TO: SAM Work Group, Management Plan Development Team, MRRIC

FROM: Independent Science Advisory Panel (ISAP)

RE: ISAP Evaluation of MRRMP v3 AM Plan and Pallid Level 3 Actions

DATE: 9 November 2015

Introduction

The review below considers two documents. The first labeled *Adaptive Management Plan Version 3* is the current AM Plan review draft (hereafter, the "AMPv3"), which is the first attempt at a comprehensive MRRP disclosure and guidance document. AMPv3 links explanatory introductory materials with species-specific technical products from the recently completed effects analyses, initiates management-scenario modeling, and considers governance and institutional needs to implement management actions designed to abate or avoid jeopardy to three listed species from the operations of six dams on the Missouri River. The second document reviewed presents the proposed Pallid Sturgeon Level 3 management actions for the Lower Missouri River (hereafter, the "Level 3 document"). The Level 3 document was generated in response to the unique challenge posed to conservation planners targeting the pallid sturgeon, for which essential ecological and behavioral attributes are weakly understood.

The AMPv3, in combination with the Level 3 document, recognizes and responds to the standing uncertainties that confront planners and managers responsible for both river operations and the conservation of the listed species. The understanding of the ecology and behavior of piping plover and least tern and their relationship with riverine habitat is sufficient to allow the authors of the *Adaptive Management Plan* to describe actions that are projected to avoid jeopardy to the listed birds and manage bird habitat to meet predetermined conservation objectives. An understanding of the relationship between the reproductive performance of the pallid sturgeon and physical and biotic attributes of the Missouri River system is not so well-informed; it is unclear how river geomorphology and hydrodynamics interact to provide the multi-dimensional habitat spaces required by the sturgeon. Accordingly, the plan emphasizes information needs for the sturgeon, its habitat, and river operations that when met will facilitate selection of management actions that can be implemented in an adaptive framework for that species.

Although many conservation efforts that focus on federally listed species assert that they are being implemented at least in part in an adaptive management framework, no readily available management planning documents offer a model approach for multiple species on a geographic scale as expansive as that of the Missouri River; therefore, the current efforts to develop a road map to and architecture for adaptive management of the three species under the MRRP is a novel challenge. However, the authors of the AMPv3 include skilled scientist practitioners and collectively have substantial experience in management planning and appear to have assimilated and applied many lessons learned. The attending federal agencies have allowed the authors latitude and supported them in creatively engaging available data and models in transparent analyses moving the effects analysis process into preliminary tests of alternative management

scenarios. In turn the authors have been able to project forward, anticipating next process steps and the staffing and governance that will be required to meet program objectives, including a palette of management actions that are informed by integration of a path-breaking stakeholder effort to integrate formally human considerations into program outcomes. The ISAP finds that the current iterative approach to the development of the Adaptive Management Plan, with sequential review opportunities as the plan matures and moves toward completion, is likely to assure that the final Adaptive Management Plan meets the needs of the MRRP.

At the same time, the ISAP recognizes that the draft management plan, while not hastily crafted, was built against a daunting deadline, and would have benefited from a later delivery date. As well, the document continues to grow, with substance and detail being added as this review is being drafted. The ISAP has benefited from opportunities to discuss the plan with its co-authors who have offered explanation for materials that are included and not included in the current draft, given insights into additions that can be expected in future drafts, and explained intent in regards to issues not yet fully explained in the document. Those exchanges (mostly during the August 2015 MRRIC meeting in Omaha) have been particularly important to this current review, allowing the ISAP to more effectively and efficiently critique the dynamic document as it continues to develop. That observation made, the ISAP enthusiastically encourages the authors to sustain their efforts and hold to the direction that this draft document is taking. The descriptive document clarifying the time horizons and other attributes for "Level-3" adaptive management actions for pallid sturgeon, which arrived during this review, was a welcome accompaniment to the draft plan. Combining the effects analyses and structured approaches to the design and implementation of the adaptive management action plan for all three species, the effort seems to be emerging as a model engagement of the adaptive management concept.

Responses by the ISAP to 23 compound questions received follow; they are organized in the order they were posed. They were not recast for clarity or technical exactness. A number of the questions reflect concerns of MRRIC members about whether certain potential management actions or implementation process elements or steps described are supported by "best available science" or appropriately informed by reliable knowledge. The ISAP encourages the adaptive management team developing the plan to justify and validate fully all proposed actions with descriptions or references to available supporting science and acknowledgement of associated pertinent uncertainties. In addition, future versions of the plan can benefit from richer description of the research agenda and monitoring schema, which together will serve to fill knowledge gaps and provide evidence that supports the proposed management actions or actions that are implemented, or that argues for adjustment to those actions.

Questions and answers regarding the draft MRRMP Adaptive Management Plan version 3

1. Is the overarching governance structure described in the Adaptive Management Plan (AMP) adequate, and realistic from your experience, to facilitate and implement the diverse and complex complement of management actions, scheduled (and potentially unscheduled) decisions, and the supportive evaluation efforts required for a successful adaptive management program to meet the needs of the species? Based on your experience and the level of monitoring that will be required, are the timeframes for data analysis and evaluation in the schedule (for birds) on page 188 adequate?

The governance structure, as currently described in AMPv3, appears to have the necessary components, including technical, programmatic, and policy reviews. The AM plan recognizes that different types of decisions will need to be made at different levels in a governance hierarchy. Changes in monitoring schedules may need to be made quickly by scientists and technical staff at analytical stages and levels; in contrast, changes that may be required in flow release magnitudes and schedules might require decisions at a policy level.

Conceptually the governance concepts seem logical but the details of actual implementation as described in the current AM plan appear to be potentially unwieldy and overly bureaucratic. In particular, the middle of the governance hierarchy, the Management Team (MT), seems complicated in terms of who will make decisions. Many programmatic decisions, as described in the AM plan, would be made jointly by the MT and one or more of the current Program Managers (PM). For example, decisions to construct more ESH would be split, with the MT deciding how much new emergent sandbar habitat (ESH) would be required and the ESH PM deciding the location of the ESH. This gives the impression that the governance structure as conceived would be laid over the top of, and coupled in potentially awkward ways to, the current management structure in the USACE. This seeming kluge is likely not to be the best structure to facilitate adaptive management. We encourage the AM team to consider the necessary governance structure for MRRP adaptive management with no regards to preserving the current organization. Likely as not, components of the current management organization may need to be reshaped and staff incorporated into a structure different from the contemporary one, and which might better support the adaptive management paradigm.

The annual budget/decision cycle depicted in Table 7 (page 188) of AMPv3 seems reasonable and manageable for the bird species, noting however, that one should not expect that any single hypothesis or management issue will get resolved in any one year, or in one pass through the decision cycle. There may be budget constraints, and a particular management recommendation may take multiple years to implement. Some hypotheses (especially at levels 1 and 2) may not be answerable in one year of research or field trials. Particular management questions may be raised in successive cycles until they are fully resolved. The Platte River adaptive management plan has developed a scoring system for its "big questions" to provide a simple means of tracking decisions through multiple cycles, as more evidence is accumulated leading to a final decision to accept or reject a particular hypothesis.

In summary, the governance structure as presented is not illogical in concept, but much more detail is needed on how decision-making processes will occur among the levels and over different time cycles. The contemporary USACE governance structure may not be particularly

well suited to implementing adaptive management. That structure may need to be adjusted to best facilitate processes and management actions as they are fleshed out in a subsequent draft.

2. Does the AMP clearly articulate the decision pathway(s), processes, and criteria by which management-action scenarios will be selected, authorized, implemented, evaluated, and adjusted (adapted) as necessary based on their performance in meeting programmatic goals and objectives?

