Missouri River Recovery Program
Independent Science Advisory Panel (ISAP)

ISAP Evaluation of the MRRMP AM Plan Version 5

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Missouri River Independent Science Advisory Panel
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Missouri River Independent Science Advisory Panel:

Steven Bartell, Ph.D.
Highwood, Inc., Greenback, TN

Adrian Farmer, Ph.D.
Wild Ecological Solutions, Fort Collins, CO

Will Graf, Ph.D.
University of South Carolina

Christopher Guy, Ph.D.
U.S. Geological Survey, Montana State University

Gary Lamberti, Ph.D.
University of Notre Dame

Dennis Murphy, Ph.D. (Chair for this evaluation)
University of Nevada, Reno

Third Party Science Neutral:

Robert Turner, Ph.D.
Oak Ridge Associated Universities, Oak Ridge, TN

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Preface

This report presents the findings and recommendations of the Missouri River Recovery Implementation Committee (MRRIC) Independent Science Advisory Panel (ISAP), a team of six scientists selected for their expertise in pallid sturgeon biology, piping plover and least tern biology, conservation biology, riverine ecology, river hydrology/geomorphology, quantitative ecology, and the use of those sciences in decision making. The independent expert panel was selected by the Third Party Science Neutral (TPSN) with input from MRRIC, and was instructed to conduct its business according to procedures outlined in the "MRRIC ISAP Approach Structure Ground Rules."

At the request of MRRIC, the panel evaluated the "Developmental Draft Version 5 Science and Adaptive Management Plan" (hereafter the AMP) dated May 2016, including its extensive appendices and attachments. These documents describe the most recent iteration of an evolving AMP, which along with an accompanying Environmental Impact Statement, will be an integral part of the Missouri River Recovery Management Plan (MRRMP) for management of three listed species, the piping plover, least tern, and pallid sturgeon, under the Endangered Species Act.

The charge to the panel was developed by the MRRIC Science and Adaptive Management (SAM) Work Group including the lead agencies and in coordination with the TPSN. Panel members discussed their ideas among themselves and had a scientist-to-scientist call for clarification questions with the AMP lead authors. They divided writing tasks and answered the charge questions according to their expertise with each question. Panelists then read, aggregated, commented on, and revised each answer to the charge questions. The TPSN reviewed later drafts, asked clarifying questions, offered suggestions, and provided an initial edit of the draft report delivered to MRRIC July 25, 2016.

This final report represents the understanding and recommendations of the six independent experts as they apply to the May draft of AMP version 5 and benefits from feedback received at the August MRRIC meeting, as well as written comments received subsequent to the meeting. The panel recognizes that work on the next iteration of the AMP is ongoing and that some of the observations and suggestions herein have already been addressed.

The ISAP looks forward to further discussion of anticipated additions to the AMP with the SAM Work Group, the Plan Development Team, and MRRIC as a whole. Findings and recommendations presented herein are generally agreed to by all of the ISAP panelists.

Robb Turner, Third Party Science Neutral
September 1, 2016

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Introduction

This report to the Missouri River Recovery Implementation Committee's (MRRIC's) Science and Adaptive Management Work Group responds to questions intended to probe the penultimate draft of the *Science and Adaptive Management Plan* (AMP Developmental Draft Version 5) in development under the Missouri River Recovery Program (MRRP) as part of the Missouri River Recovery Management Plan (MRRMP). This is the third formal review of interim drafts of and products from the AMP. In previous reviews, the ISAP has been largely affirmative (and complimentary) in its assessment of the Adaptive Management Team's work products. To the extent previous input included pointed criticisms or suggestions for additions to draft materials, the AMP's authors have responded with revisions in subsequent drafts. ISAP reviews of previous AMP drafts have combined with informal exchanges with the authors of the AMP, scientist-to-scientist exchanges on technical matters, and over-the-phone discussions facilitated by MRRIC have brought the ISAP to this AMP evaluation. The AMP thus has been the subject of extensive, iterative review, which has focused on the "science" elements of the document and the nexus of science, resource management, and policy under the MRRP.

The programmatic scientific review process, which began with ISAP input into the development of conceptual ecological models and then a series of products in support of effects analysis for the two listed species – the pallid sturgeon and piping plover – has extended over a period of nearly three years. The ISAP can state that the current draft AMP meets the criterion of having been informed by the best available science and has effectively employed prevailing methods, tools, and professional standards of practice in conservation planning for riverine ecosystems. The Adaptive Management Team authors of the AMP and their colleagues have met the challenge of delivering a plan for managing operations on the Missouri River to avoid jeopardizing species protected under the Endangered Species Act that can be described as based on defensible science. Importantly, the AMP describes an implementation scheme and governance structure that can facilitate science-based river management in an adaptive framework.

As conveyed to the AMP authors (and to MRRIC) in reviews of earlier drafts of the plan, the AMP document cannot provide too many specifics or too much detail. At the same time, the ISAP has tried not to request endless descriptions and clarifications of AMP process elements and implementation details that can only be more fully developed as adaptive management and conservation actions are implemented. Effectiveness-monitoring programs, essential to successful adaptive management, cannot be fully described until specific management actions and protocols are selected and designed. The ISAP appreciates that considerations of human uses of the Missouri River and its resource values will be added to the current document, and that certain plan attributes cannot be fully delineated until an action-plan alternative is selected from among options in the ongoing NEPA process. Like the management agenda that the draft AMP describes, the plan itself will need to adapt in response to changing circumstances, which range from unpredictable effects of the dynamic Missouri River environment to uncertainties in future federal budgets. The AMP will remain an evolving document, growing and accommodating to

new "scientific" information and responding to constraints imposed by human considerations, many of which cannot yet be anticipated.

Similarly, the current draft of the AMP does not (cannot) address every issue in adaptive management that is informed by science. In addition, not all of the scientific support for the draft AMP is presented in this document. Most of that material is presented in a series of reports to the MRRP from the Effects Analysis teams. The quality of the science is demonstrated in multiple products and tasks in the program deliverables that preceded this latest version of the draft AMP. Combined with those earlier scientific deliverables, the ISAP has concluded that the AMP is consistent with state-of-the-art conservation planning principles by

- Evaluating multiple management hypotheses with data and models;
- Integrating science into the design of alternative management scenarios;
- Acknowledging the uncertainties that challenge resource management planning and incorporating directed investigations into the adaptive framework;
- Incorporating structured decision making into a risk assessment process that brings human considerations into management decision-making; and
- Anticipating governance needs for implementing science-based adaptive management.

The ISAP knows of no other adaptive management program that has that full suite of important plan attributes. In incorporating reliable knowledge into transparent decision-making, the *Science and Adaptive Management Plan* provides a new model for future conservation planning efforts in this country.

With the pending completion of the Missouri River Recovery Management Plan including the AMP and draft Environmental Impact Statement, the role of science in the MRRP enters a next stage. Whereas science has informed management planning for listed species on the Missouri River, science will be used subsequently to help implement and assess management actions. The ISAP observes that it might be natural to expect the role of science to be sustained from program planning into program implementation. However, in other attempts at adaptive management, science has frequently been a casualty to agency prerogatives as management decisions find distance from the expertise engaged in planning phases. Individual research agendas may gain political favor, ecosystem indicators and response variables might be chosen for expediency rather than their value as proxy measures, and understanding of the species-habitat relationships may default to professional judgment.

Defensible science has informed this precedent-setting Adaptive Management Plan. Participants in the MRRP, particularly those in the MRRIC process, need to keep science as a focal point of the program. Limited budgets will force hard decisions regarding program priorities. In addition, there will be continuous, understandable pressure within the implementing agencies to default to the best judgment of staff and to manage by assertion rather than by deduction. When the leaders of the extraordinary team of scientist authors who crafted this AMP head elsewhere to meet their next challenge, a need will emerge for the in-basin agency staff, MRRIC, and its advisors to assure that science continues to light the pathway to new and more effective management of the Missouri River, its imperiled species, and the ecosystems upon which they depend. The ISAP is

encouraged by what it sees in this latest AMP iteration, but cautions that the organizational structure and processes that will be needed for successful adaptive management of the listed species still require further development and implementation.

Question 1 – A recent review of judicial decisions of adaptive management plans (Fischman and Ruhl 2016[1]) reveals a number of resource agency practices that the federal courts frequently find deficient. Does the draft AMP adequately address three common shortcomings – (1) failure to establish objectives or failure to describe monitoring protocols for a plan or project; (2) failure to define decision thresholds in monitoring; and (3) failure to identify specific actions that will be triggered when thresholds are crossed – that recur in adaptive management plans that have been remanded back to the agencies that generated them?

(1) The courts have overturned agency plans that fail to establish objectives or to effectively describe monitoring protocols. An unambiguous statement of the overall objective of the adaptive management program and the monitoring components that support it is crucial to success.

The AMP clearly defines an overarching objective of the Missouri River Recovery Program (MRRP; and by extension the AMP) in section 1.1.3. "The purpose of the MRRP is to enable the Corps to operate the Missouri River System… in accordance with the Missouri River Master Water Control Manual, to meet its authorized purposes without jeopardizing the continued existence of three species: piping plover, least tern, pallid sturgeon listed under the Endangered Species Act." Sections 1.1.4 and 1.1.6 more specifically describe the rationale for, general content of, and relationships among the Effects Analysis, Missouri River Recovery Management Plan (MRRMP), and associated Environmental Impact Statement, all of which underpin the AMP. Section 1.1.5 aptly lays out concepts and principles "…that serve as a foundation for the MRRP AM Plan." Sections 1.3.1 and 3.1.1specify objectives and sub-objectives for the birds, and Sections 1.4.2 and 4.1.1 do similarly for the pallid sturgeon. The ISAP observes that the AMP identifies programmatic objectives. Furthermore, the AMP recognizes that uncertainties in the knowledge base for the birds and the pallid sturgeon likely will necessitate the need to revisit specific objectives or sub-objectives, and describes in its governance process how that need may be addressed as the program unfolds.

