the least tern, and accounts for a significant portion of both their historic and currently occupied range.

Additional terns occur on major tributaries to the Missouri River and may use the Missouri River depending upon habitat conditions. The Missouri River may support greater numbers of least terns when tributaries (e.g., the Platte River) that do not have a stable water supply, dry up or flood. These changing habitat conditions may cause birds to move to the Missouri River to nest or renest.

Construction of the Missouri River main stem dams and the BSNP have eliminated much of the tern's essential nesting habitat on the Missouri River. Current river operations on the Missouri and Kansas Rivers, as well as the continued maintenance of the BSNP, are expected to perpetuate these habitat losses and result in additional losses in the future. Nesting failure due to operational loss of habitat and flooding of nests, in combination with degradation and vegetative encroachment on habitat, human disturbance, and predation on the species is producing poor reproductive success and declining habitat conditions. Those losses are significant and threaten the survival and recovery of the tern.

PIPING PLOVER

After reviewing the current condition of the piping plover, the environmental baseline for the action area, the direct and indirect effects of the current Operations of the Missouri and Kansas Rivers under the current CWCP and maintenance of the BSNP, and the cumulative effects of non-Federal actions, it is the Service's biological opinion that the actions, as proposed, are likely to appreciably reduce the likelihood of both the survival and recovery of the piping plover in the wild by reducing the reproduction and distribution of that species, thus jeopardizing the continued existence of the piping plover. To date, no critical habitat has been designated for this species, therefore, none will be affected.

The Missouri River supports between 12 and 31 percent of the Northern Great Plains plover population and accounts for a significant portion of both their historic and currently occupied range. The number of plovers supported by the Missouri River fluctuates depending on water cycles that occur throughout the different plover habitats in the Northern Great Plains. The Missouri River may support greater numbers of plovers when the North Dakota/Montana and Canada prairie wetlands and Missouri River tributaries experience drought.

Construction of the Missouri River main stem dams and the BSNP have eliminated much of the piping plover's essential nesting habitat on the Missouri River. Current river operations on the Missouri and Kansas Rivers, as well as the continued maintenance of the BSNP, are expected to perpetuate these habitat losses and result in additional losses in the future. Nesting failure due to operational loss of habitat and flooding of nests, in combination with degradation and vegetative encroachment on habitat, human disturbance, and predation on the species, is producing poor reproductive success and declining habitat conditions. These losses are significant and threaten the survival and recovery of the piping plover.

PALLID STURGEON

After reviewing the current condition of the pallid sturgeon, the environmental baseline for the action area, the direct and indirect effects of the current Operations of the Missouri and Kansas Rivers under the CWCP and the maintenance of the BSNP, and the cumulative effects of these actions, it is the Service's biological opinion that the actions, as proposed, are likely to appreciably reduce the likelihood of both the survival and recovery of the pallid sturgeon in the wild by reducing the reproduction and distribution of that species, thus jeopardizing the continued existence of the pallid sturgeon. No critical habitat has been designated for this species, therefore, none will be affected.

The main stem Missouri River and the lower reaches of its major tributaries such as the Yellowstone and Platte Rivers make up more than one half the pallid sturgeon's range and account for nearly eighty percent of all catch records. Less than 24 percent of the Missouri River remains in a free-flowing state, however, that habitat has been fragmented by dams and reservoirs. Except for less than 200 mi (322 km) above Fort Peck Reservoir, Missouri River hydrology in flowing reaches is affected greatly by the Corps' operation of main stem dams.

As discussed in the status section of this biological opinion, pallid sturgeon populations are declining throughout their range. Although spawning occurs, there is little evidence of successful reproduction and no indication of recent recruitment. Upper Missouri River populations are reproductively isolated and aging. Hybridization appears to be prevalent throughout much of the species' range. The Atchafalaya River population has a diverse age structure, but is also hybridizing with shovelnose sturgeon and is reproductively isolated from the remainder of the species' range. Unless aquatic features vital to the pallid sturgeon are restored to the Missouri River, the pallid sturgeon likely will not continue to exist in the Missouri River.

The Missouri River is important to the survival and recovery of pallid sturgeon for a number of reasons. The Missouri River represents a significant portion of four of six designated recovery priority management areas identified in the recovery plan (USFWS 1993). The Service believes some natural reproduction may be occurring in these three areas and they also may be important juvenile rearing areas.

Life history characteristics, previously discussed, underscore the importance of the interconnectedness of the Missouri and Mississippi Rivers in terms of pallid sturgeon population biology. The interconnectedness of those river systems may be very important in maintaining the genetic connectivity and continuity of pallid sturgeon by ensuring that genetic material is dispersed throughout the population and genetic diversity is maintained. Continued maintenance of the BSNP will perpetuate degraded habitat conditions on the Missouri River, greatly limiting the Missouri River's suitability to pallid sturgeon. Such conditions may impair the genetic exchange between pallid sturgeon in the Missouri and Mississippi rivers. Furthermore, because the pallid sturgeon population in the Missouri River is interconnected with that in the middle and lower Mississippi rivers, any adverse impact to the Missouri

River population is likely to influence the viability of populations occurring in those river reaches as well.

Although it is likely that the pallid sturgeon has already been extirpated from the Kansas River, the proposed KR Operations will perpetuate the unsuitability of this river as sturgeon habitat and thus prevent reestablishment to the detriment of the species' survival and recovery.

The continued operations of the Missouri and Kansas River and the BSNP will result in habitat loss and degradation, and perhaps more importantly, will continue to disrupt and alter dynamic natural river processes (e.g., channel meandering, erosion, deposition), leaving little opportunity to reestablishment important aquatic habitats. The most evident effect is the continued loss and degradation of existing aquatic habitat which reduces pallid sturgeon spawning substrate, larval and juvenile rearing habitat and seasonal refugia. That loss of habitat will likely lead to further reductions in the reproduction and recruitment of pallid sturgeon and increased incidences of hybridization with shovelnose sturgeon. Furthermore, the disruption and alteration of dynamic river processes also inhibits the creation and reestablishment of aquatic habitats which are important to pallid sturgeon and will lead to further reductions in pallid sturgeon productivity, but also will prevent increases in productivity necessary to ensure the continued survival and recovery of the species.

In addition to those two primary effects, continued MR, KR, and BSNP Operations and maintenance will also result in a series of secondary effects that are also of importance. Those include:

- Reductions in suspended sediment transport.
- Reductions in the quantity, quality and availability of the natural forage base.
- Continued disruption of migration routes.
- Transference and homogenization of contaminants.

Reductions in suspended sediment transport are factors in increased predation, competition with other species, and reduced foraging capability of pallid sturgeon. Similarly, operation and maintenance activities will reduce the quantity, quality, and availability of the natural forage base of pallid sturgeon. While past operation and maintenance activities associated with the Missouri River, Kansas River, and BSNP have reduced that important resource, continuation of those activities will prevent its recovery. Migration routes will continue to be blocked by dams that affect reproductive success and genetic exchange. As a result of the above, it is likely that the habitats within the riverine reaches of the Missouri River will remain so degraded that pallid sturgeon are likely to be extirpated from those areas and/or hybridization will become so prevalent that genetic swamping will occur.

Those effects will have the greatest influence on the Missouri River, which is an important portion of the species range. However, as described above, continued MR and BSNP Operation and maintenance may also substantially impact pallid sturgeon populations in both the middle and the lower Mississippi River. That is, continued operation and maintenance will affect the core of the pallid sturgeon's contiguous range (i.e., Lower Missouri, Middle and Lower Mississippi River), and hence, appreciably reduce the likelihood of both survival and recovery of the species.

REASONABLE AND PRUDENT ALTERNATIVE

Regulations (50 CFR §402.02) implementing section 7 of the Act define a reasonable and prudent alternative (RPA) as an alternative action, identified during formal consultation, that:
(1) can be implemented in a manner consistent with the intended purpose of the action; (2) can be implemented consistent with the scope of the action agency's legal authority and jurisdiction; (3) is economically and technologically feasible; and (4) would, the Service believes, avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat.

The Act requires the Service and the Corps work to develop a reasonable and prudent alternative to avoid jeopardizing the continued existence of the least tern, piping plover, and the pallid sturgeon and allow the project to continue. The Service has provided the Corps numerous documents since 1990 that outlined effects of the MR, BSNP, and KR Operations on the least tern, piping plover, and pallid sturgeon and characterized actions necessary to conserve and/or avoid jeopardy to listed species (e.g., 1990 Biological Opinion on Annual Operations, 1992 Endangered Species letter and input to the Corps, 1993 Interim Fish and Wildlife Report, 1994 Draft Biological Opinion on the Draft Environmental Impact Statement, comments on the 1994 Draft EIS, September 1999 comments on alternatives associated with the August 1998 Preliminary Revised Draft EIS, January 2000 comments on the preferred alternative for the Revised Draft EIS, March 2000 letter on avoidance of jeopardy, and various letters on the Annual Operations Plan over the last 10 years).

The primary elements necessary to avoid jeopardy to listed species have not changed substantially since they were first outlined in the 1990 Biological Opinion and later refined further in the 1994 Draft Biological Opinion. Information gained from operational and restoration experiences during the last 10 years reinforces the need for immediate adoption of those elements. During the informal phase of the current consultation, the Service and the Corps jointly developed species profiles that document biological information and needs of listed species; management actions to address those needs, and segment-specific species and management priorities; and lay the groundwork for the RPA. That information was used to prepare the biological opinion.

The Service's conclusion of jeopardy to the tern, plover, and pallid sturgeon reflects degradation of the entire ecosystem. The intent of the section 2(b) of the Act is to focus attention on the conservation of the ecosystem upon which listed species depend. Such an approach is often not readily apparent in single species consultations for small or localized project areas, but is paramount in multiple-species consultations covering large regional areas. Research emphasizes the concept that recovery of endangered aquatic biota and biodiversity conservation must be pursued through an ecosystem approach (Blackstein 1992, Williams and Rinne 1992, Sparks 1995). This concept is particularly important given the wide-ranging nature of the species, geographic scope of this consultation, and the interrelatedness of the actions.

No single elements will adequately avoid jeopardy to the three listed species. Therefore, the reasonable and prudent alternative developed to avoid the likelihood of jeopardizing the continued existence of the tern, plover, and pallid sturgeon includes elements applicable to all three listed species in the ecosystem, as well as elements specific to each of the three species.
The Service believes that, collectively, all the "ecosystem" and species elements in the reasonable and prudent alternative must be implemented successfully to restore enough of the original form and function of the Missouri River, such that the increased suitability of the aquatic habitat will ensure the survival and preclude jeopardizing the existence of listed species. Under the terms and conditions implementing the incidental take statement, the Corps will be required to provide the Service an annual report which documents progress in the implementation of the reasonable and prudent alternative.

Because this biological opinion has found jeopardy to listed species, the Corps is required to notify the Service of its final decision on the implementation of the actions of the reasonable and prudent alternative identified below.

RPA ELEMENTS APPLICABLE TO MULTIPLE LISTED SPECIES IN THE ECOSYSTEM

Elements applicable to multiple listed species in the ecosystem must be implemented to avoid the likelihood of jeopardizing the three listed species, and also will provide incidental benefits to native candidate species and other non-listed species in the Missouri River System. Implementation of these "ecosystem" elements is necessary to offset jeopardy to the listed species and the ecosystem upon which the continued existence of these species depend, and may possibly help preclude the need to list other species.

Riverine aquatic habitat, terrestrial floodplain habitat, biodiversity, and the entire health of the Missouri River ecosystem historically was shaped primarily by the timing and amplitude of the natural hydrograph and the interaction between the river and its floodplain. The natural hydrograph determined the biological resources, precontrol channel morphology, and floodplain characteristics of the Missouri River.

The high spring flows of the pre-project hydrograph stimulated native fish spawning migrations, and helped maintain high turbidity levels essential for the native fish species that evolved under such conditions (Pflieger and Grace 1987). The natural hydrograph provided spawning cues; sediment transport; organic and nutrient cycling through periodic inundation of side channels, backwaters, and the floodplain; invertebrate reproduction (Petts 1984); suitable temperature regimes for spawning and invertebrates; and dynamic variability within and among years.

Sedell and Richey (1989) described the importance of the hydrologic interaction of the river with its floodplain forests and wetlands and termed this connection the "river continuum." Junk et al. (1989) further described the "flood pulse concept" and proposed that it is the major controlling factor in river-floodplain-biota interactions. They suggested that the flood pulse linked the floodplain (i.e., a source of nutrients, organic material, and seasonal habitats) and the riverine channel (i.e., a route to gain access to feeding, spawning, nursery, or slackwater habitats created on the floodplain by the flood pulse) and concluded that most riverine animal biomass was derived directly from production within the floodplain. The principal driving force for the existence, productivity, and biotic interactions of the river-floodplain ecosystem is flooding. A periodic flood pulse is critical to floodplain connectivity and restoration of ecosystem processes (Bayley 1991, Ward and Stanford 1995, Galat et al. 1998).

The idea that rivers and their floodplains are so intimately linked that they should be understood, managed, and restored as integral parts of the same system makes up the foremost concept of river restoration efforts (National Research Council 1992). Johnson et al. (1994) summarized the scientific literature concerning the benefits of flooding to river ecosystems, and the consequence of flood control for such systems.

In a compilation of the state-of-the-art information on the restoration of aquatic ecosystems, the National Research Council (1992) defined restoration as the return of an ecosystem to a close approximation of its condition prior to disturbance. Restoration requires that both the physical form and functions of the ecosystem be recreated. Junk et al. (1989) stated: "In virtually all instances of successful rehabilitation of large rivers, it is essential to retain or reestablish some semblance of the natural hydrological cycle." Among others, Dodge and Ryder (*In* Dodge 1989), Hesse et al. (1989), Hesse and Sheets (1993), and Poff et al. (1997) maintain that mitigation of impacts to big river systems like the Missouri will require an ecosystem approach that recovers some semblance of the natural hydrology and channel morphology. Although biologists are uncertain how far a modified hydrograph can depart from the historical hydrograph and still restore the natural hydrologic cycle, Zincone and Rulifson (1991) suggested 25 percent of the expected discharge would be sufficient. The departure likely will vary from river to river. Species may not need full restoration to pre-project conditions to avoid jeopardy, but sufficient restoration of major missing components of the ecosystem, as proposed by the Service and other big river managers, may allow them to successfully reproduce and recruit.

The scientific evidence and importance of system level restoration of habitats and hydrology was reinforced by comments received on questions relating to this issue from a group of peer review scientists in May 2000 (Appendix V). Effective Missouri River habitat restoration is therefore multi-faceted, involving a combination of reservoir operational changes, structural modifications, and non-structural actions (e.g., floodplain acquisition or easements).

Current MR, BSNP, and KR Operations do not adequately provide ecosystem functions or parameters related to sediment transport, nutrient supply, turbidity, temperature, fish migration barriers, or other ecological processes necessary for long-term viability of the tern, plover, pallid sturgeon, and other fish and wildlife communities associated with the Missouri River ecosystem. Habitat loss and alteration, as well as disruption and alteration of the dynamic processes that create, restore, and maintain habitat, resulting from continued operations on the Missouri and Kansas River and maintenance of the BSNP are likely to jeopardize the continued existence of the pallid sturgeon, interior least tern, and piping plover. To avoid jeopardizing the continued existence of those species, it is necessary to (1) restore a portion of suitable riverine aquatic habitats and hydrologic conditions necessary for successful reproduction and recruitment of the three species, and (2) provide culturing and population augmentation (in the near-term) for the pallid sturgeon to ensure genetic viability of the species until the necessary habitat and hydrologic conditions are restored. To achieve that while continuing Missouri and Kansas river operations and maintenance of the BSNP, it is necessary to: (1) implement flow (i.e., variability, volume, timing, and temperature) enhancement with the goal of providing the hydrologic conditions necessary for species reproduction and recruitment; (2) implement a concurrent habitat restoration program with the goal of restoring habitat quality, quantity, and diversity so that the benefits of adequate dynamic natural river processes are restored; (3) conduct a comprehensive endangered species habitat and monitoring program to better characterize habitat use (by all life stages), longevity, and availability in the Missouri River to facilitate and guide habitat restoration and flow modification; and (4) establish an adaptive management framework to implement, evaluate, and modify the components of the RPA in response to variable river conditions, species responses, and increasing knowledge base. The Service believes that those actions will assist in restoring and maintaining the functional ecosystem, and will ensure that the likelihood of survival and recovery of the pallid sturgeon, interior least tern, and the piping plover are not appreciably reduced.

Therefore, the following RPA elements applicable to multiple listed species (i.e., least tern, piping plover, and pallid sturgeon) address structural, non-structural, and operational actions that, if implemented, will restore some of the lost habitat functions and processes of the Missouri and/or Kansas Rivers. This restoration will help offset jeopardy to the least tern, piping plover, and pallid sturgeon. Because of differences in existing habitat character and physical environment, the need and opportunities to restore river habitats vary by river reach.

XXI. Adaptive Management

The Corps shall adopt adaptive management as one tool to preclude jeopardy to least terns, piping plovers, and pallid sturgeon. Adaptive management is a process that allows regular modification of management actions in response to new information and to changing environmental conditions. Adaptive management is based on the premise that managed ecosystems are complex and inherently unpredictable. The complexity of the Missouri River ecosystem and management for fish and wildlife underscores the need for such an approach to ensure the variability and flexibility necessary to manage multiple species and be consistent with project purposes.

The adaptive management framework is a particularly effective way to address multiple species, ecosystem variability, and biological unknowns about the lifecycles, behaviors, and habitat requirements of the listed species under consultation. This is especially true with the aquatic species of concern, the pallid sturgeon. Whereas direct observations of species' behaviors often occur for terrestrial species, such as the least tern and piping plover, the ability to observe the behaviors of aquatic species is far more difficult. This difficulty is further compounded when dealing with a wide-ranging aquatic species with an exceedingly small population, as with the pallid sturgeon. Thus, adaptive management is an approach that can address various biological responses of threatened and endangered species, and other rare species to changes in the Corps' MR, BSNP, and KR Operation or habitat restoration projects.

The Service recognizes that because of the complexity of this large river system, various flow alterations may provide more immediate benefits to some listed species, while other alterations would benefit other listed species. Over the long-term, however, ensuring variable river flows and processes should provide the range of conditions necessary to support self-sustaining populations of all the species under consultation. Variability is essential to the integrity of the river ecosystem (Richter et al. 1998, Galat and Lipkin 1999). Therefore, any river operation program followed by the Corps must be based on the need to maintain variability. Adaptive management is an important and effective way to insert variability and flexibility in river operations, taking maximum advantage of the inherent variability of precipitation and runoff within the river system.

The Corps and the Service agree that subsequent resource management actions in the Missouri River shall be pursued within an adaptive management framework that embraces the uncertainties of ecosystem responses and attempts to structure management actions to best address those uncertainties, recognizing that learning is a critical outcome. Halbert (1993) notes that “adaptive management treats all management actions as deliberate experiments ... to sort out system process.” In that regard, adaptive management is viewed as a continuous process of actions based on testing, evaluating, informing, and improving. It will be the basis from which the Service can identify and evaluate performance.

