TO: Management Plan and Effects Analysis Teams, MRRIC SPA Task Group

FROM: Independent Science Advisory Panel (ISAP)

RE: ISAP evaluation of EA2b – *Hypotheses for emergent sandbar habitat, piping plovers, and least terns* and *Development of Working Hypotheses Linking Management of the Missouri River to Pallid Sturgeon Population Dynamics* – Final

DATE: July 24, 2014

Introduction

The effects analysis teams, guided by Conceptual Ecological Models (CEMs) for plovers, terns, and pallid sturgeon, developed corresponding sets of hypotheses concerning potential management actions directed towards achieving previously stated species objectives. The hypotheses will focus continued development, application, and evaluation of operational models used to project the implications of alternative management actions on the anticipated outcomes for plovers, terns, and pallid sturgeon. Hypotheses link the conceptual ecological models, through relevant available data and analyses, to model outputs, which in turn are used to identify a suite of potential management actions and their likelihood of meeting MRRMP goals.

For purposes of this review, the ISAP understands that the EA teams are formulating "hypotheses" primarily as qualitative statements that describe the effects of potential management actions on the population dynamics of the three species and their supporting habitats. These hypotheses will be evaluated using operational models developed from the corresponding CEMs. The hypotheses presented reflect current assumptions about management actions, which when carried out are expected to produce desired responses by the three species and the habitats that support them.

The ISAP recognizes that the Effects Analysis is an iterative process. The specification and prioritization of hypotheses for initial modeling allows the EA teams to focus on a manageable number of hypotheses, at the same time providing opportunity to return to previous steps and address additional hypotheses as necessary. The ISAP is aware of the limited time available to complete the Effects Analysis. The panel attempts here to differentiate review comments into those that should be considered as part of immediate EA activities (in initial modeling), and those that might be completed as part of a longer-term, less time constrained EA process (in an EA Phase 2, see below).

The compressed schedule introduces potential uncertainties, and elevates the risk that management actions identified in the EA process will be less effective than anticipated and must be adjusted as lessons are learned during their implementation in an adaptive management framework.

The ISAP considers below each of the review questions, then summarizes with conclusions and implications, and closes with recommendations for the near term (Phase 1) and longer term (Phase 2) continuation of the Effects Analysis.

Review Questions

1. **Are there important relationships likely to affect survival of the species that are not captured in one or more of the hypotheses? In other words, are there any hypotheses that were missed?**

The hypotheses developed for terns and plovers and their habitats appear to be comprehensive and consistent with the CEMs for the species. Habitat-related hypotheses include regulation of water levels and flows, and sediment transport and emergent sand bar configuration, as they relate to nesting and foraging habitat and population dynamics. Species-related hypotheses address nesting habitat, food availability, predation, immigration, human interference (including effects from pets and livestock), and overwintering survival. It is not apparent that other important hypotheses have been overlooked for terns and plovers. The hypotheses for terns and plovers are sufficiently narrowly defined that categorized subsets of hypotheses were unnecessary and all the hypotheses will be addressed in near-term modeling activities.

The lists of global and dominant hypotheses for pallid sturgeon also appear comprehensive and consistent with the CEMs. The limited understanding of population dynamics of pallid sturgeon forces a need to distill a large number of hypotheses into a more narrow set around which management actions can be crafted, and to identify priority hypotheses for immediate use in identifying and evaluating potential management actions. Accordingly the pallid sturgeon report distinguishes between Phase 1 hypotheses, which will be addressed in the near term to support the Management Plan and Phase 2 hypotheses, which can serve to broaden the set of management actions available and refine the management actions implemented during adaptive management. A primary implication of this approach to the pallid sturgeon EA (setting certain hypotheses into a reserve category to be potentially re-examined during Phase 2) is that the emerging Management Plan will need to be accompanied with a transparent, clearly articulated process for revisiting hypotheses that are currently not addressed in Phase 1.