The AMP describes in considerable detail monitoring protocols for the birds, including protocols used in the past and potential needs for improving them in the future (section 3.3.2). As outlined in that section, research conducted by the USGS and others has suggested modifications to current piping plover monitoring protocols to better account for known spatial and temporal variability in numbers of individuals. These issues will require the attention of the Technical Team. As adaptive management is implemented, the Technical Team will address foundational monitoring questions, including which population parameters to measure and where the sampling

[1] Fischman, R.L. and J.B.Ruhl. 2016. Judging adaptive management practices of U.S. agencies. Conservation Biology. doi: 10.1111/cobi.12616.

should be conducted. The Technical Team will also refine and develop specific aspects of bird management and monitoring, with adjustment during the run-up to the implementation of the AMP and during the early phases of implementation.

Given the knowledge gaps and data limitations inherent in the Pallid Sturgeon Framework, combined with its focused effort to confront management-relevant hypotheses through Level 1-4 actions, a fully dimensionalized monitoring scheme for pallid sturgeon is not yet available. The directions that monitoring for pallid sturgeon will take once Level 3 actions are implemented can be inferred from the monitoring approaches that are well described for Interception and Rearing Complexes (IRCs, section 4.2.6.3.4). Management actions also are described for the Intake Diversion Dam bypass and for pallid sturgeon propagation, but so far no formal monitoring plans are described for these activities. The AMP will require a fuller list of monitoring parameters for the pallid sturgeon as knowledge gaps are filled and management actions are better defined.

The ISAP concludes that monitoring components of the plan are generally well defined for the birds, along with a plan for needed improvements. Because of knowledge gaps regarding habitat requirements for the pallid sturgeon, many existing monitoring protocols will need to be improved and new ones identified to monitor and adapt management actions that are yet to be identified. The ISAP is encouraged by the planning for Level 1 and 2 investigations evident in Appendix C and by the monitoring protocols that have been identified for evaluation of IRC effectiveness.

(2) The courts have remanded adaptive management plans that fail to clearly define decision thresholds in monitoring. As monitoring data accrue through time and reveal fluctuations in the operation of the system and changes in the status of the listed species, operators will have to determine if the indicated changes are part of an acceptable state of system operation.

Decision thresholds, or targets, are defined for the birds (AMP section 3.2.3) as total area of available habitat, and specifies that those targets are to be met for at least 3 out of 4 years, with the median available area equaling or exceeding a specific number over a running 12-year average. The AMP explains that the approach to monitoring piping plovers and least terns should lead to more specific measures of available habitat for the birds and demographic characteristics of the bird populations.

A large-scale and long-term target or threshold has been identified for augmentation of pallid sturgeon populations through stocking of hatchery-raised fish in the lower Missouri River. This augmentation is to continue until the following criteria are met for each pallid sturgeon management area: a fish population of 5000, and the threat of extirpation as evaluated by model calculations is no more than 5% over a 50-year period (AMP section 4.1.1). The AMP recognizes that shorter-term targets and thresholds are needed for the sturgeon, but these are still to be identified based on the outcomes of Levels 1-3 actions yet to be completed. AMP Table 7 and section 1.4.3 define a timeline within which certain management actions are to be initiated if results of those investigations are inconclusive.

(3) The courts have overturned agency plans that fail to identify specific actions that will be triggered when monitoring data show that a threshold has been crossed. Adaptive management

requires that monitoring schemes identify individual parameter values to be defined and serve as thresholds; if monitoring results show that those parameter values cross the pre-determined thresholds, adjustments in operations are made.

Chapter 3 presents measures for the birds, in each case leading to a corrective measure including managing reservoir water levels or releases of flow from dams. For example, in support of the overall objective of avoiding jeopardy for continued existence of the birds and of the more refined sub-objective of maintaining a distribution of the birds across four geographic areas while accomplishing the purposes of the river operations, the AMP defines target values for the surface area of Emergent Sandbar Habitat (ESH). The target values must be met for three out of four years (AMP 3.2.2), an arrangement that permits some flexibility to account for variation in effects not directly related to the MRRP effort. Failure to do so would represent a crossing of a critical threshold, and would trigger the specific response of constructing additional ESH (AMP 3.2.31) and/or implementing habitat-forming flows from dams (AMP section 3.2.4.2). These potential flows are currently under evaluation, so that their final exact specifications are not yet available. Knowledge about the connections between bird populations and ESH is adequate to support river management decisions.

A decision tree (Figure 59 in Chapter 4) shows potential management responses to crossing qualitative thresholds for pallid sturgeon (modified from the work of Jacobson et al., in press). The plan shows hypothesized management options that could be triggered to improve conditions for the fish (AMP section 4.1.2). Examples of potential remedial management actions include decreased discharges from Gavins Point Dam to create lower flow velocities, manipulated releases from dams to alter flows and temperatures to influence reproductive cues for the fish, and reconfiguration of the river channel to increase food-producing and foraging habitats. Specific quantitative thresholds or targets are not yet known for the pallid sturgeon; the AMP and investigations described for the Pallid Framework are designed to identify management actions and targets, and provide indicators that eventually can be monitored to support adaptive management of those actions with those targets or thresholds.

The operational heart of the AMP is its governance structure, and the AMP uses one quarter of its pages to define the form and processes of this structure, explaining how the governance will work under predictable circumstances. The AMP might describe mechanisms for addressing environmental phenomena that are exceptional and inevitable, but unexpected in the near term. It might address the truly major surprises: what happens and how do the agencies respond to a large-magnitude 500-year flood (that is, 0.2% chance of occurring) with its immediate management implications, or a long-lasting event, such as a10-year mega-drought, which would present an expanding and intensifying challenge necessitating novel management approaches? Can the proposed governance hierarchy respond effectively and efficiently to mega-phenomena (or low frequency, high consequence events), and how will emergency responses be introduced into the adaptive management framework?

In summary, the ISAP finds that the AMP establishes an overall objective and some sub-objectives. The primary objective is to avoid jeopardizing the existence of the listed species while at the same time operating the river according to the Master Water Control Manual. The ISAP also finds that the AMP defines some decision thresholds for monitoring parameters, and

that the AMP specifies some actions that decision makers must take in the event that system measurements cross thresholds as defined in terms of critical values of the monitoring parameters. The ISAP and the authors recognize that more work is needed on sub-objectives, decision thresholds, appropriate monitoring parameters, and actions to be taken if decision thresholds are crossed.

Question 2 – Does AMP version 5 describe in useful detail a programmatic monitoring approach in support of adaptive management on the Missouri River that is sufficiently rigorous to detect potentially ambiguous signals of project performance and subsequently provide actionable information to guide adaptive management?

The success of the AMP depends directly on monitoring efforts that must be able to discern the effects of management actions on the listed species against the background of inter-annual variation in key environmental attributes of the Missouri River. Chapter 3 outlines the basic physical and biotic factors and the population parameters that require measurement in support of adaptive management for piping plovers; these include reservoir (water) levels, the condition and extent of emergent sandbar habitat, piping plover demographic variables, and management-action variables. The factors that must be considered in designing and implementing an effective monitoring program are identified, but many essential technical details concerning the monitoring design are not yet described in the AMP. Piping plover population parameters – including surveys of adult numbers, nest fates, and numbers of hatchlings and juveniles – have been monitored annually since 1993. However, a number of technical issues with plover monitoring protocols have been identified in recent research conducted by the USGS. The AMP describes options for responding by modifying plover monitoring protocols. The basic problem with past monitoring protocols seems to have been the inability to account adequately for detectability, because not all piping plover individuals are detected, and the proportion of individuals not detected varies temporally, spatially, and with life stage. The AMP outlines some optional protocols that would minimize the detection bias, as well as produce data that may be useful for refining life parameter values in the plover demographic model.

The monitoring section on pallid sturgeon (section 4.4) is improved from previous drafts of the AMP, and the monitoring outlined in Appendices D and E are valuable additions to the plan; however, much work remains to be done to develop a monitoring scheme for all aspects of pallid sturgeon Level 1-3 actions in order to produce results that relate to the decision criteria and can direct management actions. The monitoring plan for IRC in Appendix E serves as a model for the other proposed actions and actions that will emerge from the Pallid Sturgeon Framework. The AMP describes overall program objectives and identifies metrics that will be used to assess the objectives; however, it is unclear if targets have been agreed upon by the agencies. That is, the programmatic targets in section 4.1 are described as to be determined, but subsequent text offers narrative that describes targets.

Nested within the programmatic objectives, metrics, and targets is the Pallid Sturgeon Framework (section 4.2.1), which includes a subset of objectives, metrics, targets, and monitoring criteria (found in appendices D and E). Given the uncertainty with regard to factors that influence pallid sturgeon recruitment, the Pallid Sturgeon Framework is to be used to

conduct research (Level 1), field-scale experiments (Level 2), actions intended to elicit a population response (Level 3), and full implementation of actions (Level 4). It is within this framework that much of the monitoring for pallid sturgeon is described in detail, primarily for Levels 1-3. Monitoring and assessment is further subdivided into Implementation, Process, and Population (see section 4.4; Appendix D, section D.1.3). Implementation Monitoring adds complexity to the monitoring, such that it is unclear what the targets or decision criteria are for that type of monitoring. Furthermore, the metrics are not explicitly defined in quantitative terms; for example, a metric for Intake Dam Implementation Monitoring (section 4.4; Table 44) is "safe upstream and downstream passage of adults." How will that goal be quantified and will decisions be made based on Implementation Monitoring? That is, will they be held to the same scrutiny as the decision criteria presented in Table 46? As stated in section 4.4, Implementation Monitoring seems to require a yes/no response. If this is the case, then the Implementation Monitoring column in Table 44 should have metrics that allow for that assessment. For example, Implementation Monitoring for Intake Dam is construction of a bypass channel (yes/no). No monitoring is needed for that decision. It would be helpful if all implementation boxes were better defined and quantitative values were used where appropriate.