The adaptive management plan describes a 5-step general process that addresses decision pathways and processes associated with adaptive management (see Figure 2). The authors of AMPv3 recognize that criteria for selecting, authorizing, implementing, evaluating, and adapting specific management actions are central to the success of adaptive management. The AMPv3 presents fundamental objectives and targets for the three listed species, although specific target values remain to be determined. The AMPv3 addresses the realities of budget constraints and availability of resources for implementing selected management actions. Importantly, the document reinforces the need for adaptive management undertaken in the MRRP to be conducted within the bounds of all relevant federal and state laws and regulations. These constraints, which will vary over time, will influence the degree of flexibility in designing, implementing, and adapting selected management actions; such flexibility is emphasized as fundamentally important to the likely success of the AMP. Figure 4 further reinforces the interplay between potentially effective management actions and their feasibility of being implemented by introducing the concept of "useable decision space." Large useable decision spaces increase the inherent flexibility of adaptive management for specific management actions. As the useable decision space diminishes, so does the likely effectiveness of adaptive management. Clearly, if no overlap exists between the implementable and effective boundaries, then adaptive management becomes a forum for conflict resolution for the MRRIC.

The AMPv3 describes the decision-making entities in the governance section, and describes these well. When applied to the birds and fish, however, there are large differences. For the birds, AMPv3 clearly identifies who will be handed the information and who will make the decision (e.g., section 2.2.1 describes how a decision about whether or not to build sandbars will be made, and who will be involved in that decision). The bird section also describes how a decision will be made when different conditions exist (e.g., last paragraph of section 2.2.2). The level of specificity indicates that considerable thought has gone into how these decisions will logistically be made. In addition, these sections describe how the efficacy of decisions will be evaluated, revisited, and monitored after completed. The pallid sturgeon sections are less specific for who will make the evaluative decisions (e.g., 3.2.1.5.4). Many of the studies on which pallid sturgeon management decisions will be based are likely to result in unclear findings. As the report notes, many of the decisions that will contribute to pallid sturgeon management will be based on 'multiple lines of evidence' and rely on judgment. We agree that some of the proposed science is not conducive to a robust statistical analysis.

However, AMPv3 is unclear about who will be doing the interpreting; is the Technical Team the interpreter? Section 3.2.1.6.2 states that cumulative evidence may need to be passed to an "independent body" for judgment; who might that be? Is it the pallid sturgeon effects analysis

(EA) team? Is it the pallid sturgeon recovery team? The agencies should carefully discuss and describe what group(s), or what type of group(s), should be tasked with such interpretations and associated decisions. The ISAP suggests that the FWS in conjunction with USACE scientists must evaluate the multiple lines of evidence early to avoid last minute hurried interpretations followed by a 'policy call' later on. Moving from Level 2 to Level 3 will likely be based on balance of evidence or professional judgment rather than clear compelling science. Even deciding between different lines of science to consider, or doing science in parallel versus sequentially, will be a 'policy call.' The EA team or the ISAP could provide the context for such decisions, but they are much more appropriately made by the FWS and the USACE in their respective lead-agency roles. Recent discussions with MRRIC suggest that the Technical Team, potentially with input and review from the independent panels, MRRIC, and other groups, will do the technical analyses and interpretations and make recommendations for actions, along with the their implications, to the Management Team and Oversight Team for decisions. The ISAP expects that subsequent versions of the AMP will describe this process more fully.

Figure 3 in AMPv3 and its associated discussion demonstrates an understanding of how system knowledge integrates with management conditions and system status in informing a decision process that includes continuing a management action, making changes, or undertaking an entirely different pathway towards achieving management targets. This concept has been largely developed in support of managing the listed birds, but applies to pallid sturgeon as well.

AMPv3 addresses the fundamental aspects of adaptive management in sufficient detail, given that there currently are no selected management actions and that the programmatic goals and objectives have yet to be stated in quantitative terms. The document demonstrates an understanding of the intricacies of adaptive management undertaken in a constrained management context and further complicated by the variability and uncertainties associated with large-scale, dynamic, and incompletely understood ecological systems characteristic of the Missouri River. As objectives and management actions are more clearly specified, and as an outcome of ongoing exploration of decision-making opportunities and constraints, the ISAP expects to see a more complete specification in the plan of decision processes, pathways, and criteria in the next draft.

3. Does the AMP adequately incorporate the modeling approaches, analytical tools, findings, and conclusions from the Effects Analysis efforts, which provide the informational and technical foundations for adaptive management? What, if any, additional components and/or context would assist in understanding the AMP? What, if any, prior ISAP recommendations related to AM have not been adequately addressed, and are still pertinent?

The AMPv3 reiterates contributions provided by the Effects Analysis (EA) in helping to frame an effective adaptive management program. The document references the contributions of previously developed Conceptual Ecological Models (CEMs), and underscores the importance of subsequent modeling and analysis performed in the EAs in informing the development of the AMP. This is particularly evident in discussions of model results in relation to managing the listed bird species. The AMPv3 describes the contributions of model results in evaluating the anticipated efficacy of several management alternatives. At the same time, the authors, who also

participated in the bird EA, recognize the importance of certain remaining model uncertainties (e.g., functional relationships between management actions, such as ESH and bird population dynamics) in influencing the outcomes of selected actions implemented within an adaptive framework. The discussion is constrained in its degree of quantitative detail, because specific management objectives have yet to be defined by the participating agencies. Nevertheless, the AMPv3 adequately represents the importance of the EA in contributing a scientific basis for adaptively managing the listed birds. The key remaining issue for the birds concerns the incorporation of off-channel contributions into the overall management program.

The ISAP recognizes the degree of uncertainty associated with the current status of the pallid sturgeon demographic population model. Yet, despite the seemingly daunting uncertainties, effort should be made to develop a pallid sturgeon modeling capability that parallels that of the bird population models, which are integrated with relevant hydrologic and hydrodynamic models. The pallid sturgeon model should be expanded in spatial scale to represent differences between the upper and lower reaches of the Missouri River. The sturgeon model should be functionally linked to the available relevant physical models, even if the functional linkages derive from best professional judgment. The importance of the model development and integration lies in being able to distinguish among the anticipated performances of alternative management actions. Model bias (inaccuracy) will be inherent to the evaluation of the management actions. However, if the integrated models are sufficiently precise to just rank order management alternatives according to their modeled outcomes, then a management capability parallel to the listed birds will have been achieved – even as basic research efforts continue to improve the accuracy and reliability of the pallid sturgeon population model and its functional relationships with the physical models. Rigorous numerical sensitivity and uncertainty analysis can be routinely performed to identify key aspects of the models that require improvement. These analyses can be used to guide the basic research undertaken to improve the accuracy and reliability of the models, again with an emphasis on their usefulness in characterizing the differences between alternative management actions in helping to achieve pallid sturgeon goals and objectives.

If the recommended development of the pallid sturgeon model and its integration with relevant physical models is deemed infeasible, then at least a modeling (code) framework should be developed that will be able to readily accommodate the results of the research program in the form of alterations to model structure, formulation of functional relationships, estimation of model inputs, and identification of model outputs important to the adaptive management of pallid sturgeon in the Missouri River system.
Additionally, the previously discussed use of bioenergetics modeling as a separate, but related, approach to describing pallid sturgeon population dynamics in relation to management alternatives should be further pursued. Given the few pallid sturgeon currently thought to inhabit the Missouri River system, an individual-based modeling (IBM) approach should also be explored as a complement to the demographic and bioenergetics models. The IBM approach provides a flexible framework for incorporating behavioral, biological, ecological, and life-history attributes of pallid sturgeon not easily addressed by the demographic or bioenergetics models.