This RPA will describe the framework for an adaptive management approach to the Corps’ river operations and maintenance along the Kansas and Missouri rivers to avoid jeopardy to listed species and facilitate their eventual recovery. This approach will include a regular regime of discussion, information exchange, evaluation and reevaluation, and monitoring between the Corps and the Service. The general management actions identified in this opinion as part of the current project descriptions and as the RPA, likely will be conducted, modified and continually improved upon through adaptive management.

The Corps, in cooperation with the Service, shall identify and describe the specifics of implementing and modifying management actions needed at any given time. The specific methods of implementing the management actions may vary yearly and monthly as necessary to adapt to changing river conditions. Modifications to management actions shall be based on an evaluation of habitat, flow, climate, species response and other information that is available each year. The Corps shall address implementation of those actions through meetings held jointly with the Service at least twice a year, or more frequently if needed. Monitoring shall be used to document how management actions were implemented and their effects within the river and on listed species. Monitoring species responses shall be necessary to determine progress towards species survival. The agencies shall jointly determine what is sufficient progress within specific timeframes that will indicate that the Corps' actions are avoiding jeopardy.

Specific recommendations incorporating the adaptive management approach are included in the following elements of the Reasonable and Prudent Alternative.

V. Agency Coordination Team (ACT): An essential component of this RPA is establishment of an agency coordination team (ACT) that will serve to guide development and implementation of future river management measures to benefit listed species consistent with the Corps' statutory responsibilities. While some management actions will have more immediate benefits to listed species, all are important components of a comprehensive river operation program to prevent jeopardy and facilitate recovery. Those actions that contribute to flow variability, creation of dynamic sandbar and in-channel habitats, and those that provide triggers for reproductive response are the highest priorities, although they may take several years to implement. Physical habitat restoration, another essential component to avoid jeopardizing the tern, plover and sturgeon, may be implemented more quickly.

Therefore, the Corps shall work with the Service and other parties with biologic or engineering expertise, such as the MRNRC, MRBA, and Tribes to immediately establish an agency coordination team (ACT) to identify and implement the goals of this biological opinion. That team will be responsible for ensuring implementation of future conservation measures; tracking, evaluating, and documenting the results of those measures; and tracking and documenting sufficient progress in conserving listed species. The initial point of contact will be the Reservoir Control Center Chief for the Corps and the North Dakota Field Supervisor for the Service. The ACT should involve additional agencies or groups with appropriate biologic and engineering expertise.

The ACT shall jointly develop targets against which they can evaluate whether the Corp is making sufficient progress toward avoiding jeopardy, increasing species status and/or habitat conditions, or implementing effective conservation actions. Progress toward each target shall be evaluated semi-annually. Species responses to management actions, however, are not likely to be immediately detectable. It may take many years to see a positive species response due to difficulties in monitoring the species, particularly the pallid sturgeon; the time necessary to recreate essential river processes and habitats; the biologic "lag time" between environmental stimulus and biologic response; and the variability in climatic conditions that may delay reproductive triggers, habitat restoration, or cause other temporary setbacks in reproductive success of listed species. Therefore, targets for evaluating success shall be based on a combination of short-term physical changes in river conditions plus longer-term changes in listed species survival and reproductive success.

Coordination Meetings: As discussed above, the ACT shall meet, at a minimum, twice each calendar year (March and October) to develop an action plan for the upcoming year; to evaluate the responses/effects of the previous year's actions; and to use this information to make necessary alterations in the upcoming years management actions. The action plan shall describe in detail the range and frequency of necessary management actions to avoid jeopardy. Those actions shall be subject to further evaluation and modification by both agencies as management "experiments" are undertaken in future years. Additional coordination (i.e., meetings, conference call, etc.) shall occur as needed to address issues requiring immediate attention. Following coordination with the Service, the Corps should plan an organizational meeting of ACT for March 2001.

At the March meeting, the ACT shall develop a river management plan for the upcoming months based on river conditions, climatological forecasts, and progress over the previous years. That plan shall identify situations/conditions that create opportunities for improving river conditions for the listed species and shall designate more specific recommendations for river operations that the Corps shall implement should those situations occur. For example, opportunities for increasing spring flows may be greatest during years with above normal water levels/project inflow in the reservoirs and low to moderate river flows and precipitation in the lower basin. Alternatively, if specified spring flows have occurred during the past several years, there may be no need to discharge high flows the following spring, particularly if system inflow is low.

The purpose of the October meeting is to evaluate information on river operations conducted that year and the species' responses, changes in habitat conditions, changes in timing and volume of flows, and changes in river use, etc. Those actions that create a positive species response or positive change in habitat conditions will be continued or changed for the upcoming year based on meeting specific biological goals.

The ACT shall also determine whether actions were implemented as agreed to at the beginning of the year. They shall document improvements in listed species status or of specific river conditions, and whether sufficient progress has been made towards avoiding jeopardy. At the meeting, the Service and the Corps shall also identify potential operational changes or other management actions that likely will be needed in the upcoming year. The management plan shall then be revised as necessary in the March meeting of the following year.

B. Endangered Species and Habitat Monitoring Program: The Corps has the primary responsibility for, and shall monitor the biologic resources and responses of threatened and endangered species to changes in the Missouri and Kansas River operations, maintenance, or habitat restoration projects. Monitoring is needed to assess the biologic value of Corps management decisions. The Corps, in cooperation with the Service, shall develop a comprehensive threatened and endangered species monitoring plan within 1 year of the date of this opinion. The ACT shall serve as a forum to help accomplish this task. The Corps is to be commended for the comprehensive least tern and piping plover monitoring program it has implemented, providing state-of-the-art information on habitat and birds critical to river management decisions.

For many years, the Service has identified the need to collect comprehensive, long-term natural resource data on the river to guide management. This includes using long-term monitoring in conjunction with focused investigations to provide an adequate database to evaluate the biologic effects of additional changes to flow management. Annual progress reports are an integral and required part of the monitoring program or restoration of riverine habitats.

Monitoring of least terns, piping plovers, and pallid sturgeon shall require the Corps to apply for authorization under section 10 of the ESA. The section 10 authorization will address potential take resulting from the monitoring program.

C. Annual Report: The Corps shall provide an Annual Report on threatened and endangered species conservation activities to document compliance with the provisions of the biological opinion. This report shall document results of monitoring for each species and their habitats and the progress in implementation of the elements of the reasonable and prudent alternative, terms and conditions for implementation of reasonable and prudent measures to minimize take, and conservation recommendations. This report is similar to reports completed under the 1990 biological opinion and ESA subpermitting requirements. Specific monitoring components to be included in this report are addressed in the ecosystem RPAs for multiple listed species, RPAs for individual species, and the RPMs. The report shall be due December 31 of each year. Additionally, this report will provide the Service, ACT, States, Tribes, Missouri River Natural Resources Committee, Missouri River Basin Association, and other parties information necessary to evaluate the effectiveness of the Corps' actions.

Prior to implementing tern and plover and pallid sturgeon management strategies for each operating year, the Corps shall demonstrate that the planned System operations and the management strategies will satisfy the elements of the reasonable and prudent alternative, reasonable and prudent measures, and meet fledge ratio goals. The Corps shall provide this information to, and/or meet with, the Service during development of the draft AOP in the fall and after March 1 when the runoff forecast is made. We anticipate that this will provide enough time to plan or implement operational scenarios that will be necessary for the new operating season.

II. Flow Enhancement

A. Gavins Point: Flow modification at Gavins Point are needed to provide an ecologically improved hydrograph in the lower Missouri River (Galat 1999, Hesse 1999). Such flows would restore and maintain sandbars and shallow water areas that serve as nesting and foraging habitat for least terns and piping plover, as well as nursery habitat for pallid sturgeon and other native fishes; trigger spawning activity in pallid sturgeon and other native fishes; and reconnect potential riverine and floodplain habitats inundating side channels, backwaters, and other off-channel areas needed as spawning and nursery areas for pallid sturgeon and forage fishes, as well as providing additional foraging areas for terns and plovers. The Missouri River downstream of Gavins Point Dam, influenced by Gavins Point flows, is a high priority management area for the least tern, piping plover, and pallid sturgeon. Spring and summer flow management is an integral component of the measures to avoid jeopardy to listed species. Flow modifications that include higher spring and declining or lower summer flows than now exist will provide the necessary biological cues and habitat to benefit terns, plover, and pallid sturgeon, as well as other fish and wildlife. The Service recognizes that implementation of target flows depends on system storage and may not be met every year due to differences in the system storage, annual run-off conditions, and flood control conditions. Thus, there will be some variability from Gavins Point releases that reflects the inherent variability in the amount of water in the system. In addition, through adaptive management, the Corps can restore an additional measure of flow variability by fine-tuning flow modifications based on the results of the endangered species and habitat monitoring program.

The Gavins Point flow scenario identified below shall be considered as a starting point subject to review and modification based on the biological response of the listed species and appropriate recommended changes through the adaptive management process.

2. The Corps shall implement a spring flow from Gavins Point Dam of 17.5 Kcfs (initial target) above full service navigation level and within a range of 15-20 Kcfs an average once every 3 years, as runoff conditions permit (roughly 33 percent of the years). Those increased flows shall occur for 30 consecutive days between May 1 and June 15. Instead of an abrupt rise to target levels, flows shall be ramped up about 2 Kcfs per day the first week to reach target levels, held steady for the next 2 weeks, and then stair-stepped down about 2 Kcfs per day to base flows of full service navigation levels.

   Summer flows shall be decreased annually stair-stepping down from base current flows to an interim target of 25 Kcfs by June 21, and held at 25 Kcfs until July 15. Declining flows increase acreage of available sandbars and shallow-water, slow velocity habitat. This habitat is necessary for successful nesting, egg laying, hatching, and foraging for terns and plovers, and as nursery and refugia habitat for successful larval development of pallid sturgeon and other native fish. On July 15, the flows shall be stair-stepped down to a flow of 21 Kcfs until August 15. This 4-week period is critical for young terns and plovers. Lower flows will create additional plover foraging areas on sandbars, decrease bird predation rates by expanding habitat, and increase foraging success of terns by concentrating young-of-year fish. Lower flows will also increase slack water habitat for young-of-year pallid sturgeon and native river fish and improve recruitment potential.

On August 15, flows shall be stair-stepped up to 25 Kcfs and held there until September 1st. Lower flows during the last 2 weeks of August will benefit late nesting terns and plovers and provide additional habitat for young-of-year fish. Reservoir storage shall not be evacuated during the summer low flows unless pools are in or predicted to rise into the exclusive flood control zone.

The Corps shall implement flow modifications no later than 2003, provided system storage/runoff is adequate. The recommended flow modifications should occur when system storage/runoff is projected to be less than the upper decile, but above a lower quartile water year. In years of higher water levels (i.e., greater than upper decile), there would likely be some form of spring rise in system operations to accommodate high system input. The recommended spring flow modifications would not be needed, while summer low flows would likely be operationally infeasible. In lower water-level years (i.e., less than lower quartile), water in the system would be inadequate for a spring rise and summer flows likely would be reduced to conserve water without implementing special flow modifications. Therefore, the recommended flows from Gavins Point are not expected to contribute to effects of floods during high water years, nor exacerbate drought conditions during low flows. While full implementation of modified flows should occur by 2003, the Corps should move expeditiously to implement components of recommended flows (e.g., spring rise only, summer low flow only, modified rise or low flow) as quickly as possible.

2. In 2001 and 2002, as well as years when the recommended flows are infeasible, the Corps, in coordination with the ACT, shall examine expedited implementation of other elements of the RPA to ensure adequate progress towards avoiding jeopardy of the least tern, piping plover, and pallid sturgeon. While in many cases this may involve increasing the pace of alternative methods of habitat creation, such alternatives do not offset the need for hydrologic changes necessary for successful pallid sturgeon spawning, and production of forage for nesting terns and plovers. Therefore, such measures could not be used in-lieu of hydrologic improvements over the long-term.

B. Fort Peck: In the 200-mi (322 km) reach of the Missouri River below Ft. Peck (Segment 2), higher spring flows and warmer water temperatures during the open water period are needed to improve environmental conditions for the pallid sturgeon, least tern, and piping plover. The higher and warmer flows will provide the hydrologic cue for pallid sturgeon and other native fish to spawn. The increased water temperature will help normalize the temperature of the river, provide the temperature cue more suitable for pallid sturgeon egg maturation and spawning (as well as spawning of other native fish), and improve recruitment success for these species. The higher flows will restructure the channel and increase/ improve the available riverine habitat by partially restoring the environmental conditions that listed species evolved with, by redistributing sand for summer flow sand bars, inundating side-channels, and connecting backwater areas to increase primary production which will, in turn, provide additional nutrients, forage fish, and macroinvertebrates needed for larval fish or terns and plovers production and recruitment.

Criteria for the improved spring flows and warm water releases from Fort Peck have been jointly developed through coordination between the Service, Corps, U.S. Geologic Survey, WAPA, and Montana and North Dakota game and fish departments. Through adaptive management, modifications to these criteria may occur through the ACT.

The higher flows and warm-water releases are needed, on average, once every 3 years (33 percent frequency occurrence) and should be incorporated into the unbalancing strategy for the upper three reservoirs (discussed in Section III which follows). A combined release from the spillway and powerhouse is needed to increase water temperature. To provide adequate head for warm-water release from spillway gates (2225 msl), the minimum elevation of Fort Peck Reservoir should be 2230 msl. The Fort Peck releases should only be conducted in years of sufficient runoff (i.e., Median, Upper Quartile, or Upper Decile years) and be timed to avoid lowering the lake during the forage fish spawn (approximately mid- April to mid-May). Initiation of higher discharge shall emulate the timing of the natural inflow into the lake and occur 2-3 days after the rising stage at the Landusky, MT, gauge, but not before May 15 because of cold water temperatures. The peak discharge will range between 20 Kcfs and 25 Kcfs (approximately 19 Kcfs from the spillway and 4 Kcfs from the powerhouse) and persist for a minimum of 3 days. Warm-water releases should continue for at least 30 days. The combination of releases from the spillway and powerhouse should be mixed to achieve a minimum target temperature of 64.4? F (18? C) at Frazer Rapids (RM 1746).

1. In spring 2001, or the first year reservoir elevation and runoff criteria can be met, the Corps shall implement a “mini-test” out of Fort Peck Reservoir to gain sufficient data on combinations of spillway and powerhouse discharges and water temperatures to develop a model for relationships. The mini-test generally should follow the criteria addressed above for reservoir elevation, runoff year, and initiation, but will last only about 3 weeks as flows are varied from 7 Kcfs to 15 Kcfs as various combinations of spillway and powerhouse releases are monitored.

2. In spring 2002, or the first year following the “mini-test” that reservoir elevation and runoff criteria can be met, the Corp shall implement a “full test” of improved flows and warm-water releases out of Fort Peck Reservoir based on the criteria addressed above or as modified through coordination between ACT and the other parties involved in the development of the criteria.

3. In spring 2003, or the first year following the “full test” that reservoir elevation and runoff criteria can be met, the Corps shall implement full flow enhancement releases out of Fort Peck Reservoir based on the criteria addressed above or modified, as appropriate, by the ACT from the 2002 “full test” results.

The pallid sturgeon population remaining below Fort Peck Dam and above Lake Sakakawea represent an important portion of the total population. The adult pallid sturgeon within this reach are nearing the end of their life expectancy and individual female pallid sturgeon may only attempt reproduction during one or two more spawning events. Necessary actions, including baseline monitoring of the habitat conditions, the response of pallid sturgeon to enhanced flows, and coordination of actions, shall be conducted so that a full test of the improve improved flow regime can be implemented by 2002, if appropriate runoff and reservoir conditions occur. In cooperation with the Service, USGS, WAPA, North Dakota Game and Fish Department, Montana Department of Fish, Wildlife, and Parks, and other partners, the Corps shall establish a protocol for monitoring prior to the 2001 test.

C. **Other Segments:** Through adaptive management, the Corps shall investigate the applicability of flow enhancement at Garrison by 2005 and implement, if appropriate.

III. Unbalanced Instrasystem Regulation

Currently, the Corps "balances" the amount of water in storage in the three largest Upper Missouri River main stem system lakes, i.e., Fort Peck Lake (Segment 1), Lake Sakakawea (Segment 3), and Lake Oahe (Segment 5). This does not mean that the amount of water in storage is always directly proportional to the total storage capacity in these three lakes. Instead, it means that the water is distributed to meet the authorized project purposes in an efficient manner. For example, extra water is retained in Fort Peck Lake and Lake Sakakawea going into the winter so that this water can be available for winter power generation needs. However, at some time during the year, the amount of water is approximately proportionally distributed among those three lakes.

In recent years, the Service has regularly supported unbalanced intrasystem regulation via its comments on the Annual Operating Plans to improve reservoir young-of-year fish production and survival, and increase habitat and productivity of threatened and endangered species. This unbalancing consists of lowering the storage in one lake by approximately 3 ft (.9 m), holding the level constantly low in the second lake (drawn down the year before), and raising the level in the third lake at least 3 ft (.9 m) to inundate the vegetation that grew around its rim the prior year (held at a constant lower elevation than normal the year before). This three-lake cycle would rotate among the upper three lakes on a 3-year cycle.

The Corps indicates that two factors, both related to the inflows to the main stem system, would "shut off' the purposeful unbalancing of the three lakes. First, high inflows associated with an Upper Quartile or Upper Decile year could result in one or more of the lakes rising into its/their exclusive flood control zones. When this happens, system operations would revert to the balanced mode to limit the duration and extent of filling of the exclusive flood control zone. Second, and in a contrasting situation, an extended drought often associated with lower quartile or lower decile years would also "shut off" the unbalancing. A threshold elevation in the upper part of each multiple use zone (that zone containing the water to be used to meet project purposes during droughts) would be designated as the trigger below which the system would revert to the balanced mode. The unbalancing would restart the year after the system refilled to levels above the prescribed threshold elevations. The threshold elevations would be developed through coordination with ACT, the MRNRC, and specifically, the upper three basin states' game and fish departments.

