APPENDIX III

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 for the purpose of endangered species conservation 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 verbally 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 peer review the biological opinion. Thus, from the onset, there were intense time pressures involved in canvassing for and establishing a capable panel of scientific experts, acquiring input from them and utilizing 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. The Service and the Corps Interagency Section 7 work group jointly developed a list of 45[1] potential scientific experts in the fields of fishery biology, ornithology, and lotic systems (aquatic ecology/hydrology/habitat, etc.) that the workgroup initially believed might have 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 of employment 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 determine who might be willing to participate. Consideration was given to the candidates' areas of specialty as they were being contacted to prevent overweighing the group within a narrow range of specialization (e.g., fisheries biology), in hopes that the perspectives of the panel members would be broader in scope and their input would have a wider range of application.

Time constraints prohibited canvassing all 45 of the candidate panel members included on the original list developed by the interagency Section 7 work group. The 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.

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[1] The list developed was lengthy due to concerns that many potential panel members would not be willing to serve due to the austere time constraints. This was especially the case for candidates in academia who were approaching finals week and trying to get graduate students through their oral exams, thesis defense, etc.). Willing participants were asked to review a package of information, respond to three questions, and issue their analysis within approximately a three week period. The review information and three questions were overnight mailed to the scientific panel members on May 1 and they were asked to respond by May 23, 2000.

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 for the conservation of endangered species. The telephone interview queried each candidate regarding the applicability of his/her academic background and experience relative to the nature of the scientific evaluation being proposed, asked them to state if they believed they had any appreciable conflict(s) of interest and, whether they could perform the intended evaluation within the austere time limitations associated with 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 for the conservation of endangered species. When the questions had been framed, they were submitted to the Service's Regional Directors in Regions 3 and 6 for comments and concurrence. Their input was included into finalizing the questions prior to releasing them to the scientific panel

Prior to initiating their review and analysis, a large package of background briefing 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 had representatives available on both of 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 their answers to the questions submitted to them for evaluation.

The panel members were mailed the questions and asked to begin their review on May 3, 2000, and provide their input to the Service by May 23, 2000, so that it could be included in the draft biological opinion originally scheduled for release June 1, 2000. Six of the 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. So, scientific evaluations of the three questions posed were received from six panelists. These six evaluations are contained in this appendix

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.)

Missouri River Peer Review Panel
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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Missouri River Coordinator
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MAY 3 2000

Dr. Rochelle Renken
Missouri Dept. of Conservation
Columbia Fish and Wildlife
Research Center
1110 South College Avenue
Columbia, Missouri 65201

Dear Dr. Renken:

This letter provides information for conducting the Missouri River Scientific Review Panel process. First of all, thank you for volunteering your expertise to this important task. The Fish and Wildlife Service (Service) and the U.S. Army Corps of Engineers (Corps) greatly appreciate your willingness to step up and assist. The questions for your consideration will be sent to you via e-mail on Wednesday, May, 3rd

You may contact each other if you wish (address list enclosed); however, the opinions you provide to the Service and Corps on this matter should be your own and do not need to represent a consensus from the reviewers. We would like to have your response to these questions, in writing, by May 23rd. The Service will then review and address your comments, as appropriate, to strengthen or correct deficiencies in the Biological Opinion. The Service will deliver the draft Biological Opinion to the Corps on June 1st and then the Corps will share with you those sections from the opinion that deal with the questions you have addressed. We would than appreciate your final review of the specific recommendations provided by the Service to ensure they are appropriate and scientifically defensible. Please understand that you are not responsible for the Service's biological opinion on these actions

Please limit your input on the questions to your own areas of expertise (i.e., if you are most familiar with piping plover ecology do not feel you need to comment on pallid sturgeon life history requirements). You may comment on any and all aspects of the species life history requirements or hydrology necessary to support particular habitats you deem important to make your point. We are not looking for you to provide an extensive bibliography of available literature regarding these questions. However, if you know of particular references that you want to make us aware of, or that support a particular aspect of your response, please include the citation.

We have set up a followup conference call to deal with any initial questions you may have on May 11th at 2:00 p.m. Central time. The call in number will be sent with the questions on Wednesday

I have enclosed copies of some of the information which may be of help regarding these questions. We understand that many of you are more familiar with other rivers than with the Missouri River system.

The enclosures include:

a. Map of the system
b. The Service's 1994 draft biological opinion on revised Master Manual
c. Various species recovery plans
d. Sections of a recently completed biological opinion on the Mississippi River that address life history of the species we are consulting on.
e. Biological Assessments from the Corps
f. The project description summaries
g. Additional material regarding pallid sturgeon life history
h. Names and addresses of reviewers

If you have questions or concerns, please contact Casey Kruse (birds), Corps at 402-667-7873, Ext. 3333; Doug Latka (fish), Corps at 402-697-2477; Mike Olson, Service at 701-250-4481; or Mark Wilson, Service at 573-876-1911, Ext. 104.

Sincerely,

Michael Olson

Enclosures

cc/wo Enclosures:
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Regional Director, FWS, Region 3, Fort Snelling
Supervisor, Fisheries, N. Ecosystems, Denver (60101)
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bcc: Chief, ES, Washington, DC
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May 19, 2000

In Reply Refer To:
USGS/MESC/SRES

SRES: 700

Mr. Michael M. Olson
Missouri River Coordinator
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Dear Mike:

Please find enclosed, my comments regarding the Questions for Scientific Review Panelists. My area of expertise is primarily associated with the physical habitat characteristics and dynamics in the upper Missouri and lower Yellowstone Rivers. Although I comment primarily on habitat for pallid sturgeon, many of the concepts I discuss could probably be applied to terns and plovers as well.

My colleagues and I will be finishing our preliminary habitat comparisons of the lower Yellowstone and upper Missouri (above and below Fort Peck) sometime this fall. I believe that the information contained in this manuscript might be of use to you and the Corps during your deliberations. If you would be interested in receiving a copy of the document, with the caveat that it will be a draft, let me know and I will send it to you as soon as it is completed.

Sincerely,

Ken D. Bovee
Hydrologist

Responses to Questions for Scientific Review of Missouri River Section 7 Consultation on Endangered Species – Kenneth S. Lubinski, USGS

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 share the belief, which seems to be "generally accepted", that the populations of the three species in question are dependent on certain predictable features of Missouri River flow and stage regimes. It also appears fairly certain that habitat restoration by itself won't be sufficient. First, floodplain structure is only part of the equation. The needs of the species are dependent on appropriate seasonal overlays of water and habitat surfaces together, and it doesn't seem possible that the water overlay can be addressed by habitat restoration alone.

Second, based on my knowledge of habitat restoration on the Upper Mississippi River, it seems unrealistic to think that habitat restoration, which has so far been limited to "sites", will solve species problems that are more "system" oriented. Over the last 12 years, habitat restoration on the Upper Mississippi has been intended to improve conditions at specifically selected sites. A recent Corps of Engineer's progress report projected that 30 projects would be completed during the first phase of the program, affecting 97,000 acres at a cost of about $130 million. The affected acres amount to less than 4% of the system's floodplains.

I suspect, from a federal budget perspective, that if a habitat restoration program were implemented on the Missouri River, that it would not have a greater budget, or consequent spatial scope, than the one that exists on the Upper Mississippi. Even at that level, and even if it was entirely successful, it could only address a small proportion of the target habitats over the next 20 or 30 years. This to me seems to be too great a risk. The species in question are already at low population levels. A site approach to their systemic population problems may be doomed from the start, and all of the expensive eggs should not be put into a habitat restoration basket, only to find out 20 years from now that it wouldn't have worked in the first place.

There are many unknowns, or uncertainties, involved with the primary question. The following statements seem to be relevant:

1. While the species are dependent on certain predictable aspects of Missouri River flows and stages, river science has just begun to quantify those dependencies.

1. The perceived relationships are supported by information derived from available, but not always site-relevant, life history studies and broad river ecological theory. Lots of details remain.

1. The most effective hydrologic patterns for one species may not work for the others. Even within a species, selecting one reach of river where target conditions will be established, or one flow feature, may not work every year. What if the population redistributes itself later? What if the population's needs are density dependent? What if they need certain reproductive habitat conditions in one year, and flow-related food resources in the next year?

1. Science cannot, within the near future, fill all of the quantitative gaps needed to support specific decisions about which flow regime feature is most critical, what the most appropriate duration time is, etc. Only actual operational experimentation, coordinated with a monitoring program designed to provide adequate information on species status and response to the proposed management actions, will provide the necessary documentation to correctly modify any actions if they are not working.

These items confirm the need for an adaptive management approach to insure the future viability of the

species with the Missouri River system.

Can populations of 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?