As stated in section 4.4, Process Monitoring is used to assess an ecological response that will increase survival or inform the program to move to another level of implementation. Tables 37, 40, and 41 provide the prioritization path for developing monitoring plans that should be outlined in Process Monitoring. Currently, for the upper river, pallid sturgeon propagation and passage for the fish at Intake have the highest priority for Level 1-3 actions (Table 37). For the lower river, the highest priorities are channel reconfiguration (IRC) and propagation. With a focus on the highest priority actions, it is difficult to follow the connection between the metrics in Table 44 and the decision criteria in Table 46.

Appendix E presents detailed process monitoring and assessment for IRC, which is a well-designed program that uses historical data to understand data limitations and construct enhanced experimental (sampling) designs. The monitoring and assessment outlined in Appendix E should be used as a model for other actions. However, similar to the observations stated above, a disconnect exists between the hypotheses and metrics used in the process monitoring outlined in Appendix E and the decision criteria in Table 46. One may find it difficult to use the decision criteria in Table 46, if those metrics are not being measured or adequately addressed by the design outlined in Appendix E. Process monitoring for other high priority actions, such as passage at Intake and propagation, are being developed by other agencies and consortia. This could be problematic if the metrics measured and monitoring is designed so that they are not congruent with the decision criteria outlined in Table 46. We recommend close coordination among agencies to make sure that decisions can be made from findings drawn from the agreed-upon monitoring programs, so that no information required for effective adaptive management is left out of the monitoring program.

Population Monitoring is the third type of monitoring presented in the AMP. A considerable amount of material in Appendix D addresses population monitoring and modeling for pallid sturgeon. The authors make the argument that population monitoring is necessary in seven statements listed in Appendix D. ISAP concurs that the proposed restructuring of the Pallid Sturgeon Population Assessment Program (PSPAP), as outlined in Appendix D, will be

beneficial to the program. As the ISAP has mentioned in previous reviews, the revised PSPAP must focus on decision criteria related to management actions that are hypothesized to benefit pallid sturgeon. Appendix D presents several arguments for incorporating population abundance and modeling into the population-monitoring program. The ISAP recognizes, as do the authors, that much work is needed to refine the population-monitoring program. As the ISAP has mentioned in the past, a more parsimonious program than what is currently outlined in Appendix D is needed. We realize the Missouri River is a large, complex system, but the ISAP thinks that a more efficient population-monitoring program can be established if it is highly focused at least initially on pallid sturgeon population (or sub-population) responses to specific management actions.

Question 3 – Does AMP version 5 adequately describe how additional data and analyses from internal and external sources will be evaluated and incorporated into the adaptive management program as appropriate for identifying, implementing, and assessing management actions? Does the AMP adequately describe a data-collection agenda, a schedule for data collection, and a process for data storage, synthesis, and communication? Have protocols been developed for information archiving, retrieval, reporting, and updating? Is the proposed information system friendly to the wide range of spatial and temporal scales and user requirements and capabilities presented by the Missouri Basin?

The AMP develops and refines protocols for data acquisition, processing, storage, retrieval, and dissemination as part of the MRRP. While considerable gaps still exist in some of these areas (as acknowledged by the authors), the document describes a general process for integrating the vast amounts of data that will be generated by various entities and for various components of the program. The basic structure of the data management program is presented in Chapter 6 (*Data Acquisition, Reporting, and Communication*), but specific topics are also treated in other areas of the document, including the governance, piping plover, and pallid sturgeon chapters. It might be beneficial to consolidate this information in one section of the document to reduce redundancy and to allow readers ready access to the full data management plan, recognizing that some references to the plans are necessary in the other AMP chapters.

The data management plan is first addressed in Chapter 2 on governance (not counting the overview Chapter 1) in the context of information needed by the three governance levels (oversight, management, and technical teams) to consider routine data streams (for example, monitoring results) along with new information. Section 2.5.3 is particularly pertinent as it describes a process to handle new findings, including a progressive evaluation scheme to determine the validity of new information that terminates with evaluation by the ISAP. Although this process has not yet been tested with a real case (but may soon be for assessment of fish physical condition), it appears to be a rigorous and objective method for evaluating new information that could influence management actions. Section 2.5.4 presents a process to address disputes that may arise from divergent interpretations of existing or new information. The inclusion of this process strengthens the AMP, and reduces uncertainty and suspicion of the management process. One potential concern pertains to the timeliness of incorporating new information, given the sequence of formal procedures and requirements outlined in section 2.5.3. New data or information, particularly from outside of the AM program, which could influence

the implementation of management actions and/or their associated monitoring, might enter the decision-making process with delays that could diminish the value of that information. We acknowledge, however, that the origin of the new information (e.g., supported or not supported by the MRRP) may influence the accessibility of that information, and therefore the ability to incorporate it into the management plan in a timely manner.

The bird and fish chapters (3 and 4, respectively) present guidance specific to handling information pertinent to the listed species. For example, section 3.5.6 details a process for updating bird model parameters as new information is generated. Chapter 4 also addresses aspects of new information relevant to fish, with Tables 44 and 45 providing guides for monitoring and evaluation of data needs and management. As the AMP authors point out in section 4.1.2, however, factors potentially important to the distribution, population growth, and persistence of pallid sturgeon, such as hybridization, fitness, and the effects of climate change, currently have no clear position in the monitoring program due to lack of clarity about linkages to USACE authority and jurisdiction.

A synthesis of the data management protocols is provided in Chapter 6; it appropriately uses the five steps of the generalized adaptive management cycle to organize the details of current and proposed data treatments. In general, this chapter is detailed and useful, although gaps remain (again, pointed out by the authors). The guiding principle of "actionable science" is stressed to link decisions and associated risks to data, modeling, and tools (e.g., HydroViz). The MRRP Monitoring and Assessment Plan (MAP) serves as the primary guide for data acquisition and management. The AMP authors suggest a number of revisions to the pallid sturgeon (Appendix D) and piping plover (Appendix H) monitoring programs, although assessment of those programs is beyond the scope of this particular question. The authors emphasize the need for a rigorous and consistent process to evaluate the merit of new findings and present the general process for incorporating new data and information into the AM process in section 2.5.3. However, many of the details of this review process are still to be worked out, and presumably at least some of those will described in the next version of the AMP. The ongoing test case of pallid sturgeon possibly in poor condition ("skinny pallids"; see section 4.1.2.4) may contribute to refining the process of evaluation of new information. The charter recently developed for this fish condition issue by Bonneau and Kruse provides a template for this review process.

In section 6.4, the AMP offers a general process for data management that will require additional details in the next version of the AMP. Figure 80 illustrates the general components of a data management system, but specific computing platforms are yet to be selected. Data management and technology concerns are detailed (pages 410-411) and will need to be addressed in the next AMP version, along with the identification of a common computing environment for users. Considerable thought has been directed to establishing an Information Technology Management (ITM) team to address data management and use. The proposed ITM process is then further described and applied to two operational scenarios for the piping plover. The need to integrate existing data management technologies remains, which presumably will be addressed by the ITM. Integrated provision of data and their metadata across legacy and new platforms in a format that is useful to all potential users will be required. The proposed data portal to the public (moriverrecovery.org) should be evaluated to assess its utility and ability to reach a general audience. Section 6.4.6 on a data management strategy remains to be developed. Within that

section, aspects of the data management strategy, including purpose, structure, hosting, management, content, and access will need to be conceptualized further and described in greater detail in the next AMP version. At the heart of the QA/QC process (section 6.5) is the QAPP, which presents a systematic means of assessing data quality, and is still in refinement. Appendix 1 provides a detailed treatment of this important component. Reporting and communication (section 6.6) are critical aspects of the MRRP that are relevant to scientists, managers, agencies, stakeholders, and the general public. Table 50 presents actual and proposed products for dissemination, with some gaps yet to be filled. The timing and distribution of these products are still to be determined.

Although the treatment of information management and dissemination has been advanced in version 5 of the AMP, whether the proposed information system is or will be friendly to the wide range of spatial and temporal scales and user requirements and capabilities in the Missouri River basin is not yet evident. Who all the users are or will be and what their requirements are or will be should be documented. Design, prototyping, and testing of all components of the information system by their various users should be further developed and described in the next version of the AMP.

Question 4 – Do the decision criteria in AMP version 5 demonstrate how the best available science that was generated and used in the effects analysis will influence the continued development of the adaptive management process, including the selection of management actions, development of implementation plans, and implementation of actions in an adaptive framework?

The ISAP has stressed the need for the MRRP to maintain and document a tight tie between the best available science and proposed management actions since its initial 2011 report. This latest version of the Adaptive Management Plan does a creditable job of achieving that goal. From the comprehensive summary Chapter 1 through the detailed Chapter 2 on governance and Chapters 3 and 4 (and associated appendices) for the piping plover and the pallid sturgeon, the links between identification and vetting of best available science and its intended uses in management approaches are evident.