The Service believes that unbalanced intrasystem regulation of the upper three reservoirs is an integral element of the reasonable and prudent alternative to avoid jeopardy to the least tern, piping plover, and pallid sturgeon. Unbalanced intrasystem regulation of the reservoirs enhances both the creation and availability of nesting and foraging habitats of the least tern and piping plover in the reservoir reaches (Segments 1, 3, and 5) and the river reaches below Fort Peck Dam (Segment 2) and below Garrison Dam (Segment 4). It also enhances conditions for the pallid sturgeon in Segment 2. In the first year of the unbalanced cycle, releases from the lake being drawn down must be higher than normal to ensure the drawdown. Additional shoreline and island habitat for nesting terns and plovers becomes available on the lake being drawn down. The higher releases provide some semblance of a natural hydrograph in the river reach, and, thus, provide spawning cues for native fish (e.g., pallid sturgeon in Segment 2), enhance backwater areas, and scour vegetation inundated on the sandbars. In the second year, when the same lake is being held at a constant lower level, the releases are somewhat lower than they were the previous year. Additional habitat for terns and plovers is available on both the reservoir being held stable and the river reach below the dam. During the third year when the same lake is raised to inundate vegetation for spawning and nursery habitat for reservoir fish, the releases from the dam are even lower yet, thus exposing additional barren sandbars on the river reach below. Some vegetation encroachment on the previous years sandbars is likely. Preliminary results of Corps' models for unbalanced intrasystem regulation for the Master Manual indicate that benefits to least terns and piping plovers will occur from increases in acres of suitable habitat on the upper three reservoirs and on river reaches below Fort Peck and Garrison Dams (R. McAllister, pers. comm. 2000).

As part of the RPA, the Corps shall implement unbalanced system regulation as described above on the upper three main stem reservoirs beginning in 2001 if system storage and runoff conditions are suitable. Implementation shall occur on annual basis dependent on the storage in those lakes and projected runoff conditions, and shall be coordinated with ACT, MRNRC, and the upper three basin states' game and fish departments to insure other appropriate issues (e.g., smelt spawning criteria) are considered. The goal shall be to unbalance one of the upper three reservoirs each year on a 3-year cycle.

IV. Habitat Restoration/Creation/Acquisition

The Service's 1994 Draft Biological Opinion on the Master Manual documented actions to restore river functions and habitats, as well as target acreages, and provides the foundation for targets for the current consultation. Additional restoration actions have been documented in a Missouri River Natural Resources Committee document entitled "Restoration of Missouri River Ecosystem Functions and Habitats" adopted by the Missouri River Basin Association as part of their Missouri River Planning

Document. The Service's current recommendations for habitat restoration follow.

Corps' programs and authorities already exist to implement most, if not all the structural and non-structural modifications and changes in water management needed to restore Missouri River habitats. Those include, but are not limited to, the following: BSNP, BSNP Fish and Wildlife Mitigation Project, Section 1135, 206 and Section 33 Programs, Flood Control Act of 1938, Missouri National Recreation River, Master Manual, Annual Operating Plan, and Section 7(a)(1) of ESA. The Corps shall pursue any additional authorizations, appropriations, or partnerships it believes are necessary to implement this portion of the RPA. Other programs, such as the Service's Big Muddy National Fish and Wildlife Refuge, and the NRCS' Wetland Reserve and Emergency Wetland Reserve Programs may also contribute to habitat restoration goals when the Corps works in concert with those programs to leverage its habitat restoration efforts.

Continued survival of listed species depends on restoration of riverine form and functions, as well as some semblance of the pre-development or natural hydrograph. Missouri River habitat restoration is, therefore, multi-faceted, and involves a combination of reservoir operational changes (e.g., hydrograph and temperature), structural modifications (e.g., chute restoration), and non-structural actions (e.g., floodplain acquisition or easements). The maximum benefits of physical habitat projects to listed species can only be realized when coupled with complementary hydrology. The following habitat elements of the reasonable and prudent alternative act together with the other elements as a functional unit to ensure the continued existence of the least tern, piping plover and pallid sturgeon.

Habitat management efforts will vary by species, habitat needs, opportunity, river segment, and year depending on water conditions. The health and status of listed populations and their habitats, and the opportunities to further their conservation are not uniform throughout the basin and, therefore, warrant varying levels of management effort and priority within each of the 16 designated river or reservoir segments. Thus, the Service developed a reasonable, flexible process to prioritize actions within a river segment.

Prioritization of habitat or other actions to benefit/preclude jeopardy to threatened and endangered species in each segment must consider the current status of the population of the species, condition and availability of habitat, needs associated with the species and habitats, and realistic management opportunities to improve the status and condition of the species and its habitats. Management direction provided by species' Recovery Plans also must be considered. Designation of a priority classification for species within each segment will provide flexibility and help focus management on those species where the need and opportunity most exists.

Therefore, to address these factors in the prioritization process, the Service and Corps developed a matrix to help provide direction within each segment of river, as well as an efficient, logical framework for the implementation of management actions to benefit or help recover threatened and endangered species. Species/habitat needs (biology) and management opportunities for each species within a reach were respectively characterized as either high, moderate, or low and combined into a matrix to yield either a high, moderate, or low priority for management of the species in a particular segment (Table 21). In general, this designation means that implementation of positive actions to benefit a particular species either will be a "high, moderate, or low" priority in the river segment. However, low priority does not mean that a species is ignored, but that, in general, management opportunities for the species in that segment are meager and would provide little return to the resource. An obvious long-term goal would be to strive to elevate the low and moderate priorities to a higher status over time. Management actions in one segment may greatly influence other segments and therefore, add to the priority of that particular segment.

Although currently the lower Missouri River Segments 11-15, the Kansas River Segment 16, and the Missouri River Segment 2 have minimal habitat for nesting terns or plovers because of inundation, through adaptive management, the Corps and the Service may identify future opportunities to improve conditions in those areas to benefit the least tern and piping plover. **Table 21. Endangered species management action priorities for Missouri and Kansas River segments. Refer to Table 7 and Figure 9 for segment locations.**

Missouri and Kansas Segments	Species Management Action Priorities			
	Least Tern	Piping Plover	Pallid Sturgeon	Bald Eagle
Segment1	Low	Low	Low	Low
Segment 2	Moderate	Low	High	Low
Segment 3	Moderate	High	Low	Low
Segment 4	High	High	Low	Moderate
Segment 5	Moderate	High	Low	Low
Segment 6	Low	Low	Moderate	High
Segment 7	Low	Low	Low	Low
Segment 8	High	High	High	Moderate
Segment 9	High	High	Low	Moderate
Segment 10	High	High	High	Moderate
Segment 11	Moderate/Low	Moderate/Low	High	Low
Segment 12	Moderate/Low	Moderate/Low	High	Low
Segment 13	Moderate/Low	Low	High	Moderate

Segment 14	Low	Low	High	Low
Segment 15	Low	Low	High	Low
Segment 16	Moderate/Low	Moderate/Low	Moderate	Low

The same can be said of currently developing deltas in the Missouri River reservoir segments 1, 6, and 7 .

As one element of the RPA, the Corps shall provide the quantity and quality of habitat on the Missouri and Kansas Rivers as described below.

C. Restoration of Submerged In-Channel Shallow Water Habitat in the Channelized River: Roughly, 105 ac (43 ha) of shallow water habitat (0-5 ft [0-1.5 m] depths) per river mile existed in the pre-development river channel below Sioux City, IA, to Kansas City, MO, during the low flow period of August through October (Table 18). Assuming a similar acreage below Kansas City, 77,000 ac (31,185 ha) of such habitat occurred in the now channelized river from Sioux City (RM 735.0) to St. Louis (RM 0.0).

The distribution of shallow water habitat in today's channel is much different than the historical distribution. In the pre-development channel much of the shallow water habitat was associated with mid-channel sandbars (braided channels), large side channels, and chutes, and was generally available over a wide variety of flows. In today's channel, no shallow water habitat occurs in the middle of the channel, few chutes or side channels exist, and shallow water habitat is essentially confined to dike fields or the margins of point bars. For this reason, restoration of shallow water areas will have to concentrate on increasing shallow water in channel habitats out of the thalweg and dike fields if the navigation function is to be maintained.

Using August as the template for average acres of shallow water, slow velocity habitat in the lower river, the Gavins Point reach (Segment 10) is the only river reach where current habitat conditions under CWCP exceeds 50 percent of the historical acreage (Table 22). The current acreage of shallow water habitat in Segments 11-15 from Sioux City to the mouth is approximately 2-5 percent of the historical acreage.

Within the action area, other than River Segment 2, some of the largest main stem river populations of pallid sturgeon and other native river fishes, such as the candidate sicklefin chub and sturgeon chub, occur in the lower Missouri River below Kansas City (Segments 14 and 15). This is based on data collected about 15 years ago (Carlson et al. 1985, Pflieger and Grace 1987), and recent status survey data from the Missouri River Benthic Fish Study (Dieterman et al. 1997, Young et al. 1998), (Grady and Milligan (1998), and Robert Hrabik, MO Department of Conservation, pers. comm. 2000). Compared to upstream reaches (Segments 11, 12, and 13), the lower reaches have approximately 2-4 times greater summer shallow-water habitat under the current hydrograph/operation. However, Carlson et al. (1985) and others have documented hybridization between the pallid sturgeon and shovelnose sturgeon in these river reaches, evidence that existing river habitat conditions may not be meeting pallid sturgeon and other native fish habitat needs.

Offsetting the difference between the amount of historical channel habitat and today's conditions would require restoration of over 74,500 ac (30,173 ha) in the channelized river. Given the continued decline of pallid sturgeon and some native cyprinids in the lower river, some level of habitat restoration above the existing conditions in this reach is necessary.

Table 22. Mean acres of shallow water, slow velocity habitat for the month of August and habitat restoration goals/deficits by river segment below Gavins Point Dam.[1]

River Reach (Segment)	Segment Length (mi)	Mean Acreage of Shallow Water, Slow Velocity Habitat for August: Historical Ac/mi	Historical Acres	CWCP Ac/mi	CWCP Acres	Habitat Restoration Goal of 20-30 acres/mile: @ 20 Ac/mi	Deficit from CWCP Ac/mi	Deficit from CWCP Acres	@30 Ac/mi	Deficit from CWCP Ac/mi	Deficit from CWCP Acres
Unchannelized											
Gavins Point (Segment 10)	58	106.6	6,183	61.4	3,561	1,160	-	-	1,740	-	-
Channelized											
Sioux City (Segment 11)	18	107.0	1,926	2.0	36	360	18.0	324	540	28.0	504
Omaha (Segment 12)	140	107.0	14,980	1.8	252	2,800	18.2	2,548	4,200	28.2	3,948
Nebraska City/ St. Joseph (Segment 13)	228	101.9	23,233	4.6	1,049	4,560	15.4	3,511	6,840	25.4	5,791
Kansas City/ Boonville (Segment 14)[2]	237	101.9	24,150	4.6	1,090	4,740	15.4	3,650	7,110	25.4	6,020
Osage to Mouth (Segment 15)[2]	130	101.9	13,247	4.6	598	2,600	15.4	2,002	3,900	25.4	3,302
Totals	811		83,719		6,586			12,035			19,565

[1]Table computed from data provided by the Corps for Table 18 (USACE, unpublished data, November 2000).

[2]As with Table 18, comparable data was not available for Segments 14 and 15. For analytical purposes, we assumed the historical and CWCP average acres/mile for August for Segments 14 and 15 were similar to Segment 13, and therefore, used these numbers. If data were available, the numbers likely would

be higher.

To meet a shallow water habitat goal of 20-30 acres/mile in the channelized Missouri River, the Service believes that restoration of 12,035 ac (4,874 ha) to 19,565 ac (7,924 ha) is reasonable and prudent. Table 22 indicates that the range of desirable habitat is currently being met in the Gavins Point reach (Segment 10) under the CWCP. Restoration of shallow water habitats (30 acres/mile) should be distributed as follows:

Ponca, NE to Sioux City, IA (Segment 11)	504 total acres
Sioux City, IA to Platte River (Segment 12)	3,948 total acres
Platte River to Kansas City, MO (Segment 13)	5,791 total acres
Kansas City, MO to Osage River (Segment 14)	6,020 total acres
Osage River to the mouth of the Missouri River (Segment 15)	3,302 total acres

Restoration of this level of shallow (<5 ft/<2 fps aquatic habitat is almost equivalent to 20 percent of the estimated aquatic habitat loss (100,000 acres) attributed to the BSNP (USFWS 1980). Shallow-water habitat may be restored through flow management, increasing the top width of the channel (widening), restoring chutes and side channels, manipulation of summer flows, or combinations thereof. The habitat goal for the lover 170 mi (274 km) of the Kansas River also should be 20-30 acres/mile.

Protection shall be afforded for those areas that have existing habitat (i.e., River Segments 2 and 10) by maintaining existing habitat values. Coordination with the Service on existing projects in these areas will help insure habitat values are not lost.

Performance Standards

1. The Corps shall ensure no-net-loss of existing shallow water habitat from operations and maintenance activities in the lower Kansas River and channelized Missouri River.

2. (2001) The Corps shall develop habitat restoration plans and strategies to restore shallow/slow-water sandbar/island habitats in river segments 10 through 16. The plan shall identify existing habitats and restoration activities throughout the priority river segments. As part of the adaptive management process, the Corps, in cooperation with the Service, shall provide to the Service implementation plans and strategies and schedule for implementation.

3. (2002) The Corps shall implement habitat restoration plans and strategies to restore and protect shallow/slow-water habitats, and begin mapping of important pallid sturgeon habitats (i.e. shallow/slow-velocity, gravel areas).

4. (2003) The Corps shall continue implementation of habitat restoration plans and strategies to restore and protect shallow/slow-velocity habitats; and the Corps shall finalize mapping

of priority river segments for pallid sturgeon habitat.

5. (2004) Based on habitat measurements between mid-July and mid-August, the Corps shall have reached 8 percent (1,700 ac [688 ha]) of the shallow-water habitat goals identified in the Habitat Restoration/Creation/Acquisition element of the RPA.

6. (2005) Based on habitat measurements between mid-July and mid-August, the Corps shall have reached 10 percent (2,000 ac [810 ha]) of the shallow-water habitat goals identified in the Habitat Restoration/Creation/Acquisition element of the RPA.

7. (2010) Based on habitat measurements between mid-July and mid-August, the Corps shall have reached 30 percent (5,870 ac [2,377 ha]) of the shallow-water habitat goals identified in the Habitat Restoration/Creation/Acquisition element of the RPA.

8. (2015) Based on habitat measurements between mid-July and mid-August, the Corps shall have reached 60 percent (11,739 ac [4,754 ha]) of the shallow-water habitat goals identified in the Habitat Restoration/Creation/Acquisition element of the RPA.

9. (2020) Based on habitat measurements between mid-July and mid-August, the Corps shall have reached 100 percent (19,565 ac [7,924 ha]) of the shallow-water habitat goals identified in the Habitat Restoration/Creation/Acquisition element of the RPA.

B. Restoration of Emergent Sandbar Habitat:

3. Natural Habitat: Natural tern and plover nesting habitat shall be provided as a priority and other management actions implemented to create and maintain tern and plover habitat at levels seen on Segments 4, 8, 9, and 10 in 1998, and provide a diversity of shallow water habitats for refugia also beneficial to pallid sturgeon and other native fishes. Accordingly, the Corps shall, through flow regulation or other means provide for this sandbar habitat in complexes of various sizes in totals as noted below. The habitat should be available to nesting birds at a minimum of one out of three years. (The habitat goals on the Missouri River would be waived during years when the ACT, through the adaptive management process, recommends the Corps release high flows for habitat creation and/or other ecosystem/listed species benefits.)

   d) (2005) Minimum emergent interchannel sandbar habitat acres on average per river mile during the nesting season shall be as follows: Gavins Point - Segment 10 (40 ac [16.2 ha]), Garrison - Segment 4 (25 ac [10 ha]), Fort Randall - Segment 8 (10 ac [4 ha]), and Lewis and Clark Lake - Segment 9 (40 ac [16.2 ha]) to be measured in late July. This emergent sand shall be comprised of a minimum 60 percent dry sand.

   b) (2015) Minimum emergent interchannel sandbar habitat acres on average per river mile during the nesting season shall be as follows: Gavins Point - Segment 10 (80 ac

[32 ha]), Garrison - Segment 4 (50 ac [20 ha]), Fort Randall - Segment 8 (20 ac [8 ha]), and Lewis and Clark Lake - Segment 9 (80 ac [32 ha]) to be measured in late July. This emergent sand shall be comprised of a minimum 60 percent dry sand.

c) (2003) The Corps will complete 1998 baseline habitat evaluations on the Missouri River below Fort Peck - Segment 2 and by 2015 meet minimum baseline emergent sandbar acres. This habitat shall exist during the late July period. This emergent sand will be comprised of a minimum 60 percent dry sand.

Desirable Habitat Conditions: Optimum habitat has been described as a complex of side channels and sandbars with the proper mix of habitat characteristics required by the birds. Such sandbar complexes provide higher regularly scoured habitat for nesting and brood rearing and shallow pools and wetted perimeters for foraging. Single, large, unbraided monotypic sandbars with linear shorelines rarely provide these conditions because they often remain above the scour zone and the associated channels and chutes are often deep and provide little opportunity for foraging. Sandbar complexes suitable for least terns and piping plovers must provide two basic needs, food and security, during the nesting and brood rearing seasons. The Service recommends the following physical conditions for nesting habitat, brood rearing habitat, and foraging habitat.

Nesting Habitat:

? Substrate – Nesting substrates consist of well draining particles ranging in size from fine sand to stones < 1 in. (2.5 cm) in diameter.

? Size/Shape – Nesting areas should be a minimum of 1 ac (.4 ha), preferably 10 ac (4 ha); circular to oblong in shape, maximizing surface area; recommended slopes of 1:25 with maximum slopes not exceeding 1:10; surface height above water to exceed 18 in. (45.7 cm) at nest initiation.

? Visibility – Smooth topography with < 10 percent early successional vegetation.

Brood Rearing Habitat:

? Substrate – Same as nesting substrate but may contain fine silts, organic detritus, and other unconsolidated fine particulate matter.

? Size/Shape – Brood-rearing areas should be 3-5 times larger than the nesting area; very irregular in shape, maximizing shoreline to water interface; recommended slopes of 1:25 with maximum slopes not exceeding 1:10.

- ? Visibility – Vegetation can increase up to 25 percent ground coverage but should occur in a patchy pattern.

- ? Connectivity – Brood rearing areas must occur connected to nesting areas or immediately adjacent and separated only by shallow channels (< 1 in. [2.5 cm] deep) or mud flats.

Foraging Habitat:

- ? Substrate – Least terns require shallow, slow velocity water that provides habitat for schooling baitfish that are 0.5 – 3.0 in. (1.3-7.6 cm) in length. Piping plovers require wetted sand zones consisting of ephemeral ponds < 0.5 in. (1.3 cm) deep, nutrient enriched lagoons, swash areas, and braided shallow channels. Substrates range from large grained sand to heavy silts.

- ? Size/Shape – Foraging habitat should comprise 40 percent of the brood rearing habitat for piping plovers.

- ? Connectivity – Least tern foraging areas should not be greater than 438 yds. (400 m) from the brood rearing areas. Piping plover foraging areas must occur connected to nesting areas or immediately adjacent and separated only by shallow channels (< 1 in. [2.5 cm] deep) or mud flats.