4. Does the monitoring approach described in the AMP adequately address the design, implementation, and staffing requirements for gathering and interpreting data (direct, indirect, and cumulative) in support of resource management in an adaptive framework? If not, please provide specifics and additional comments as appropriate.

The monitoring section of AMPv3 should be further developed in an enhanced level of detail. For the pallid sturgeon, monitoring is mentioned throughout the document, but it is difficult to determine how monitoring will be implemented and who is responsible for monitoring. The ISAP recognizes the difficulties in developing a monitoring program for pallid sturgeon absent well-defined management actions. However, the ISAP realizes that ongoing management actions exist at Levels 3 and 4 that can be integrated into the AMP while waiting for the development of a full Level 3 and 4 agenda. The authors of AMPv3 recognize that a propagation program (and planned actions at Intake) are currently being implemented (or are proposed), but do not include those projects or related monitoring in the AMPv3. The propagation program is a Level 3 action that comfortably fits into the AM process model (see Figure 2) at Level 3 or 4. We realize that Big Question 6 (Upper and Lower) is related to the conservation propagation program; however, the structure of 3.2.6 and 3.3.6 is challenging to follow. It is plausible that current challenges with the conservation propagation program might have been elucidated earlier had the program been structured in an adaptive framework. The current monitoring program for pallid sturgeon (that is, the Pallid Sturgeon Population Assessment Program; PSPAP) is not linked to a specific management action; hence steps 3-5c are not formally assessed for application in a management action. Component 6b provides an example of monitoring that is directly related to a management action, the Intake Project. The ISAP recommends that current Level 3 actions and related monitoring be more explicitly included in subsequent AMP versions.

The ISAP recommends that any monitoring (as defined on page 206) be tightly tied to management actions. The ISAP suggests that the population-trends monitoring ("…a redesign of the Pallid Sturgeon Population Assessment Program," as outlined on page 67 in AMPv3) should only be conducted after monitoring for management actions has been fully funded and implemented. Resources should be dedicated to monitoring that is directly connected to level 3 and 4 actions. Some argue that population-trend monitoring (i.e., surveillance monitoring) has little value unless tied to management actions (Nichols and Williams 2006). The ISAP agrees, and as monitoring is currently defined in section 3.1.1 and page 70, it is likely to provide little value to understanding the response of pallid sturgeon to a management action. There seems to be no relationship between how monitoring is defined on page 206 and how monitoring is used in the pallid sturgeon section. We support the definition on page 206 and suggest that the characterization of monitoring be consistent throughout the document.

The ISAP would advise removing the need for a directed effort at a pallid sturgeon population estimate in the next draft. Redesigning the PSPAP program to estimate abundance is not overly beneficial to the AMP. Although population estimates are of value, the critical information is whether the population is increasing, decreasing, or remaining stable, and this can be adequately estimated using catch per unit effort. Again, we strongly advise that monitoring be directed at addressing research hypotheses and/or management actions as they influence pallid sturgeon population dynamics. We recommend that the authors clearly define terms such as opportunistic monitoring or robust monitoring—we would hope that all monitoring is robust. Finally,

monitoring efforts should be primarily focused on sampling and estimating early life-stage survival given that most of the Big Questions address this aspect of the Missouri River pallid sturgeon population.

The monitoring section for the birds as described in section 2.3 is well thought out and relatively easy to follow. Once management actions have been selected, we expect the authors to present more detail on design and implementation (this may already be in the materials to be provided in Appendix D: Monitoring Protocols). For all species, it is a bit difficult to follow who is gathering the monitoring data related to management actions and who will be interpreting those data. A flow chart that illustrates various agency responsibilities for designing, gathering, and interpreting monitoring data is needed.

Nichols, J. D., and B. K. Williams. 2006. Monitoring for conservation. TRENDS in Ecology and Evolution 21:668-673.

5. Information pertinent to management decisions under the MRRP will likely be drawn primarily from project-specific monitoring and from focused research and directed modeling efforts. Does the AMP describe how such information will be identified and assembled? Does the AMP adequately describe monitoring needs, a data collection agenda, a schedule, and reporting protocols? Does the AMP describe how unanticipated data from external sources can be evaluated and incorporated if appropriate? If not, please provide specifics and additional comments as appropriate.

In draft form, the AMPv3 addresses the broad concepts of monitoring and research. The AMPv3 also addresses monitoring needs, data collection, and reporting protocols (section 5.1). However, for the pallid sturgeon in section 5.1, much of the narrative is related to the current Pallid Sturgeon Population Assessment Program, which is not directly related to evaluating management actions or hypotheses. In the next draft, we anticipate much of the data acquisition, management, and reporting described in Section 5 will be more directly related to monitoring in response to specific management actions. We also encourage that the data analysis for the pallid sturgeon be more structured. That is, we encourage defining a team (with a lead investigator) to conduct the data analyses that are tied to specific management actions (see our response to question 8). The AMPv3 does describe how data from external sources will be evaluated (section 5.2 New Information), and the approach seems logical to the ISAP.

The AMPv3 describes the application of an integrated physical habitat and bird population model for projecting the potential outcomes of alternative management actions. The corresponding capability to model pallid sturgeon population dynamics in relation to management actions has yet to be implemented for the Missouri River. Substantial level 1 and 2 research will be required to develop the needed functional relationships between habitat quality and pallid sturgeon population demographics, particularly for early life stages of these fish. The AMPv3 addresses uncertainties associated with the integrated habitat-bird model and indicates how sensitivity analysis and newly available data and information might help revise and refine the model. The overall modeling framework developed for supporting the management of the bird populations appears compatible in concept with the pallid sturgeon modeling. The ISAP

encourages continued interaction between the two resource modeling groups in ensuring the models are usefully implemented to support the AM program and productive management of the listed species.

6. Does the AMP effectively describe a programmatic capacity for timely interpretation of monitoring data, translation of those data into management-friendly assessments, and information transfer to decision–makers and stakeholders? If not, please provide specifics and additional comments as appropriate.

The AMPv3 describes real-time processing of monitoring data, assessment of those data, and information transfer to decision makers and stakeholders. However, the section is still under development and needs more detail. Specifically, the current structure of the "Data management" (section 5.3) and "Reporting and communication" (section 5.4) sections seems appropriate, but lack the detail to be operational. More detail is needed with respect to scheduling of product deliverables and decisions. Data acquisition, management, and reporting should be focused on management action activities rather than on surveillance monitoring. Section 5 could also be better integrated into the AM process; that is, where and how do data acquisition, management, and reporting fit into the AM process? This seems to be an integral part of the third and fourth step of the AM process as outlined in Figure 2. This approach should be followed for other sections of the document. As currently written, it is difficult to determine how all the sections integrate in a comprehensive AM plan.

7. Does the AMP describe a data and information management plan and demonstrate capacity for communicating information derived from the monitoring, research, and modeling efforts in supporting the evaluation of management actions in an adaptive framework? Will that information be accessible and in forms useable by decision-makers, resource managers, technical advisors, and stakeholders? If not, please provide specifics and additional comments as appropriate.