The question appears to reflect the late-January status of the Adaptive Management Plan document, in which a then-comprehensive “Catalogue of Decision Criteria in AMP V4” was presented in a set of nested tables recognizing the forms of decision criteria (as guiding principles, qualitative decision rules, decision trees, quantitative decision rules, multiple lines of evidence, or schedules) and the decisions supported by criteria including compliance with permits and regulations, program performance, movement through “levels” for pallid sturgeon and evaluating the effectiveness of those actions, and protecting human considerations (interests) during implementation, accompanied by an inventory of criteria in that version of the Adaptive Management Plan. A master list of decision criteria is not in the Adaptive Management Plan; descriptions of program elements that require decisions that benefit from scientific information and technical guidance from experts are distributed throughout the document. This current structure places decision criteria in proximity to the background text that provides and sets context for the decisions that will be made. Assessing whether the role of reliable technical

information in decisions will continue from the effects analysis into the implementation of adaptive management under the MRRP is challenging; evidence of it must be harvested from the full text, including appendices. Nonetheless, it is fair to say, yes, the decision criteria in the AMP appear to be well informed by best available science (consistent with the requirements for best science in the federal ESA, attending regulations, and the wildlife agencies' Consultation Handbook). In addition, as can be drawn from the graphics in the introductory material and inferred from the essential attributes of the governance scheme presented in Chapter 2, science is likely to continue to inform decision-making under the MRRP into the future.

The MRRP was designed to ensure that it "incorporates the best available scientific information into decisions by conceptualizing and quantifying the effects of Missouri River operations and MRRP actions on the listed species" (from the MRRP web site). The importance of that objective to stakeholders and the greater public is highlighted in a letter (dated 17 December 2015) to the Assistant Secretary of the Army (Civil Works), signed by 20 members of Congress, which underscored that the Corps and FWS in considering a "comprehensive set of alternatives, such alternatives should be guided by the best available science." It is through the MRRP's formative activities, including the effects analysis, leading up to and reflected in the AMP, that science has informed the project alternatives. The effects analysis and accompanying elements of the AMP process that depend on reliable knowledge closely track the recommendations for the use of best available science in implementation of authorities under the Federal Endangered Species Act in a recent published report (see D.D. Murphy and P.S. Weiland. 2016. *Guidance on the Use of Best Available Science under the U.S. Endangered Species Act* in the journal Environmental Management).

The draft Adaptive Management Plan promises in its introduction to articulate: 1) the activities anticipated to be undertaken to assess the effectiveness of actions implemented under the selected alternative, 2) decision criteria used to determine if changes to the selected alternative are necessary, 3) research and study activities to address hypotheses for which specific management actions have not yet been identified, and 4) a governance process used to collaborate with stakeholders and make decisions. It should be expected that each of those areas of concern would either be informed by reliable knowledge or employ it in decision making activities, such that the actions to be carried out under the Adaptive Management Plan can be described as having been informed by the best available science.

The AMP describes the sequential steps to a "selected alternative BA/ESA" in its Figure 2 (page 6). It describes the "process leading to development of this AM plan" in four categories: 1) ISAP report and MRRIC proposed actions, 2) Effects Analysis, 3) Management Plan-EIS, and 4) the Adaptive Management Plan. The question can be asked whether each of the process steps and their associated deliverables has been informed by the best available science. Figure 2 provides a list of component activities up to and including the effects analysis that serves as an inventory of MRRP process attributes that rely on best science (reliable knowledge or technical information and tools) and the "scientific" support for the EIS, the AMP and the selection of a management alternative. They include the ISAP recommendations (from its first assessment report), foundational documents for the effects analysis and conceptual ecological models, evaluation of other programs, commitment to design monitoring programs, identifying decision criteria, evaluating the Missouri River hydrograph, completion of CEMs, synthesis of existing scientific

information, development of management hypotheses, hypothesis assessment, development of hydro-geomorphic and population models, and inventorying potential management actions.

For piping plovers, application of best available science can be traced to the development and testing of system-wide ESH targets (Table 2), and the identification of critical uncertainties related to bird management and associated management hypotheses (Table 1). A modeling framework that relates reservoir operations, river flows, the availability of emergent sandbar habitat, and bird populations is presented (Section 3.1.2.30). The model framework provides a mechanism for projecting the probability distribution of future habitat area and population size for the birds, and was applied using historical hydrological data to help establish targets for habitat based on a population viability analysis (see Section 3.1.1 for information on the models). Habitat metrics [including standardized emergent sandbar habitat in acres, available emergent sandbar habitat in acres, available shoreline (feet), inundation (feet) during the nesting season]; species metrics (population size, population growth rate, fledge ratio]; and metrics of management conditions [standardized ESH in acres and distribution, vegetated habitat in acres, storage in reservoirs (million acre-feet) and planned releases in cfs, tributary flows in cfs and downstream stage in elevation, and bird population density as adults/acre] all were vetted among species experts and, in conjunction with considerations for other authorized purposes (from the Master Water Operations Manual), inform the management-action decision process for piping plovers.

The decision process, along with guidelines and decision criteria/triggers for proceeding with specific management actions, are presented in Section 3.6. Decisions informed by technical information (science) range from continuing actions from previous years to adjustments of varying degree including adding new management actions and potentially changing targets or objectives. The decision process generally involves using new information from monitoring and research, coupled with modeling of habitat and population responses, to address the current status of plovers and key management conditions (Figure 7). Contingency plans that provide a pre-specified roadmap to decisions are identified where feasible owing to their efficiency and effectiveness. Figure 7, “Factors affecting AM decisions for birds and the nature of those decisions,” describes how system knowledge (from monitoring, research, and predictive models) links species needs in terms of a sustainable population size and habitat extent and condition with management conditions (hydrology, population size, habitat, and budgets for conservation action) through numerical (operations) models to inform decisions to continue management or adjust it. The answer to whether the MRRP is science based for proposed management actions that may be undertaken for the birds is affirmative.

Some observers have noted an apparent discrepancy between results of MRRP analyses and those in the piping plover recovery plan. The population and habitat models that were used in the piping plover effects analysis supporting the AMP can be characterized as (using) the best available science. While other applications and interpretation of demographic data for piping plover, including in the piping plover recovery plan, have merit, they should not distract from the MRRP process as it moves forward. The identity of best science as it applies to all elements of the AMP will itself change, or adapt, through time, and it is conceivable that a different best predictive model of plover survival and persistence on the lower Missouri River will emerge as

the AMP is implemented, and its goals and targets converge with those in the piping plover recovery plan.

For pallid sturgeon, intensive vetting of the available science (including focused workshops) revealed that essential information necessary to justify directed management actions was lacking. A Pallid Sturgeon Framework provided in the "Plan/Design" step for that species, serves as the foundation for the AM strategy targeting that species. The framework (in Section 4.2.1) describes four "levels" of actions anticipated to have progressively greater influence on pallid sturgeon populations through management as the scientific information base necessary to direct conservation actions grows – Level 1 is research, Level 2 is focused field-scale experiments, Level 3 is limited-scale implementation with monitoring, and Level 4 is full-scale implementation of management actions in an adaptive framework. The scientific basis for Levels 1 and 2 and for stepping through the components of the framework is detailed in Appendix C. Details for Level 3 and 4 actions are presented in remaining sections of Chapter 4, and are generally summarized as they pertain separately to the upper Missouri River and lower Missouri River.

The effects analysis for the pallid sturgeon evaluated available reports and models, as well as other scientific literature, to provide an integrated assessment of the current state of the science and understanding of the potential benefits of management actions for pallid sturgeon in the Missouri River. It also documents uncertainties in that assessment (see Section 4.1.2). Furthermore, it introduces a collaborative population dynamics model developed as part of the EA (Section 4.1.2.3). That "scientific" foundation revealed uncertainties for pallid sturgeon that are expressed as Big Questions related to potential management actions. Each of the six "Big Questions" in the upper river and six in the lower river has an associated hypothesis. Confronting management hypotheses with available science and new information from research, monitoring, and modeling assures that incrementally the knowledge base for pallid sturgeon will reach a level that enables identification and implementation of Level 4 management actions that can reduce the collected impacts of the environmental stressors that place the species in its current perilous state on the Missouri River. The ISAP observes that the information needs for pallid sturgeon are substantial and the need to facilitate directed research is pressing, but ISAP can opine that the best available science has been and will be used in the adaptive management of pallid sturgeon.

In summary, this version of the Adaptive Management Plan reflects the intent of the MRRP to use the knowledge base of best available science that it has developed over the past several years, and to improve, maintain, and utilize that knowledge base as it adaptively manages a selected alternative for the next 15 years. Ongoing work to hone a governance process with the ability to follow through and hold participants accountable to achieving that intent is encouraging.

Question 5 – (5a) Will the monitoring program as outlined in the draft AMP v5 enable models to be developed for the pallid sturgeon CEMs, similar to the models used for terns and plovers?