It is not clear in the draft sturgeon report whether any of several hypotheses were fully considered in developing the global hypotheses for pallid sturgeon. Within the standing set of dominant hypotheses for pallid sturgeon, none addresses the potential importance of possible diseases (e.g., iridovirus), known to be of concern in hatchery conditions, but only of speculated importance among wild fish. Parasites are also not mentioned. Agrochemicals are considered as candidate working management hypotheses (Tables 4 and 5), but we were unable to locate a relevant underlying dominant hypothesis for it in previous Tables. Persistent pollutants (e.g., PCBs, atrazine, selenium, mercury) and novel chemicals (e.g., pharmaceuticals) from municipal point sources are not specifically identified as hypotheses that should be addressed in relation to early life stage survival.[1]

[1] There is an inconsistency in labeling and numbering hypotheses among the categories making the resulting hierarchy difficult to understand. The major contaminant hypothesis is – regulation of agricultural runoff and

Another hypothesis to potentially consider is related to the fact that reproductively mature, wild pallid sturgeon are reported to be rare in the Missouri River, particularly above Lake Sakakawea (U.S. Fish & Wildlife Service 2013). Is it possible that there are insufficient numbers of mature, wild male or female adults for functional spawning aggregations to develop and successful spawning (i.e., egg fertilization) to occur at a magnitude that will maintain a viable genetically wild component in the population?

Additionally, pallid sturgeon historically used the lower reaches of some of the larger tributaries of the Missouri, Yellowstone and Mississippi rivers. More recent observations indicate that Missouri River tributaries may be more important than originally recognized when the species was listed and may be beneficial to the pallid sturgeon during certain times of the year or perhaps during certain life stages (U.S. Fish and Wildlife Service 2013). The Service listed 8 tributaries where hatchery-reared pallid sturgeon have been collected and Delonay et al. (2014) report that pallid sturgeon are suspected to have spawned in the Platte River. The EA team might reference evidence of the contributions of major tributaries to the Missouri River system to pallid sturgeon recruitment.

Subsequent to our EA2b draft report the ISAP has discussed questions above with the sturgeon EA team lead. The ISAP understands that additions/clarifications will be made to the sturgeon report regarding hypotheses that were considered, and that hypotheses not initially modeled may be revisited later as needed.

2. Are there important hypotheses, significant to species recovery, not included in the initially modeled category (i.e., hypotheses currently in the 'reserve') that should be modeled now?

As previously indicated, the habitat and species hypotheses for terns and plovers are sufficiently few that all the presented hypotheses have been identified for inclusion in the initial modeling activities underway in support of the Effects Analysis. And, in contrast, the large number of hypotheses developed for pallid sturgeon required categorization and prioritization to identify a smaller number of hypotheses that could be realistically addressed in the near term. The ISAP does not have sufficient knowledge to recommend specific hypotheses currently in the reserve hypothesis list that should be addressed in the initial modeling efforts.

While the ISAP recognizes the need to distill the hypotheses down to a tractable subset, the categorization process and its final results for pallid sturgeon raise some concerns. The final assignment of pallid hypotheses to the reserve category based on agency responsibility and authority is understandable from the perspective of policy. However, if factors important to the

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municipal waste discharge will decrease exposure to endocrine-disrupting chemicals, thereby decreasing the incidence of intersex individuals and increasing reproductive success of adults. That hypothesis is variously labeled # 43 or 44. It is ranked high with low uncertainty in Fig. 5 (#44, pg. 26); however, a precursor to it does not appear in Table 2 or 3 (Candidate working dominant hypotheses). Then it shows up in Table 4 (Candidate working management hypotheses before third survey – #43, pg. 38) and Table 5. Then it is dropped.

overall population dynamics of pallid sturgeon in the Missouri River system are omitted from the near term (or overall) modeling effort as a result of this categorization, the resulting Effects Analysis could inaccurately characterize the effectiveness of modeled management actions in achieving species objectives. For example, the expert elicitation process identified toxic chemicals as a potentially important component of early life stage pallid mortality. The ISAP understands that the agencies are not responsible for or authorized to address these kinds of contaminant issues. But, if the potential impacts of these chemicals are not included in the initial modeling effort, and if they are in fact key factors in determining early life stage survival, the model results will be incorrect, even if the included modeled components of mortality (including predation, flows, sedimentation, and natural baseline mortality) are accurately represented.