The AMPv3 includes a chapter (yet to be completed) that outlines data acquisition, management, reporting, and communications. This component is a critical aspect of the AM plan; data management is at the core of the adaptive management process. The AMP must describe in detail the mechanisms that will be used to support standard data collection and storage so that information can be readily accessed, shared, and integrated into decision making. Such a data management program can perhaps best be accomplished through electronic, onsite data capture and centralized data management, as outlined in the chapter. The draft chapter is somewhat general in its initial presentation of the processes for acquiring, managing, and communicating data as part of the overall AM process. Additional detail will hopefully be included as the AMP is revised and data management needs become understood and presented in greater detail. The MRRP does not necessarily have to reinvent the wheel with regards to implementing an effective data management program. Various other operational AM programs exist that have developed online data systems and the features of these should be reviewed for their applicability to the MRRP.

8. A successful adaptive management program for the piping plover and pallid sturgeon will require technical expertise in ecology, biostatistics, hydrodynamics, fluvial processes, decision analysis, and river operations (including an adequate monitoring program for the least tern). Accordingly, does the AMP adequately identify and describe staffing needs, representative expertise, and technical skills that are essential in the design, implementation, and evaluation of management actions within an adaptive framework? If not, please provide specifics and additional comments as appropriate.

The governance and staffing elements of the AMPv3 are still rudimentary, certainly in part reflecting the authors' priorities for the draft document, which at this early stage appropriately have focused on the technical aspects of AM design and implementation. The engagement of outside advisory expertise to contribute to the next draft will help advance the effort against the pressing time line.

The next draft of the plan should describe the participant skill sets and tasking of the Adaptive Management Technical Team, which is the focal advisory body and essential interpreter of best available science and emerging new information for the Management Team and Oversight Team. Establishing the optimal composition and level of engagement for that essential entity is critical to progress toward full implementation of AM. The technical expertise required argues for practicing scientists. The level of engagement might approach a commitment of one quarter to full time (assuming adequate staff support). A balance of agency and outside experts might be viewed as optimal. Combined those criteria may prove challenging to meet.

The ISAP suggests a team approach that utilizes an AM Technical Team leader, a full-time federal employee who coordinates and oversees other part-time team members. The AM Technical Team (or its roles) might include (1) a pallid sturgeon expert (an ecologist with interests in species-habitat relationships), (2) a bird expert (an ecologist with modeling experience and metapopulation interests), (3) a river-process expert (with expertise in fluvial processes and hydrodynamics, and an understanding of how both relate to river operations), (4) a biostatistician, and (5) an expert in population dynamics (not necessarily with experience with the three listed species, but in analytical approaches to population modeling). An additional participant might have applied experience in conservation planning, particularly in translating data and analyses into management prescriptions, using risk (cost-benefit) analyses that include human considerations.

The AM Technical Team will not just be involved in interpreting monitoring data. An ambitious research agenda will accompany management for pallid sturgeon; the team will be involved in developing and prioritizing essential studies. Some tasking to the AM Technical Team may include directing studies that might validate the use of surrogates and proxy measures to assess program performance (addressing issues, such as whether management actions directed to and monitoring of piping plover can serve least tern equally well; or, might combinations of more-readily assessed species or habitat proxies serve as valid surrogates for the performance of the scarce pallid sturgeon, which may not reach even minimalist encounter/sampling rates for many years to come). It seems unlikely that all of the elevated, distinct, and complementary technical skills that will be required of AM team members will be found entirely in the agencies in the Missouri River basin; nonetheless, at least one of the team's participants should be from an

Interior agency and one from ERDC or from the USACE's science staff.

The ISAP acknowledges that the document's authors are tracking the decision and implementation steps for mock AM action scenarios to accrue information on such needs. They have queried the necessary procedural steps in implementing AM in regards to the needs for scientific (technical) input, analysis, and interpretation; translating information into management actions; implementing the action on the ground; assessing its performance; and administrating those and other activities. From that effort, governance and staffing needs are being projected. The ISAP encourages the author group to continue that pursuit, and if it has not yet occurred, draw agency management staff into the effort.

9. What, if any, additional explanation is needed regarding the relationship between ESA (particularly for objectives, targets, and jeopardy) and adaptive management (particularly for pallid sturgeon and the level 1-4 actions)?

Piping Plover

Adaptive management planning for the piping plover is moving forward, but rigorous documentation of the underlying rationale for agency findings, beginning with those in the biological opinions for the species on the Missouri River and extending into the recent derivation of management targets, is lacking. The FWS should move quickly to present a thorough and open explanation of the basis for and analyses and supporting documentation leading to the identification of numerical demographic targets for the MRRP.

Lacking documentation, it appears to the ISAP that the FWS made the jeopardy call with no supporting analyses or model results linking operation of the six Missouri River dams to the "continued existence" of the entire Northern Great Plains population of the piping plover, as required under the Endangered Species Act and directed by the FWS's Section 7 Consultation Handbook. Instead, the jeopardy determination appears to have been based on the unsupported assumption that operation of the dams caused a decrease in available emergent shallow water habitat, a related decline in the average annual number of nesting adult birds on the Missouri River, and a decline in the viability of the entire metapopulation of the species sufficient to cross an unidentified jeopardy threshold.

The RPA in the 2003 biological opinion does not appear to have been based on analyses of the impacts of dam operations on bird habitat or populations, nor of the level of management that would be required to offset those impacts. Instead, the RPA appears to have been linked post-hoc to the results of a GIS analysis of emergent sandbar habitat (ESH) that was available following a prolonged high-flow, sandbar-forming period in the late 1990s. The GIS-based survey, conducted by the Omaha District, indicated that about 12,000 acres of habitat was available in 1998, and that figure was later adopted as the management target, then parsed into the amount of habitat (in acres per mile) that should be required by river reach. Notwithstanding the fact that this approach is not a proper basis for a RPA, the 1998 estimate of available habitat was inaccurate and significantly overstated the amount of nesting habitat that was available to the birds at that time for several reasons (McGarry and Wiley 2004).

The FWS has recently taken a new approach to demographic modeling based on population viability, using the piping plover model constructed for the EA, following procedures described by Buenau (2015). Population viability is the probability that a population will not go extinct within a specified time period. In the Missouri River case, viability criteria were chosen to be a 95% probability that the Missouri River population would not go extinct locally (arbitrarily defined as less than 50 individuals) within 50 years. The Missouri River target for piping plover then is to sustain managed habitat conditions that would support a population with at least a 95% probability of persisting for at least 50 years (in both the upper and lower river). The population viability approach is ecologically sound, and potentially offers the capability to conduct analyses and provide documentation that have been lacking since the initial jeopardy call.

The net impacts of project operations on the plover can be estimated (including confidence limits on the estimate) using the results of the modeling effort conducted by Buenau (2015). An estimate of the impacts of dam operations, however, should be accompanied by detailed sensitivity analyses on model parameters, especially for the ESH model. The ESH model is a statistical model fitted to contemporary river data in the Gavins Point reach, and historic channel morphology and sediment dynamics are outside the domain of observations used to calibrate the model. Thus, predictions about the historic amount of available ESH that occurred on the river, estimates of the impacts project operations on the plover, and species targets based on mitigating the estimated Impacts are subject to large uncertainty. This has been made clear in some model results for the pre-dam, unregulated Missouri River, which predict impossibly high levels of ESH availability and thus appear to exaggerate the estimated impacts of dam operations (Buenau 2015). In that light the following questions should be answered:

1) What amount of sandbar nesting habitat for the piping plover was available under the widely varying annual flow conditions on the unregulated Missouri River before the dams were constructed and operating? What are the confidence limits on the estimated pre-dam availability of sandbar habitat? How does that availability compare to contemporary circumstances (also considering inter-annual variation in flows)?
2) Were impacts of project operations (as estimated by the model analyses above) enough to jeopardize the continued existence of the species as a whole? What are the explicit criteria that must be met for jeopardy of the species as a whole?
3) Why have the specific viability criteria been chosen? Apparently, the specific viability criteria (95% probability of persistence for 50 years) were chosen because they were also used in a recent modeling effort that supports a revised Piping Plover Recovery Plan (see McGowan et al. 2014). However, we note that "avoiding jeopardy" and "meeting recovery criteria" are neither the same policy nor ecological objective. How do these two objectives relate to each other on the Missouri River?
4) Given the specific viability criteria, and the specific numerical targets derived from them, would management plans designed to achieve the targets fully offset the impacts of project operations?