I don't know enough about the full range of management options for each species to answer this question. The management options do seem to be limited, in part because the populations of the species are already at low levels. All I can offer is the remander that the ultimate goal is to get these species to naturally sustainable levels. "Naturally sustainable" to me means without continual artificial support (projects, time, money) from humans. Short-term, high-cost fixes to sustaining an individual species may be necessary to help them survive present population constraints. But such short-term "life lines" are not realistic long term solutions.

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?

It seems to me that initial progress can be made on three fronts simultaneously. There is no point in modifying flow rates unless you can measure the biological outcomes.

There are two philosophies about proceeding with or without specific goals. One holds that we should simply do whatever we can with our limited resources. The system will likely "get better" even if we haven't set a specific goal. My experience is that this approach is not going to work in the future as government presses for more and more evidence of outcome (as expressed in the Government Performance and Results Act). The second approach is to set a goal, and I would recommend using measures related to population viability (see "Science" below). Don't be worried about the possible down side of not meeting the goal by a short-term deadline. You'll be able to tell the public and agency heads how much progress you've made, and if community and agency values in the species persist, you'll get support to do more. All will benefit at the start by understanding how big the job might be.

Science:

A monitoring system needs to be established to record the species responses to modified flow rates. The sooner you start, the sooner you'll know about critical uncertainties.

Don't gage success from only one year's data. Schedule "success" reports based on biologically relevant timeframes.

At the same time, interim population targets (at several relevant spatial scales) need to be established. A first step to establishing interim population targets might be the use of population viability modeling approaches to get an initial estimate of the minimal populations necessary to sustain each species.

Habitat restoration:

A strategy for creating the kinds of habitats required, and locating them within the Missouri River system on a priority basis, is required. Have you collected all of the floodplain elevation data to support inquiries of the kinds of habitats that are inundated at different stages now, or that would be inundated under different modified flow regimes? The predicted flow data have to be translated into probable acres of inundated habitat.

Remember – the job is to protect a species, not a site.

How modification:

Just do it. Learn by trial and error and in a logical progression. You'll understand the economic tradeoffs at the same time. Models will only get you so far.

Missouri River Scientific Review Panel Comments

Ken D. Bovee, Hydrologist
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May 17, 2000

Responses to provided questions:

1. **Based on the most current information on pallid sturgeon, interior least tern, and piping plover:**

   A. **Is there a generally accepted relationship between Missouri River flows (and stage) and habitat quality for threatened and endangered species?**

   I am not aware of any quantitative or qualitative relationship between flows and habitat quality in the Missouri River. The U.S.G.S. has been working for about four years to develop these relationships for various segments of the river system. The Midcontinent Ecological Science Center (Fort Collins) has been working above Lake Sakakawea and the Columbia (Missouri) Environmental Research Center has been involved in the lower Missouri. There are large segments from North Dakota to Nebraska, however, that have not been mapped or analyzed for habitat quality-discharge relationships. Preliminary results from current U.S.G.S. work should be available by October, 2000.

   This question implies that a single, universal relationship exists between discharge and habitat quality. I would not expect habitat quality to vary with discharge the same way everywhere in the Missouri River system. Likewise, habitat quality will not be the same for different habitat types within the same segment of river at a single discharge. For example, flood flows in the lower Yellowstone will produce large areas of fast, deep water as well as extensive areas of standing backwater and flooded riparian areas. Comparable flows in the segment downstream from Sioux City will probably only produce extensive areas of fast, deep water.

   B. **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 ...to the Missouri River downstream from Gavins' Point Dam to improve habitat conditions for and conserve pallid sturgeon, least tern, and piping plover?**

   Many ecologists (see for example, Poff et al. 1997) are currently advocating the natural flow regime as a means of restoring river ecosystems (actually, the only means of doing so). From an ecological perspective, there can probably be no harm in restoring the Missouri River hydrograph to a "semblance" of its historical

character. There may be other dangers, such as political backlash, but ecologically, the question is one of "how much of a semblance is required?" I am aware of proposed alternatives that would require a modest increase in spring discharges and a lowering of reservoir releases during late summer. I am not convinced that these changes will be sufficient to alleviate a potential ecological bottleneck in this system. Given the sandy, shifting nature of the historical channel, one could suppose that the historical food source of this river was primarily detrital and of terrestrial origin. If this were the case, restoration of the ecological function of a detrital food base would require flooding, not just a simple bump in the spring hydrograph.

One of the main differences we have observed between the lower Yellowstone and the Missouri below Fort Peck is a much higher proportion of woody debris in the channel of the Yellowstone. The large amount of woody debris in the Yellowstone can be attributed to flooding in two ways. First, frequent overbank flooding in the Yellowstone has resulted in a much more extensive riparian forest (i.e., there are more trees). Second, high flows result in meander migration which undercuts mature trees and deposits them in the river (i.e., there are more trees recruited to the river).

The danger of managing water supplies to achieve only a semblance of the natural hydrograph is that such management will be seen as ineffective if it does not go far enough toward curing the real problem. A measurable biological response may not occur if the change in management is not sufficient to address the ecological problem. Thus, the alternative can be easily dismissed, when the problem was not the alternative, but its implementation.

2. **(a) 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?**

The analysis of the relationships between flow, habitat, and biology has only begun, so it is difficult to answer this question definitively. I suspect, however, that recovery of the pallid sturgeon (and protection of other species of concern) will involve a combination of flow modification, habitat restoration, water quality enhancement, and fish culture.

(b) ...could the physical habitat modifications by themselves, or in combination with other management and restoration techniques result in the conservation of the listed species without modifying the current operational schedule?

I doubt it. I have already mentioned the possible link between flooding and trophic dynamics. Although flooding also has habitat implications, the relationship between habitat and food supplies is probably correlative, not causative (i.e., they are both caused by flood flows, but habitat creation does not cause accretion of woody debris). For example, shallow, low velocity backwaters can be created either by flooding or

by channel modification. However, only flooding provides shallow, low-velocity backwaters and accretion of terrestrial debris to the river.

(c) 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?

We have a long way to go in describing the habitat characteristics necessary for the well-being of the pallid sturgeon or for the northern Great Plains fish assemblage in general. However, we know something about the importance of certain habitat types to sturgeons and other species. We will know more over the next few years as results from current research become available.

Despite our incomplete understanding of the habitat requirements and life history of the pallid sturgeon, it is possible to deduce potential habitat-flow related bottlenecks:

It is apparent that recruitment is a problem with this species. Pallid sturgeons mature at a relatively advanced age and do not spawn every year. The low population density may exacerbate the problem, because encounters between potential spawners may be rare. Until discernible links can be established between flow/habitat characteristics, maintenance of the species will probably have to be supported through hatchery culture and stocking.

The larvae of Acipenserids are buoyant and pelagic. The Draft Biological Opinion mentions habitat fragmentation as it affects migration of adults. However, the potential effects of dams and reservoirs on drifting larvae have not been explored Historically, larvae probably drifted into riverine-associated rearing areas, such as shallow backwaters and side channels, where food was plentiful and predation pressure light. Now, larvae drift into reservoirs where the density of food items is lower and the exposure to predators higher. I recommend exploring more fully the potential benefits of creating rearing habitats for larval sturgeon in reservoir headwaters.

Frequent mention is made of the importance of aquatic macroinvertebrates and small fish in the diet of the pallid sturgeon. Although pallid sturgeons are reported to utilize sandy substrate, it is generally accepted among aquatic entomologists that sand is the least productive substrate type in a river. Furthermore, the mouth structure of the sturgeon suggests that it is more effective as a scavenger than as a hunter. This evidence leads me to believe that both *Scaphirhynchus* species probably feed in depositional areas, such as backwaters, side channels, and deep pools. These locations would favor the collection of vegetational detritus to support a productive benthic invertebrate community. Shallow backwater habitats are also known to be extremely important in the production of numerous species of cyprinids. It may not be coincidental that declines in sturgeon populations are occurring contemporaneously with declines in minnow (especially *Hybopsis*) populations.

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…of those measure or various proportions of each that would yield the greatest benefits?**

It seems inevitable that habitat restoration and hydrologic modification will both be necessary for the conservation of Missouri River T&E species. Prudence would dictate a phased approach. However, where there are multiple habitat bottlenecks, fixing one aspect of the environment (or not fixing it enough) may be insufficient to produce a detectable change in the management objective.

Sometime during autumn, 2000, current U.S.G.S. research will provide a picture of the habitat dynamics of the upper Missouri River system. This analysis will include the Yellowstone River, which is considered by many to be the best remaining representative of the northern Great Plains large river ecosystem. In lieu of other information regarding the habitat dynamics of the historic Missouri River, the lower Yellowstone can be used as a management template. That is, various segments of the Missouri can be analyzed to determine which habitat classes are absent or poorly represented, compared to the Yellowstone on a monthly or seasonally basis. Management could then focus on providing these missing habitat types when they would naturally occur in the river.