Other hypotheses for pallid sturgeon that are presently assigned to the reserve may subsequently need to be incorporated into the initial modeling and Effects Analysis as more information is obtained about them, or as other hypotheses are determined not to be effective at achieving species objectives. A complete and most useful Effects Analysis ultimately would address all (important) factors affecting species survival, and is needed to specify a suite of actions likely to achieve species objectives, independent of agency responsibility or authority.

The ISAP understands that the limited data on and understanding of environmental factor effects on pallid sturgeon constrains the derivation of accurate and defensible stressor-response functions for toxic chemicals and other stressors implicit in other hypotheses now in reserve. Nevertheless, it should be possible to describe plausible stressor-pallid sturgeon response relationships to include in the initial modeling efforts, and to perform scenario-consequence analyses or sensitivity analyses by systematically varying the corresponding parameter values to characterize the potential importance of these currently omitted stressors (e.g., disease, parasites) on survival at relevant life stages and overall population dynamics of pallid sturgeon in the Missouri River system. Such analyses might be deferred to Phase 2 given constraints in time and resources, but the Effects Analysis will provide more accurate management guidance if such exploratory modeling activities are included in Phase 1.

3. Are the hypotheses (global, working dominant, working management, and initially modeled) logical and appropriate given our understanding of the science and of the institutional context (e.g., schedule, MRRP, uncertainty about the scientific information, and the need to move forward) in which we are working?

The hypotheses are generally logical and appropriate, consistent with available science, and workable within the institutional context of management planning for the Missouri River. The report for plovers and terns clearly illustrates the relationship between proposed hypotheses and the corresponding CEMs. Relevant pathways in the CEMs are highlighted for each hypothesis. The relative importance of each hypothesis and associated uncertainties in relation to the species objectives appear to well reflect the state of the science for these two species.

Similarly, the CEMs developed for both the population-level and life-stage components of pallid sturgeon were used to guide the development of hypotheses for the Effects Analysis. The hypotheses appear consistent with current understanding of pallid sturgeon population dynamics

within the Missouri River system. However, there is considerable uncertainty associated with this understanding, including knowledge gaps relevant to the survival of the pallid sturgeon's early life stages. The approach for arriving at initially modeled hypotheses for pallid sturgeon by working from the "Multiple Management Hypotheses" from the left side of Figure 3, combined with the "Dominant Biological Hypotheses" from the right side of the figure, was a creative way to rapidly and meaningfully reduce the number of potential hypotheses to be addressed in the Phase 1 Effects Analysis. Continued analysis of existing MRRP project data, synthesis of information on similar species in other, similar systems, and exploratory modeling might help to improve the overall understanding of sturgeon population dynamics and help refine the pallid hypotheses.

Because of the time constraints imposed on the EA process, the pallid sturgeon EA team chose to categorize the "global" hypotheses using expert opinion into "working dominant" hypotheses and "working management" hypotheses, and then by imposing agency sideboards to produce a narrow set of "initially modelled" hypotheses. Numerous hypotheses were conveyed into a set of hypotheses in reserve. The process used by the EA team to filter hypotheses seems to produce reasonable results with regards to identifying the set of sturgeon management actions that will be initially evaluated in the EA process. As mentioned above in Q2 and below in Q4, the ISAP has concerns about hypotheses put in reserve because of agency sideboards.

Nonetheless, there are two aspects of that filtering process that are poorly defined and need further explanation and documentation. First, it is not clear how hypotheses that are filtered out – not ending up in the "initially modeled" hypothesis set and instead in the reserve set – might later be reconsidered as part of the Management Plan (should initially selected hypotheses prove to be inadequate to achieve species objectives, or if more detailed examination of empirical evidence supports alternative hypotheses). In reality, the Management Plan will be challenging to modify and likely be only incrementally modified once implementation has begun, and the "initially modelled" hypotheses will likely be the drivers of management actions for at least several years. Substantial resources and time will be expended in support of testing these hypotheses. Given the extremely short time allowed for the EA process, there is the very real possibility that one of the hypotheses set aside in the reserve may prove to be more effective and efficient, or may have stronger empirical support upon further consideration and analysis. Thus, the process that will be used to revisit reserve hypotheses is an essential one, and should be outlined in the documentation of the filtering process and described in detail in the developing Adaptive Management Plan.