The ISAP emphasizes that the species habitat and population targets developed for the Missouri River based on population viability model analyses should be considered conditional. Whereas the ecological constructs underlying the modeling approach are sound, the actual numerical targets are subject to all the uncertainties inherent in the models used to derive them. As more is

learned in the future, and the models (especially the ESH model) are revised to reflect improved understanding, the targets calculated with the models will likely change. Thus, the AM effort should not be anchored on the initial numerical targets, but should remain open to the need to continually adjust not only targeted management actions, but the quantitative bird and habitat targets as more knowledge is gained and the AM plan moves forward.

Pallid Sturgeon

Similar to the piping plover, the pallid sturgeon was listed and a jeopardy determination was made for operations of the dams on the Missouri River absent summary data or quantitative analysis. Given the pallid sturgeon's apparently dire demographic circumstances (including no evidence of natural recruitment) and unquantified evidence that the dams, reservoirs, and bank stabilization and navigation projects on the river may provide barriers or other impediments to essential early life-stages of the sturgeon, both the listing of the species and the standing jeopardy determination appear to be warranted. That and the knowledge base (from the EA) for the pallid sturgeon considered, identifying quantitative targets for demographic purposes of setting objectives related to Level 3 or Level 4 actions, MRRP performance assessment, or recovery planning is simply premature.

Setting quantitative targets for pallid sturgeon including population size and distribution, and habitat extent, distribution, and condition logically awaits knowledge that will accrue with research and monitoring associated with level 1, 2, and 3 activities. That new information, along with ongoing, targeted research (and inferences from other sturgeon species in similar riverine circumstances), should allow parameterization of models that inform population viability analysis with essential environmental data, including quantified information on the stressors that are thought to be limiting pallid sturgeon. In the meantime, a guesstimate species recovery target, like the 5000-fish target that has been invoked in recovery planning for the sturgeon, have no pertinence to conservation planning under the MRRP and is not supported by the contemporary understanding of pallid sturgeon ecology and genetics. At this point in planning for the sturgeon, an appropriate programmatic conservation target might be recruitment in the wild, combined with evidence of diversifying age structure for the fish in the Missouri River.

Buenau, K. 2015. Modeling to Support the development of habitat targets for piping plovers on the Missouri River. PNNL-24227. Department of Energy, Pacific Northwest National Laboratory, Richland, Washington.

McGarry, M., and R. Wiley. 2004. Interview with U.S. Army Corps of Engineers staff in preparation of the programmatic EIS. David Miller & Associates, Inc., Great Lakes Regional Office, 210 Highland Avenue, Hamburg, New York.

McGowan, C. P., D. H. Catlin, T. L. Shaffer, C. L. Gratto-Trevor, and C. Aron. 2014. Establishing endangered species recovery criteria using predictive simulation modeling. Biological Conservation 177:220-229.

10. Do the 12 'big questions' still allow the 21 hypothesized management actions to be addressed? How would you propose proceeding?

The 12 "big questions" outlined in the Pallid Sturgeon chapter of AMPv3 consist of six questions addressing upper Missouri River pallid sturgeon recovery issues and six questions for the lower Missouri River. These questions represent a condensation and distillation of the 21 "working management hypotheses" presented in the EA for pallid sturgeon.

While it may not have been feasible for the authors to directly incorporate all aspects of the original 21 hypotheses into the 12 big questions, the ISAP did not detect any major omissions of crucial ideas or hypotheses in the 12 big questions as presented. In general, the major factors potentially limiting pallid sturgeon reproduction, recruitment, or population growth are encompassed within the 12 big questions and their detailed descriptions. However, as the management agencies address the 12 big questions with targeted Level 1 and 2 testing, it may be necessary to revisit some of the original hypotheses as new information emerges. The big questions, or the actions associated with them, may warrant modification and adaptation as evidence suggests alternative mechanisms that may limit pallid sturgeon in the Missouri River. That is, the EA, and the management actions that are derived from it, should be revisited as new data and understanding become available.

The AMPv3 does not provide an explicit pathway towards reviewing and potentially resurrecting the original 21 hypotheses. We suggest a periodic (perhaps annual or biennial) revisit of the original EA hypotheses by the adaptive management team and agency administrators, with stakeholder input to ensure that important mechanisms and relationships are not overlooked as AM moves towards Level 3 and 4 actions.

11. A number of the big questions (specific to Level 1 and Level 2 pallid actions) begin with "Can naturalization of the flow regime …" – is that the correct phrasing given what the Level 1 and 2 actions are intended to accomplish? Would there be different phrasing that more appropriately frames the Level 1 and 2 actions?

While the original intent of the AMPv3 was not to focus solely on Level 1 and 2 actions, for pallid sturgeon this focus was the outcome of the current document because of many uncertainties concerning sturgeon responses to actions (cf. birds) and the general limited state of the knowledge on pallid sturgeon ecology. The current AMPv3 explicitly considers "naturalization of the flow regime" in one of the Upper River big questions (#2) and in two of the Lower River big questions (#3 and #4). However, there is also a question specific to spring pulses for both the Upper and Lower River (#1 in both cases), which in some ways is related to naturalization of the flow regime.

Naturalization of the flow regime is a broad concept that, in its literal sense, cannot be accomplished with the current configuration of the river and dams. The concept, however, contains many specific aspects that can, and should, be more precisely articulated. This may include increasing flood stage, decreasing low-flow periods, or extending the duration of high (or low) flows. The AM team recognizes that naturalizing the flow regime is intended to rhetorically

capture these elements, although some more so than others. The EA team and the AM team have carefully considered how different aspects of the flow regime may work in isolation, or in combination with channel morphology, to affect biological responses. As such, it is possible to articulate these big questions more precisely, or potentially to reword it as "manipulation of the flow regime."

The ISAP views "naturalization of the flow regime" as a Level 3 (experimental, if limited in space or time) or a Level 4 (full-scale implementation) action, and in that sense is inconsistent with the remainder of the pallid sturgeon adaptive management plan as currently written. Indeed, the AM plan recognizes that many aspects of the system and the pallid sturgeon need to be better understood before moving on to flow manipulation (e.g., 3.2.2.6 in AMPv3). Flow naturalization has been the subject of considerable discussion by the agencies and MRRIC for many years, and has generally been dismissed as being unrealistic in the current fragmented state of the Missouri River. We suggest a focus instead on "manipulations" of flow that could benefit pallid sturgeon (and potentially birds as well) following detailed assessments of flow requirements with Level 1 and 2 efforts. As in Upper River Big Question #5, we suggest that the phrase "naturalization of flow regime" be modified to "manipulation of flow regime" in subsequent versions of the AMP, followed by a description of the specific elements of that manipulation that may contribute to Level 3 or 4 actions.