The Missouri segment between Fort Peck and Lake Sakakawea is well-suited to hydrologic experimentation. Our preliminary analysis indicates that this segment is structurally similar to the lower Yellowstone (the relationships between habitat class and discharge are similar). However, the flow regime of the Missouri is quite different from that of the Yellowstone. Because a substantial biological database exists for this reach, representing existing operations at Fort Peck, it would be possible to conduct one or more control-treatment experiments here. Fort Peck could be operated to mimic the flow regime of the Yellowstone, and the biological response monitored. The historic habitat time series and biological data could serve as the experimental control, and each modified flow regime and associated biological data would be a treatment.

For the lower river, I defer to my colleagues from Columbia (MO), who undoubtedly know more about this reach than I do. It would seem logical, however, to replace those habitat types and streamflow characteristics most obviously missing. It appears that the habitat types associated with islands and braided channels are notably absent or inactive in this segment. Therefore, acquiring bottomlands, opening side channels, and "unleveeing" the channelized section of the Missouri would have merit. A baseline biologic database also exists for the lower Missouri, so control-treatment experiments could be conducted here as well. The first treatment might consist solely of habitat restoration in the form of re-opening side channels and breaching levees. Subsequent treatments could include the semblance-of-natural-flow alternative, and variations thereof (up to and including intentional flood flows).

Literature Cited

Poff, N.L., J.D. Allan, M.B. Bain, J.R. Karr, K.L. Prestegaard, B.D. Richter, R.E. Sparks, and J.C. Stromberg. 1997. The Natural Flow Regime: a paradigm for river conservation and restoration. Bioscience 47(11): 769-784.

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May 22, 2000

Mr. Michael M. Olson
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Missouri River Coordinator
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Mr. R. Mark Wilson
U. S. Fish and Wildlife Service
Missouri Ecological Services Field Office
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Dear Mrs. Olson and Wilson.

Thank you for the opportunity to serve on the Missouri River Scientific Review Panel to address questions related to recovery of the Federally listed species along the Missouri River. My area of expertise is primarily aquatic so I will focus my responses on the pallid sturgeon However, I have been involved with research on least terns in the lower Mississippi River and will provide some insights based on our flow and habitat work there. I have no familiarity with the piping plover so it is not considered.

It is my conclusion, after reviewing the information you provided as well as many of the references cited therein, that there is a great deficiency in specific knowledge of flow and habitat requirements for pallid sturgeon life stages (i.e., egg, larvae, juveniles, and adults) and major life functions (i.e., reproduction, feeding, and overwintering). Here is a sampling of often encountered phrases: "...little is known about .", "Little information exists on...", "Information on... is limited...", "... has not been well documented. .", "details of...are not known, but may be

similar to ...". Because so little observational information and experimental evidence exists on pallid sturgeon ecology, it will be necessary to base my answers to your questions largely on a weight of evidence approach from other fluvial dependent fishes and my 25+ years experience in aquatic and fish ecology.

Overwhelming empirical and theoretical evidence supports the contention that flow is the master variable driving the ecology of rivers (Vannote *et al.* 1980, Karr and Dudley 1981, Welcomme 1985, Junk *et al.* 1989, Poff and Ward 1989, 1990, Heede and Rinne 1990, Schlosser 1991, National Research Council 1992, Dynesius and Nilsson 1994, Walker *et al.* 1995, Petts and Amoros 1996, Poff 1996, Stanford *et al.* 1996, Lorenz *et al.* 1997, Scott *et al.* 1997). So paramount is the flow regime as an underpinning to ecological integrity that its protection or restoration has been accorded, "the natural flow paradigm" (Poff *et al.* 1997, Richter *et al.* 1997). The essence of the natural flow paradigm is that intra- and inter-annual variability in river flow, including magnitude, timing, duration, frequency, and rate of change are critical to sustaining the full native biodiversity and integrity of aquatic ecosystems (Walker *et al.* 1995, Poff *et al.* 1997, Richer *et al.* 1997,1998). Thus my answer to the question, will it be necessary, "*to restore some semblance of the historic (pre-project) annual hydrograph to the Missouri River downstream from Gavin's Point dam to improve habitat for and conserve pallid sturgeon, least tern and piping plover*", is an emphatic, yes

Can, "*physical habitat modifications by themselves, ... result in the conservation of the listed species without modifying the current operating schedule*"? I believe, and the available evidence cited above supports the view, that habitat modifications by themselves will be insufficient to recover the listed species. It is my opinion that flow and habitat are interdependent variables and that some degree of restoration or rehabilitation of both will be necessary to conserve and recover the listed species. At the present time I content there is insufficient information available on the ecological requirements of the listed species to recommend, "*.. phasing implementing [one before the other]... or various proportions of each...*" Unless or until information on specific habitat and flow needs for all life stages of the listed species is available to warrant implementing various proportions of each, it is prudent to be risk adverse and implement flow and habitat modifications when extinction is a potential outcome of not doing both.

Let me provide some support for the rationale behind these conclusions. Life history information indicates that the pallid sturgeon is a fluvial specialist, i.e., it requires riverine conditions for all life-history stages. Consequently, its ability to feed, reproduce and over winter is dependent upon hydrology and suitable habitats in which to accomplish these functions. It is generally accepted that high-flow events and their timing provide essential spawning cues for riverine fishes (Junk et al. 1989, Poff et al. 1997, Richter et al. 1996, 1997) and references cited therein). Bramblett (1996, pg. 147) concluded that discharge, and particularly increasing flow, was an important environmental cue for timing of movements by pallid sturgeon in the lower Yellowstone and upper Missouri. Photoperiod was coupled with discharge as a good predictor of movements by pallid sturgeon. He implied these movements were related to spawning, although reproduction was not observed. Consequently, the magnitude and timing of the annual spring flood pulse appear to provide essential cues for pallid sturgeon.

Early life stages of most fishes, including sturgeons, are extremely sensitive to environmental influences. All larval fishes during this "critical period" are planktonic, that is they are very weak swimmers and are carried by water currents. Thus, it is necessary for fluvial dependent fishes to drift into shallow, low-flow, river-margin habitats if they are to locate food and not be washed out of the system (Copp 1991, Schiemer et al. 1991, Scheidegger and Bain 1995, Robinson et al. 1998). These nursery areas are generally associated with low river flows and complex nearshore habitats with an abundance of shoal areas. Providing lower summer flows even in the present channelized Missouri River will result in a significant increase in low-velocity, shallow water habitat (<5 ft depth, ≤2 ft/s velocity) in the area near Omaha, NE, based on information provided by the COE (Figure 1). The post-regulation (1967–1996) August median flow at Omaha was 36.9 kcfs (Galat and Lipkin 1999) which yields about 1 acre/mile of this habitat class. Were contemporary August median discharge at Omaha reduced to 22.4 kcfs, the 1929-1948 pre-regulation August median flow (Galat and Lipkin 1999), the amount of this habitat class in the present river channel configuration would increase to about 8 acres/mile (bottom, thick line). Relative to the 100* acres/mile of shallow, low-flow habitat in the pre regulation river channel at nearby Blair, NE (top, thin line), this increase might seem trivial, but to the rare pallid sturgeon it may be the difference between survival and extinction. Further increases in low-velocity, shallow-water habitat necessary for recovery of endangered sturgeon

and candidate sicklefin and sturgeon chubs will require habitat modification of the current channel to increase the amount of shoal area above that which could be accomplished by reducing summer flows alone. This example also illustrates how flow and habitat modifications need to be coupled to increase potential fish nursery habitat above 10% of the historical amount in the Omaha reach. No information was provided to estimate how much shallow water, low-flow habitat might be produced by habitat modifications without any change in the current summer hydrograph.

Research on the interior least tern from a broad area, including the lower Mississippi, lower Ohio, lower Platte and Yellowstone Rivers, also supports the contention that both flow and habitat are necessary for its recovery. The importance of high spring flows to create and maintain sand-bar habitat for least terns is well known as is the need for low summer flows to expose these sand bars for nesting (Hardy 1957, Smith and Renken 1991, Kirsch 1996, Bacon and Rotella 1998). Most recently, Dugger et al. (in press) showed a significant correlation between river water elevation and number of fledglings produced per pair for least terns in the lower Mississippi. For the period 1986 through 1993 the number of fledglings per pair increased as maximum water elevation in July decreased. Tibbs and Galat (1998) developed a conceptual model from empirical data collected on the lower Mississippi River which summarizes the interplay between flow and habitat that is vital for tern reproduction. High spring flows scour sand-bar habitats and provide spawning cues for riverine fishes. As water levels recede in May and June sand-bar habitats become exposed for tern nesting and young fishes move from the floodplain to the river channel. Availability of high numbers of small fishes in June coincides with the period of high forage demand by fledgling terns. This evolutionary linkage of prey availability with predator demand is orchestrated by predictable patterns in flow and habitat variability.