2. <u>Reservoir Habitat</u>: Between 1986 and 2000, nearly 44 percent of piping plovers and 27 percent of least terns were recorded on reservoir habitats during the adult census (C. Kruse, pers. comm. 2000). Productivity surveys have shown reservoir habitat significantly contribute to plover and tern recruitment, particularly during drought or low runoff years when reservoir elevations are lower and habitat is more abundant. In 2000, 223 piping plover chicks fledged from Lake Sakakawea (fledge ratio 1.61 chicks per pair) and 102 from Lake Oahe (fledge ratio 1.46 chicks per pair). A piping plover fledge ratio of 2.45 chicks per pair and a least tern fledge ratio of 2.33 chicks per pair were achieved on Lewis and Clark Lake in 1998 with 103 and 140 chicks fledging respectively (C. Kruse, pers. comm. 2000). Since listing the species, the Service has recognized the difficulty in managing water levels on both the reservoir and lotic segments of the river. Recently, through efforts of the Corps and with more intensive monitoring, data has shown that reservoir habitats provide a vital resource for the birds, especially during periods of substantial pool fluctuations as have occurred since the mid-1990s. Management opportunities being investigated by the Corps, including protection of peninsular habitat, overburden removal, island construction, and water control structures may provide long-term habitat to support least terns and piping plovers on the reservoirs.

   Therefore, the Service believes the Corps should continue its investigations into the value of reservoir habitats and into opportunities to enhance these habitats for least terns and piping plovers. The Service recognizes that if opportunities can be developed, reservoir habitat may provide a significant level of the habitat necessary to meet the forementioned recruitment rates and populations goals for terns and plovers on the Missouri River.

a) (2001) The Corps shall maintain reservoir habitats for least terns and piping plovers through intra-system regulation.

b) (2005) The Corps shall have identified all potential habitat enhancement on reservoir segments (Segments 1, 3, and 5).

c) (2010) The Corps shall have completed 25 percent of the reservoir projects identified in letter b above.

d) (2015) The Corps shall have completed 50 percent of the reservoir projects identified in letter b above.

e) (2020) The Corps shall have completed 100 percent of the reservoir projects identified in letter b above.

3. Artificially or Mechanically Created Habitat: When habitat goals listed in IVB(1) are not met through flow regulation (i.e., 40 acres/mile on Gavins Point by 2005), and tern and/or plover fledge ratio goals have not been met for the 3-year running average, other means (e.g., creation of habitat) will be necessary to ensure the availability of habitat to meet fledge ratio goals. Created habitat shall be established to supplement natural habitat required by element B(1) above. The habitat shall be created following the desirable habitat parameters listed above in element B(1). Suggested management techniques for habitat creation include: (1) replenishment or nourishment of river sandbars and islands; (2) creation of suitable nesting habitat in reservoir depositional zones; (3) creation or enhancement of shallow and backwater areas, off-channel chutes, and flats as foraging habitat; (4) removal of early successional vegetation from nesting areas; (5) peninsular cutoffs or island creations in reservoir side bays; and (6) dike construction to dewater reservoir side bays for nesting and foraging habitat. Created habitat shall be monitored for available forage for piping plovers. If plover forage is inadequate, habitats shall be supplemented with acceptable forage.

C. Initiation of Sediment Transport/Habitat Studies: The Corps shall initiate other studies as appropriate to research the long-term effects of riverbed changes/sediment transport and their impact to tern and plover nesting habitat, forage availability, and forage areas. The results of these studies shall be reported each year in the annual report and considered and included in operations as appropriate.

The Corps shall research and develop a way to restore the dynamic equilibrium of sediment transport and associated turbidity in river reaches downstream of Fort Peck (Segment 2), Garrison (Segment 4), Fort Randall (Segment 8), and Gavins Point Dams (Segment 10), and stop or reverse bed degradation of the river. Sediment input is necessary to restore instream habitats and turbid waters. Initially, the Corps should determine the sediment deficit from natural conditions and the functional quantities needed to restore instream sandbars, and implement a pilot project at one of the main stem dams.

Options to achieve sediment transport might include sediment bypass pipelines or physical deposition of sediments at the face of dams. Sediment bypass around large dams is feasible (Singh and Durgunoglu 1991). Bed degradation below dams and head cutting at the mouths of tributaries might be addressed with grade control structures. Weir notches at grade control structures would allow for fish passage to the tributaries. Because of the large sediment deposition zone at the upper end of Lewis and Clark Lake and its proximity to Gavins Point Dam, Gavins Point may provide the best opportunity for a pilot study.

The Corps also should restore turbidity to functional levels downstream of Fort Peck, Fort Randall, and Gavins Point Dams. Turbidity will increase with actions taken to restore sediment transport; however, additional measures may be needed if reintroduced sediments are clean of small particulate matter that needs to be resuspended. Through the ACT, the Corps, in cooperation with the Service, shall develop a study plan by 2002 and initiate studies by 2003 with a completion by 2005.

D. Monitoring of Tern and Plover Nesting Habitat: The Corps shall monitor and map, on a periodic basis (at least every 3 years), all essential tern and plover nesting habitat on the Missouri River as identified. The mapping information, in conjunction with the Corps' Habitat Conservation and Recovery Project, will be used to determine tern and plover habitat available under different operating scenarios and to assist in establishing and implementing management actions to meet fledge ratio goals. Mapping products or updates on data collection will be provided in the annual report (see Annual Report under Adaptive Management RPA).

RPA ELEMENTS APPLICABLE TO SPECIFIC SPECIES

V. Least Tern and Piping Plover

In addition to the above “multi species” elements of the RPA, the following elements are necessary to provide successful reproduction and recruitment of the least tern and piping plover and offset jeopardy.

A. Kansas River: The Kansas River (Segment 16) shall be operated to provide overall benefit to the conservation of least terns and piping plovers. Decisions concerning operations of the

Kansas River for terns and plovers will occur through ACT. To facilitate decision making on Kansas River terns and plovers, the Corps shall collect and evaluate productivity, habitat, and other pertinent data to identify whether the Kansas River provides a source or sink for least terns and piping plovers. A study plan shall be developed and agreed upon by the Service and Corps through ACT by 2002. An evaluation to this effect will be made by the Corps by 2005.

B. **Habitat/Fledge Ratio Goals:** Habitat shall be provided as a priority and other management actions implemented to meet or exceed fledgling per pair ratio goals of 0.70 for least terns and 1.13 for piping plovers. These are to be determined as the recent (past) 3-year running average (i.e., if the past 3-year least tern fledge ratios were 0.20, 1.90, and 0.00, tern fledge ratios would be met for those years). However, the Corps would have to take steps to ensure that a fledge ratio of at least 0.20 did occur in the following year to maintain the average.

C. **Piping Plover Foraging Ecology Study:** The take associated with the loss of forage for piping plovers has never been addressed. Therefore, before the end of 2005, the Corps shall initiate and conduct a piping plover foraging ecology study on the Missouri River to document forage abundance and richness, and forage availability during the nesting season and impacts of operations on foraging. Subsequently through adaptive management, system operations can be modified to reduce impacts on plover forage and forage availability, and reduce take. The scope of the study shall be developed and agreed upon by the Service and the Corps through ACT by 2002. The results and management implications of the study shall be coordinated between the Service and the Corps through adaptive management.

VI. Pallid Sturgeon

As stated previously, habitat loss and alteration, as well as disruption and alteration of the dynamic processes that create, restore, and maintain habitat, resulting from operation and maintenance of the Missouri River and Kansas River Reservoir System and the BSNP are likely to jeopardize the continued existence of the pallid sturgeon.

As previously identified in Table 21 in the Habitat Restoration/Creation/Acquisition element of the RPA, the Corps shall consider Segments 2 and 8-15 as high priority for management efforts of pallid sturgeon.

The other segments are ranked based on the presence/absence of existing populations and potential management opportunities. The Pallid Sturgeon Recovery Plan further refines its Recovery Priority Management Areas to include, but not limited to, 32 kilometers (20 mi [32 km]) upstream and downstream of the major tributaries of the Platte, Kansas, and Osage Rivers. River and Reservoir Segments 1, 3 and 9 also have potential management implications for the pallid sturgeon because the amount of riverine habitats in the headwater areas of those reservoirs depends on reservoir levels.

Various elements of a reasonable and prudent alternative act together as a functional unit to ensure the continued existence of the pallid sturgeon. Therefore, to preclude jeopardy, it is the Service's scientific judgement that operations of the Missouri and Kansas Rivers and the BSNP must provide conditions suitable for successful pallid sturgeon reproduction and recruitment by implementing all elements of the reasonable and prudent alternative. In addition to the "multi-species" elements above, the Corps must implement the following to offset jeopardy to the pallid sturgeon.

G. Pallid Sturgeon Propagation and Augmentation: Due to the lack of recruitment of pallid sturgeon into the wild population and the lack of fish for research purposes, the Service and the Pallid Sturgeon Recovery Team have developed and partially implemented propagation and augmentation plans for the pallid sturgeon populations to ensure the genetic integrity and prevent extinction of existing pallid sturgeon populations in the Missouri River. To partially offset jeopardy to the pallid sturgeon as a result of system operations, the Corps shall assist in pallid sturgeon propagation and augmentation efforts and subsequent monitoring of the stocked pallid sturgeon juveniles in those recovery priority areas in the Missouri River Basin that are identified in the Pallid Sturgeon Recovery Plan. That program shall start in 2001 and continue through 2011, with an evaluation of the propagation and augmentation efforts in 2003. This program can be accomplished using Service and State hatcheries. The Corps shall meet the following objectives with the cooperation, and under the supervision of the Service.

(8) The two agencies shall work cooperatively to capture, hold, and spawn at least nine female broodstock each year, with at least three females being used for propagation at each of the three designated pallid sturgeon propagation facilities (i.e., Blind Pony SFH, Gavins Point NFH, and Garrison Dam NFH), and subsequent release of the adult broodstock at the point of capture.

(9) The ultimate goal will be to produce a total of 4,700 juvenile to 1-year old pallid sturgeon (per year class) (Corps responsibility-2491 fish) for subsequent stocking, which will include up to 50 juvenile representatives of nine family lots to maintain genetically diverse juveniles for future broodstock and refugia purposes (Table 23). The annual details of the stocking shall be developed and agreed upon by the Service, Pallid Sturgeon Recovery Team/Work Group, and the Corps through ACT during 2001.

(10) The two agencies shall work cooperatively to increase the production, rearing, and release of pallid sturgeon juveniles into each priority area identified in the Pallid Sturgeon Recovery Plan to augment current efforts and achieve levels identified in stocking plans referenced in "A" above.

(4) The two agencies shall work cooperatively to monitor juvenile stocked pallid sturgeon to determine habitat use, distribution and movements, and survival, and guide future restoration/management efforts. The scope of the monitoring shall be developed and agreed

upon by the Service and the Corps through ACT during 2001.

(5) The Corps and the Service shall meet annually through ACT where the Service will evaluate the level of success in meeting this RPA element.

Table 23. A summary of the pallid sturgeon propagation and augmentation efforts from 1997 through 1999.

Year Class	Number of Refugia Fish	Recovery Priority Area #1 Stocking (MR above Ft. Peck Lake)	Recovery Priority Area #2 Stocking (MR Seg. 2)	Recovery Priority Area #3 Stocking (MR Segs. 8 & 9)	Recovery Priority Area #4 Stocking (MR Segs. 10-15)	Total Number of Pallid Sturgeon Stocked for Recovery Priority Areas 1 - 4	Total Maximum Target	Shortfall	Total Number of Families Stocked to Date
1997	250	750	750	400	2000	4150	4700	550	11
1998	100	pending	200	100	0	400	4700	4300	2
1999	150	pending	480	pending	0	630	4700	4070	3
							Total	8920	
							Annual Average	2973	

B. **Pallid Sturgeon Population Assessment**: The endangered species and habitat monitoring program shall be designed to detect annual improvement in the ecosystem. This will be accomplished by documenting pallid sturgeon reproduction and recruitment, physical habitat improvements, improvements of the warm water benthic fishery (surrogate species), hydrograph improvements in form and function, improved water temperature regimes, and increased aquatic nutrient cycling, sediment transport, and in turbidity.

Pallid sturgeon population assessment shall include: (1) Total number of fish captured and tag number, (2) GPS coordinates of capture sights, distribution, recapture incidences and numbers, (3) channel and substrate mapping of the habitats used by the fish, (4) tributary use and concentrations by pallid sturgeon, (5) temperature, surface and bottom velocity, turbidity, and depth at capture locations, (6) length of fish frequency, (7) morphological measurements of fish and meristic counts, (8) species characterization utilizing morphological measurements, (9) genetic analysis of fish, and (10) productivity and recruitment. Additional information needs and priorities for the monitoring program should be developed through a cooperative effort between the Service, Corps, and Recovery Team. The population assessment information shall be included in the Annual Report referenced earlier under Adaptive Management.

To better direct management efforts at flow regulation and habitat restoration, the Corps shall:

(3) Identify the causes for lack of reproduction, lack of recruitment, and hybridization and dependant on the limiting factor, initiate efforts to restore conditions that would restore reproduction, recruitment and minimize the occurrence of hybridization with shovelnose sturgeon. If and when appropriate data is gathered on pallid sturgeon populations and spawning habitat to warrant creation of spawning habitat, the Corps shall coordinate the initiation of these projects with the Service.

(2) Identify and map the location of gravel/cobble/rock substrates that may provide potential spawning habitat for sturgeon within the prioritized river segments. The habitat monitoring plan shall document locations and characteristics of known spawning habitat (i.e., physical substrate, depth, velocity, temperature, turbidity) and areas of potentially suitable spawning habitat. The Corps shall also determine if construction and maintenance activities would disturb or impact potential spawning areas and activities. By 2001, the Corps shall have implemented a study strategy, and by 2002 begun to map and delineate potential gravel/cobble/rock substrates.

(3) Incorporate modifications into channel training structure maintenance projects to maintain and improve aquatic habitat diversity (e.g, notching of wingdams, incorporating woody debris, etc.). Construction activities will continue to be coordinated with the Service and affected State resource management agencies.

(4) Participate with Service and partners to prioritize research needs and projects for the pallid sturgeon on an annual basis starting in 2000.

Implementation of the monitoring program for pallid sturgeon shall begin in 2001 and the data collected will be reviewed by the Service, Pallid Sturgeon Recovery Team and Recovery Workgroups in order to develop priorities that would assist with research and recovery needs.

The system-wide elements of the reasonable and prudent alternative mentioned earlier, which apply to the pallid sturgeon, as well as the tern and plover, are compatible with these objectives.

As part of the Annual Report due to the Service by December 31 of each year beginning with the first report in 2001, the Corps shall describe progress made to avoid jeopardizing the pallid sturgeon and the results of monitoring.

RPA SUMMARY

The Service concludes that implementation of all elements of the RPA, both those described above as applicable to and benefitting multiple species and those identified for specific species, is necessary to avoid jeopardy to the least tern, piping plover, and pallid sturgeon. The Service believes the science clearly supports the combination of needs identified through the elements of the RPA to change the current hydrograph to one which more closely mimics some semblance of the natural hydrograph and to restore aquatic and terrestrial habitats in the riverine/floodplain ecosystem. Hundreds of research studies cited in the Literature Cited section, comments from the scientific review panel (Appendix V), and scientific evidence being compiled by the National Academy of Science all support the direction for an institutional change in the management of the Missouri River main stem reservoir system.

As described throughout the RPA section, the Service believes that the elements of the RPA are needed to restore sufficient form and function of the river for the listed species to successfully forage, reproduce, and recruit to the population. Adaptive management and monitoring will provide the mechanism to evaluate the performance and biological response to river and reservoir management. Hydrologic improvements at Fort Peck through warm water releases and higher flows, intrasystem unbalancing at the upper three reservoirs, improved flow management at Gavins Point Dam, as well as similar operations at Fort Randall Dam, physical habitat restoration (i.e., shallow, slow velocity) in the lower Missouri River, and a pallid sturgeon propagation and augmentation program are all needed to avoid jeopardizing the continued existence of the pallid sturgeon. Cumulatively, they will provide diversity of biological cues (rising spring flows and warmer water) for spawning, spawning and nursery habitat, increased forage base, and supplemental hatchery stock until habitat conditions in the wild support reproduction and survival of one-year-old fish into the population.

Similar hydrologic and habitat restoration actions as described above are necessary to provide successful reproduction and recruitment of the least tern and piping plover and avoid jeopardy. Experiences in the 1990s have shown that the creation of high quality sandbar complexes (resulting from high flows) is the key to successful reproduction, increased forage base of minnows or invertebrates, reduced predation, and achieving the fledge ratio goals to sustain the populations.

Preliminary unpublished data from the Corps suggests that increased spring flows from Gavins Point will not achieve the desired attributes down river in terms of shallow water, slow velocity habitat, floodplain connectivity, or creation/maintenance sandbar habitat. However, the Corps acknowledges significant benefits to terns and plover from lower summer flows. The Service agrees that spring flows, alone, will not achieve the total desired habitat attributes. However, they will provide a significant improvement over current conditions and will provide the biological cues that habitat restoration, alone, can not provide. This reinforces the premise that benefits from a combination of hydrology (i.e., higher spring flows and lower summer flows) and habitat restoration is needed to achieve the attributes to avoid jeopardy. Through the adaptive management process, the Corps can adopt any additional or amended measures which prove necessary for the survival of the pallid sturgeon, least tern and piping plover.

INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA 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 to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not 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 ESA 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 Corps so that they become binding conditions of any grant or permit issued to an applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require an applicant 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. To monitor the impact of incidental take, the Corps 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)].

These RPMs are determined to be necessary to minimize take from the actions based on the Service's current understanding of the species status. Through an adaptive management process, the incidental take statement, the RPMs, and the terms and conditions may be modified on an annual basis, or as otherwise determined through the ACT.

BALD EAGLE

The Service has determined that the MR, BSNP, and KR Operations will result in incidental take of bald eagles in the form of harm. The Service anticipates that harm will be difficult to detect and will reflect habitat loss that impairs essential behavior patterns of bald eagles and occurs over the long term as discussed below.

As noted previously, bald eagles that use the Missouri River main stem system depend on adjacent cottonwood forests both for nesting and wintering habitat. Past and ongoing operations have restricted overbank flooding which results in degradation of cottonwood forests. Operations provide only minimal overbank flooding of cottonwood forests, and known major wintering and nesting habitats in the upper Missouri River are not expected to experience any overbank flooding in the future. Therefore, cottonwood forests will continue to degrade and be lost as bald eagle habitat. Wintering eagles have been documented on the Missouri River for many years. Wintering eagles use cottonwood forests for roosting, foraging, and perching. In the upper river, bald eagles continue to favor certain cottonwood forests adjacent to those tailrace areas that also support large numbers of wintering waterfowl and fish resources. Some of those wintering areas have been designated as essential bald eagle wintering areas. Additionally, although eagle population studies have revealed that both reproduction and survival are important, changes in survival rates seems to have more effect on the population than similar changes in reproduction rates (Grier 1980). Population modeling predicts that eagle populations with lower reproduction but adequate survival might do better than other populations with higher reproduction but poor survival. Adult eagles must prepare themselves for the next breeding season, and subadults and immatures must survive stressful environmental conditions. Therefore, maintaining and/or improving winter survival is crucial to eagle recovery (USFWS 1983).