Additionally, the selection process for expert panel members should be described more thoroughly; the scoring of hypotheses highly influences the EA process and potentially the subsequent Management Plan. That is, the "dominant working" and "dominant management" hypotheses that are selected for initial inclusion in the modeling will likely lead to specific management actions to be considered for the Management Plan. Considering the relatively large proportion of agency personnel on the expert panel – nearly 30% of participants were from the U.S. Geological Survey, CERC, Columbia, Missouri and 15% were from the U.S. Army Corps of Engineers – the EA team should convey in the document the skill areas and mix of expertise of participants to best convey the breadth of disciplinary representation in the process.

There appeared to be some inconsistency with the final analysis of the results of the Delphi process in selecting sturgeon hypotheses for initial modeling. If the median score was below 4 (neutral) and the variability was high for a proposed management action, the action was placed in reserve. However, if the median score was above 4 and variability was high for a scored hypothesis, it was carried forward for initial modeling. High variability in either case would logically imply that the "real" median score could be less than or greater than 4 – and perhaps both situations should result in placing the hypothesis in reserve. The initial modeling, particularly given constraints in time and resources, might reasonably focus on those proposed management actions with median score >4, and degrees of uncertainty that would not likely shift the score below 4. The document does not mention the use of variability or uncertainty in carrying management actions forward; only the median score is mentioned. However, the figures that summarize the Delphi results show that the number of "no knowledge responses" substantially reduces the number of experts actually evaluating many of the hypotheses. In some cases, the range of scores among the remaining experts spans the possible range of scores. This is not to suggest that the Phase 1 Delphi process be repeated. However, future applications of expert elicitation, for example, to develop management-response functions absent data or models, might be based on a refined Delphi method that addresses the above-mentioned concerns.

The hypotheses selected for initial modeling for the three species appear to reflect currently acceptable approaches and tools available to the Corps and sideboards placed on management actions in terms of types and scale of actions. The EA team recognizes that, given the realities of modifications of the river, it may no longer be effective or efficient to attempt to recreate putative historical conditions, and, instead, is hypothesizing alternative, potentially more ecologically effective strategies that focus on the functional ecological conditions that the target species require. The EA team might directly answer the question – are there tools or techniques that could provide specific physical and biotic conditions that may be beneficial to the targeted species, but are dissimilar from those associated with assumed historical channel morphologies and flows? Is there the opportunity to consider a "designed ecosystem," which prioritizes specific engineered features that are thought to satisfy the ecological needs of terns, plovers, and pallid sturgeon in specific geographic areas without harming other native species?

4. Are there risks to the management plan moving forward based on the initially modeled hypotheses or in the manner in which they have been identified?

If important components of pallid sturgeon population dynamics are implicit in the hypotheses currently placed in reserve, the initial modeling efforts that fail to include those components might incorrectly characterize the effectiveness of alternative management actions evaluated in the Effects Analysis. Management actions that are selected and implemented on the basis of incomplete modeling results might fail to achieve anticipated outcomes; an important consideration for environmental stressors known or strongly suggested to be scientifically important, but assigned to reserve status due to policy decisions.

High uncertainty exists as to the strength of many of the "initially modeled" hypotheses and/or input variables for models designed to evaluate them. Thus there is risk that management actions

selected based on those evaluations will not achieve intended outcomes. This necessitates a precautionary approach to implementing such uncertain management actions.

Field scale prototype management actions might test the robustness of individual hypotheses and differentiate among competing hypotheses with design and implementation at smaller spatial scales (e.g. at habitat-patch scale or by river reach) and shorter temporal scale (1-3 year), in a manner that also would minimize larger-scale or longer-term impacts to stakeholder interests and other biota. Monitoring the success of such smaller-scale actions will inform agencies of their potential effectiveness, and the desirability of scaling-up implementation. This approach is central to Adaptive Management and will require a performance-based monitoring and assessment program.