Restoring either flow or habitat to pre-development conditions is neither judicious nor possible given present water depletions within the river reservoir system, degradation of the river channel below Gavins Point dam, and current development and uses of the lower Missouri River and its floodplain. A more tenable approach has been termed "normalization" by Stanford et al. (1996), where the norm or standard is established from what is possible in a natural-cultural context as opposed to striving for pristine conditions which are difficult, if not possible

to define or achieve. In conclusion, it seems prudent when detailed environmental requirements of the multiple listed species are poorly known and their survival is in jeopardy to normalize to some degree the two environmental drivers deemed equally critical to their conservation and recovery.

I hope that my responses will be helpful in your deliberations. If I can be of further assistance please contact me.

Sincerely,

David L. Galat, Ph.D.
Assistant Unit Leader- Fisheries
and Associate Professor

Enc.

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Figure 1

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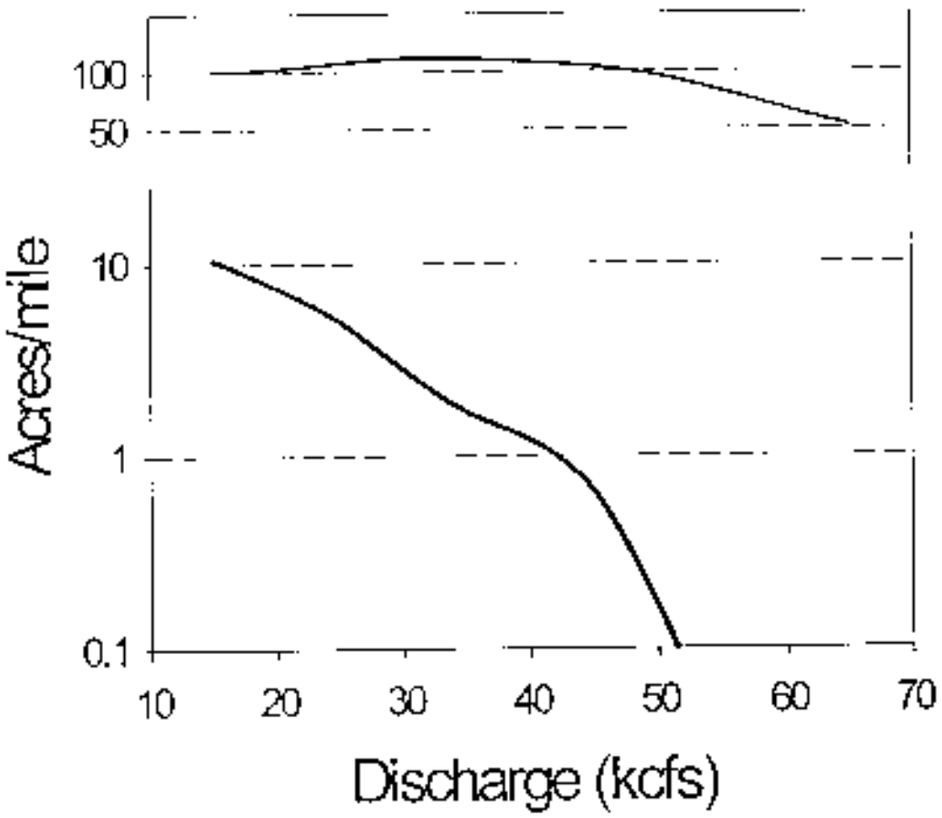
Figure 1. Number of acres per mile of water depths ≤5.0 ft & velocities ≤2.0 ft/s for a range of EVQ2 modeled Missouri River discharges at Omaha, NE, for the 1923 channel (top, thin line) & at Blair, NE, (bottom, thick line) for the contemporary channel.



Source: Data from D. Latka, USACOE

MISSOURI RIVER SCIENTIFIC REVIEW PANEL

Responses of Dr. Paul Holden Related to Pallid Sturgeon

May 21, 2000

1. Based on the most current information on pallid sturgeon: 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? 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.

Response: The life history needs of pallid sturgeon appear to be poorly understood. Recent radio telemetry studies (Bramblett 1996, Sheehan et al. 1998) of pallid and shovelnose sturgeon have started to show some of the habitat use and selection for adults of these species, but habitat use, habitat selection, and other needs of juvenile and young are still not understood. This lack of understanding is not unusual but fits the norm for most endangered or threatened species. All of the studies that I have reviewed on pallid sturgeon have concluded that key habitats for this species have been lost in much of the Missouri and Mississippi rivers, and the reason for this loss in habitat is the loss of natural flow pattern and timing coupled with the loss of the natural river floodplain. Therefore, there is a generally accepted relationship but it is based on relatively little hard data.

This situation is very similar to one I am more familiar with, and that is the large-river fishes of the Colorado River system of the American southwest. Six large-river fishes inhabit the Colorado River and four of them are currently listed as endangered, the razorback sucker, Colorado pikeminnow, humpback chub, and bonytail. These are all relatively large bodied species, the pikeminnow would rival the pallid sturgeon in size with adults at one time reported to be as large as 80 pounds. Construction of dams on the mainstem Colorado River started in 1935 with Hoover Dam, but intensified under the Colorado River Storgage Project (CRSP) in the early 1960s when four large dams were placed in the upper Colorado Basin. Sounds like the Missouri and Colorado were influenced by the same era of dam building. Although some of the large-river fishes may have been declining in the Upper Basin due to irrigation and other threats prior to the 1960s, the loss of these species following the CRSP dams was dramatic and caused their listing. As we started to learn about these species, most biologists initially considered the dams and the change of much of the riverine habitat to reservoir habitat, as well as the cold tailwaters, as the major problems for the fish. But many of us also thought the change in flow pattern and timing may also be important. As time and study has gone on, we have learned that changes in flow and the loss of active floodplains also are very important in the decline of these species. Although we did not have the Corps of Engineers to levee the river from the floodplain.

we did have invasion of exotic trees and shrubs (salt cedar and Russian olive) that stabilized banks and simplified the channel in many areas since high spring flows no longer occurred.

As we started to learn about the habitat needs of the four endangered species, we found that their life histories were all closely tied to the cycle of the natural hydrograph. The other large river fishes, two suckers (flannelmouth and bluehead suckers) generally were doing well. The flannelmouth sucker is close to the razorback sucker in many aspects, and they have hybridized in nature since before the dams, perhaps similar to pallid and shovelnose sturgeon. Both spawned at about the same time, at or just after the peak of the spring hydrograph. Razorback sucker appear to use a few areas for spawning and show fidelity to these areas. Flannelmouth sucker spawn on cobble bars throughout the system. Young flannelmouth suckers were easy to find, but young razorback have seldom been found, until recently. We have now learned that razorback larvae apparently require flooded bottomland habitat (warm, rich in plankton with abundant cover) as nursery areas, available only during normal to high spring runoff years due to overbank flooding, but habitats that have been very rare since the dams were put in due to reduced spring releases. This was discovered almost accidentally when a USFWS waterfowl management area pond (in the old floodplain) was drained in the mid-1990s, and about 45 young razorbacks were found. Larval flannelmouth suckers require only some low velocity habitats but nothing special.

As we have learned more about Colorado pikeminnow, we have found that they generally use only a few spawning areas (in the Green River system, only 2 in over 600 miles of river). They spawn as flows recede in July and their young use ephemeral backwater habitat within the river channel as nursery areas. The spawning areas are some of the most clean cobble in the river, with depth to embeddedness of 5 or more cobble diameters.

The more common species such as the flannelmouth sucker do not have the same detailed needs as the endangered species. Although much of their life history appears the same, it actually is much different. I suspect that this is also the case for the pallid and shovelnose sturgeon. They likely use some of the same spawning areas, which is suggested by the number of hybrids. But it is very likely that pallid sturgeon have a more specific need for a particular portion of the spawning area, or are more specific on timing, than the shovelnose. I also suspect that their young require certain key habitats, habitats that are seldom found today but which were more common in the undammed river. I suspect the life history of the pallid sturgeon includes requirements for key habitats that are much more closely tied to the natural hydrograph, and the habitats produced by that hydrograph, than is the shovelnose.

Therefore, although I noted above that there is a generally accepted relationship that is based on little data, I suspect it is the right relationship. Natural flows in the Missouri River were likely important in providing key habitats for the pallid sturgeon. The biologists working on the system still don't know what those habitats are, and it may take a while to find them because the river and floodplain are so heavily altered, but it appears to me that they are generally on the right track.