The Service concludes that MR Operations are likely to result in the following types of harm to bald eagles.

1. Nesting bald eagles return to the same nesting site year after year. Loss of nesting habitat may result in the loss of a pair's reproductive capability and may result in the loss of the pair for lack of available nesting habitat.

2. Loss of protective habitat for eagles during the winter, particularly during severe weather conditions. Habitat loss would likely have an adverse effect on the physiological condition, foraging efficiency, and survival of wintering eagles.

While we are aware that the Corps has conducted some management actions on Corps land to enhance cottonwood forest habitats, we are unaware of any long-range plan or commitment of the Corps to enhance and restore cottonwood forest habitat.

Amount or Extent of Take Anticipated

The Service anticipates that all Missouri River cottonwood forests that are not subject to overbank flooding will continue to degrade and either be succeeded by tree species such as green ash, willow, or other communities that are not as suitable for bald eagle wintering or nesting habitat, or they will be lost entirely to development or other uses that are unsuitable as bald eagle habitat as a result of System operations. The extent of overbank flooding anticipated under system operations is unknown, thus the amount of habitat likely to remain, be created, or enhanced by overbank flooding is unquantifiable. Take would be in the form of harm because the Corps' proposed actions would significantly impair essential bald eagle breeding, feeding and sheltering behavior due to loss of habitat resulting in harm or actual death or injury as described above.

Effect of the Take

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

Reasonable and Prudent Measures to Minimize Take

The Service believes the following reasonable and prudent measures (RPM) are necessary and appropriate to minimize take of bald eagles.

3. The Corps shall map and evaluate the current health of cottonwood forests that currently provide or may provide wintering, non-breeding, and breeding habitat for bald eagles on the Missouri River. This mapping also shall identify which stands will be experiencing overbank flooding under proposed operations. The baseline level of mortality and tree vigor of cottonwood forests shall be measured and determined for comparison against future levels of mortality. A subsampling scheme may be set up for measurement purposes after an initial inventory.

4. For cottonwood and other riverine forest areas that are not experiencing regeneration, a management plan shall be developed that will allow for natural regeneration, periodic seed germination, and seedling establishment at a sufficient rate such that regeneration is maintaining pace with or exceeding mortality. Those areas that lack regeneration are those areas that no longer experience overbank flooding. The majority of these areas would occur in Segments 2-10. The regeneration scheme may require planting of young trees and/or incorporation of

measures to protect seedlings from adverse factors for some time after planting. This management plan may be generalized for the entire river so that it may be stepped down for Corps project lands and other public and private lands where the Corps may be involved with section 404/10 activities or other authorizations and fundings.

5. The Corps shall fund and implement actions in accordance with developed management plans on their project lands, and where appropriate, in partnership with adjacent landowners to ensure that no more than 10 percent of the cottonwood forest habitat identified in RPM 1 above, that is suitable for bald eagles is lost as eagle habitat during the project life (Refer to the Effects Section on the bald eagle).

Terms and Conditions for Implementation of Reasonable and Prudent Measures

To be exempt from the prohibitions of section 9 of the ESA, the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures described above for the bald eagle and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary. The Corps is responsible for the funding and means to carry out all reasonable and prudent measures.

Terms and Conditions (RPM 1): Within 2 years of completion of this biological opinion, the Corps, in coordination with identified partners (e.g., State game and fish agencies, Tribes, private landowners), shall map and evaluate cottonwood forests that provide or may provide bald eagle wintering or nesting habitat. This habitat shall be monitored every 2 years for the first 4 years and every 5 years thereafter.

Terms and Conditions (RPM 2, 3, and 4): Management and/or regeneration plans shall be completed and implemented within 2 years after completion of the mapping and vigor analysis (Terms and Conditions-RPM1). Beginning with the December 2001 Annual Report to the Service, the Corps shall provide documentation of progress on Corps efforts detailed above. That report shall incorporate bald eagle winter and breeding survey information from the various entities that are collecting information and relate that information to management efforts. The Corps shall include in the Annual Report an assessment of overall conditions of cottonwood forests and identify any needed modifications to Corps operations and management plans to prevent further habitat degradation.

The Fish and Wildlife Service will not refer the incidental take of any migratory bird or bald eagle for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. Sec. 703-712), or the Bald and Golden Eagle Protection act of 1940, as amended (16 U.S.C. Sec. 668-668d), if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

Closing

The Service believes that the reasonable and prudent measures, with their implementing terms and conditions, will minimize the impact of incidental take that might otherwise result from the proposed

actions. If, during the course of the actions, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Corps shall immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.
In July 1999, the Service proposed delisting the bald eagle and anticipated a final delisting decision by July 2000. The Service is currently evaluating and responding to all comments and information received during this period. Once this process is completed, the Service will publish a final determination in the Federal Register. During the comment period, the Service received numerous questions concerning protection the bald eagle will still have under other Federal laws if it is delisted under the ESA. If delisted, the bald eagle would no longer be subject to section 7 consultation, however, it will still be protected by the Bald and Golden Eagle Protection Act, the Migratory Bird Treaty Act, and other Federal laws. The Service is preparing clarification of the protections afforded the bald eagle under those laws following delisting when protection under the ESA no longer applies. The Service will keep the Corps informed on the status of the bald eagle in relation to this biological opinion.

LEAST TERN AND PIPING PLOVER

Amount or Extent of Take Anticipated

The Service has developed the following incidental take statement based on the premise that the reasonable and prudent alternative will be implemented. Even if the elements of the reasonable and prudent alternative are successfully implemented, a minimum amount of incidental take of terns and plovers will occur directly or indirectly as a result of operations of the Missouri and Kansas Rivers and maintenance of the BSNP. Such take includes killing, harming, and harassing which could include loss of habitat, individuals, and recruitment. The Service acknowledges that there are “Acts of God” or “Acts of Nature” that are beyond the operational control of the Corps; that type of take is not incidental take and is not addressed as such.

Although the Corps has been implementing elements of the reasonable and prudent alternative described in the Service's 1990 biological opinion on the AOP, some nests and chicks have been and will continue to be lost. Therefore, the Service anticipates that, in the near term, even after implementation of the reasonable and prudent alternative in this biological opinion, losses of terns and plovers during the nesting season will occur. While the reasonable and prudent alternative is designed to avoid jeopardy to the species, losses may be expected because of operational limitations, flood control, unanticipated effects of operational changes, and human error.

Incidental take in the form of harm and harass (i.e., habitat loss and alteration due to operation and maintenance of the Missouri and Kansas Rivers and BSNP) will result in actual death or injury in the form of loss of reproduction and recruitment. This take will be difficult to detect because terns and plovers are wide-ranging, may change nesting colonies from year to year, and reduced reproductive success may be masked by annual variability in localized population numbers. However, an unquantifiable level of take of these species can be anticipated by continued river operations that fail to provide habitat conditions that support self-sustaining populations of terns and plovers in the project area. The level of take is based on periodic nest innundation, erosion and/or degradation of suitable nesting and foraging habitat, and continued predation of terns and plovers along the Missouri and Kansas rivers resulting in actual death and injury to members of these species. The following types of unavoidable losses are possible:

1. Taking of eggs and chicks by flooding or erosion;

2. Precluding nesting and renesting of terns and plovers by inundation or wetting of sandbars, islands, or shoreline nesting habitat;

3. Increasing predation on nests and chicks as a result of reduced nesting habitat or changes in predatory/prey relationships;

4. Increasing susceptibility of eggs and young to disturbance and/or destruction by human activities as a result of reduced nesting habitat;

5. Continued loss of habitat due to degradation and vegetation encroachment, resulting in actual death and injury as described above.

Effect of Take

In the accompanying biological opinion, the Service determined that a level of take that does not cause the recent (past) 3-year average fledge ratio for terns to drop below 0.70 and for plovers to drop below 1.13 is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat when the reasonable and prudent alternative is implemented. Implementation of the reasonable and prudent measures below will minimize incidental take. In other words, any incidental take that may occur should be offset by the implementation of the reasonable and prudent alternative and reasonable and prudent measures. If new information becomes available that reveals effects of the action that may affect the species in a manner or to an extent not previously considered, section 7 consultation must be reinitiated.

Reasonable and Prudent Measures to Minimize Take

The following reasonable and prudent measures with their implementing terms and conditions are necessary and appropriate to minimize take for the least tern and piping plover on the Missouri and Kansas Rivers.

Reasonable and Prudent Measure 1: In order to determine fledge ratios and so that current operations can continue in a manner to avoid unnecessary take, all tern and plover sites on the Missouri and Kansas River reaches below dams, including the headwaters of Lewis and Clark Lake as well as reservoir areas, shall be surveyed and monitored. Population surveys will be conducted and information collected annually during May through August and will include the total number of colonies, total number of adult birds and breeding pairs, total number of eggs and chicks, total number of nests and nest fates, total number of fledged chicks per pair and other chick fates and the elevation of nests above the water level, and maps of nest site locations.

Reasonable and Prudent Measure 2: The Corps shall monitor and evaluate the effect on habitat of daily and hourly fluctuations in releases below Missouri River and Kansas River dams and changes in releases due to maintenance or other reasons to avoid take, and to document unavoidable take. This action shall be implemented immediately by compiling and evaluating previous information on impacts of take from 1) daily and hourly release fluctuations below dams, 2) changes in releases due to maintenance or other isolated causes, and 3) changes in releases to prevent downstream flood impacts. This information will be used to institutionalize preventive measures for the take of least terns and piping plovers in the Master Manual or Annual Operating Plans as appropriate. An established process for monitoring, evaluating, establishing preventive measures, and incorporating them into the Master Manual or Annual Operating Plans shall be established through the ACT by 2002 and continue into the future.

Reasonable and Prudent Measure 3: The Corps shall continue to evaluate operational changes to avoid take.

Reasonable and Prudent Measure 4: The Corps shall continue to follow the "Contingency Plan for Protection of Least Tern and Piping Plover Nests and Chicks" (Appendix VI) and the "Captive Rearing Program Protocol" (USACE 1999).

Reasonable and Prudent Measure 5: The Corps shall implement public information and education programs to increase public awareness and reduce disturbance to nesting birds.

Reasonable and Prudent Measure 6: The Corps shall implement aversive actions to reduce predation on least tern and piping plover nests, chicks, and adults.

Terms and Conditions for Implementation of Reasonable and Prudent Measures

To be exempt from the prohibitions of section 9 of the Act, the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary. The Corps is responsible for the funding and means to carry out all reasonable and prudent measures.

The Fish and Wildlife Service will not refer the incidental take of any migratory bird or bald eagle for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. Sec. 703-712), or the Bald and Golden Eagle Protection Act of 1940, as amended (16 U.S.C. Sec. 668-668d), if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

Terms and Conditions (RPM 1): Productivity and population surveys on reaches below Missouri River and Kansas River tributary dams shall be conducted each year. Missouri River reservoirs shall also be surveyed to monitor birds that pioneer exposed reservoir shoreline areas and thus provide accurate estimates of system-wide productivity and population sizes. Reservoir shorelines can account for significant numbers of both species. For example, during the severe drought of 1988 and 1989, 13 percent of least terns and 39 percent of piping plovers nesting within the Missouri River system were found above system dams. Had these birds not been accounted for, population sizes and productivity rates would have been grossly inaccurate.

Population survey information shall include (1) the total number of colonies, (2) the total number of birds, and (3) mapping of habitat used by birds (i.e., general location map of colony sites and acreage determination).

Productivity (i.e., nesting and fledge success) estimates may be conducted on all areas but shall be based at least on subsamples of the nesting population in each reach. Monitoring information shall include (1) the total number of nests, (2) the total number of fledged birds per nesting pair and causes of nest and chick loss, and (3) elevation of nests above water levels. The fledge ratio standard shall be calculated as a weighted average for the entire river based on the number of pairs. Until such time as the Captive Rearing Program success has been peer reviewed and documented to contribute to bird productivity, the captive reared productivity data cannot be used in calculating the overall system fledge ratios. The Corps and the Service, through ACT, shall jointly develop the method used to calculate the fledge ratio.

Survey and monitoring information, in conjunction with the Corps' Habitat Conservation and Recovery Plan can be used to develop management plans that will avoid taking of birds during the nesting season as well as determine if fledge ratios are met as described in the reasonable and prudent alternatives and requirements for reinitiations of consultation. With such a monitoring program in place, the Corps will know when and how operations may result in take, as well as be able to avoid take.

In addition to those items identified in Reasonable and Prudent Alternative I.B and I.C, the Corps will include the following in the Annual Report:

1. Quantification of any taking, including loss of eggs, chicks, adults, and habitat, that occurred, including reasons for take and actions to avoid take; and

2. Evaluation of operational efforts to avoid take (habitat and birds).

3. Captive rearing activity including numbers of eggs taken, nests taken, identification of reason for take, i.e., compliance with Contingency Plan, eggs hatched, chicks fledged, location of release, and re-sighting reports.

Terms and Conditions (RPM 2): All incidences of take on both the Missouri and Kansas Rivers shall be documented and immediately reported to the Service's South Dakota Field Office Supervisor. The Corps shall conduct a thorough evaluation of all operational attributes on both rivers and their impacts on the take of terns and plovers and their habitats. This evaluation should begin with data from 1986 when the birds were listed and address all impacts as discussed in the effects and take sections above. For example, this evaluation should consider 24-hour hydropeaking below Gavins Point, Fort Randall, and Garrison Dams and its impacts to terns and plovers and their habitats. A recommendation to avoid impacts where possible shall be made available for review by ACT. The purpose of this evaluation is to identify and document specific operational measures taken or that can be taken now or in the future to avoid take and institutionalize these measures in Annual Operating Plans and/or the Master Manual as appropriate. The Corps shall conduct this evaluation in coordination with the Agency Coordination Team (ACT). The initial report shall be completed by January 2002 and include a summary of 1986-2000; subsequent reports (post 2000) shall be part of the annual report to the Service and appropriately considered by the Corps in future Annual Operating Plans and/or the Master Manual as appropriate.

Terms and Conditions (RPM 3): The Corps shall coordinate regularly with the Service through ACT, to ensure that proposed operations will avoid take of terns and plovers to the maximum extent practicable. If, because of water conditions, take is unavoidable (i.e., innundation by raising reservoir levels versus passing that water through the dams), the Corps shall coordinate with the Service to ensure that such take is consistent with that identified in the incidental take statement and the "Contingency Plan for Protection of Least Tern and Piping Plover Nests and Chicks" (Appendix VI) and the "Captive Rearing Protocol" are followed. If the Corps develops new operational scenarios that were not considered during this consultation, the Corps shall reinitiate consultation for those new actions (see above annual reporting requirements).

Operational-caused flooding of nests or habitat shall be avoided during the nesting season unless determined by the management team to be of a greater overall benefit to the ecosystem and the long-term viability of tern and plover populations. Therefore, once nests have been initiated, flows should not be increased to imperil nests. The Corps shall avoid spiking (i.e., 2 days low, 1 day high) of flows as a management tool during the tern and plover nesting season.

Terms and Conditions (RPM 4): The Corps shall continue their Captive Rearing Program and shall coordinate regularly with the Service during the nesting season in regard to this program. The Corps shall initiate peer review on the Captive Rearing Protocol every 5 years beginning in 2000. Any changes recommended by peer review will be coordinated with and approved by the Service. The Corps shall continue to conduct research into the effectiveness of the captive rearing program to contribute to tern and plover conservation and recovery. Specifically, the Corps shall finish the current research on the piping plover. When the research has been completed, the Corps shall work through the adaptive management process with the Service to identify if additional research is necessary or if captive rearing should continue as an effective management technique. The Corps shall also initiate and conduct research to evaluate the effectiveness of the captive rearing program to contribute to least terns. The Corps shall coordinate with the Service through ACT on the scope of the research. When the research has been completed, the Corps shall work through the adaptive management process with the Service to identify if additional research is necessary or if captive rearing should continue as an effective management technique.

Terms and Conditions (RPM 5): The following actions shall be taken to implement this reasonable and prudent measure.

1. The Corps shall produce and update Public Service Announcements (radio release and television video) informing the public of terns and plovers on the river. The Public Service Announcements shall be distributed to radio and television stations within the States bordering the Missouri River to be used at least from May through August. The video shall be available for public use and used in the Corps' project office interpretive programs.

2. The Corps' project offices shall engage in intensive public relations efforts for tern and plover conservation to take place on Corps' land, including but not limited to displays, video productions, naturalist talks, information flyers or brochures, information placed in campground notices, and informational posting of boat ramps.

3. The Corps shall post all tern and plover nesting areas off limits to human disturbance. Each year State and Service personnel will coordinate efforts with the Corps to determine adequate levels of enforcement.

4. Initiate appropriate studies that will address the cumulative impacts of increased recreational facility expansion on the Missouri River on least terns and piping plovers with a view toward appropriate management actions that would avoid and minimize impacts to these nesting species.

Terms and Conditions (RPM 6): The following management actions shall be taken to implement this reasonable and prudent measure.

1. The Corps shall implement all available predator management techniques to support tern and plover productivity, including, but not limited to:

    a) nesting exclosures
    b) trapping

c) strobe light systems

Closing

Because of the complexity of the issues surrounding incidental take, the comprehensive definition of take (i.e., harm, harass, kill) and the need for adaptive management to effectively manage for all Federally listed species, we have proposed the following approach to determine the level or extent of incidental take. The take of terns and plovers and/or their habitats shall not exceed that amount that would allow the 3-year average fledge-ratio goals to drop below 0.70 (terns) and 1.13 (plovers) except as identified under the following conditions:

1. If the Contingency Plan for Protection of Least Tern and Piping Plover Chicks is initiated, the number of birds that may be taken cannot exceed the capacity of the Corps' facilities (year 2000) and staff to successfully implement the Captive Rearing Protocol(s). The handling of birds taken will be permitted to the Corps by the Service through a section 10 permit of the ESA.

2. If ACT consensus is reached, tern and plover nests may be purposely flooded and the Contingency Plan for Protection of Least Tern and Piping Plover Chicks may be implemented for adaptive management purposes that are in the overall interest of species conservation and recovery. This level of take will not exceed that which is identified under number 1 above as the capacity of the Corps facilities (year 2000) and staff to successfully implement the Captive Rearing Protocol.

The reasonable and prudent measures, with their implementing terns and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need to modify the reasonable and prudent measures.

PALLID STURGEON

Amount or Extent of Take Anticipated

The Service has developed the following incidental take statement based on the premise that the reasonable and prudent alternative will be implemented. The Service anticipates that incidental take of pallid sturgeon will occur between issuance of this biological opinion and complete implementation of the RPA, as well as for a short period following implementation of the RPA (approximately 5-10 years).