The relationship between piping plover performance (abundance and recruitment) and the extent and condition of its habitats is well understood. As such, models can be developed that directly link habitat availability to piping plover demographic targets. Unfortunately, such relationships are not ascertained for the pallid sturgeon. Thus many of the Level 1-3 actions for pallid sturgeon are based on hypotheses generated from the species-habitat-stressor relationships that were outlined in the conceptual ecological models and are thought to elicit a population-level response in the pallid sturgeon. While the AMP indicates that models similar to those developed for the birds is a central objective, and an objective of the pallid sturgeon population model is to "*provide a quantitative framework to forecast pallid sturgeon population dynamics given the inputs from the CEMs*" (section D 4.2.4.1), it is unlikely that well-articulated relationships between habitat attributes and pallid sturgeon performance will be available in the near future. As a result, an understanding of the pallid sturgeon-habitat relationships will not be at the level of the birds at the point of Level 3 implementation and the scope actions time limits (see Table 39). Both research and the fact that few individual pallid sturgeon are encountered in monitoring efforts indicate that spatial and temporal variability might provide significant barriers (signal-to-noise ratio) to deriving relationships between environmental forcing functions (between flows and spawning habitat, and geomorphological features and food availability) and key components of an age-based population model for pallid sturgeon. Appendix D explores opportunities to adjust existing sturgeon monitoring programs to obtain data that might be used to support the modeling activity. The details of desired monitoring efforts outlined in Appendix D suggest that the technical team understands the requisite inputs for developing and implementing a pallid sturgeon population model commensurate with the bird model for use in evaluating likely outcomes of proposed management actions. At the same time, a stated recognition exists that the results of monitoring might not provide sufficient data for quantifying age-based survival and growth rates necessary for the model.

For the complex Missouri River system, efforts to develop demographic parameters for early life stages of pallid sturgeon and monitoring for them will prove particularly challenging. While Appendix D is detailed in outlining existing monitoring activities for sturgeon and speculating on possible adjustments to them to more directly support the AM program, the discussion does not tie all the pieces together in furthering the collaborative pallid sturgeon population model. That integration will depend on the actual results of monitoring. The monitoring of IRC as outlined in Appendix E likely will begin to provide the understanding necessary to relate habitat parameters to species performance and consequently to develop forecast models. We recommend that other monitoring programs consider the emerging IRC monitoring plan as a template.

(5b) – Does AMP version 5 provide the necessary information, monitoring, and decision criteria to enable decisions to be made to progress from Level 2 to Level 3 and to address the hypotheses necessary to meet the species objectives?

Many of the comments in the answer to question 2 address this question. For the pallid sturgeon, only the IRC action has the level of detail in monitoring and decision criteria required for us to

assess whether it would allow resource managers to address the hypotheses necessary to meet the species objectives. However, as noted above, the decision criteria in Table 46 are not parallel with the metrics and hypotheses outlined in the IRC monitoring; that may lead to ambiguity or confusion in sampling design, data analyses, and assessments of the success or failure of an action as it relates to the species objectives.

(5c) – Does the AMP present the appropriate hypotheses, monitoring, and decision-making criteria to distinguish among the effects of the management actions for the birds and fish? Does the AMP set the stage for those developing and implementing the plan to consider and address the effects of the management activities for one species on the other species (i.e., potentially synergistic or conflicting actions)?

The AMP has not clearly articulated or considered the synergistic or conflicting effects of conservation actions that would affect the birds and the pallid sturgeon. In section 3.2.4.2 the AMP states that: "*relevant models would also be run to assess synergistic or detrimental impacts of flow action on pallid sturgeon*." The relevant models in the previous sentence refer to ESH models. We realize that it would be a daunting task to speculate on all potential interactive effects of all possible actions. However, a section laying out in some more detail an approach to addressing the potential interactive effects of some of the more likely management actions would be a useful addition to the next version of the AMP. The selection of a preferred management alternative might help focus the discussion on possible corresponding interactive effects among birds and pallid sturgeon.

Question 6 – Does AMP version 5 describe how monitoring results can be used to adaptively manage potential policy-directed Level 3 implementations of actions that lack underlying Level 1 and Level 2 causal understanding, particularly for pallid sturgeon?

Management-response functions developed using Level 1 and 2 causal understanding can be used to interpret the results of monitoring in relation to achieving management objectives within an adaptive management framework. The ISAP previously has expressed concern that, absent Level 1 and 2 understanding and supporting science, implementation of one or more management actions could result in no measurable change in the distribution or abundance of the pallid sturgeon, as can be detected via monitoring. Alternatively, monitored changes in these resources might not be attributable unequivocally to individual management actions. In either situation, the results of monitoring would not usefully inform adaptive management. Level 1 and 2 understanding provides the scientific basis for designing management actions with an anticipated outcome, that is, a target or metric for monitoring. Level 1 and 2 actions should provide insights concerning the magnitude of a management action required to (1) elicit a response that will likely be measurable with statistical confidence and (2) be able to ascribe a measured response to the specific management action. Both elements are critical to monitoring and decision-making within an adaptive management framework.

The discussion in section C.1.3 of the AMP Appendices addresses the need to develop a Level 1 and 2 understanding in relation to ongoing Level 3 actions related to IRC and shallow water habitat, population augmentation, and the Yellowstone River Intake Diversion. It is recognized

that performance monitoring of Level 3 metrics for these and other proposed management actions can provide useful information for adaptive management; however, the AMP further emphasizes the need to develop corresponding Level 1 and 2 studies to provide the necessary understanding of causal relationships that can be used to further refine Level 3 actions within an overall adaptive management program.

Appendix C provides detailed descriptions of Level 1 and 2 studies, including monitoring, mesocosm research, and field experiments needed to provide additional understanding of factors that underpin Level 3 management actions related to the Big Questions for pallid sturgeon in the upper and lower Missouri River. The appendix presents metrics, timelines, contingencies, and decision criteria for each of the Big Questions. The emphasis lies in Level 1 and 2 studies that will provide the scientific foundation needed to implement Level 3 management actions associated with each of the Big Questions.

Appendix D explores options for refining the current population trends monitoring program to collect information that directly supports an adaptive management program for pallid sturgeon. For example, the Pallid Sturgeon Population Assessment Program (PSPAP) is the primary monitoring effort that has been underway for years to assess long-term trends in sturgeon abundance, population structure, and habitat use. However, the key metrics have been based on catch per unit effort (CPUE) and the PSPAP was developed to meet the reasonable and prudent alternatives (RPAs) in the 2003 biological opinion (BiOp). As discussed in Appendix D.4.3, questions remain about whether CPUE is the best metric to quantitatively assess the pallid sturgeon population in the Missouri River, particularly in relation to the population modeling. Similarly, the Habitat Assessment and Monitoring Project (HAMP) was implemented to examine the effectiveness of shallow-water habitat as “nursery” habitat. The Comprehensive Sturgeon Research Project (CSRP) has been developed to increase understanding of the reproductive ecology of pallid sturgeon to better inform management decisions. While it was not designed as a monitoring project, the CSRP has generated some time-series data that might contribute to adaptive management of pallid sturgeon in the Missouri River. Appendix D.4.3.4 and D.4.3.5 discuss in detail the necessary statistical power (i.e., data quality and sufficiency) necessary to detect the outcomes of management actions and effectively inform decision-making within an adaptive management framework.

Appendix E describes (draft) monitoring plans for interception-rearing complexes (IRCs) for age-0 pallid sturgeon. That appendix states that similar monitoring plans will be developed for other management actions as the adaptive management process progresses. As stated elsewhere in this report, the monitoring program outlined for IRC management actions contains the level of detail that is needed for Level 3 actions.

The discussions presented in the AMP and its supporting appendices demonstrate a detailed understanding of the essential and requisite data and information needed to inform an effective adaptive management program and to evaluate Level 3 management actions even where they may proceed without Level 1 and 2 scientific investigations. The appropriate discussions of models, monitoring, decision criteria, and uncertainty are all encouraging.

Question 7 – Does AMP version 5 describe how Level 3 implementation of selected management actions will be scaled to produce population responses that can be (1) measured to an acceptable degree of statistical power and (2) unequivocally related to the management actions? If multiple Level 3 or Level 4 actions are implemented, is it made clear how monitoring results will be used to adjust adaptively any or all of the management actions?

The Level 3 actions proposed for initial implementation include population augmentation (in the upper and lower Missouri River), pallid sturgeon passage at Intake Dam on the Yellowstone River (upper river), creation and management of interception and rearing complexes (IRC) (lower river), and creation and management of spawning habitat (lower river).

Stocking of pallid sturgeon has occurred since 1998 with the objective of measurably increasing the population. The propagation program has been largely successful in meeting that objective, especially in preventing the near-term extirpation of pallid sturgeon in the Missouri River. Currently, the propagation program, particularly in the lower basin, has faced issues such as disease outbreak and developmental malformations (e.g., fin curl). Furthermore, challenges to a successful stocking problem relate to the most appropriate stocking rate, ages, genetics, and the source of stocked pallid sturgeon, as well as identifying stocking locations that contribute to maximizing survival, technical issues that are currently being debated by the Pallid Sturgeon Recovery Team, Corps, and FWS. The ISAP suggests a rapid resolution of the issues and early incorporation of the new information into the AMP; this is especially important given that the propagation program is an essential part of the contemporary recovery of pallid sturgeon and a Level 3 action. However, the ISAP recognizes that resolution of these issues is not under the control of the AM team, and will be determined mainly by progress made by the Pallid Sturgeon Recovery Team.

Pallid sturgeon passage through a proposed bypass at the Intake Diversion Dam on the Yellowstone River has been planned. The objective of the proposed action is to provide access for adult pallid sturgeon to enter and spawn in the upper Yellowstone River, far enough upstream to allow sufficient drift distance for free embryos and exogenously feeding larvae to mature before encountering the anoxic environment of Lake Sakakawea. Determining the success of this action will hinge on positive monitoring results for several metrics – numbers of adults passing upstream above Intake Diversion Dam, frequency and location of spawning events, numbers of free embryos collected to demonstrate successful reproduction, successful passage of drifting larvae downstream past Intake Diversion Dam, and capture of naturally recruited age-0 and older pallid sturgeon. Section 4.2.5.2 of the AMP provides a discussion of experimental design and decision criteria for assessing the effectiveness of the bypass, but few details of the sampling strategies, sample sizes, and data analyses that would be necessary to detect the anticipated increases in any of the above metrics. Recognizing that the Bureau of Reclamation is largely responsible for monitoring the Intake Diversion management action, the AMP should present the general monitoring schema and more specificity on how the Corps will partner with the Bureau to further define the monitoring program and incorporate and communicate the results as part of the AMP.