The next part of this question, physical habitat and flow restoration, appears to be somewhat off base from my perspective. Based on what I said above, habitat follows flow. The natural flow pattern and timing created a series of habitats that the native fish evolved with. Some evolved to use certain unique portions of that habitat and its pattern of availability; they are now rare. Others evolved to use more common habitats; they are still common. From the fishes' perspective, physical habitat restoration by itself is almost a misnomer. We don't even know what habitats to restore. I think you likely mean floodplain restoration rather than physical habitat restoration. And floodplain restoration or reconnection in tandem with restoration of a more natural flow regime is likely what will be needed to restore the key habitats needed by pallid sturgeon. We have found this to be the case in the Colorado River Basin. As we have learned what the key habitats are, we have found that mimicry of a natural hydrograph is the easiest, and likely only, way to restore those habitats. We are starting to see that habitat quality, such as the depth to embeddedness of cobble bars used by Colorado pikeminnow to spawn on, requires high flows. In the last few years we have seen strong year classes of pikeminnow in the year or two following 50-100 year flood events. Some researchers think this is due to increased egg hatching success, and number of larvae, when the spawning cobbles are super clean. A study has been proposed and I believe funded for the next few years to investigate this hypothesis in more detail. Although I am sure the pallid sturgeon key habitat needs are different from that of Colorado pikeminnow or razorback sucker, I suspect they also are tied to the natural riverine habitat and how that habitat changed with the natural flow regime. The more of that flow regime and habitat that can be restored, most likely the better chance pallid sturgeon will have of recovery.

Therefore, flow restoration is needed perhaps even more than floodplain restoration since there appear to be a few areas that have not been channelized and have some floodplain connection below Gavins' Point Dam. These areas may still provide some semblance of key habitats with natural flows and may be key areas to study.

The final point dealt with spawning cues. The literature I reviewed noted that pallid sturgeon and paddlefish cue to spawn on the spring rise. But the only citation I could find appeared to be more of a review paper than actual research. Many biologist thought that Colorado pikeminnow also needed high flows to cue spawning, but we have found they spawn even in years with no spring flow, suggesting that cueing may not be all that important. Spawning success in dry years is poor as measured by larval production and success of young. I am not sure for pallid sturgeon, but I would suspect that a natural temperature regime during the spring, and the proper spawning habitat, and the proper nursery habitat for larvae, are the key ingredients that are missing and that would potentially be restored with a more natural hydrograph, and these factors are why the natural hydrograph are important rather than a cue to spawn.

Based on the material I read concerning pallid sturgeon and the results of recent studies, I suspect that the natural flow regime and the natural river channel (floodplain) configuration are the elements that need to be restored to help pallid sturgeon. I also suspect that as these features are restored, the life history needs of the fish will become clearer, and perhaps easier to study, and the key habitats this species requires will be discovered. The subtle differences that help

shovelnose sturgeon recruit but not pallid sturgeon also will become more evident. You are lucky as we are in the Colorado Basin that you have a long lived fish to work with.

2. Can populations of the Federally listed pallid sturgeon of 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 other management and restoration techniques result in the conservation of the pallid sturgeon 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 the species needs in order to thrive?

I believe I also answered this question in my response to number 1 above. Because it does not appear that the actual key habitats that are missing are known, it seems like it will be very difficult to restore something that is not well known. Another interesting point is recent research has tended to find adult and one or two young pallid sturgeon in diverse or habitat rich portions of the river. Lots of secondary channels, braids, islands, and likely a high habitat count (meaning the river is broken into many habitats, perhaps even the same ones, but each habitat is relatively small compared to an entire reach being comprised of 65% run and that habitat is all contiguous). This is very similar to habitats we find both razorback sucker and Colorado pikeminnow selecting in the San Juan River, which is over 80% run habitat. We have found that high spring flows are one factor in creating and maintaining that high habitat diversity, as well as a floodplain that is connected to the river.

Twenty or more years ago some folks in the Colorado Basin tried to create backwater for young pikeminnow. They constructed backwaters that were permanent features of the river, unlike the ephemeral backwaters used by young pikeminnow. The backwaters either filled in over time or became home for exotic predators such as green sunfish. In the last 10 years river geomorphologists have been added to the study teams and they have helped bring forward the need to mimic the natural hydrograph to create the key habitats needed by the rare fish.

Based on my understanding of the Missouri system, and my experience working with rare fish, I doubt that the pallid sturgeon will be recovered unless the current operational schedule is changed to mimic a natural hydrograph. Once that is initiated, then habitat restoration or creation may possible. We do know that as habitat has been degraded in the Missouri River, that pallid sturgeon have responded by losing the ability to recruit, and that they are doing the best in areas that are least changed. We do not know how they will respond to habitat improvements, with through flow restoration or physical habitat restoration. As noted above, we do not know what pallid sturgeon needs in order to thrive, but we have a better idea of what is not good for them, the present situation.

3. If physical habitat restoration and hydrological modifications are both necessary for the conservation of Missouri River threatened and endangered species, are there great benefits to phasing implementation (one before the other) of those measures or various proportions

of each that would yield the greatest benefits?

I would suspect that flow modifications would be needed first, and would also give the earliest chance for a response from the pallid sturgeon. I am not sure there is enough information known about the key habitat needs of the fish to know what type of habitat restoration to initiate, other than to restore diverse reaches of river. If pallid sturgeon young are truly large river dwellers, then restoration of secondary channels may be more important than reconnection of floodplains. I don't think enough is known about the young to draw this type of conclusion, yet.

In the real world we seldom have the opportunity to do exactly what we think is right. Hence, I suspect some flow modification, and some habitat restoration, will likely be the most prudent course of action. Some portions of the river will lend themselves to flow changes, other areas to habitat restoration, hopefully some reaches will allow for both concurrently. I am not familiar enough with Missouri River to be able to say where and when, but you folks are

Hopefully, my comments have helped in your decisions. As is typically the case, I am completing this on Sunday evening and wish I had more time to put into my responses. I have not cited any literature but could back up my various statements with citations if need be. We need to remember that generalist species do not become endangered. Species become endangered because they react to changes in their environment more dramatically than generalist species. This usually means that their habitat needs are more specific. As biologists studying these species, the big task is to find those key habitats, and then to restore them. This is often an iterative process, with small successes coming here and there that lead to a major positive reaction from the species. I appreciate the opportunity to learn more about the Missouri system and the pallid sturgeon. I will be in the field all this week, looking for a new population of razorback sucker in the upper end of Lake Mead where we found larvae in the past couple weeks. I hope to be in touch via email and my secretary will have a number of a motel where we will be staying. If you need to contact me for clarification, it may be difficult but likely possible.

Paul B. Holden, PhD
BIO/WEST, Inc.
Logan, Utah

25 May 2000

Missouri River Section 7 consultation peer review response from Rochelle Renken

Rochelle Renken

I respond to the three peer review questions submitted to me by the U.S. Fish and Wildlife Service as a researcher who has worked on interior least tern issues on the Mississippi River since 1989. I also am a member of the Missouri River Natural Resources Committee subcommittee on least tern and piping plover management. I have been a member of that team since its inception in 1992.

My responses to the three questions follow.

(Question 1.) Will some semblance of the historic hydrograph be necessary, along with physical habitat restoration, to conserve endangered and threatened species below Gavin's Point dam?

In my opinion, a semblance of the historic hydrograph with an increase in flows, along with the transport of sediment, during a period prior to the nesting season for interior least terns and piping plovers would most efficiently create and maintain the sandbar and sand island habitat necessary for tern and plover nesting and foraging. I think flows that are a semblance of the historic hydrograph are necessary for the long-term (next hundred to two hundred years) ability of these populations to maintain themselves or even increase. I draw this conclusion based upon the following evidence and information:

A) High flows (up to 70,000 cfs) from Gavin's Point dam in 1995, 1996, and 1997 resulted in an approximate 3 to 45 fold increase in sandbar and sand island habitat below Gavin's Point dam during the 1998 interior least tern and piping plover nesting season as compared to habitat estimates for the 1992 and 1996 nesting seasons (U.S. Army Corps of Engineers, 1998 Biological Assessment). Mechanical and other man-induced manipulations of existing sandbar and sand island habitat prior to 1995 had resulted in small, local, and very short-term (one nesting season) gains in habitat for terns and plovers. Even when "winning these small battles" in restoring habitat, overall, "the war was lost" because the overall amount of sandbar and sand island habitat in the system was declining due to vegetation encroachment and succession, and sediment-hungry water released from the dam. The high flows of 1995, 1996, and 1997 demonstrated what high flows could so efficiently and effectively do in creating nesting and foraging habitat for terns and plovers on the Missouri River.