The Service anticipates that incidental take of pallid sturgeon due to continued operation and maintenance activities will be difficult to detect, monitor, and predict for the following reasons: (1) pallid sturgeon are wide-ranging, (2) occur in habitats and at densities that make detection difficult and finding a dead or impaired specimen unlikely, and (3) changes to fitness parameters (e.g., decreased recruitment) are difficult to assess in small populations and may be masked by seasonal fluctuations. Implementation of the elements of the reasonable and prudent alternative and the following reasonable and prudent measures focusing on the above environmental factors will minimize the amount or extent of incidental take.

During the period immediately following implementation of the RPA, pallid sturgeon habitat is likely to continue to decline as a result of continued MR, BSNP, and KR Operations and the processes that create and maintain such habitat will continue to be disrupted and altered. The habitat restoration program in the lower river (River Segments 10 through 15) is long-term (30-35 years according to expanded mitigation project) and immediate trends toward significantly increasing habitat quality, quantity and diversity are not likely in the next 5 years (e.g., the amount of habitat restored is not initially likely to off-set the amount lost due to operation and maintenance activities). The exception is the warmer water habitat created by the Fort Peck releases, which is a near-term restoration activity. Therefore, incidental take, in the form of harm and harass (i.e., habitat loss and alteration due to operation and maintenance of the Missouri and Kansas Rivers and the BSNP) will result in actual death or injury through loss of reproduction and recruitment. Such harm likely will continue for some time (approximated at 5-10 years) following full implementation of the RPA.

The following types of unavoidable losses are anticipated:

a. Loss of reproduction due to missing environmental cues including spawning cues, the form and function of a natural hydrograph, warmer temperature regimes, lack of sediment or turbidity regime, inadequate quantity and quality of available habitat and sufficient aquatic nutrient input.

b. Loss of recruitment due to the lack of the quantity and quality of a sufficient diversity of spawning and nursery habitats, forage base, and sufficient environmental factors noted in a above.

c. Loss of genetic purity due to hybridization attributed to insufficient quantity and quality of diverse habitats.

d. Loss of adults and progeny associated with artificial propagation.

More specifically:

? Within River Segments 2, 8, and 10, pallid sturgeon spawning cues and maturation are affected by the clear, hypolimnetic releases from the main stem dams. Until flows are improved, loss of spawning opportunities will continue to prevent reproduction and recruitment for the pallid sturgeon.

? In River Segments 11 through 15, lack of suitable slow velocity and shallow, submerged sandbar habitat severely limits larval and juvenile pallid sturgeon rearing areas, thereby reducing or eliminating recruitment into the pallid sturgeon population.

? In River Segment 2, which includes the lower Yellowstone River, and Segment 16 - Kansas River, lowhead dams prevent pallid sturgeon migration upstream to potential spawning areas, thereby, reducing the amount of available spawning habitat.

Effect of the Take

In the accompanying biological opinion, the Service determined that a level of take that does not impact the ability of pallid sturgeon to naturally reproduce, recruit and survive in the wild within pallid sturgeon recovery priority areas is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat when the reasonable and prudent alternative is implemented. Implementation of the reasonable and prudent measures below will minimize incidental take. In other words, any incidental take that may occur should be offset by the implementation of the reasonable and prudent alternative and reasonable and prudent measures.

Reasonable and Prudent Measures to Minimize Take

Although implementation of the elements described in the multi-species RPA section and the pallid sturgeon RPA section will, in part, minimize take of pallid sturgeon, the Service believes the following reasonable and prudent measures also are necessary and appropriate to minimize take of pallid sturgeon:

Reasonable and Prudent Measure 1. The Corps shall evaluate operational and maintenance activities to avoid take.

Reasonable and Prudent Measure 2. The Corps shall increase awareness of the pallid sturgeon by Missouri River user-groups and stake holders to achieve support for recovery and conservation measures proposed in the Recovery Plan and the Biological Opinion.

Terms and Conditions for Implementation of Reasonable and Prudent Measures

To be exempt from the prohibitions of section 9 of the Act, the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary. The Corps is responsible for the funding and means to carry out all reasonable and prudent measures.

As part of the Annual Report, the Corps shall provide information on pallid sturgeon conservation activities similar to ESA subpermitting requirements and annual reports currently provided by the Corps' least tern and piping plover program. The report shall include progress and management actions, including elements of the reasonable and prudent alternative and reasonable, and prudent measures implemented during the operating year, habitat restoration actions, and anticipated actions for the upcoming year. The purpose of this report is to provide the Service, ACT, Recovery Team, and Recovery Workgroups the information necessary to evaluate the effectiveness of the Corps' actions.

Terms and Conditions (RPM 1): The Corps shall avoid annual operational changes that may affect spawning activities and survival of juvenile pallid sturgeon. All incidences of take shall be documented and immediately reported to the Service's North Dakota Ecological Service Field Supervisor. The Corps shall evaluate means to avoid impacts to pallid sturgeon and provide recommendations to ACT. The purpose of this review and evaluation is to identify and document specific operational measures taken or that can be taken now or in the future to avoid take and institutionalize these measures in Annual Operating Plans and/or the Master Manual as appropriate. The Corps shall conduct this evaluation in coordination with the ACT. The initial report shall be completed by January 2003 and subsequent reports shall be part of the Annual Report to the Service and appropriately considered by the Corps in future Annual Operating Plans and/or the Master Manual revisions as appropriate. If the Corps develops new operational scenarios not considered during this consultation, the Corps shall reinitiate consultation with the Service for those new actions.

Terms and Conditions (RPM 2): The following actions shall be taken to increase public awareness and support conservation measures.

a. The Corps shall produce and update Public Service Announcements (radio release and television video) informing the public of pallid sturgeon on the river. The Public Service Announcements shall be distributed to radio and television stations within the States bordering the Missouri River to be used at least from May through August. The video shall be available for public use and used in the Corps' project office interpretive programs.

b. The Corps' project offices shall engage in intensive public relations efforts for pallid sturgeon conservation, including but not limited to displays, video productions, naturalist talks, information flyers or brochures, information placed in campground notices, and informational posting of boat ramps.

c. Within 1 year of the final biological opinion, the Corps shall develop and implement an outreach program on pallid sturgeon. At a minimum, the program must include annual announcements through various media to inform sport and commercial fishermen that pallid sturgeon could be captured incidentally and that they must be released unharmed. Announcements would also encourage reporting of tagged fish.

d. The Corps shall work with the Service and the pallid sturgeon recovery team to implement regional pallid sturgeon workshops to educate researchers and continue development of handling protocols for pallid sturgeon. These should be conducted every three years starting in 2001.

Closing

Because of the complexity of the issues surrounding incidental take as a result of continued or ongoing habitat degradation and the need for adaptive management to effectively manage for all Federally listed species, we have proposed the following approach to the level or extent of incidental take. The Service believes that take at a level which would not allow the pallid sturgeon to naturally reproduce, recruit and survive in the wild in the pallid sturgeon recovery priority areas is unacceptable. Therefore, the level of take of pallid sturgeon incidentally taken as a result of the proposed actions is as follows:

The take of pallid sturgeon through habitat modification that results in actual death or injury shall not exceed that level of habitat modification preventing the pallid sturgeon from naturally reproducing, recruiting and surviving in the wild in pallid sturgeon recovery areas except as identified under the following conditions;

4. During the spring flow enhancement testing at Fort Peck and Gavins Point Dams.

5. If ACT consensus is reached that flow enhancement testing needs to be modified or cannot be implemented for reasons beyond the Corps' control, or the Corps shall contribute resources approved by the Pallid Sturgeon Recovery Team and Recovery Workgroups to pallid sturgeon propagation efforts approved by the Pallid Sturgeon Recovery Team until such time as the quantity and quality of habitats or environmental factors necessary for pallid sturgeon to naturally reproduce, recruit and survive in the wild exists in pallid sturgeon recovery areas.

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Corps must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out programs to conserve endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop biologic information. The Service provides the following recommendations to further the conservation of the bald eagle, least tern, piping plover, and pallid sturgeon on the Missouri River and lower Kansas River.

For the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests the Corps notify us upon their implementation of any conservation recommendations.

RECOMMENDATIONS APPLICABLE TO MULTIPLE SPECIES

1. **Recovery and Implementation Program:** Implementation of actions described in this Biological Opinion that may be periodically refined by monitoring and research would be enhanced by a "Recovery and Implementation Program" that engages user groups and organizations as well as individuals interested in Missouri River management. This approach has been used successfully in other large river systems with competing interests. This program could be a forum for interested parties to assist the Corps and Service in implementing necessary actions in a timely and effective manner for the benefit of the listed species. This program could also be an opportunity to provide and transmit information that will be used through the adaptive management approach to modify actions for the benefit of species.
2. **Water Depletions:** The Service recommends the Corps initiate a study to document current and future water depletions in the basin as addressed in the Service's 1994 draft biological opinion under "Future Federal Actions."

BALD EAGLE

The recovery plan for the Northern States population of the bald eagle lists tasks to meet recovery objectives for the species. Implementation schedules in the plans prioritize recovery tasks. Many of these tasks are underway by the Corps and other agencies and organizations. The Service recommends that the Corps continue to pursue the recovery tasks assigned to the Corps in the implementation schedules and listed below for Missouri and Kansas River habitats:

3. Conduct or participate in annual wintering and nesting bald eagle surveys.

2. Determine population dynamics of wintering and nesting birds.

3. Protect and manage bald eagle habitat.

4. Conduct public outreach on the value of river habitat to the bald eagle.

5. Exercise Section 10/404 permit authority to protect, maintain, and enhance riparian forest usable by bald eagles. In particular, bank stabilization projects should only be authorized if in conjunction with perennial riparian buffers. Restoration of stands of cottonwood, and sycamore in the Kansas River floodplain, should be pursued in all permit reviews.

LEAST TERN AND PIPING PLOVER

In addition to the reasonable and prudent alternative and measures listed above to preclude jeopardy and reduce anticipated incidental take, the following recommendations will further the conservation of the least tern and piping plover on the Missouri River.

1. The Corps should work with the Service and other partners to research connectivity or interchange (population dynamics/interactions) between Missouri River least terns and least terns nesting on Missouri River tributaries and other rivers. Such research may reveal information that would have implications to species recovery and adaptive management on the Missouri River.

2. The Corps should work with the Service and other partners to research connectivity or interchange (population dynamics/interactions) between Missouri River piping plovers and other plovers nesting in the Northern Great Plains particularly the Prairie Coteau region. Such research may reveal information that would have implications to adaptive management on the Missouri River.

3. The Corps should investigate the response of invertebrate production to river operations and address any implications to least tern and piping plover survival, growth and energetics.

4. The Corps should modify or eliminate development activities that adversely impact species reproductive success and lead to habitat destruction and modification.

5. The Corps should assess the feasibility of intensively managing a limited number of tern and plover breeding areas for high reproductive output.

6. The Corps should develop a population model of the tern and plover along the Missouri River that predicts survival and long-term population trends.

7. The Corps should investigate the role of Missouri River sandbar habitat complexes to migration, staging and pre-winter conditioning of least terns and piping plovers.

8. The Corps should work with the Service and other partners to research the impacts wintering ground activities have on long-term survival of Missouri River tern and plover populations.

PALLID STURGEON

In addition to the reasonable and prudent alternative and measures listed above to preclude jeopardy and reduce anticipated incidental take, the following recommendations will further the conservation of the pallid sturgeon on the Missouri River. Some of these recommendations are taken from the Pallid Sturgeon Recovery Plan Implementation Schedule, where they are listed as tasks for implementation by the Corps. The Service recommends the Corps:

9. Complete a feasibility study to identify and evaluate the effects of tributary dam and other structures on sturgeon spawning migrations and to recommend alternatives to enhance sturgeon passage should the study find that the structures are impeding spawning migrations. Tributary dams and other structures (e.g., Johnson County Weir and Bowersock Dam on the Kansas River; Intake Diversion Dam on Yellowstone River may impede pallid and shovelnose sturgeon migrations from the Missouri River, thus adversely affecting reproductive success by denying access to appropriate spawning habitat and nursery areas. In addition, they may contribute to hybridization between the pallid and shovelnose sturgeon by forcing both species into limited spawning habitats during the spawning season. As warranted, the Corps should work with other Federal agencies (e.g., BR at Intake Diversion Dam) to facilitate and support their efforts.

10. Implement a basin-wide educational and outreach program for anglers to identify sturgeon species to minimize accidental take.

11. Assist the Service and states with identifying the impacts and extent of commercial harvest in the basin on pallid sturgeon.

12. Provide funding to continue development and conduct sturgeon genetic techniques to ensure sufficient genetic variation is considered in all propagation programs and to monitor and determine the extent and management implications of hybridization between sturgeon species.

13. Provide funding to conduct a Population Viability Analysis to determine appropriate recovery numbers.

14. Evaluate standard recommendations on placement and design of municipal and industrial intakes permitted by the Corps to ensure they are adequate to protect against entrainment of early life stages of sturgeon. Complete a report of findings with recommended modifications as needed.

15. Evaluate standard recommendations on practices for channel dredging, and sand and gravel

mining as permitted by the Corps to ensure they are adequate to protect against direct harm to shallow-water habitat and to spawning habitat and early life stages of sturgeon. Complete a report of findings with recommended modifications, as needed.

16. Evaluate the cumulative effects of bank stabilization as permitted by the Corps to determine to what extent continued stabilization is reducing sedimentation, turbidity, import of organic matter and elimination of cut-bank habitats on the Missouri River. Complete a report of findings with recommended modifications as needed.

17. Evaluate capability and practicality of increasing water temperature of the Missouri River in priority reaches during critical periods for native warm-water fish through adjustment of EPA water temperature discharge requirements for power plants and other industries.

18. Participate as a partner in regional pallid sturgeon recovery work groups, as established by the recovery team on the Missouri River, to provide input on recovery needs and priorities; and to assist with funding to address recovery needs with other partners.

19. Provide funding to develop and validate a sturgeon aging technique.

20. Evaluate effects of severe, rapid flow reductions or complete flow reductions on native fish such as the pallid sturgeon as what occurs below Fort Randall Dam (River Segment 8) occasionally.

21. Assist the Service and other partners with fish health issues as they relate to pallid sturgeon.
22. Assist the Service and other partners with cryopreservation banking of pallid sturgeon sperm.

SUMMARY TABLES

To help the Corps track the reasonable and prudent alternative in the biological opinion, as well as the incidental take statement with its reasonable and prudent measures, conservation recommendations and reporting requirements, the Service outlined the key points and implementation schedule in Tables 24 and 25.

Table 24. Summary of Reasonable and Prudent Alternative, Reasonable and Prudent Measures to Minimize Take, and Conservation Measures

Reasonable and Prudent Alternative	Implementation Objective
<u>**Elements Applicable for Multiple Listed Species in Ecosystem**</u>	
IX. Adaptive Management	
A. Establish an Agency Coordination Team (ACT)	March 2001
1. Coordination Meetings	Twice a year
A. Develop Endangered Species and Habitat Monitoring Plan	Within 1 year
B. Annual Report	Annually
II. Flow Enhancement	
B. Gavins Point Dam:	
1. Spring Rise: 17.5 Kcfs above full service for 30 days between 1 May - 15 Jun	Once every 3 years/start 2003
Summer Low: flows stepped down to 25 Kcfs by June 21 held until July 15 July 15 flows stepped down to 21 Kcfs and held until August 15 August 15 flows stepped up to 25 Kcfs and held until September 1.	
A. Fort Peck Dam	
1. Implement mini-test	2001
2. Implement full test. Spring release between May and the end of June with: Range of flows 20 to 30 Kcfs, temperature (18? C) at Frazer, MT for a minimum of 3 weeks.	2002
3. Implement full enhancement flows, modified based on test	2003, once every 3 years
B. Other Segments Investigate the applicability of flow enhancement at Garrison Dam, implement if applicable	2005

Reasonable and Prudent Alternative	Implementation Objective
III. Unbalanced Intrasystem Regulation	2001
IV. Habitat Restoration/Creation/Acquisition	
C. Restoration of Submerged Shallow Water Habitat (Goal: restoration of 19,565 total acres)	
1. Ensure no-net-loss of existing shallow water habitat from O&M in lower river.	
2. Develop habitat restoration plans and strategies in segments 10 through 16	2001
3. Implement habitat restoration plans and strategies	2002
4. Continue implementation of habitat restoration plans and strategies	2003
5. Reached 8% (1,700 acres) shallow-water habitat goal	2004
6. Reached 10% (2,000 acres) shallow-water habitat goal	2005
7. Reached 30% (5,870 acres) shallow-water habitat goal	2010
8. Reached 60% (11,739 acres) shallow-water habitat goal	2015
9. Reached 100% (19,565 acres) shallow-water habitat goal	2020
A. Restoration of Emergent Sandbar Habitat	
1. Provide natural sandbar habitat complexes	
a. Minimum emergent interchannel sandbar habitat acres per river mile: Garrison (25 acres) Fort Randall (10 acres) L&C Lake (40 acres) Gavins Point (40 acres)	2015
Garrison (50 acres) Fort Randall (20 acres) L&C Lake (80 acres) Gavins Point (80 acres)	2015
b. Complete 1998 baseline habitat evaluations on Fort Peck River (Segment 2)	2003
c. Meet minimum baseline acres on Fort Peck River (Segment 2)	2015

Reasonable and Prudent Alternative	Implementation Objective
2. Provide reservoir beach and island habitat.	
a. Maintain reservoir habitats through intra-system regulation	2001
b. Identify all potential habitat enhancement on reservoir segments (Segments 1,3,5)	2005
c. Complete 25% of reservoir projects identified above	2010
d. Complete 50% of reservoir projects identified above	2015
e. Complete 100% of reservoir projects identified above	2020
3. Artificially or Mechanically Created Habitat	
a. Provide created sandbar habitat on Segments 2, 4, 8, 9, 10 to supplement B1 above	Years B(1a), B(1c) are deficient
B. Initiate studies of the lack of sediment transport and impacts on habitat regeneration and turbidity	2003
C. Monitoring of tern and plover nesting habitat	Once every 3 years

Elements Applicable to Specific Species

V. Least Tern and Piping Plover

D. Operate the Kansas River to provide overall benefits to conservation of least terns and piping plovers	2001
1. Develop a study plan.	2002
2. Gather data and evaluate whether Kansas River provides source or sink.	2005
A. Provide habitat to meet or exceed fledge ratio goals of 0.70 for least terns and 1.13 for piping plovers	2001 (3 year average)
B. Initiate and conduct a piping plover foraging ecology study on the Missouri River	2005

Reasonable and Prudent Alternative	Implementation Objective
VI. Pallid Sturgeon	
A. Support, assist, and increase pallid sturgeon propagation and augmentation efforts.	2001 -2011 2003 - Evaluation
1. Collect and spawn female broodstock.	
2. Goal - produce 4,700 juvenile to 1-year olds (Corps responsibility 2,491)	
3. Production, rearing and release of juvenile fish.	
4. Monitor stocked juvenile pallid sturgeon	
5. Meet annually through ACT	
B. Conduct pallid sturgeon population assessment including habitat parameters.	2001
1. Identify the causes for the lack of reproduction and recruitment, causes for hybridization, and identify restoration actions.	Begin in 2001
2. Identify and map spawning habitat	Implement strategy by 2001 to conduct mapping by 2002.
3. Channel training structure maintenance	Coordinate construction activities with the Service and affected State agencies.
4. Prioritize research needs	2000

Reasonable and Prudent Measures to Minimize Take	Terms and Conditions
Bald Eagle	
Measure 1 Map and evaluate current health of cottonwood forests on Missouri River.	Complete within 2 years of final BO.
a. Identify stands with periodic flooding	

	b. Determine baseline mortality and tree vigor	Monitor every 2 years for first 4 years, then every 5 years after that.
Measure 2	Develop management plan for cottonwood regeneration	Complete & implement within 2 years of completion of measure 1 above.
Measure 3	Implement actions to ensure no more than 10% eagle habitat is lost.	