Creation of Interception and Rearing Complexes (IRC) by mechanical means and the

experimental (sampling) design needed to provide data that would validate the predicted value of each of the three components as defined – interception, food producing, and foraging habitats – is fraught with technical challenges. The AMP in section 4.2.6.3 indicates that more than 15 years of study will be required to shed significant light on how IRCs should be constructed; that timeframe may be an underestimate. Chapter 4 in the AMP contains details about the conceptual basis for the need for IRC habitat, the overall approaches that will be employed to construct IRC habitats, the hypotheses that will be tested, and the information that will be needed to scale up IRC construction from Level 3 to Level 4. Appendix D.4.3.4 and D.4.3.5 discuss in detail the necessary statistical power (data quality and sufficiency) required to detect the outcomes of management actions and effectively inform decision-making within an adaptive management framework. However, the hypothetical examples of power analysis in the AMP focus mainly on the sampling that is required to measure statistical responses to management. The described efforts, including Bayesian approaches, appear to fall short of developing management-response functions. Such functions are required to increase the likelihood that management actions were implemented at sufficient scale and magnitude to produce a measurable response that can be unequivocally related back to one or multiple specific management actions.

Appendix E goes into depth on statistical design considerations and this work is impressive in both its scope and depth. However, it is not apparent from the AMP or its supporting appendices how the monitoring results of multiple Level 3 actions will be related or scaled to specific Level 4 management action. Lacking any clearly defined capability to relate monitored changes in populations to specific actions, the results of monitoring will be difficult to interpret in relation to adjusting one (or multiple) management actions.

Certain basic information concerning the spatial definition of an IRC site, and how the various study results on different habitat components will be integrated, appears to have been overlooked. From a mapping perspective, how is the boundary of an IRC site defined? A protocol must be established, because much of the river sampling as described will be conducted downstream of IRC "sites." In a given river reach, at a given discharge, the spatial extent of the three assumed components of IRC can be mapped using computer models. But a "site" is defined as having all three components in "proximity." How is proximity defined: must foraging habitat be, for example, within 10 m, 1 km, or 10 km from interception and food producing habitat to be usable? Does proximate also mean contiguous, or can there be spatial separation between components (e.g., must foraging habitat be contiguous with food producing habitat?). Is there a minimum relative amount of any one of the three components to ensure that the complex functions properly? For instance, two complexes of equal size, one comprising mainly interception habitat and the other comprising mainly foraging habitat, might function quite differently as measured by the condition of pallid sturgeon juveniles. Finally, how do the above spatial parameters of an IRC site vary with river discharge? These spatial definitions of an IRC site are necessary for consistency before establishing an experimental design to evaluate IRC sites in the river.

The monitoring program described in Appendix E will focus on the interception habitat component, whereas the food producing and foraging habitat components are apparently already being studied under HAMP. It would be reassuring for the AMP to better describe how results of now-separate studies, being conducted under different management agencies, will be integrated

under the AMP.

Creation of spawning habitat in the lower river relates to Big Question 5; the AMP will need to determine how channel reconfiguration and spawning substrate construction may increase the probability of pallid sturgeon survival through fertilization, incubation, and hatching. As described in section 4.2.6.4 and Appendix C, the spawning habitat hypotheses are highly uncertain, with multiple hypotheses influencing potential management directions and action; hence, creation of spawning habitat will initially be treated as a Level 1-2 action, with specific hypotheses related to understanding the physical and chemical conditions that relate to the suitability of spawning habitat. The AMP in section 4.2.6.4 does a reasonable job of outlining the Level 1-2 studies that will be necessary to better characterize high-quality spawning habitat for pallid sturgeon.

Question 8 – Does AMP version 5 identify and adequately explain how and through what mechanisms the full complement of program attributes will be amended and adjusted with new information and emerging opportunities and constraints under the proposed adaptive management regime?

The AMP does an adequate job, and promises to do more, in addressing this important topic. Most observers appreciate that management actions and assessment procedures will change in time as new information derived from research, monitoring, and modeling emerges, and with changed social and economic circumstances. Fewer observers may appreciate that a breadth of program attributes also must adapt with adaptive management; program governance, management implementation strategies, species targets, decision criteria, data collection and archiving capabilities (and more), all will need to be revisited and some amended under an adaptive management framework.

Chapter 2 (section 2.5) in the AMP includes new material on the procedures for changing governance, adjusting objectives, targets and decision criteria, addressing new information, and resurrecting reserve hypotheses. These procedures seem complete; they address who can initiate the process to recommend a particular change, what information is required to accompany the recommendation, how the recommendation is processed, who makes the final decisions, and how the change is implemented. The section (2.5.4) on procedures for dispute resolution, which is not detailed but attempts to cover the breadth of disputes that may occur when changes are suggested in the AMP structure, is a necessary component of the plan.

Chapter 3 describes technical issues with piping plover monitoring protocols that are based on recent research results from the USGS and others. A shortcoming with past monitoring protocols has been the inability of biologists to account fully for detectability issues; the fraction (proportion) of individuals that are present and not detected in surveys varies temporally, spatially, and with life stage. The AMP outlines some optional protocols that would minimize detection bias, as well as produce data that may be useful in refining life parameter values in the piping plover population model. We encourage the Corps to reevaluate the plover monitoring protocols along the lines suggested in the AMP.

Appendix A includes a section (Attachment A.5) entitled "Procedures to Adjust Water Management Technical Criteria." That section deals with procedures for adjusting the Master Manual and the individual reservoir Water Control manuals. This information is important and timely; making such adjustments may be essential to effective adaptive management. However, the information is currently incomplete and will apparently be completed by Water Management. As a likely contentious matter for the MRRP, it is important to complete this section in the next version of the AMP. Another section (Attachment A.6) entitled "Procedures for Adjustments to Significant Components of the AM Plan" is currently blank. This material, when presented, might supplement that already available in Chapter 2. The title of this pending additional section is all encompassing and we would caution against any tendency toward writing a new adaptive management plan for the Adaptive Management Plan. Recognition that changes to any part of the AMP may be needed, and a general mechanism to do so is important, but every conceivable change cannot be prescribed. Brief descriptions such as those included in Chapter 2, but covering new ground, could be adequate.

Question 9 – Does AMP version 5 adequately identify and describe an overall structure as well as expertise needed and technical skills essential to the design, implementation, and evaluation of management actions within an adaptive management framework?

This latest version of the AMP presents a still-evolving plan for an adaptive framework that would identify, implement, evaluate, and adjust management actions intended to avoid jeopardy for the listed species. The ISAP is encouraged by the thought and care that have gone into describing the general design, implementation, and evaluation processes for future management actions that will be critical to program success. Chapter 1 attempts to summarize the structure for adaptive management, and makes considerable progress towards that goal, but gaps still remain in presenting a logical structure that will potentially lead to avoidance of jeopardy for the listed species. In Section 1.1.2, the authors invoke the ISAP's 2011 report that recommended the development of a comprehensive adaptive management plan for the Missouri River Recovery Program. The AMP authors interpret that mandate in the following manner: *"…that such a plan would contain essential components of any AM program, including a monitoring program that collects data that can be used to evaluate management actions; a process to use those data and established performance metrics and data to evaluate past and guide future management actions; and decision criteria that define success or failure"* (Section 1.1.2). The AMP makes considerable progress in outlining those facets of the program, but naturally more is known about the monitoring programs currently in use, and less is known about actually applying those data to future management actions and in determining appropriate decision criteria or endpoints. Closing this loop will be important to future iterations of the AMP as more information is acquired.

The AMP authors also state that "*A lesson from the handful of existing AM programs for large-scale ecosystem efforts is the need for early adjustments to the decision process, decision criteria, monitoring programs, data management, and reporting and communications practices. A process that demands self-evaluation, external review, and periodic assessment of potential change is warranted, and agencies and stakeholders must seek and embrace the changes needed to ensure the program's success*" (Section 1.1.1). The ISAP agrees with this statement and notes that elements of the AM process (targets, performance criteria, monitoring and assessment,

research, decision criteria, and governance; see Figure 2) are, at least in principle, well described in this document. Still, the document acknowledges gaps in understanding that will necessitate the early-term program adjustments to be made by program managers within an adaptive-management framework.

The fixed structure of an adaptive management plan will continue to be challenged by the differential requirements of the listed species. In the Missouri River system, increasing habitat availability and enhancing habitat quality will likely be key to avoiding jeopardy for the listed species. The AMP recognizes that while habitat requirements for the piping plover and least tern are relatively well known and management actions to improve them are implementable, factors constraining pallid sturgeon recruitment remain elusive, especially in the lower Missouri River. Knowledge about the pallid sturgeon will need to "catch up" with bird knowledge before a truly integrated approach to species management can be achieved. More specifically, while the needs of the listed birds are relatively well known, and actions have proceeded to Level 3 or 4 (e.g., ESH construction), pallid sturgeon actions remain in the research and testing phases (at Levels 1 and 2). Only the propagation program and the Intake Dam Bypass can be viewed as Level 3 or 4 actions; those do not address population viability per se.