B) This tremendous amount of sandbar and sand island habitat in 1998 resulted in very productive nesting seasons for interior least terns and piping plovers. The plover and tern reproductive rates in 1998 were 2 and 2.6 times greater respectively, than the highest rates observed during 1988 through 1997. The 1998 reproductive rates were also two and four times greater than reproductive rates suggested as levels to stabilize plover and tern populations, respectively (Ryan et al. 1993, Kirsch and Sidle 1999, U.S. Army Corps of Engineers 1998 Biological Assessment). These great reproductive rates were in part, a result of low predation rates. It appears there was so much habitat in 1998 that tern and plover predators were very

inefficient at locating nests and chicks. The 1998 reproductive rate also may have been the result of greater amounts of good tern and plover foraging habitat because of the great amount of sandbar and sand island habitat. Dugger (1997) reported that food availability influenced least tern reproductive parameters (egg weights, clutch sizes, and chick weights), and thus could influence fledging rates. Least terns eat small fish that are most abundant in shallow water zones around sand islands and sandbars in large river systems (Tibbs and Galat 1998)

C) The benefits of the high flows and subsequent great amounts of sandbar and sand island habitat observed in 1998, were also observed in 1999. Even though it appeared that approximately half of the sandbar and sand island habitat may have been lost to a sediment hungry river between the 1998 and 1999 tern and plover breeding seasons (C. Kruse, U.S. Army Corps of Engineers, personal communication), 1999 estimates of plover and tern reproductive rates were 2.5 and 1.5 times, respectively, larger than reproductive rates observed during 1988 through 1997 (C. Kruse, U.S. Army Corps of Engineers, personal communication). The success of the 1999 tern and plover nesting season supported the conclusions drawn from the 1998 season - that high flows from Gavins Point dam can create abundant excellent interior least tern and piping plover nesting and foraging habitat, with subsequent excellent reproductive rates for the birds.

In addition, though I do not have the fisheries research experience to add to the argument, in my opinion, it appears that restoring a semblance of the historic hydrograph below Gavin's Point dam would also greatly benefit pallid sturgeon populations by 1) by providing more aquatic habitat diversity among the many sandbars and sand islands created by the high flows, and 2) provide the water temperatures that are apparently needed to stimulate sturgeon reproduction

In conclusion, it is my opinion that semblances of historic hydrograph flows will be necessary for the long-term conservation of endangered and threatened populations below Gavin's Point dam. The mechanical manipulation (grading, sandbagging, etc.) of dwindling and limited sandbar and sand island habitat was not enough to provide the nesting and foraging habitat needed by these populations for self-maintenance. In addition, in 1998 and 1999 we have seen what good high flows have done for tern and plover reproductive rates. The water releases will do a better job of efficiently and effectively restoring and creating habitat in the long-term than any man-made manipulations of habitat.

Question 2) Can the endangered and threatened populations be conserved by physical management and restoration techniques without modifying the current hydrograph and operational schedule?

In my opinion, I doubt that enough good interior least tern and piping plover nesting and foraging habitat could be created and maintained in perpetuity to have self-maintaining populations without modifying the current operations and hydrograph. Prior attempts at physical habitat modifications during 1987 through 1994 proved to last only one or two seasons, affected only very small amounts of habitat (especially compared to the amount of habitat created by high flows), and were money and manpower costly (U.S. Army Corps of Engineers, 1998 Biological

Assessment). In the landscape of the upper Missouri River, these small and local restoration efforts had little to no influence upon the system's overall reproductive rates for terns and plovers in the nesting seasons following the restoration efforts.

Interior least terns and piping plovers have adapted to an early succession, ephemeral habitat that is best created and maintained by the river, and the seasonal increases and decreases in flows. In my opinion, these seasonal fluctuations do not need to occur every year nor at the same levels every year. I suggest they should occur at a rate of every three to five years to assist least terns and plovers in maintaining themselves.

The current operation schedule does not work for the long-term self-maintenance of these endangered and threatened populations. The reproductive rates observed in 1988 through 1997 (U.S. Army Corps of Engineers, 1998 Biological Assessment) are evidence that the populations can not maintain themselves under the current operation. The only observed reproductive rates at a level allowing self-maintenance or growth (1998 and 1999) were rates that were a direct result of high flow releases from Gavin's Point dam during 1995, 1996, and 1997. As discussed earlier in my response to question 1, these high flows resulted in 3 to 45 times the amount of habitat available in previous years. The earlier "status quo" flows under current operations always resulted in population reproductive rates lower than needed for self-maintenance.

Question 3) If physical habitat restoration or hydrologic modifications are both necessary, are there benefits to phasing implementation of those measures? Or combinations of either strategy?

For interior least terns and piping plovers, I suggest implementing the hydrologic modifications first before any physical habitat modifications. During the 1998 and 1999 tern and plover nesting seasons, we know that no further physical habitat modification was needed for terns and plovers following the high flows of 1995, 1996, and 1997 (U.S. Army Corps of Engineers, 1998 Biological Assessment). The high water releases with sediment created the habitat the birds needed for very successful nesting seasons. I suggest observing what high releases can do for endangered and threatened species habitat for 3 to 4 years, then incorporating additional physical manipulations into the operation, along with occasional (every 3 to 5 year) high releases. After observing the effects of the high releases, we can probably be more efficient and judicious in our physical habitat modifications efforts by doing the modifications where they would provide the greatest benefit to the populations for the long-term.

Literature Cited

Dugger, K.M. 1997. Foraging ecology and reproductive success of Least Terns nesting on the lower Mississippi River. Ph.D. Dissertation, University of Missouri -Columbia.

Kirsch, E.M., and J.G. Sidle. 1999. Status of the interior population of Least Tern. Journal of Wildlife Management 63:470-483.

Ryan, M.R., B.G. Root, and P.M. Mayer. 1993. Status of piping plovers in the Great Plains of

North America: a demographic simulation model. Conservation Biology 7:581-585.

Tibbs, J.E. and D.A. Galat. 1998. The influence of river stage on endangered least terns and their fish prey in the Mississippi River (USA). Regulated Rivers: Research and Management 3:257-266.

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Biological Resources Division
Upper Midwest Environmental Sciences Center
2630 Fanta Reed Road
La Crosse, Wisconsin 54603

Mark Wilson
U.S. Fish and Wildlife Service
608 E. Cherry Street Room 200
Columbia, MO 65201.

Dear Mark,

Enclosed is a signed copy of the comments I provided to you on 23 May 2000 concerning least terns on the Missouri River. If I can be of any further assistance please do not hesitate to call.

Sincerely,

Eileen M. Kirsch

Eileen M. Kirsch, Ph.D
Research Wildlife Biologist

Eileen M. Kirsch [signature]

Scientific Review panel Question #1

Below the Gavin's Point dam (as well as Fort Peck and Garrison) a more natural hydrograph would benefit least terns in a number of ways. It would force them to nest on the highest portions of available sandbars, thus decreasing risk of inundation. A more natural hydrograph would provide for greater available habitat more years, through scouring and deposition. In the USFWS Biological Opinion of 1994, the FWS preferred alternative flow may yield 137 more acres of exposed sand, but more importantly a greater number of years where more sand will remain exposed than the current flow management. I do not think that flows should increase during the period April-June as the preferred alternative suggests, but rather peak in April and May and decline through June. Furthermore, sediment needs to be restored to the system along with the spring flows. Severely reduced sediment loads and increased sand fraction of sediment load indicates that the sandbar habitat and bed morphology are likely to continue to degrade. Sediments from bed load and bank erosion can only go so far in creating high sandbars. If higher sediment loads are not also restored to the system the long-term effect will likely be a further reduction in sandbar numbers, distribution, and total area. It may be fruitful to expend some of the habitat maintenance and manipulation money on dredging sediment from behind dams and releasing it downstream of the dam. Although the Corps Biological Assessment models indicate that there would be very little in additional shallow water habitat for fish and thus least tern forage base and foraging areas, any improvement in this arena is good. My educated guess is that the lack of sediment load at given flows leads to there being very little difference in amounts of shallow water habitats among the different flow regime models. I would like to have seen data on amount of bare sand related to flow and flow related to stage.

The Missouri River below the Gavin's Point dam (and the other 2 areas listed above) is a very important area for least terns on the Missouri River System. The primary reason least terns are at risk on the System is habitat loss and degradation. Dams and flow management have severely reduced the number and amount of area of sandbars, hence creating a survival problem for least terns. Furthermore, current flow management has lead to decreased bare areas for nesting because of vegetation encroachment which increased chances for flooding of nests as terns are forced to nest at lower elevations, and increased risk for predation as terns become more concentrated and sandbars have more cover for predators. That sandbars become vegetated in a couple of years due to current flow management exacerbates the problem. Sufficient flows to scour the tops of existing sandbars and create new sandbar areas cannot be expected every year, however this system is under a great deal of control and more can be done to insure some good habitat and the safety of the habitat than is currently. Higher spring flows more often would help keep higher portions of sandbars clear of vegetation and require less manual energy (and perhaps less expense) than all the spraying, disking, hand-pulling, bulldozing, tree demolition, etc that the Corps is doing. These activities may continue to be necessary to maintain the highest portions of sandbars for least terns, depending on if spring flows allow total scour often enough (6-8 years in my estimation). The intermittent years of sustained very high flows are good for the system as the Corps BA mentions, because new high bare habitat is created. However, such high water conditions during the nesting season for 3 years in a row is unusual, and not necessary for habitat management. Three years of low to no productivity due to minimal habitat and flooding of that minimal habitat is not good, especially for Piping Plovers which have a shorter life span.