12. Is it clear how the AMP defines in-channel and/or off-channel habitat? Is there any biological reason why management actions to develop additional nesting habitat along reservoir shorelines, reservoir bays, or the river banks, in chutes and backwaters, etc., are not viable? Should they be included in the AMP? [Please also review the USFWS letter regarding on-channel and off-channel habitat (anticipated in early September) when responding to this question]

From a biological perspective, all of the nesting habitat types could be effectively created and managed under the AM plan. Moreover, each of the habitat types has unique characteristics that make it a more preferable target of conservation actions under certain climatic and river-flow situations. Further, given future uncertainties (e.g., climate change) we would argue that intentionally conserving and developing nesting habitat in diverse physiographic circumstances is the best strategy to ensure future persistence of the species in the Missouri River basin.

The AMPv3 does not differentiate among different types of nesting habitat for the piping plover and least tern. Three types of habitat need to be considered. *In-channel nesting habitat* is defined as emergent sandbars within the wetted river channel that are completely surrounded by water. All emergent sandbars, however, are not equally suitable as nesting habitat. The bird models recognize one important variable affecting suitability – surface elevation, and they define "available" habitat as sandbar areas with sufficient elevation as to remain exposed during the nesting season. Other important determinants of the suitability of in-channel sites, including sandbar size, proximity to forested areas, and vegetation cover are not currently addressed. Hence, the models likely over-predict the amount of suitable in-channel habitat. *Reservoir nesting habitat* includes exposed, sandy shorelines of system reservoirs. Historically, about half of the plover nesting has occurred on reservoir habitat. *Off-channel nesting habitat* is essentially

all other sandy, sparsely vegetated areas of appropriate extent and habitat signature. Such areas may be adjacent to the river or located within the floodplain associated with scoured-river-bypass areas, oxbows, sandpits, and other disturbed sites. A number of such off-channel sites in the Missouri River basin, which could potentially be managed for the two bird species, were identified in a recent report (U.S. Army Corps of Engineers 2012).

All three of the nesting habitat types could be constructed and managed under an AM plan. Moreover, each of the habitat types has unique characteristics that make it more preferable under certain climatic and river-flow situations. Given future uncertainties (e.g., climate change), we would argue that intentionally developing a variety of nesting habitats is the best strategy to ensure future persistence of the species in the Missouri River basin. The ISAP recognizes that the FWS is focused on creating and managing in-channel ESH using river flow manipulation consistent with their interpretation of the Endangered Species Act. That perspective may be too narrow, as it seems to ignore aspects of plover biology, as well as constraining realities of current circumstances on the Missouri River. First, piping plovers do not show a particularly strong affinity to riverine situations (and in-channel habitat), and historically nest in a variety of other habitats including lakes, reservoirs, alkali lakes and flats, sand pits, and (even) gravel parking lots (Ferland and Haig 2002). Second, modeling in support of the AM plan currently shows that the plover targets cannot be met with flow manipulation alone. Some mechanical construction of nesting habitat will be required. Mechanical construction of in-channel ESH has been shown to be effective, but such constructed sandbars are not a panacea and are beset by certain problems, such that they may be a population sink for Missouri River plovers, especially during periods of declining overall habitat extent and quality. They also can be relatively expensive to create and maintain.

On Nebraska's central Platte River, creation and maintenance of off-channel nesting habitat has been shown to be more cost-effective over the long-term than creation of in-channel habitat. The Missouri basin is physiographically distinct, but the Platte River program demonstrates a potential that should be capitalized on in the Missouri River at this early stage in development of adaptive management. No single management strategy – flow manipulation, mechanical creation of in-channel ESH, creation and maintenance of off-channel habitat – appears to be sufficient alone to meet program targets. More than one management strategy will be required; off-channel habitat should be part of the mix to be considered.

Note: the USFWS letter regarding on-channel and off-channel habitat (anticipated in early September) and referenced in the question above has not been received.

Ferland, C.L., and S.M. Haig. 2002. 2001 International Piping Plover Census**.** U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Corvallis, Oregon. 293 pp.

U.S. Army Corps of Engineers. 2012. Off channel emergent sandbar habitat creation opportunities. U.S. Army Corps of Engineers, Northwestern Division, Portland, OR 97208.

Questions for ISAP Regarding Draft Pallid Targets and Criteria and Level 3 Actions

1. [Additional Context: The timelines provided with the level 3 actions seem fairly short to collect adequate data for some decision making in the highly variable river system.] Do the timeframes for moving from Level 1/2 to Level 3 make sense? Is the logic understandable? Are the risks associated with moving at the proposed pace adequately described?

The timelines may be somewhat optimistic given the natural variability in river ecosystems, the difficulty in surveying for young pallid sturgeon, and logistical constraints associated with conducting research; however, the Level 3 document authors recognize this and stated:

"As knowledge is gained from level 1, 2 and 3 actions, the timeframe for implementation may be adjusted, targets may be changed, management actions may be refined, and hypotheses may be dismissed. The 'rules' by which these decisions will be made are outlined in the decision criteria for the respective management hypotheses, subject to the overarching MRRP governance and decision process laid out in the AM Plan."

The last sentence in the quote above is important because the authors state in the AMPv3 that many of the decisions to move from one level to the next will be based on multiple lines of evidence, which could be interpreted differently by scientists and stakeholders. Establishing firm decision criteria and a well-functioning governance structure is essential to this process.

The authors state that criteria for accepting or rejecting specific hypotheses will be described in Appendix C (not included with the draft document). Appendix C is an essential element because of the likely uncertainties that will accompany Level 1 and Level 2 research results. The ISAP understands that Appendix C will be included with AMPv4. In the Level 3 document, Table 3 assists in describing the decision process to move to Level 3, but the decision to check a box as Yes, Unknown, or No in the table will be challenging without clear criteria that should be specified in Table 2. The ISAP recommends adding metrics and decision criteria to Table 2.

In general, the policy-driven 2-year time frame for implementing Level 3 management actions without a solid basis in understanding of the expected impacts on pallid sturgeon population dynamics (i.e., Levels 1 and 2 research) poses several risks. First, a substantial allocation of resources across multiple management actions might fail to produce any measurable positive impact on pallid population dynamics in the LMR. Second, if monitoring results demonstrate an increase in the size of the sturgeon population, it might prove impossible to determine the relative contribution of individual management actions to the measured increases. Such circumstances would fail to inform the AM program and presumably require continuation of all management actions indefinitely, or at least until better understanding permits the identification and termination of actions that are not contributing to sustainable pallid sturgeon survival and recovery. Third, monitoring results might demonstrate that the combined effects of multiple management actions not only fail to improve conditions for pallid sturgeon, but produce undesired impacts on other desired species in the lower Missouri River. Those circumstances would argue for terminating certain management actions, even if some were contributing positively to pallid sturgeon population growth.

2. Does the proposed parallel approach described make sense for staging the Pallid Sturgeon science components of the plan? Why? Are there aspects of the other approaches considered (surge; sequential) that should be integrated into the preferred approach?

Various approaches may be necessary to arrive at Level 3 implementation; as was mentioned in a recent webinar call, any one approach might not fit all Big Questions. For example, if it were thought that one Big Question was more important in terms of immediate science needs than another one, then the surge approach might work for that Big Question, and a sequential approach might be appropriate for another Big Question. In addition, the approach might be based on science needs, such that for a particular Big Question, planners must address one hypothesis before moving on to the next hypothesis, thus a sequential approach would be most appropriate. The ISAP encourages the authors to reevaluate the Level 1 and 2 approach to the Big Questions and propose a surge, sequential, or parallel approach for each Big Question along with a justification for the selected approach.