Terns and Plovers

Measure 1	Monitor all tern and plover nesting sites on Missouri and Kansas Rivers	Conduct population surveys and productivity monitoring annually.
	1. Population survey information	
	a. Total # of colonies	
	b. Total # of birds	Report survey and monitoring information in the Annual Report.
	c. Map nest site locations	
	2. Monitoring information	
	a. Total # of nests and nest fates	
	b. Total # of fledged chicks/pair and other chick fates	
	c. Elevation of nests above water level	

Reasonable and Prudent Measures to Minimize Take		**Terms and Conditions**
Measure 2	Compile and evaluate the previous impacts to take from:	Submit report by Jan 2002 of the impacts to take resulting from historic operational changes (1986-2000). To include protocols to prevent historic cases of take from
	1. Daily and hourly release fluctuations below dams	
	2. Changes in releases due to maintenance or other isolated causes	

		reoccurring.
	3. Changes in releases to prevent downstream flood impacts	
Measure 3	The Corps shall continue to evaluate operational changes to avoid take.	Avoid operational caused flooding and spiked releases. Report all documented incidental take immediately to Service. Coordinate regularly through ACT to ensure proposed operations will avoid take. If take is unavoidable - take shall be consistent with incidental take statement. The Corps will re-consult with the Service if the Corps develops new operational scenarios not considered during initial consultation.

Reasonable and Prudent Measures to Minimize Take		**Terms and Conditions**
Measure 4	The Corps shall follow the “Contingency Plan for Protection of Least Tern and Piping Plover Nests and Chicks” and the “Captive Rearing Protocol.”	
	1. Continue captive rearing program, coordinate with Service	Any changes to Protocol will be coordinated with and approved by the Service.
.	2. Initiate a peer review on Captive Rearing Protocol	Peer review every 5 years start in 2001. Finish the captive reared plover study. Through the adaptive management process, identify if additional research necessary or if captive rearing should continue.
	3. Continue research into the effectiveness of the captive rearing program.	Report all captive rearing activities in the

Reasonable and Prudent Measures to Minimize Take		Terms and Conditions
		Annual Report.
Measure 5	The Corps shall implement public information and educational programs to increase public awareness and reduce disturbance to nesting sites.	Produce and update public service announcements.
		Engage in intensive public relations efforts for tern and plover conservation.
		Post all tern and plover nesting areas off limits to human disturbance.
		Initiate studies to address cumulative impacts of increased recreational facility expansion
Measure 6	The Corps shall implement aversive action to reduce predation on least tern.	Apply all available predator management techniques including, cages, strobe lights, and trapping.

Reasonable and Prudent Measures to Minimize Take		Terms and Conditions
Pallid Sturgeon		
Measure 1	The Corps shall evaluate and modify operational changes and maintenance activities to avoid take.	Avoid operational changes that may affect spawning.
		Report all documented incidental take immediately.
		Coordinate regularly through ACT to ensure proposed operations will avoid take.
		The Corps will re-consult with the Service if the Corps develops new operational scenarios not considered during initial consultation.

Measure 2	The Corps shall increase awareness of the pallid sturgeon on the Missouri River and develop support for recovery and conservation measures.	Produce and distribute public service announcements for use in states bordering the Missouri River. Project offices shall incorporate pallid sturgeon conservation into public education efforts. Within 1 year of the final BO, develop and implement an outreach program for pallid sturgeon. Implement workshops every 3 years starting in 2001 to educate researchers and continue developing of handling protocols.

Conservation Recommendations

Recommendations Applicable to Multiple Species

1. Develop a Recovery and Implementation Program.

2. Document current and future water depletions.

Recommendations Applicable to Specific Species

Bald Eagle

Pursue the recovery tasks assigned in the implementation schedules.

1. Conduct or participate in wintering and nesting bald eagle surveys.

2. Determine population dynamics of wintering and nesting birds.

3. Protect and manage habitat.

4. Conduct public outreach on the value of river habitat to the bald eagle.

5. Protect, maintain and enhance riparian forest usable by bald eagles through the Section 10/404 permit authorities.

Least Tern and Piping Plover

1. Research connectivity or interchange between Missouri River least terns and least terns nesting on tributaries and other rivers.

2. Research connectivity or interchange between Missouri River piping plovers and plovers nesting in the Northern Great Plains.

3. Investigate the response of invertebrate production to operations as it applies to tern and plover survival, growth, and energetics.

4. Modify/eliminate development activities that negatively impact reproductive success or lead to habitat destruction.

5. Assess the feasibility of intensively managing a limited number of tern and plover breeding areas for high reproductive output.

6. Develop a population model of terns and plovers on the Missouri that predicts survival and long-term population trends.

7. Investigate the role of sandbar complexes to migration, staging, and pre-wintering conditioning of terns and plovers.

8. Work with the Service and other partners to research and examine impacts wintering ground activities have on long-term survival.

Pallid Sturgeon

1. Complete a feasibility study to identify and evaluate the effects of tributary dams and other structures on spawning migrations.

2. Implement basin-wide education and outreach programs for anglers.

3. Assist the Service and States with identifying impacts and extent of commercial harvest in the basin on pallid sturgeon.

4. Provide funding to continue development and conduct sturgeon genetic techniques to ensure genetic variation.

5. Provide funding to conduct Population Viability Analysis to determine appropriate recovery numbers.

6. Evaluate standard recommendations on placement and design of municipal and industrial intakes.

7. Evaluate standard recommendations on practices for channel dredging and sand and gravel mining.

8. Evaluate the cumulative effects of bank stabilization.

9. Evaluate capability and practicality of increasing water temperature in priority reaches during critical periods for native warm-water fish.

10. Participate as a partner in regional pallid sturgeon recovery work groups.

11. Provide funding to develop and validate a sturgeon aging technique.

12. Evaluate effects of severe rapid flow reductions or complete flow reductions on native fish below Ft. Randall Dam.

13. Assist the Service and other partners with fish health issues as they relate to pallid sturgeon.

14. Assist the Service and other partners with cyropreservation banking of pallid sturgeon sperm.

Table 25. Reporting Requirements for Missouri and Kansas River Operations and the BSNP

Action	Data	Report Requirements	RPA/RPM
Flow Management			
Gavins Point Dam	Baseline habitat information (i.e. discharge, temp., turbidity, nutrient cycling)	2001	RPA I(B), RPA II(A)
	Physical metric associated with release (see above)	Annually	RPA I(B), RPA II(A)
	Sturgeon response	Annually	RPA I(B), RPA II(A)
Fort Peck Dam	Baseline habitat information, turbidity, nutrient cycling	2001	RPA I(B), RPA II(B)
	Physical metric associated with release (see above)	2002	RPA I(B), RPA II(B)
	Sturgeon response	2002	RPA I(B), RPA II(B)
Habitat creation/restoration	Quantity and quality of shallow-water habitat	2001 (and annually thereafter)	RPA I(B), RPA IV(A), RPA VI(B)
	Map and assess quantity and quality of sandbar habitat (mid-July thru August)	2001 (every 3 years thereafter)	RPA I(B), RPA IV(D)

Action	Data	Report Requirements	RPA/RPM
	Studies on sediment transport, habitat regeneration, and turbidity	2003	RPA I(B), RPA IV(C)
	KS River study plan/evaluation	2002/2005	RPA I(B), RPA V(A)
Terns and Plovers	Evaluate previous operations/effects on take	2002	RPA I(B), RPM 2
	Management actions/progress for that year	Annually, start 2001	RPA I(B)
	Incidental take from operations	Annually, start 2001	RPA I(B), RPM 2, RPM 3
	Fledge ratios	Annually, start 2001	RPA I(B), RPA V(B), RPM 1
	Population survey (total birds, breeding pairs, eggs, chicks)	Annually, start 2001	RPA I(B), RPM 1
	Nest elevations	Annually, start 2001	RPA I(B), RPM 1
Terns and Plovers (Cont.)	Incidental take and captive rearing activity	Annually, start 2001	RPA I(B), RPM 4
	Habitat mapping and changes during nesting season	Annually, start 2001	RPA I(B), RPM 1
	Historic hourly release data and water levels from 5/1-8/30	When requested	RPA I(B), RPM 2
	Forage ecology study	2005	RPA I(B), RPA V(C)
Sturgeon	Management actions/progress for that year	Annually, start 2001	RPA I(B)
	Augmentation and recruitment, progress and habitat use of stocked fish	Annually, start 2001	RPA I(B), RPA VI(A)
	Population assessment	Annually 2001	RPA I(B), RPA VI(B)
	Map all potential pallid sturgeon spawning habitat	Plan (2001), Map (2002)	RPA I(B), RPA VI(B)
	Causes of insufficient reprod., recruit., hybrid	Start 2001	RPA I(B), RPA VI(B)
Bald eagle	Map/evaluate cottonwood forests known to provide habitat for eagles	By 2002 (every 2 to 5 years after)	RPA I(B), RPM 1

Action	Data	Report Requirements	RPA/RPM
	Management plan for cottonwood regeneration	Within 2 years of above	RPA I(B), RPM 2

REINITIATION NOTICE

This concludes formal consultation on the actions outlined in the Corps' request, dated March 30, 2000. 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.

For example, if the sturgeon chub or sicklefin chub, candidate species not addressed in this opinion, are listed in the future; or if new information warrants including the scaleshell mussel; or if the Master Manual Review and Study results in a change in the CWCP criteria, other than the changes specified in this biological opinion, the Corps shall reinitiate consultation with the Service and modify/amend the opinion as appropriate. Specifically, if Federal water projects that depend on System storage and System operations, and their implementation would initiate changes in System operations not considered in this Biological Opinion, this section 7 consultation must be reinitiated. Agency agreement to an adaptive management process may provide the mechanism for amendments to the current Biological Opinion in lieu of preparation of a new biological opinion.

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APPENDIX I

COORDINATION WITH

FEDERAL/STATE/TRIBAL GOVERNMENTS

COORDINATION WITH FEDERAL/STATE/TRIBAL GOVERNMENTS

As required under the Endangered Species Act, the Fish and Wildlife Service sent out letters to states, tribes and Federal agencies which may have biological information relevant to the consultation. Letters were sent in October 1999, March 2000, and December 2000. In addition, meetings were held in Denver, Colorado, on February 4, 1999, and Bismarck, North Dakota, on April 25, 2000, to collect additional information. This appendix includes copies of the letters sent to the states, tribes, and Federal agencies, as well as a list of the incoming correspondence resulting from the letters and meetings.

The following correspondence has been received regarding biological input to the Biological Opinion:

DATE	AGENCY	FORM/PAGES
April 25, 2000	Robert J. Vincze, Atty. Hall & Evans, L.L.C. (MO-ARK Association and the Missouri Levee and Drainage District Association)	Letter and box of reprints and video
April 25, 2000	John Drew, Missouri DNR	Handouts and overheads
April 25, 2000	Gene Zuerlein, Missouri River Natural Resources Committee	Handouts, overheads, and video
April 25, 2000	Chad Smith - American Rivers	Handouts
May 1, 2000	Bureau of Indian Affairs - Washington	Letter - 2 pages
May 2, 2000	Robert J. Vincze, Atty. Hall & Evans, L.L.C. (MO-ARK Association and the Missouri Levee and Drainage District Association)	Letter - 1 page and attachment
May 2, 2000	Missouri Dept. of Conservation - Jefferson City	Draft Letter - 3 pages
May 3, 2000	Three Affiliated Tribes - New Town	Letter - 12 pages
May 3, 2000	ND Game & Fish Dept. - Bismarck	Letter - 15 pages
May 5, 2000	Missouri Dept. of Conservation - Jefferson City	Final Letter - 4 pages

May 8, 2000	Crow Creek Tribe, Ft. Peck Tribe, Lower Brule Sioux Tribe, Omaha Tribe, Ponca Tribe of Nebraska, Santee Sioux Tribe, Standing Rock Sioux Tribe, Three Affiliated Tribes, Turtle Mountain Band of Chippewa, Winnepago Tribe, and Yankton Sioux Tribe	Fax - 4 pages
May 8, 2000	Kansas Dept. of Wildlife & Parks - Topeka	Letter - 2 pages
May 8, 2000	Kansas Dept. of Agriculture - Topeka	Letter - 2 pages
May 12, 2000	Governor of Missouri - Jefferson City	Letter - 27 pages
May 12, 2000	Governor of South Dakota - Pierre	Letter - 2 pages

APPENDIX II

ROUTINE ANNUAL MAINTENANCE SCHEDULES

BANK STABILIZATION AND NAVIGATION PROJECT

Proposed Coordination Calendar for a Typical Maintenance Year – Omaha District									
			Participation *						
Item	Time Frame	Tasks to be Completed	OD	ED	PM	MRR	FWS	Responsible Office	Products
Low Water/ Winter Inspection	December 15 To January 20	1) Conduct boat and/or land inspection of entire river. 2) Meet with landowners and river users to discuss problem areas.	X	X	X		X	ED/OD	Structure Damage List
Initial Annual Maintenance Schedule	January 20 to March 1	1) Evaluation of Damages. 2) Evaluation of past channel performance. 3) Evaluation of risks.		X	X			ED	Initial Maintenance Schedule
Feed Back from USFWS	March 1 To March 15	Review of the initial maintenance schedule and provide comments to the District.					X		Letter
Final Maintenance Schedule	March 15 To April 10	1) Respond/incorporate USFWS comments. 2) Verify location, quantities, priorities, etc.		X				ED	Final Maintenance Schedule
Follow-up Inspection (As needed)	June 15 To August 31	1) Verify priority list. 2) Document new damages. 3) Update Maintenance Schedule.	X	X	X	X	X	ED	Revised Maintenance Schedule

OD – Operations Division, ED – Engineering Division, PM – Environmental and Economics Section, MRR – Missouri River Regional Office, FWS – US Fish and Wildlife Service

- The low water inspection will consist of viewing as many of the structures as possible to determine the extent of damage. During the inspection, the FWS will identify sensitive areas, restricted areas, etc. as well as areas where there is no room for flexibility. The Corps will identify maintenance performed within the last year, and discuss the reasoning behind any changes that were made from the previous year's maintenance schedule. Due to space limitations, there will be no more than one representative from each office on the inspection. The inspection is weather dependent, and is often scheduled/rescheduled on short notice. Also, during the low water inspection, any areas/structures to be salvaged will be pointed out to the FWS.

- The initial annual maintenance schedule will be developed with consideration of the following items; degree of damage, potential for navigation/stabilization problems, logistical limitations, and FWS concerns. The schedule will be Faxed and mailed to the designated FWS office.

- The FWS will review the schedule, and provide comments.

- The Omaha District will finalize the annual maintenance schedule after review and consideration of the FWS comments. If all of the FWS comments can not be incorporated, a meeting will be held to clarify the situation and discuss options. This meeting, may be help on site.

- A follow-up inspection will be conducted as needed. Situations that would warrant a follow-up inspection are: unusual high water either during the winter or spring, a significant change in maintenance funding, and unforeseen navigation/stabilization problems.

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OD – Operations Division, ED – Engineering Division, PM – Environmental and Economics Section, MRR – Missouri River Regional Office, FWS – US Fish and Wildlife Service

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APPENDIX III

SUMMARY OF PAST IMPACTS TO THE MISSOURI RIVER ECOSYSTEM

SUMMARY OF PAST IMPACTS TO THE MISSOURI RIVER ECOSYSTEM

Summary of effects of river channelization (c), including snag removal, and construction of dikes, revetments, and levees; construction and operation of mainstream dams (d), and both types of alterations (cd) on the lower Missouri River ecosystem (Adopted from Galat et al. 1994).

Physical

C Changes in channel geomorphology:
- 8 percent reduction in channel length
- 27 percent reduction in bank-to-bank channel area
- 50 percent reduction in original surface area of river
- 98 percent reduction in surface area of islands
- 89 percent reduction in number of islands
- 97 percent reduction in area of sandbars

resulting in reduction in channel diversity through loss of side channels, backwaters, islands, and meandering (Funk and Robinson 1974, Hesse et al. 1988).

C Change in physical substrate from dominance of silt, sand, and wood to rock riprap.

C Increased water depth and velocity in main channel.

D Pre- versus postimpoundment declines in suspended sediment loads at Omaha, Nebraska, and St. Louis, Missouri, respectively, of 175 to 25 and 250 to 125 million tons per year (Schmulbach et al. 1992).

D Reduction in river sediment load resulting in channel bed degradation including channel deepening, increased bank erosion, and drainage of remnant backwaters downstream from dams (Hesse et al. 1988, 1989a, b).

D Silt-clay fraction of suspended sediment load reduced by 50 percent, but sand fraction increased 260 percent, following closure of Gavins Point Dam in 1954 (Slizeski et al. 1982).

D Reduction in turbidity resulting in increased light penetration (Morris et al. 1968, Pflieger and Grace 1987).

D Modification of natural flow regime by evening maximum and minimum discharges and eliminating periodic flood pulse.

D Reduction in annual temperature range.

CD Loss of periodic flooding and floodplain connectivity.

Chemical

- C Higher water velocities reduce travel time for dissolved ions, nutrients and contaminants.

- D Increase in dissolved oxygen concentrations below main stem dams (Morris et al. 1968).

- D Higher postimpoundment summer flows for navigation dilute impacts of point source discharged pollutants (Ford 1982).

- D Reductions in nitrogen and phosphorus concentrations downstream from reservoirs and changes in spiraling patterns (Ward and Stanford 1983, Schmulbach et al. 1992).

Biological

- C Decline in habitat richness resulted in presumed decrease in diversity of periphytic algae (Farrell and Tesar 1982).

- C Elimination of plankton and invertebrates produced in standing water chutes and sloughs with loss of these habitats (Whitley and Campbell 1974).

- C Loss of instream snag habitat and functions of organic matter retention and substrate for invertebrates and fishes (Benke et al. 1985).