Question #2

It is well known that least terns are rather flexible in terms of what substrate and situation they will accept for nesting. It appears that they key in on bright white/gray substrate that is nearly devoid of vegetation. Nearby water is also essential. In Nebraska, least terns use sandpit areas extensively along the Platte and Loup rivers, and when rivers are flooded for extended periods the only nesting that occurs is on sandpits. However, manmade habitats are not a panacea for not restoring habitat in the river, as other problems may be more acute on manmade habitats. Predator and habitat management must be intensive and ongoing. Habitat creation may be far more costly than letting the River do the habitat creation and maintenance.

The work already done by the Corps to reclaim and restore sandbars does not appear to be very effective in terms of bolstering numbers of terns or fledgling success. A great deal of labor and expense has gone into these efforts and while any increase in habitat is good and provides chances for greater productivity, these efforts have not paid off to the extent that the increase in habitat caused by higher river flows (1995-1997) did in 1998.

May 10, 2000

Mark Wilson
U.S. Fish and Wildlife Service
608 E. Cherry Street, Room 200
Columbia, MO 65201

Dear Mark,

Enclosed is a printed copy of the Section 7 Consultation response I e-mailed you on 5/9/00.

Ken Dubinski

USGS
Upper Midwest Environmental Sciences Center
La Crosse, WI

Responses to Questions for Scientific Review of Missouri River Section 7 Consultation on Endangered Species – Kenneth S. Lubinski, USGS KL7

Is there a generally accepted relationship between Missouri River flows (and stages) 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 share the belief, which seems to be "generally accepted", that the populations of the three species in question are dependent on certain predictable features of Missouri River flow and stage regimes. It also appears fairly certain that habitat restoration by itself won't be sufficient. First, floodplain structure is only part of the equation. The needs of the species are dependent on appropriate seasonal overlays of water and habitat surfaces together, and it doesn't seem possible that the water overlay can be addressed by habitat restoration alone.

Second, based on my knowledge of habitat restoration on the Upper Mississippi River, it seems unrealistic to think that habitat restoration, which has so far been limited to "sites", will solve species problems that are more "system" oriented. Over the last 12 years, habitat restoration on the Upper Mississippi has been intended to improve conditions at specifically selected sites. A recent Corps of Engineer's progress report projected that 50 projects would be completed during the first phase of the program, affecting 97,000 acres at a cost of about $130 million. The affected acres amount to less than 4% of the system's floodplains.

I suspect, from a federal budget perspective, that if a habitat restoration program were implemented on the Missouri River, that it would not have a greater budget, or consequent spatial scope, than the one that exists on the Upper Mississippi. Even at that level, and even if it was entirely successful, it could only address a small proportion of the target habitats over the next 20 or 30 years. This to me seems to be too great a risk. The species in question are already at low population levels. A site approach to their systemic population problems may be doomed from the start, and all of the expensive eggs should not be put into a habitat restoration basket, only to find out 20 years from now that it wouldn't have worked in the first place.

There are many unknowns, or uncertainties, involved with the primary question. The following statements seem to be relevant:

1) While the species are dependent on certain predictable aspects of Missouri River flows and stages, river science has just begun to quantify those dependencies.

2) The perceived relationships are supported by information derived from available, but not always site-relevant, life history studies and broad river ecological theory. Lots of details remain.

3) The most effective hydrologic patterns for one species may not work for the others. Even within a species, selecting one reach of river where target conditions will be established, or one flow feature, may not work every year. What if the population redistributes itself later? What if the population's needs are density dependent? What if they need certain reproductive habitat conditions in one year, and flow-related food resources in the next year?

4) Science cannot, within the near future, fill all of the quantitative gaps needed to support specific decisions about which flow regime feature is most critical, what the most appropriate duration time is, etc. Only actual operational experimentation, coordinated with a monitoring program designed to provide adequate information on species status and response to the proposed management actions, will provide the necessary documentation to correctly modify any actions if they are not working.

These items confirm the need for an adaptive management approach to insure the future viability of the species with the Missouri River system.

Can populations of 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?

I don't know enough about the full range of management options for each species to answer this question. The management options do seem to be limited, in part because the populations of the species are already at low levels. All I can offer is the reminder that the ultimate goal is to get these species to naturally sustainable levels. "Naturally sustainable" to me means without continual artificial support (projects, time, money) from humans. Short-term, high-cost fixes to sustaining an individual species may be necessary to help them survive present population constraints. But such short-term "life lines" are not realistic long-term solutions.

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?

It seems to me that initial progress can be made on three fronts simultaneously. There is no point in modifying flow rates unless you can measure the biological outcomes.

There are two philosophies about proceeding with or without specific goals. One holds that we should simply do whatever we can with our limited resources. The system will likely "get better" even if we haven't set a specific goal. My experience is that this approach is not going to work in the future as government presses for more and more evidence of outcome (as expressed in the Government Performance and Results Act). The second approach is to set a goal, and I would recommend using measures related to population viability (see "Science" below). Don't be worried about the possible down side of not meeting the goal by a short-term deadline. You'll be able to tell the public and agency heads how much progress you've made, and if community and agency values on the species persist, you'll get support to do more. All will benefit at the start by understanding how big the job might be.

Science:

A monitoring system needs to be established to record the species responses to modified flow rates. The sooner you start, the sooner you'll know about critical uncertainties.

Don't gage success from only one year's data. Schedule "success" reports based on biologically relevant timeframes.

At the same time, interim population targets (at several relevant spatial scales) need to be established. A first step to establishing interim population targets might be the use of population viability modeling approaches to get an initial estimate of the minimal populations necessary to sustain each species.

Habitat restoration

A strategy for creating the kinds of habitats required, and locating them within the Missouri River system on a priority basis, is required. Have you collected all of the floodplain elevation data to support inquiries of the kinds of habitats that are inundated at different stages now, or that would be inundated under different modified flow regimes? The predicted flow data have to be translated into probable acres of inundated habitat.

Remember – the job is to protect a species, not a site.

Flow modification.

Just do it. Learn by trial and error and in a logical progression. You'll understand the economic tradeoffs at the same time. Models will only get you so far.

MISSOURI RIVER FORMAL CONSULTATION
ANNOUNCEMENT

Same Letter Sent To:

Montana Governor - Helena
Montana MRBA Representative - Helena
Montana Dept. of Fish, Wildlife & Parks - Helena
Montana MRNRC Representatives - Helena/Miles City
North Dakota Governor - Bismarck
North Dakota MRBA Representative - Bismarck
North Dakota State Game & Fish Dept. - Bismarck
North Dakota MRNRC Representative - Bismarck
South Dakota Governor - Pierre
South Dakota MRBA Representative - Pierre
South Dakota Game, Fish and Parks Dept. - Pierre
South Dakota MRNRC Representative - Pierre
Nebraska Governor - Lincoln
Nebraska MRBA Representative - Lincoln
Nebraska Game and Parks Commission - Lincoln
Nebraska MRNRC Representative - Lincoln
Kansas Governor - Topeka
Kansas MRBA Representative - Topeka
Kansas Dept. of Wildlife and Parks - Topeka
Kansas MRNRC Representative - Topeka
Missouri Governor - Jefferson City
Missouri MRBA Representative - Jefferson City
Missouri Dept. of Conservation - Jefferson City
Missouri MRNRC Representative - Jefferson City
Iowa Governor - Des Moines
Iowa Dept. of Natural Resources - Des Moines
Iowa MRNRC Representative - Missouri Valley
Wyoming Governor - Cheyenne
Wyoming-MRBA Representative - Cheyenne
Exec. Director, Mni Sose Coalition - Rapid City, SD
Tribal Chairman - Cheyenne River Sioux Tribe - Eagle Butte, SD
Game, Fish & Parks Dept. - Cheyenne River Sioux Tribe - Eagle Butte, SD
Tribal Chairman - Chippewa Cree Tribe - Box Elder, MT
Natural Res. Dept. - Chippewa Cree Tribe - Box Elder, MT
Tribal Chairman - Crow Creek Sioux Tribe - Ft. Thompson, SD
DNR - Crow Creek Sioux Tribe - Ft. Thompson, SD
Tribal Chairman - Spirit Lake Tribe - Ft. Totten, ND
Fish & Game Dept. - Ft. Totten, SD

Same Letter Sent To:

Tribal Chairman - Ft. Belknap Comm. Council - Harlem, MT
Fisheries Program - Gros Ventre & Assiniboine Tribe - Harlem, MT
Tribal Chairman - Ft. Peck Tribe - Popular, MT
Fish & Wildlife Dept. - Assiniboine & Sioux Tribes - Popular, MT
Tribal Chairman - Kickapoo Tribe - Horton, KS
Tribal Chairman - Lower Brule Sioux Tribe - Lower Brule, SD
Dept. of Wildlife, Fish & Rec. - Lower Brule Sioux Tribe - Lower Brule, SD
Tribal President - Northern Cheyenne Tribe - Lame Deer, MT
Natural Res. Dept. - Northern Cheyenne Tribe - Lame Deer, MT
Tribal President - Oglala Sioux Tribe - Pine Ridge, SD
Fish & Wildlife Div. - Oglala Sioux Tribe - Kyle SD
Tribal Chairman - Omaha Tribe - May, NE
Wildlife & Parks Dept. - Omaha Tribe - May, NE
Tribal Chairman - Ponca Tribe - Niobrara, NE
Game & Fish - Ponca Tribe - Niobrara, NE
Tribal Chairman - Prairie Band of Potawatomi of Kansas - Mayetta, KS
Natural Res. Div. - Prairie Band of Potawatomi - Mayetta, KS
Tribal President - Rosebud Sioux Tribe - Rosebud, SD
Natural Res. Dept. - Rosebud Sioux Tribe - Rosebud, SD
Tribal Chairman - Sac and Fox Tribe - Reserve, KS
Land Manager - Sac and Fox Tribe - Reserve, KS
Tribal Chairman - Santee Sioux Tribe - Niobrara, NE
Parks & Wildlife - Santee Sioux Tribe - Niobrara, NE
Tribal Chairman - Sisseton-Wahpeton Sioux Tribe - Agency Village, SD
Fish & Wildlife Dept. - Sisseton-Wahpeton Sioux Tribe - Agency Village, SD
Tribal Chairman - Standing Rock Sioux Tribe - Ft. Yates, ND
Fish & Game Dept. - Standing Rock Sioux Tribe - Ft. Yates, ND
Tribal Chairman - Three Affiliated Tribes - New Town, ND
Fish & Wildlife Div. - Three Affiliated Tribes - New Town, ND
Tribal Chairman - Turtle Mt. Band of Chippewa - Belcourt, ND
Water Resources - Turtle Mt. Band of Chippewa - Belcourt, ND
Tribal Chairman - Winnebago Tribe - Winnebago, NE
DNR - Winnebago Tribe - Winnebago, NE
Tribal Chairman - Yankton Sioux Tribe - Marty, SD
Game & Fish Div. - Yankton Sioux Tribe - Marty, SD
Tribal Chairman - Blackfeet Tribe - Browning, MT
Fish & Wildlife Dept. - Blackfeet Tribe - Browning, MT
Tribal President - Flandreau Santee Sioux Tribe - Flandreau, SD
Fish & Wildlife Dept. - Flandreau Santee Sioux Tribe - Flandreau, SD
Tribal Chairman - Crow Tribe - Crow Agency, MT
Fish & Wildlife - Crow Tribe - Crow Agency, MT

Same Letter Sent To:

Tribal Chairman - Arapaho Tribe - Ft. Washakie, WY
Fish & Wildlife Dept. - Arapaho Tribe - Ft. Washakie, WY
Tribal Chairman - Shoshone Tribe - Ft. Washakie, WY
Fish & Wildlife Dept. - Shoshone Tribe - Ft. Washakie, WY
Tribal Chairman - Iowa Tribe of Kansas & Nebraska - White Cloud, KS
Fish & Wildlife Officer - Iowa Tribe of Kansas & Nebraska - White Cloud, KS
Div. Engineer, Missouri River Region, COE, Omaha, NE
Div. Comm. NW Division, COE, Portland, OR
Field Supervisor, ES, Bismarck, ND
Field Supervisor, ES, Pierre, SD
Field Supervisor, ES, Helena, MT
Field Supervisor, ES, Grand Island, NE
Field Supervisor, ES, Columbia, MO
Field Supervisor, ES, Rock Island, IL
Field Supervisor, ES, Manhattan, KS
Field Supervisor, ES, Cheyenne, WY

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
3425 Miriam Avenue
Bismarck, North Dakota 58501

[illegible]

Honorable Tom Harkin
United States Senate
Federal Bldg. Room 733
210 Walnut Street
Des Moines, Iowa 50309

Dear Senator Harkin:

The Corps of Engineers, Northwest Division, Portland, Oregon, and the Fish and Wildlife Service (Service), Region 6, Denver, and Region 3, Minneapolis, have entered into formal consultation on April 1 under the Endangered Species Act on the (1) Operation of the Missouri River Mainstem Reservoir System, (2) Bank Stabilization and Navigation Project, and (3) the Operation of the Kansas River Tributary Reservoirs (see enclosed press release). The consultation will address issues affecting listed species in the project area, including the pallid sturgeon, least tern, piping plover, bald eagle, and Indiana bat. We also will consider issues affecting the sturgeon chub and sicklefin chub, which are candidate species. The Service is proposing to complete its biological opinion within 90 days.

To help the Service complete this opinion, I have requested input on biological issues from the Governors, Game and Fish Directors, and Tribes in each of the States in the basin. A sample of those letters and a list of all addressees is enclosed.

Thank you for your attention to this matter. If we can provide additional information, please contact Mike Olson, Missouri River Coordinator, or me at 701-250-4481.

Sincerely,

Allyn J. [illegible]
Field Supervisor
North Dakota Field Office

Enclosures

Incl/enc: Regional Director, USFWS, Region 3, Ft. Snelling
(Attn: John Blankenship)
Regional Director, USFWS, Region 6, Denver (60100)
(Attn: Susan Linner)
External Affairs, USFWS, Region 6, Denver (60160)
(Attn: T. Sexson/D. Katzenberger)
Field Supervisors, ES:
Helena, Montana
Cheyenne, Wyoming
Pierre, South Dakota
Manhattan, Kansas
Columbia, Missouri
Rock Island, Illinois
Grand Island, Nebraska
Division Engineer, Missouri River Region, COE, Omaha
(Attn: P. Johnston)
Division Commander, NWD, COE, Portland
(Attn: D. Ponganis)

Same letter sent to:

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Honorable Tom Harkin
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210 Walnut Street
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Honorable James A. Leach
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Honorable Chuck Hagel
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Lincoln, Nebraska 68508

Honorable Terry Lee
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Honorable William E. Barrett
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Honorable Michael B. Enzi
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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Missouri River Coordinator
3425 Miriam Avenue
Bismarck, North Dakota 58501

APR 1 5 2000

MEMORANDUM

To: Bill Mauck, Center Director, U.S. Geological Survey
Columbia, Missouri

From: Missouri River Coordinator
Bismarck, North Dakota

Subject: Missouri River Formal Consultation

The Corps of Engineers' Northwest Division, Portland, Oregon, and the Fish and Wildlife Service (Service), Region 6, Denver, Colorado, and Region 3, Ft. Snelling, Minnesota, have begun formal consultation April 1 under the Endangered Species Act on the (1) operation of the Missouri River Mainstem Reservoir System, (2) Bank Stabilization and Navigation Project, and (3) the operation of the Kansas River tributary reservoirs. The Service is proposing to complete a biological opinion within 90 days. The North Dakota Field Office in Bismarck is the lead office for the consultation and will coordinate the effort for the Service.

I am advising you of this consultation as a follow up to our January 26, 2000, Denver briefing, and request any final input on biological issues that you believe may be useful in completing the Service's biological opinion. This information needs to be provided to me in writing by May 8, 2000. The consultation will address issues affecting listed species in the project areas, including the pallid sturgeon, least tern, bald eagle, Indiana bat, and piping plover. We also will consider issues affecting the sturgeon chub and sicklefin chub, which are candidate species

If you have questions regarding this consultation, please contact me. We appreciate your input into our process. Thank you for your attention to this matter.

cc: Regional Director, USFWS, Region 6, Denver
(Attn: Acting NGARD, Denver)
Regional Director, USFWS, Region 3, Ft. Snelling
Division Commander, Northwestern Division, Corps of Engineers, Portland
(Attn: D. Pongratis)
Division Engineer, Missouri River Region, Corps of Engineers, Omaha
(Attn: P. Johnston)

MISSOURI RIVER FORMAL CONSULTATION
FEDERAL AGENCY LETTER
April 13, 2000

Same Letter Sent to:

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Ms. Susan Kelly
Bureau of Reclamation
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Ms. Lauren Johnson
National Park Service
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Mr. Bill Mauck, Center Dir.
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Mr. Larry Dawson
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Mr. Bob Cox
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Ms. Ayn Schmit
U.S. EPA, Region 8
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Denver, CO 80202-2466