Constraints and tradeoffs should be considered in that evaluation. Given the current level of understanding of pallid sturgeon population dynamics in the Missouri River, a parallel approach may be sensible for addressing the multiple potential population bottlenecks. The separate effects of velocity, substrate, and turbidity on spawning behavior can be addressed in parallel studies. Evaluation of channel (habitat) characteristics that contribute to food production or opportunities for interception of young fish can be similarly addressed independently. The large number of unquantified relationships between key factors that influence early life stages and subsequent pallid sturgeon population dynamics suggests that a sequential approach would require more time than might be available to sustain the fish in the Missouri River (absent a stocking program). A surge approach seems to imply a greater, more immediate level of effort than could be implemented in either a parallel or sequential approach. The efficacy of a surge would depend mainly on the near-term (e.g., 1-5 years) commitment of resources and availability of necessary researchers in performing the proposed studies at an accelerated pace.

3. Are the decision criteria as included in the level 3 actions document adequate to implement the AM plan? Are "lines of evidence" adequate decision-making criteria? Does the AMP adequately lay out criteria by which it will be determined if additional data or monitoring is needed to support decisions to start, stop, or adjust experimental or management (level 1-3) actions?

Decision criteria are described in general terms in the Level 3 document. Quantitative metrics and decision criteria remain to be specified (see Table 2). Given the degree of generality in the document, it would be difficult to implement an AM plan at the current time. The adequacy of the "lines of evidence" approach to decision-making depends upon the quality of the scientific information underlying the various lines of evidence. In practice, this approach often includes some lines of evidence that are based on defensible science and other lines of evidence that reflect current professional judgment. To the extent that various contributing lines of evidence are primarily based on professional judgment, the utility and reliability of this approach is diminished.

The AMPv3 well describes the AM process for using decision criteria and the results of monitoring programs in relation to starting, modifying, or ending management actions. However, without specific management actions developed for implementation, it remains difficult to specify detailed quantitative decision criteria and the corresponding specific decision-making processes that are fundamental to adaptive management.

4. Are the level 1-3 actions appropriately described in a scientific and sequential manner to provide for an understanding and decision making path forward?

The Level 1-3 actions are usefully described in relation to their possible contributions to a sustainable pallid sturgeon population in the lower Missouri River. The criteria specified in Table 3 of the Level 3 document define a path forward regarding decisions for implementing Level 3 management actions. If all five questions are answered affirmatively, it appears that Level 3 implementation would be "scientifically justified." However, if the answers to either question 1 or 2 are "uncertain," the Level 3 implementation may be justified in terms of policy related to avoiding jeopardy. The implicit hypothesis is that Level 3 and Level 4 implementation of the proposed management actions will have a positive impact on pallid sturgeon population dynamics in the lower Missouri River. However, without compelling Level 1 and 2 results supporting the proposed actions, it is possible that Level 3 implementation, while avoiding jeopardy purely on a consensus policy basis, will have no measurable positive impact, apart from the stocking component, on the pallid sturgeon population in the lower Missouri River.

It is possible that achieving a self-sustaining pallid sturgeon population is not possible under current operations of the lower Missouri River supporting navigation, flood protection, hydropower, and other human uses. Implementation of AM may not guarantee a viable, persistent pallid sturgeon population, absent an ongoing stocking program.

5. The level 3 actions document seems to be focused on a need to attract PS to the reach below Gavins Point Dam for successful spawning and recruitment. Is this a valid focus for the AMP?

The Level 3 document indicates that the location and distribution of spawning habitat remains poorly characterized for the lower Missouri River; a focus on the reach below Gavins Point Dam is not particularly evident in the document. The discussion of Gavins Point Dam in both the AMPv3 and the Level 3 document relates primarily to the manipulation of spring flows or water temperature as potential cues for fish aggregation and spawning. A potential justification for focusing on reproductive success in the upper reaches of the lower Missouri River is that embryos produced farther upriver would be more likely to remain in the Missouri River rather than being transported to the middle Mississippi River, depending on flow conditions. And, the role of the Mississippi River in providing rearing capacity for pallid sturgeon that might later migrate into the lower Missouri River to mature and reproduce remains unclear. If that capacity is high, then suitable spawning habitat in most locations on the lower Missouri River could provide valuable contribution to pallid sturgeon recovery.

6. Related to question #10 for the AMP v3, are the Big Questions and Components designed from a species need perspective?

The Big Questions and Components do address the prevailing hypotheses concerning factors potentially limiting and contributing to recruitment and population growth of the pallid sturgeon, while recognizing the considerable uncertainties surrounding limiting factors for pallid sturgeon in the modified Missouri River system. The major hypothesized demographic bottlenecks for pallid sturgeon – including spawning habitat and cues, larval development and feeding, and survival to reproductive age – are addressed in the Big Questions for the upper and lower river. No attempt is made in the AMPv3 to prioritize these questions, and one could argue that the sole currently effective action – population augmentation via stocking – should lead the questions rather than trail each set of Big Questions. The ISAP is mindful the pallid sturgeon in the Missouri River must be sustained by effective propagation in order for other actions to elicit positive population-level responses in the near- and far-term, with the eventual goal of a self-sustaining wild population.

The Big Questions and Components in the AMPv3, as well as the Level 3 document, focus primarily on the spawning success, survival and growth, interception, and recruitment of early life stages – all key components in fostering a self-sustaining population of pallid sturgeon in the lower Missouri River. Species needs in relation to these potential bottlenecks in population dynamics are identified and described qualitatively in relation to pallid sturgeon success. However, as emphasized in the documents, much uncertainty remains in quantification of the requisite contributions of these individual species needs in achieving a sustainable population. Because of the underlying uncertainties, substantial Level 1 and Level 2 activities are outlined to address each of these potential population bottlenecks, while Level 3 implementations are advocated where currently sensible.

7. Related to question #11 for the AMP v3, are the hypotheses formed around a "natural flow regime" valid in the highly modified Missouri River or in the best interest of the species; or, should the AMP be attempting to identify habitats, flows, timing and location of flows that will best benefit the species in the modified environment?

As stated in our response to Question #11 for the AMPv3, the ISAP suggests an adjustment to the notion of a "natural flow regime" or "naturalization of the flow regime" in the highly altered Missouri River system. A natural flow regime is clearly not attainable within the current fragmented river. Instead, the ISAP favors terminology such a "manipulated flow regime" or "manipulation of the flow regime," which could be achievable within the Missouri River with timed dam releases or flow withholding. The notion that flows can replicate pre-dam construction conditions is not realistic in the current river state. Furthermore, and importantly, pallid sturgeon are spawning in the Missouri River under the current managed flow regimes, suggesting that necessary spawning cues are occurring. Rather than focusing on a manipulated flow regime from Gavins Point Dam, the ISAP suggests focusing on other hypotheses first to determine if they may be most appropriate for Level 3 consideration.

8. Relatedly, does the AM plan rely too heavily on flows rather than on what the pallid needs from that flow?

These two aspects of the Missouri River system – flows and pallid sturgeon needs – are complex and intertwined. The flow needs of pallid sturgeon are imprecisely known at all life stages, therefore considerations of flow manipulations to benefit pallid sturgeon are now based on imprecise knowledge. Pallid sturgeon evolved in the natural, highly variable flows of an unmodified Missouri River system, hence it is logical and appropriate to consider the flow needs for different life stages of pallid sturgeon, and to attempt to recreate or simulate some aspects of those flows (albeit in a modified system where the historical flow regime is not reproducible) that can potentially benefit the species.

The AMPv3 emphasizes flows, not surprisingly because flow manipulations constitute one of the available management actions in addition to habitat construction. Yet, the AMPv3 recognizes that beyond determining current velocities and water elevations, the effects of managed hydrodynamics are primarily important in relation to habitat formation and provisioning. The AMPv3 and the Level 3 document describe posited relationships between hydraulic variables and quality of spawning habitat, as well as the formation of interception, food producing, and foraging habitats – all potentially important in contributing to a sustainable pallid sturgeon population in the LMR.