In absence of a detailed quantitative understanding of early life stage population dynamics for pallid sturgeon in the Missouri River, management of habitat appears to be a preferred approach to achieve programmatic species objectives. For such an approach to be effective, however, pallid sturgeon "habitat" must be operationally defined for the Missouri River in terms of both physical resources and biological resources; combined they provide the environmental elements necessary for pallid sturgeon survival, persistence, and recovery. Channel morphology, fluvial characteristics, and flows regime are key factors in a definition of pallid sturgeon habitat. Other environmental attributes, including chemical and biological drivers that affect pallid sturgeon survival and persistence should be considered in defining the suitability of “habitat” for purposes of the quantitative modeling in support of the Effects Analysis.

The Effects Analysis is fundamentally a scientific investigation. Implementing agencies initiate the Effects Analysis with a needs assessment, establish programmatic goals and objectives, and define the spatial and temporal planning boundaries. The agencies select from alternative management actions that have been evaluated in the Effects Analysis for their capacities to deliver desired species or environmental responses. In between, an expert effects analysis team crafts conceptual ecological models, identifies and synthesizes pertinent scientific information, assesses the need for and efficacy of candidate actions, and constructs and runs quantitative models linking alternative management actions and likely species or environmental responses. To assure that a complete array of management responses (vetted using best available scientific information) is available to the agencies that manage the river and its resources the Effects Analysis must consider all environmental stressors. A truncated list of management hypotheses and candidate management actions increases risk to the potential success of the overall program.

Conclusions

The hypotheses presented for terns and plovers appear to capture the important relationships likely to affect their continued viability within the Missouri River basin. These habitat- and species-focused hypotheses can usefully guide the initial modeling in support of the overall Effects Analysis. Similarly, the “global” hypotheses developed for the pallid sturgeon appear to include the important relationships that are known or suspected to influence the viability of the species in the Missouri River. The ISAP recognizes that there remain important gaps in understanding the early life stages of pallid sturgeon and that the current incomplete

understanding of pallid population dynamics constrains the pallid sturgeon hypothesis sets. The process of categorizing "global" hypotheses into a smaller set for purposes of initial modeling raises concerns that some or even many effective and/or efficient management actions that could benefit pallid sturgeon will not be considered. The use of agency management authority as a decision criterion for identifying Phase 1 initial modeling hypotheses could detract from the quality and usefulness of the overall Effects Analysis, particularly if water-quality related or other environmental stressors now held "in reserve" prove to be important determinants of early life stage survival for pallid sturgeon.

Implications

The ISAP recognizes the time constraints associated with the ongoing Effects Analysis. However, if key hypotheses for pallid sturgeon are mis-prioritized, or prematurely assigned to reserved status based on agency authority, culling of these hypotheses from the initial modeling efforts might lead to erroneous evaluations of the expected efficacy of candidate management actions. Such errors could propagate throughout the management alternatives selection process and result in selection of management actions that will fail to achieve the species or habitat objectives.

Recommendations

The effects analysis teams should continue to make maximum use of available data to the extent possible. They should use the current understanding of the species and the river system to develop predictive models as possible, and use those models to identify priority questions based on the sensitivity of associated model parameters to potential management actions. The Effects Analysis and subsequent Management Plan should make use of focused laboratory/field studies to reduce specific knowledge gaps identified in the previous stages of the Effects Analysis and the modeling that supports it. Given time and resource constraints, the pallid sturgeon team should attempt to include environmental stressors that have been set aside in the reserve hypotheses in the Phase 1 Effects Analysis.

The effects analysis and adaptive management teams should consider small-scale management actions that can increase understanding of actions' efficacy while minimizing risk to stakeholders and other native species. All small-scale management actions need to be considered very carefully given the pallid sturgeon requires large reaches of river to fulfill its life-history requirements. Evaluating hypotheses via management actions can be best accomplished by a sequence of incremental steps as described above. This stands in contrast to implementing large-scale, costly habitat or flow modifications where the acknowledged uncertainty of demonstrable progress on achieving species objectives over the next decade is high.

The ISAP stresses the importance of species- and population-focused fundamental objectives. To the extent possible, the MRRMP should not rely on proxy response variables, such as acres of spawning habitat, in lieu of species performance measures, while acknowledging the uncertainties that plague the current understanding of pallid sturgeon habitat attributes and their

contribution to fitness. As the effects analysis team progresses and as the Management Plan is developed, direct measures of species performance should serve as the principal metrics for assessing success of the Management Plan.

References

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