An integrated approach to bird and fish requirements will be needed in the basin, as Level 3 and 4 management actions implemented for one species could well affect the other – positively or negatively. In addition, limiting factors for the listed species may well vary among river segments, and not in concert, so that management actions applicable to one segment will not necessarily produce success in other segments. As demonstrated in the pallid sturgeon "Big Questions" different sets of actions will likely be needed in specific river segments, which should be relevant to both birds and fish and not operate at cross purposes. Because of uncertainties, the AMP does not yet say much about integration across species, at different spatial scales, or over time. However, the Pallid Sturgeon Framework investigations and the governance structure and processes described should eventually facilitate meeting that need.

Appropriate composition of the AM teams will be essential to success. A successful adaptive management program for the three listed species will require technical expertise in biology, ecology, statistics, hydrodynamics, fluvial processes, modeling, information management, decision analysis, river operations, and in additional scientific and engineering disciplines. These skill sets are necessary to implement adaptive management, interpret emerging information, and inform decision-makers in the AM process. The MRRP has assembled an impressive array of expertise within the agencies, drawing staff with special skills from outside the Missouri River basin to help meet the challenges of knowledge acquisition, data interpretation, and risk assessment defined by the AMP. The Technical Team described in Section 2.2.3 of the AMP will comprise the scientific and technical expertise necessary to address the complex array of challenges for managing the system to avoid jeopardy for the listed species. The authors describe the Technical Team as consisting of experts in "*ecology, biostatistics, hydrodynamics, fluvial processes, decision analysis, river operations and socioeconomics, (and experts in) plovers, pallid sturgeon, and hydrogeomorphology of the Missouri River.*" The ISAP considers all of these areas to be essential to successful adaptive management of the listed species on the Missouri River, but recommends some additional expertise be added to the team. A broader view of the system would be offered by the inclusion on the team of a landscape ecologist who has

expertise in spatial analysis and statistics to offer a broad view of the Missouri River system from the headwaters to its confluence with the Mississippi River. In general, the ISAP recommends that the Technical Team be flexible in adding expertise as warranted to address significant management issues as they emerge during program development.

Question 10 – Does AMP version 5 address how incompatibilities in time scales between the biology/ecology of the listed species, supporting habitat dynamics, and the described AM process (e.g., governance, potential need for supplemental EIS and/or changes to the Master Manual) affect the likelihood of managing adaptively and achieving the stated species objectives? Does AMP version 5 address adequately the implications of anticipated year-to-year discontinuities in the AM process (generated for example by insufficient funding, governance conflicts, or litigation) on achieving and sustaining the species objectives in the MRRMP?

The AMP chapter on governance (Chapter 2) begins with the caveat that the presentation should be viewed as provisional and for the purpose of promoting discussion. The following comments should be similarly interpreted. They are based on approximately 100 pages of detailed descriptions of the governance structure and processes. ISAP members collectively have many experiences in helping to interpret scientific knowledge for applied decision-making situations, but have limited academic expertise in matters of governance. ISAP has not been participating in ongoing discussions of the AM Ad Hoc Group regarding governance, and so it is not aware of some of the clarifications and changes that the AMP authors are proposing to address regarding issues raised in Question 10.

A focal concern in the implementation of adaptive management is that delays in decision-making that result from simply passing information throughout a multi-tiered governance structure inevitably could impair the effectiveness of the program. Regional Directors of the USFWS will collaborate with similar levels of management in the Corps (e.g., NWD Commander), along with participants at lower management levels and outside of the lead agencies (e.g., MRRP ISP, tribes, states, MRRIC), in making decisions that will define management actions for the adaptive management program. Section 2.2 describes a structure within which decisions will be made at three levels of organization: Oversight, Management, and Implementation (or Bird Team and Fish Team). Figure 11 provides a useful illustration of the tiered AM organization. The overall success of the AM program will be influenced by the efficiency of information flow up and down the three levels of organization. Encouragingly, the process of governance as described in Chapter 2 emphasizes decisions made at the lowest possible level in the management hierarchy (see Section 2.4.1).

At the same time, monitoring results and new information of likely relevance to decision-making will enter the process on time scales defined by the Fall Science Meeting (October/November), the Annual Adaptive Management Workshop (February), and the release of the draft Work Plan (April/May). Two In-Progress Review (IPR) meetings are also prescribed for sharing initial findings of ongoing monitoring and other studies. The IPR meetings will be held in conjunction with the Fall Science Meeting and the Annual AM Workshop. These activities contribute to the annual Science Update process (Section 2.4.3). However, key environmental factors and

demographic processes that influence the population dynamics of the listed species operate continuously. Certain seasonal windows (nesting and spawning periods) may prove critical in determining growth and survival rates of annual cohorts that can impact population dynamics in subsequent years. The structure and process of the AM governance would benefit from demonstrating the capability to identify and react to short- and near-term local events important on temporal scales defined by the life histories of the species and the dynamic environments in which they survive and reproduce. The flow and timelines of information, recommendations, and decisions illustrated in Figures 15 and 16 suggest the incorporation of "last year's" data and information into a revised annual work plan just around the time of the current year reproductive periods for birds and pallid sturgeon. At the same time, it is recognized that an annual cycle of evaluation appears effective for managing terns and plover as part of the Platte River adaptive management program. Greater uncertainty resides with the management of the pallid sturgeon and it might be reasonable to anticipate that several years of study and management might be necessary to define appropriate temporal and spatial scales for evaluating the Missouri River AM program. Section 2.5.3 describes a formal process for introducing "new information" (i.e., originating from outside the AM program). The highly detailed and documented process underscores the conduct of credible science throughout the AM program; however, the process might well delay the incorporation of new information in sufficient time to make best use of the information in managing the listed species.

Importantly, as described in Section 2.3.4.2, the Integrated Science Program (ISP), while not shown on the AM organization charts, will play a critical role (through contracts and staffing) in the conduct of the science (see "all science activities…" p. 79, line 26) necessary for carrying out the AM program. The transfer of information from the described AM hierarchy to the ISP and subsequent actions of the ISP can introduce additional or unforeseen delays in implementing science activities at time scales critical to the management of the listed species. Other obligations of the ISP in coordinating science throughout the Missouri River (apart from the adaptive management program) and conflicts regarding available resources among competing science activities could prove detrimental to continued and reliable operation of the AM program, particularly during years characterized by funding challenges. Section 2.5.7 further identifies information requirements (e.g., project management plans) that must satisfy the ISP in order for the AM program to operate. To the extent that the ISP remains committed to the success of the AM program, the potential for conflicts in allocating limited resources and the possibility for delays in completing the necessary research fundamental to pallid sturgeon management might be avoided or at least minimized.

The success of an adaptive management program in sustaining desired distribution and abundance of the listed species depends on the continued and reliable availability of resources (e.g., funding, labor) sufficient to carry out the program. Significant portions of Chapter 2 are devoted to describing the federal budget process and cycle that will impact the conduct of the AM program. The reality suggested by Chapter 2 is that any AM program for the listed species will have to be form-fitted to aspects of traditional Corps operations, including the budget process. It may prove challenging to forecast FY+2 program needs absent real-time information from ongoing science and monitoring activities. Section 2.4.5.2 describes how the AM governance process would change during periods of insufficient resources (e.g., budget, staff, and implementation capacity). The revised process essentially parallels the operation of the AM

program during periods of sufficient resources, but adds additional time for review of any modified work plan by the Oversight Team. This additional time for review poses potential delays in the timely execution of the AM program. The AMP discussion recognizes a need to set priorities among competing project interests during periods of insufficient funding. A process to examine the potential implications of budget shortfalls in meeting species objectives and for allocating limited resources among the competing management actions is outlined in Section 2.4.5.2. The discussion goes as far as it can without actually working through the prescribed process.

Question 11 – Does the AMP effectively demonstrate how adaptive management as described for the listed species will be integrated with the goal of "minimizing impacts to human considerations"?

The overarching objective of the Adaptive Management Plan is to offer a means by which operations of the six dams on the Missouri River and other Corps actions can be carried out, while avoiding jeopardizing the continued existence of the piping plover, interior least tern, and pallid sturgeon. In operating reservoir levels and flows in the river channel for the benefit of those endangered species, the Corps is likely to impact other congressionally authorized purposes for the system, potentially including flood risk reduction, navigation, fish and wildlife, hydropower production, recreation, water supply, and water quality.

Human considerations (HCs) thus are additional important factors that must be taken into account in system operations. Human considerations are a set of objectives and their associated metrics related to the uses of and interests of stakeholders on the Missouri River; examples include availability of irrigation water during periods of drought, generation of hydropower at times when electricity is at its highest price, accessibility of boat ramps in reservoirs, ability of community water intakes to obtain reliable inflows, and navigability of the river (section 5.1.3).

As with other concerns in operating the river, HCs must be measured, monitored, and integrated into operations planning. Operating rules for the system, described in the Missouri River Main-stem Reservoir System Master Water Control Manual (“master manual”) operate the system largely by manipulating the releases from dams and their reservoirs. The master manual, most recently revised in 2006, incorporates HCs in short- and long-term decisions (section 5.1.1.3), including in the formulation of an Annual Operating Plan (AOP), constructed each year in the autumn.

The parameters driving impacts on human considerations related to water in the Missouri River system have been measured for several decades, so there is a continuing record of system indicators that are of interest to people who live along the river or use the river directly as a resource. This long record, publically available on line from the U.S. Geological Survey, the Corps of Engineers, and the National Weather Service, as well as other sources, allows users to consider changes in the hydrologic system on time scales ranging from real time instantaneously to decades. Examples of these hydrologic data include stream flow, reservoir storage volumes, and stage/elevations of flows (section 5.1.12).