9. Is the terminology "channel reconfiguration", which is not defined, appropriate or should the AMP be identifying habitat types needed for successful spawning, development, nursery, and food supply in the lower Missouri and Mississippi Rivers?

The ISAP views the term "channel reconfiguration" as referring to a suite of in-channel modifications and enhancements designed to benefit the listed species. In the case of pallid sturgeon, the term is used to describe (1) construction of adult spawning habitat, and (2) construction of shallow water habitat (SWH) as food-producing and foraging habitat, and (3) construction of off-channel habitat (e.g., chutes or other slow waters) for larval retention and development. The latter two components are collectively termed "interception and rearing complexes" (IRC) because of their dual purposes of retaining larvae to the exogenously feeding stage, then providing suitable rearing and foraging habitat during age-0. The AMPv3 and Level 3 document should be more precise regarding what specific "reconfiguration" is being considered, in which scenario, and at what location. In some cases, it is unclear where or how geomorphic adjustments will be made in the channel, along with the expected responses by the species, at which life history stage.

10. Is the minimum and maximum scope of level 3 actions described in terms of the best available science?

The Level 3 document states (p. 6) that "Requirements for level 3 were developed collaboratively by the USACE and USFWS and reflect both best available science and policy considerations." The Level 3 document further describes each of the four level-3 actions (as

listed in Table 4 with minimum and maximum scope), and provides varying degrees of technical and policy justification and support for the maximum and minimum scope presented for each management action.

The Population Augmentation section presents the Action Description without supporting explanation of theory, why augmentation is needed, or other justification – although perhaps these omissions are implicit in the Objectives discussion or the Decision Criteria section. The stocking rate and target number of stocked fish is intended to ensure a 95% probability of persistence over a 50-year period. This persistence probability cannot be addressed through monitoring in any practical or useful AM program. An alternative approach to evaluating the probability of persistence lies in applying the available population models in a manner that parallels the bird-extinction probability modeling. Yet, without compelling Level 1 and 2 understanding that permits formulation of the effects of the proposed management actions on corresponding pallid sturgeon population model components (e.g., early life stage survival, fecundity, spawning behavior, bioenergetics, etc.), the ISAP wonders how the necessary modeling studies will be performed? For example, the recovery plan identifies 5000 individuals per management unit as a desired objective towards obtaining a self-sustaining population (although see the answer to AMPv3 question 9 for an opinion as to the validity of that figure for pallid sturgeon). It would be informative to know if the current population model projects a quasi-stable state or increasing population sizes over the 50-year planning period when initialized with 5000 individuals and stocking rates set to zero. This modeling need emphasizes the importance of obtaining the necessary information from Levels 1 and 2 studies of early life-stage vital rates for pallid sturgeon as quickly as practicable.

The Interception Rearing Complex action references functional definitions from the EA in its Action Description, and lists Associated Hypotheses and includes several Objectives and Metrics, but there is little direct scientific justification for the values listed. Page 11 states "Long-term (Level 4) targets will be based on bioenergetics requirements of the Missouri River pallid sturgeon population. Lacking the ability to reliably establish those needs at present, Level 3 targets for IRC are to be based on the rate the Corps has demonstrated that they can create shallow water habitat (SWH)." The SWH will essentially be characterized as acre-days/year with an emphasis on the June – September time period. The AMPv3 would benefit from a clearer description and discussion of acre-days/year as a metric. It remains largely unknown if this Level 3 implementation will prove sufficient to meet the bioenergetic needs of free embryos. Yet, it would seem that the bioenergetic needs of free embryos could be at least approximated using the currently available bioenergetics model for pallid sturgeon. Even initial estimates as part of a Level 1 or 2 experimental study would seem possible within a time frame that could inform Level 3 implementation. In addition, presumably free embryos are classified as age-0 individuals, and the IRC discussion should refer to survival to age-1.

The Spawning Habitat action initially discusses a Hypothesis followed by a combined Description and Objectives section and a Decision Tree. No justification is offered for the minimum of 3 spawning patches, and the "see decision tree" directive in Table 4 for the maximum gives only a general idea of the process by which maxima may be developed. The authors state that Level 3 targets for spawning habitat may be beyond the 15-year timeline of the planning process. This might be the state of the science, but it could be stated and described

more clearly. The current understanding of spawning habitat precludes development of Level 3 targets for that management action. The Level 3 document describes competing hypotheses (e.g., insufficient high quality habitat versus too much poor quality "confusion" habitat) and outlines habitat metrics and detailed monitoring of fish behavior to be examined in relation to those hypotheses. The ISAP has some concern that the proposed technologies required for detailed observations of spawning behavior cannot be developed and successfully deployed to provide the necessary information to evaluate the hypotheses. It would seem critical to develop quantitative relationships between availability of high-quality spawning habitat, successful spawning, survival, and recruitment to a self-sustaining population to justifiably identify Level 3 and 4 targets for spawning habitat.

The Spawning Cue Flows action presents a hypothesis without compelling technical support. Table 4 describes an uncertain scope, to be refined with additional modeling. The Action Description of bi-pulse flows and frequency is very detailed, but without readily apparent scientific justification. Presumably the detail is for the benefit of the NEPA analysis. At the same time, while detailed, the progression of flow releases is presented in a manner that is difficult to understand. The Timeline described does allow for further assessment of functional spawning habitat and for habitat and propagation efforts to enhance potential success of spawning cue flows. However, the detailed description and discussion of the Level 3 managed releases from Gavins Point Dam do not articulate the underlying understanding of the relationship between spring pulses (magnitude, temperature, timing, duration) and pallid sturgeon recruitment. It remains unclear whether the pulse magnitudes, determined mainly by considerations for navigation and flood protection, affect recruitment success. The effectiveness and efficacy of managed flows from Gavins Point Dam in relation to pallid sturgeon spawning has been reviewed previously by the ISAP in 2011. The ISAP notes again that the observation that pallid sturgeon are spawning under the currently managed flows suggests that such proposed managed pulses likely are not be necessary to stimulate pallid sturgeon spawning in the lower Missouri River.

As the Level 3 document becomes integrated with anticipated revisions of the AMP, the ISAP recommends that the presentations of these potential Level 3 actions be better standardized and the scientific justification, including uncertainty, be clearly articulated. How that uncertainty will be reduced with ongoing Level 1 and 2 actions should also be detailed. Perhaps much of that information will be presented in the forthcoming Appendix C.

11. Are the pulse flow criteria described in terms of the best available science?

The pulse flow criteria are presented in great detail. However, the Level 3 document does not present the underlying information that was used to prescribe the selected temporal patterns or magnitudes of releases from Gavins Point Dam. The releases appear to be guided mainly by the flows needed to permit navigation throughout the lower Missouri River and by flood targets. The prescribed magnitudes of specific releases seem not to reflect previous evaluation – including by the ISAP in 2011 – of the efficacy of spring pulses from the Gavins Point Dam in providing pallid sturgeon spawning cues. The document indicates that sensitivity analyses of the pallid sturgeon and bird population models will be used to evaluate the potential implications of

planned releases on the fish and birds. However, no mention is made of how a modeled relationship between flows and any aspect the pallid sturgeon model will be developed. The Level 3 document does underscore the uncertainty associated with that management action and addresses the interrelationship between planned releases and the availability of quality spawning habitat, as well as possible food limitation, in determining the likelihood of ascertaining spawning success in relation to the releases.