- C Greater standing crop of benthic invertebrates in main stream of unchannelized versus channelized river sections (Berner 1951, Morris et al. 1968, Nord and Schmulbach 1973).

- C Smaller standing crops of benthic invertebrates in chutes and mud banks of unchannelized versus channelized sections (Morris et al. 1968).

- C Larger standing crop of drift in unchannelized than channelized sections of river and little similarity between drift and benthos (Morris et al. 1968, Modde and Schmulbach 1973).

- C 67 percent reduction in benthic area suitable for invertebrate colonization (Morris et al. 1968).

- C 54 percent decline in benthic invertebrate production from all unchannelized habitats of Missouri River downstream from main stem dams between 1963 and 1980 and 74 percent decrease in production in chute/backwater habitats (Mestl and Hesse 1992).

C Loss of river-floodplain connection for fish migration, spawning and rearing.

C Reduction in microhabitats resulting in decreased abundance of fish species in channelized versus unchannelized section of river in Nebraska (Schmulbach et al. 1975).

C Higher standing crop of sportfishes in unchannelized sections of river in Nebraska compared with channelized sections attributed to more backwater habitat and greater habitat diversity (Groen and Schmulbach 1978).

C Loss of nesting habitat for sandbar/sand island birds leading to drastic population declines (e.g., *Sterna albifrons, Charadrius melodus*).

D Elimination of riparian forests and stream channels in areas flooded by reservoirs, totaling over one-third entire length of Missouri River (Hesse et al. 1988).

D Entrainment of fluvial particulate organic matter in reservoirs.

D Temperature induced shifts in periphyton and phytoplankton community structure, particularly below dams (Farrell and Tesar 1982, Reetz 1982).

D Increase in periphyton primary production below dams (Ward and Stanford 1983).

D Increased relative importance of phytoplankton biomass and primary production compared with upstream allochthonous inputs.

D Increase in diversity and density of zooplankton community in river downstream from reservoirs (Repsys and Rogers 1982).

D Changes in standing crop and diversity, and shifts in functional feeding groups of benthic macroinvertebrates in river downstream from reservoirs (Ward and Stanford 1979).

D Alteration of emergence cues, egg-hatching, diapause-breaking, and maturation of aquatic insects due to thermal modifications below reservoirs (Ward and Stanford 1979, Petts 1984).

D Blockage of riverine fish migration.

D Inundation of floodplain fish spawning and nursery habitats.

D Development of extensive sportfisheries in reservoirs and tailwaters (Hesse et al. 1989a).

CD Near elimination of natural riparian community (Hesse et al. 1988, 1989a, b). Changes reported:

-41 percent deciduous vegetation
-12 percent grasslands
-39 percent wetlands

CD 25 percent decrease in post-dam tree growth in North Dakota floodplain compared with pre-dam period related to absence of annual soil profile saturation, lowering of water table in spring to reduce downstream flooding (Reiley and Johnson 1982), and lack of nutrient silt deposition (Burgess et al. 1973).

CD Increasing proportion of mature forest to other successional stages in remaining floodplain (Bragg and Tatschl 1977).

CD 80 percent decline in organic carbon load of post-control Missouri River to Mississippi River compared with pre-control (Hesse et al. 1988).

CD Loss of major floodplain habitat types reduced populations of associated flora and fauna (Clapp 1977).

CD Decreases in endemic large river fishes (e.g., *Scaphirhynchus albus, Polydon spathula, Cycleptus elongatus, Hybopsis gracilis*, and increases in pelagic planktivores (e.g., *Dorosoma cepedianum, Alosa chrysochloris*) and sight-feeding carnivores (e.g. *Morone chrysops, Lepomis macrochirus*) (Pflieger and Grace 1987, Hesse et al. 1992).

CD Population declines of 11 native Missouri River Basin biota leading to listing as federally threatened or endangered (Table 7).

CD As much as an 80 percent decline in commercial fishery in Nebraska and 97 percent decline in tailwater recreational fishery below Gavins Point Dam (Hesse and Mestl 1992).

CD Decline in legal sized catfishes in Missouri River, Missouri, attributed in part to increased susceptibility to exploitation due to lost habitat diversity (Funk and Robinson 1974, Robinson 1992).

CD Introduction and establishment of non-native fishes and invertebrates (e.g., *Oncorhynchus* spp., *Osmerus mordax, Mysis relicta*). See Table 6 for list of introduced fishes.

Social

D	Hydroelectric power generation of over 2.2 Gw, sales totaling $1.5 billion from 1943-86 (Sveum 1988).
D	Development of major reservoir based recreation and associated commercial services, supported spending of $65 million in 1988 (General Accounting Office 1992).
CD	Commercial navigation industry transports about 2 million tons of goods, producing gross revenues of $17 million in 1988 (General Accounting Office 1992).
CD	Water supply provided to 40 cities (3.2 million people), 21 power plants, and 2 chemical manufacturers in lower Missouri River (General Accounting Office 1992).
CD	4,000+ increase in area of agricultural land use (Hesse et al. 1988).
CD	95 percent of protected floodplain now in agricultural, urban, and industrial uses (Hesse et al. 1989b).

APPENDIX IV

POPULATION DISTRIBUTION OF BREEDING AND WINTERING BALD EAGLES ON THE MISSOURI RIVER MAIN STEM

Population distribution of breeding and wintering bald eagles on the Missouri River main stem.[1/]

Location of Population	Year[2/]	Wintering Population	Nesting Population Pairs	Fledgings Per Pair
Missouri River Main Stem				
Above Fort Peck Reservoir, MT 2000	+	+	+	
	1999	102	29	1.48
	1998	78	23	1.34
	1997	70	18	1.56
	1996	83	17	1.29
	1995	59	+	+
	1994	77	+	+
	1993	110	12	1.75
	1992	75	12	0.92
	1991	90	7	1.14
	1990	125	8	1.13
	1989	135	4	1.75
	1988	84	2	2.00
	1987	35	0	0
	1986	79	0	1.00
Fort Peck Reservoir, MT	2000	-	0	0
	1999	-	0	0
	1998	-	0	0
	1997	-	0	0
	1996	-	0	0
	1995	-	0	0
	1994	-	0	0
	1993	-	-	-
	1992	-	-	-
	1991	-	-	-
	1990	-	-	-
	1989	-	-	-
	1988	-	-	-
	1987	8	0	0
	1986	-	-	-

Location of Population	Year[2/]	Wintering Population	Nesting Population Pairs	Fledgings Per Pair
Fort Peck Dam to Lake Sakakawea, MT, ND	2000	+	0	0
	1999	17	0	0
	1998	32	0	0
	1997	19	0	0
	1996	6	0	0
	1995	35	0	0
	1994	34	0	0
	1993	38	0	0
	1992	47	0	0
	1991	45	0	0
	1990	41	0	0
	1989	36	0	0
	1988	10	0	0
	1987	11	0	0
	1986	7	0	0
Lake Sakakawea, ND	1993-2000	0	-	-
Garrison Dam to Lake Oahe, ND	2000	32	+	+
	1999	28	8	+
	1998	32	+	+
	1997	2	8	1.50
	1996	23	2	1.00
	1995	12	1	2.00
	1994	2	1	1.00
	1993	25	1	3.00
	1992	59	1	2.00
	1991	12	1	2.00
	1990	27	1	2.00
	1989	24	1	2.00
	1988	57	1	1.00
	1987	43	0	0
	1986	30	0	0

Location of Population	Year[2/]	Wintering Population	Nesting Population Pairs	Fledgings Per Pair
Lake Oahe, ND and SD	2000	1	+	+
	1999	0	0	0
	1998	4	0	0
	1997	1	0	0
	1996	8	0	0
	1995	1 0	0	
	1994	1	0	0
	1993	-	0	0
	1992	-	0	0
	1991	19	0	0
	1990	17	0	0
	1989	9	0	0
	1988	10	0	0
	1987	6	0	0
	1986	5	0	0
Oahe Dam to Big Bend Dam, SD	2000	16	+	+
	1999	47	0	0
	1998	39	0	0
	1997	40	0	0
	1996	102	0	0
	1995	98	0	0
	1994	78	0	0
	1993	49	0	0
	1992	9*	0	0
	1991	50	0	0
	1990	143	0	0
	1989	104	0	0
	1988	60	0	0
	1987	88	0	0
	1986	54	0	0

Location of Population	Year[2/]	Wintering Population	Nesting Population Pairs	Fledgings Per Pair
Big Bend Dam to Fort Randall Dam Tailrace, SD	2000	21	+	+
	1999	11	0	0
	1998	116	0	0
	1997	8	0	0
	1996	3	0	0
	1995	0	0	0
	1994	2	0	0
	1993	-	0	0
	1992	1	0	0
	1991	0	0	0
	1990	2	0	0
	1989	54	0	0
	1988	42	0	0
	1987	59	0	0
	1986	7	0	0
Karl Mundt NWR, SD**	2000	+	2	+
	1999	200	2	3
	1998	162	2	2.5
	1997	153	2	3
	1996	150	2	1
	1995	169	1	1
	1994	138	1	3
	1993	58	1	2
	1992	39	1	0
	1991	49	0	0
	1990	52	0	0
	1989	54	0	0
	1988	43	0	0
	1987	81	0	0
	1986	47	0	0

Location of Population	Year[2/]	Wintering Population	Nesting Population Pairs	Fledgings Per Pair
Karl Mundt NWR to Rulo (inc. Desoto NWR): SD, NE, and IA**	2000	312	8	+
	1999	251	1	2
	1998	435	2	1
	1997	186	1	2
	1996	188	1	1
	1995	216	0	0
	1994	283	0	0
	1993	174	2	0
	1992	420	0	0
	1991	235	0	0
	1990	244	0	0
	1989	209	0	0
	1988	150	0	0
	1987	282	0	0
	1986	41*	0	0
Rulo to St. Louis: NE, KS, and MO	2000	298	+	+
	1999	427	1	2
	1998	289	2	1
	1997	475	2	3
	1996	398	2	1
	1995	294	1	1
	1994	409	1	1
	1993	323	1	2
	1992	136	1	0
	1991	181	1	0
	1990	399	1	0
	1989	+	0	0
	1988	130	0	0
	1987	199	0	0
	1986	-	-	-

Location of Population	Year[2/]	Wintering Population	Nesting Population Pairs	Fledgings Per Pair
Kansas River	2000	119	2	1
	1999	388	1	2
	1998	244	1	0
	1997	159	1	1
	1996	187	-	-
	1995	86	-	-
	1994	65	-	-

+ Not available at date of biological opinion.

- No surveys or not determined. Fort Peck reservoir is usually ice-covered.

* Partial survey.

** Winter survey numbers at National Wildlife Refuges represent the highest count for that winter.

1/ Information sources include G. Bade, D. Christopherson, , R. Collins, M. Dryer, G. Guenther, D. Haley, L. Hanebury, R. Hazlewood, D. Howell, W. Jobman, R. Kreil, J. Ledwin, M. LeValley, D. Mulhern, J. Peterson, B. Schoonover, T. Benzon, J. Sidle, and E. Stukel (personal communication); National Wildlife Federation (1988).

2/ The year noted is the year when surveys were completed; i.e., the 1988-1989 winter survey results are recorded as 1989.

APPENDIX V

SCIENTIFIC EVALUATION OF THE ROLE OF RIVER HYDROLOGY IN THE CONSERVATION OF MISSOURI RIVER ENDANGERED SPECIES

SCIENTIFIC EVALUATION OF THE ROLE OF RIVER HYDROLOGY IN THE CONSERVATION OF MISSOURI RIVER ENDANGERED SPECIES

Modification of the current pattern of flow releases from Gavins Point Dam to conserve endangered species is probably the most controversial issue associated with the Missouri River Operations section 7 consultation. For that reason, Ralph Morgenweck, the U.S. Fish and Wildlife Service's (Service) Regional Director for Region 6, requested that a panel of experts conduct an analysis of the scientific basis for flows and habitat quality below Gavins Point. Brigadier General Strock, Commanding General for the Portland Division of the U.S. Army Corps of Engineers, also orally endorsed the concept of conducting a scientific analysis of this issue.

Recognizing that input from the scientists would be useful in developing a reasonable and prudent alternative (RPA), the scientists were asked to respond to three questions relative to flows and habitat quality for threatened and endangered species below Gavins Point. They were not asked to review the RPA, nor would they be asked to review the biological opinion. Thus, from the onset, there was little time to identify and establish a capable panel of scientific experts, acquiring input from them and using the analyses they provided.

The Corps agreed that the Service would take the lead on this project and the task was assigned to the Service's Ecological Services Field Office in Columbia, Missouri. Recommendations for panel members were solicited informally from the Corps, Service, other Federal and state agencies, the Missouri River Basin Association, Missouri River Natural Resources Committee, and the Tribes. The Service and the Corps Interagency section 7 work group jointly developed a list of 45 potential scientific experts in the fields of fishery biology, ornithology, and lotic systems (aquatic ecology/hydrology/habitat, etc.) that the workgroup believed had relevant expertise to effectively contribute to this scientific review project. The list of candidates included nominees from government research offices, academia, and the private sector. Representatives from all three of these broad categories were eventually selected to serve on the review panel. A subcommittee of the interagency section 7 workgroup, consisting of one Service and three Corps representatives were assigned to shepherd the scientific review process to completion.

Since the Service had the lead on this project, personnel from the Ecological Services Field Office in Columbia, Missouri, began contacting people from the list of candidates in early April 2000, to identify willing participants. Consideration was given to the candidates' areas of specialty to adequately represent all areas of expertise and in hopes that the perspectives of the panel members would be broader based and have a wider range of application.

Time constraints prohibited canvassing all 45 candidates included on the original list. Solicitation of candidates for the scientific panel ceased when positive responses were received from seven candidates. A list of the people chosen to serve on the scientific panel is included in this appendix.

Candidates were initially contacted by telephone and subsequently sent a follow-up e-mail note soliciting their participation in a scientific evaluation of proposed modifications to the current pattern of annual flow releases from Gavins Point Dam to conserve endangered species. The telephone interview queried each candidate regarding the applicability of his/her academic background and experience relative to the scientific evaluation being proposed, asked them to identify any appreciable conflict(s) of interest and, whether they could perform the evaluation within the time limitations of the project. The e-mail note contained a request for a resume or curriculum vitae and asked each candidate to sign a confidentiality form that reiterated their belief that they were unaware of any matter that might inhibit their ability to participate in the proposed evaluation in an objective and unbiased manner.

The Corps/Service Interagency Peer Review Subcommittee jointly developed three questions to submit to the scientific panel members. The group strived to develop questions that would focus the panel member's expertise directly upon the controversial issue at hand: the biological validity of recommending flow release modifications from Gavins Point Dam to conserve endangered species.

Prior to their review and analysis, background material was mailed to the panel members and two conference calls were held to brief the scientific panel members and let them ask questions. The Corps and the Service both participated in these conference calls. During these calls, the panel members were informed that their evaluations would be independent, and that they were not expected to come to a group consensus regarding answers to the three questions.

The panel members began their review on May 3, 2000, and were asked to provide their input to the Service by May 23, 2000, to be included in the draft biological opinion (originally scheduled for release June 1, 2000). Six panel members provided their input on or about May 23, 2000. Late in the evaluation period, one panel member had to excuse herself from the scientific review process due to computer-related technical problems. The three questions and six evaluations follow. A full administrative record is on file at the Service's Columbia, Missouri, Ecological Services Field Office.

Questions for Scientific Review Panelist Consideration:

1. Based on the most current information on pallid sturgeon, interior least tern, and piping plover:

   Is there a generally accepted relationship between Missouri River flows (and stage) and habitat quality for threatened and endangered species? In addition to the need for physical habitat restoration, will it also be necessary to restore some semblance of the historic (pre-project) annual hydrograph (i.e., higher spring and lower summer flows) to the Missouri River downstream from Gavins' Point Dam to improve habitat conditions for and conserve pallid sturgeon, least tern, and piping plover? For example, will flows that more closely simulate the historic hydrograph provide endangered species with spawning or nesting cues, thus providing more effective utilization of available physical habitat.

2. Can populations of the Federally listed threatened and endangered species associated with the Missouri River ecosystem be conserved by some other means not involving flows specifically targeted for that purpose? For example, could the physical habitat modifications by themselves, or in combination with the other management and restoration techniques result in the conservation of the listed species without modifying the current operational schedule? Can we adequately define how the target species respond to habitat conditions and is there adequate information describing what each species needs in order to thrive?

3. If physical habitat restoration and hydrological modifications are both necessary for the conservation of Missouri River threatened and endangered species, are there greater benefits to phasing implementation (one before the other) of those measures or various proportions of each that would yield the greatest benefits?

(Note: questions should be considered within the scope of the existing projects - i.e., dams and channel in place.)

APPENDIX VI

CONTINGENCY PLAN FOR PROTECTION OF LEAST TERN AND PIPING PLOVER NESTS AND CHICKS

CONTINGENCY PLAN
FOR PROTECTION OF LEAST TERN AND PIPING PLOVER
NESTS AND CHICKS

The Corps of Engineers will carry out the following contingency plan for the protection of least tern and piping plover nests and chicks threatened with termination due to natural events, inundation due to poor nest selection under normal system operation, or flood control operations. All efforts will be made to protect nest site viability in the wild prior to collection for captive rearing. Nests will only be collected immediately preceding the inundating release to restrict renesting efforts on unstable habitats. Listed below is a sequential operating plan for nests and chicks threatened by rising water levels. All guidelines are subject to State and Fish and Wildlife Service permit approval and conditions.

NESTS

1. Consult with Reservoir Control Center for water level management options.
    a. Exercise options if available.
    b. If options not available, step 2.

2. Move nest to higher ground that will not be inundated until after the eggs anticipated hatching date.
    a. If successful continue to monitor nest.
    b. If nest cannot be successfully moved, step 3.

3. Elevate nest using a tire or other object if rise in water is expected to be short term.
    a. If successful continue to monitor nest.
    b. If water rise is expected to be long term or if nest cannot be raised, step 4.

4. Evaluate the option of egg removal and captive rearing.
   If option 4 is to be exercised, the US Fish and Wildlife Service and appropriate State agencies will be contacted for coordination and concurrence.

    a. Remove eggs to captive rearing facility to be incubated and raised for release into the wild.
    b. Remove eggs to captive rearing facility to be incubated and raised for research that will aid in meeting the recovery goals of these species.

CHICKS

1. Consult with Reservoir Control Center for water level management options.
   a. Exercise options if available.
   b. If options not available, step 2.

2. Remove chicks and place on adjacent islands within sight of adult birds, if sites unavailable, step 3.

3. Remove chicks to captive rearing facility.
   If option 3 is to be exercised, the US Fish and Wildlife Service and appropriate State agencies will be contacted for coordination and concurrence.

   a. Remove chicks to captive rearing facility to be raised for release into the wild.
   b. Remove chicks to captive rearing facility to be raised for research that will aid in meeting the recovery goals of these species.