The hydrologic variables of the system are also of importance to the listed species and their perpetuation in the Missouri River system. The magnitude, frequency, duration, and timing of flows are all relevant to the creation, degradation, and maintenance of habitat for the listed species. If a hydrologic variable is intentionally changed through management, the resulting flow adjustment is likely to affect both species and HCs. Dealing with this direct connection between species and people lies at the heart of creating an effective adaptive management plan for the Missouri River. The "sweet spot" in the planning process is to achieve species objectives while at the same time minimizing impacts on HCs.

In dealing with potential negative impacts of adaptive management on human considerations, the AMP scores several successes. Presentation and discussion of HC objectives and performance measures are made and condensed effectively. They are reviewed in greater detail in the extensive 2014 report by MRRIC on "Human Considerations (HC) Objectives and Performance Measures." The AMP offers example protocols and processes for direct measures and proxy, or indirect, measures in a helpful discussion. It presents several principles for incorporating HCs in decision-making. The AMP successfully explores how management will operate in the Annual Operating Plan, with appropriate adjustments if needed. These discussions will be helpful because they outline process frameworks for decisions, and legal review (if it occurs) of management will likely address process. The AMP also presents a clear statement of philosophy in selecting what to monitor for short- and long-term issues.

For all its successes in describing in principle how to minimize negative effects on HC, the AMP remains hamstrung by lack of specificity in terms of actually choosing what to measure in the monitoring program. The present version of the AMP outlines what to do about identifying measures, parameter thresholds, and the problem of what do when thresholds are crossed, but the plan does not yet go to the conclusion of actually directing choices. This shortcoming occurs in part because expected HCs will be derived from analyses being performed for the Draft Environmental Impact Statement, and that document (or results of its analyses) is not yet publically available. Innovative, combined social science and engineering/natural science techniques will probably be needed to formally link adaptive management decisions that benefit the species to efforts to minimize impacts on HCs.

One exercise that may further advance the utility of the AMP is to compile a complete list of the parameters that will be measured in the adaptive management process. Having such a list in hand may reveal previously unsuspected connections among monitoring activities, indicate overlaps, identify candidates to be added or dropped from the list, and provide an avenue for understanding anticipated costs. Such an exercise was a successful effort in the Everglades restoration project in central and southern Florida. In that multi-billion-dollar project, the initial (early 2000s) monitoring and assessment plan described about 150 measures with about 70 measures for water quality, 20 for hydrology, and 60 for the biological system. By 2007, budget restraints and a search for efficiency reduced the list to 53. The obvious lesson for the MRRP is that it will likely go through a similar process of beginning with an initial wish list that is trimmed by necessity to a shortened version.

Other large-scale restoration projects have dealt successfully with the issue of assessing the negative impacts of restoration adaptive management on HCs. Two specific examples illustrate

the process. In the restoration of the Colorado River downstream from Glen Canyon Dam, all restoration measures involve some modification of releases from the dam and its reservoir, Lake Powell. As these releases pass through the dam, the hydropower plant generates large amounts of electricity that is distributed to designated cities and rural cooperatives. Any adjustment to flows that deviates from normal operations can be evaluated as dollars of revenue gained or lost by comparing the actual sales to those expected under the normative model. In a second example, the Mississippi River Delta restoration project will divert substantial flows of the river onto eroded portions of the delta. Sediment from those diverted flows will be deposited there and the delta rebuilt, but this large-scale terra-forming process may also affect commercial shrimp and oyster fisheries, as well as potentially change sport-fishing opportunities. To determine whether the proposed diversions may in fact negatively affect HCs, models link catches and harvests to the expected biophysical changes, and then translate them into expected effects on regional employment. Like the Colorado River example, the Mississippi Delta example shows that HCs can be inserted into the (risk) analysis of expected outcomes for restoration adaptive management plans.

The AMP does not yet provide a complete demonstration of how adaptive management for species preservation will be integrated with the goal of minimizing impacts to Human Considerations. The vital information on measurements and models for this purpose are still in development in the Draft EIS. The adaptive management plan, however, does make substantial progress toward defining the general principles, indicating how decisions will be made, how thresholds will be dealt with, and how both short-term and long-term approaches will work. Once the measures and their inter-connections are established in the Draft EIS, authors of the plan will be in a "plug and play" mode, whereby they will be able to blend the plan and its monitoring measures together.

Question 12 – Does AMP version 5 adequately explain how management actions for the birds and sturgeon fit in to the larger recovery plans for each?

For the pallid sturgeon, actions in the AMP and those in the Revised Recovery Plan are reasonably parallel. For example, in several places in the AMP the authors describe metrics and targets that are similar to the "reclassification criteria" in the Recovery Plan. For example, possible targets for sub-objective 2 in the AMP (section 4.1.1) are:

"*…1) positive population growth rates (i.e., lambda (λ) > 1) of pallid sturgeon age 2 and older; 2) estimated survival rates of all size/age classes sufficient to provide a stable population of pallid sturgeon age 2 and older; and 3) acceptable probabilities of persistence and recovery over a 50 to 100 year time frame. For example, the Lower Missouri Framework (USFWS and USFWS 2015) described two preliminary decision criteria for halting population augmentation: 1) when population monitoring demonstrates a self-sustaining population in excess of 5000 adult fish in each management unit; and 2) when the threat of extirpation is less than 5 percent in 50 years. New criteria may be developed as part of a revised Propagation Plan.*"

The reclassification criteria for pallid sturgeon described in the Revised Recovery Plan are:

"*…when the listing/recovery factor criteria are sufficiently addressed such that a self-sustaining genetically diverse population of 5,000 adult Pallid Sturgeon is realized and maintained within each management unit for 2 generations (20-30 years). In this context, a self-sustaining population is described as a spawning population that results in sufficient recruitment of naturally-produced Pallid Sturgeon into the adult population at levels necessary to maintain a genetically diverse wild adult population in the absence of artificial population augmentation. Metrics suggested to define a minimally sufficient population would include incremental relative stock density of stock-to-quality-sized naturally produced fish (Shuman et al. 2006) being 50-85 over each 5-year sampling period, catch-per-unit-effort data indicative of a stable or increasing population, and survival rates of naturally produced juvenile Pallid Sturgeon (age 2+) equal to or exceeding those of the adults (see Justification for Population Criteria below for details). Additionally, in this context a genetically diverse population is defined as one in which the effective population size (Ne) is sufficient to maintain adaptive genetic variability into the foreseeable future (Ne ≥ 500), conserve localized adaptations, and preserve rare alleles.*"

Not surprisingly, given the overlap of participants on the pallid sturgeon recovery team and those involved in the development of the pallid sturgeon conceptual ecological models and the effects analysis for the species, many of the recovery tasks in the Revised Recovery Plan for Pallid Sturgeon are similar or even identical to the management hypotheses and Levels 1, 2, and 3 actions described in the AMP. For example, a recovery task in the Revised Recovery Plan for the Pallid Sturgeon states "*Evaluate flow scenarios from Fort Peck Dam to increase retention times and/or reduce larval development times (i.e., reduce drift rates and/or increase water temperatures) for larval Pallid Sturgeon,*" and the parallel Level 1 study for the upper Missouri River (Table 40) in the AM is "*Field studies: validating advection/dispersion model*." Another task from the recovery plan is stated as "*Quantify growth and survival rates from hatch through the transition to exogenous feeding, and from the onset of exogenous feeding through the termination of the growing season as related to environmental conditions (e.g., temperature, dissolved oxygen, food type, and ration size),*" and the parallel Level 1 study outlined for the lower Missouri River (Table 41) is "*Field studies: food and forage habitat gradients*."

Furthermore, the priorities of Levels 1 through 3 actions closely match the priorities outlined in the Implementation Schedule in the Revised Recovery Plan for Pallid Sturgeon (see page 77 in the recovery plan). Although the connection between the AMP and the Revised Recovery Plan for Pallid Sturgeon is not addressed explicitly in the AMP, our crosswalk review of both finds that Level 1-3 actions for pallid sturgeon are congruent with the recovery tasks and priorities for the species outlined in its recovery plan.

In contrast, the AMP offers no explanation of how management strategies designed for the Missouri River Recovery Program (MRRP) correspond with actions proposed in the newly released Recovery Plan for the piping plover. Management action alternatives targeting piping plover on the Missouri River have the goal of "avoiding jeopardy," which is not the same as species "recovery," as is addressed in the recovery plan. In practice, however, the two efforts share the same operational objective; that is, achieving a plover population size on the Missouri River that has a 95% probability of persisting (>50 individuals) for at least 50 years. Accordingly, the two planning documents should arrive at the same estimated amount of habitat

that would be needed to achieve the specified level of population persistence. They do not do so, however.

The conservation targets for in-channel piping plover habitat differ in the MRRP and Recovery Plan. This situation has been a source of some confusion and misunderstanding. The habitat targets differ for two reasons: 1) the models used to derive the estimates of the extent of habitat necessary to support a viable and locally persistent demographic unit of the birds are fundamentally different and 2) "habitat" itself is defined differently by the two planning efforts, with the MRRP habitat target focusing on emergent sandbar habitat. The analytical approaches and inconsistencies should be addressed and to an appropriate extent reconciled so that the resource agencies and MRRIC have a mutual understanding of the conservation objectives in the two planning documents and common expectations for adaptive management in the MRRP and piping plover recovery across its broad geographic range in the Midwest. Because completing that task is important to the future success of the MRRP, and the Service may not have the requisite expertise on staff, an independent group of experts perhaps should be commissioned to take on the task of describing how the MRRP and the Recovery Plan relate to each other and can succeed in tandem.