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

FROM: Independent Science Advisory Panel (ISAP)

RE: ISAP Evaluation of Draft Species Objectives and Draft Conceptual Ecological Models (CEMs)

DATE: 26 February 2014

The MRRIC Independent Science Advisory Panel (ISAP) was tasked to consider a set of nine questions regarding two deliverables to the Missouri River recovery planning process – draft species objectives statements, and draft conceptual ecological models (CEMs) for the three listed species, including narrative texts and graphical presentations. These deliverables are referred to in the Critical Engagement Points document as Effects Analysis Deliverable #1. The Evaluation that follows is the final report of Task 1a of the TPSN/ISAP Call Order #1. It incorporates the results of discussion of a February 3 draft with the EA Team and SPA on February 10, 2014.

The ISAP finds both programmatic documents to be on track and suitable for use in continuation of the effects analysis and PrOACT processes. The species objective statements adequately reference demographic goals for the three species, while acknowledging that specific targets remain to be defined in the effects analysis. However, the statements fall short of being comprehensive with respect to inclusion of other essential MRRP program elements, namely environmental drivers, controlling (limiting) factors, and habitat attributes. We presume that these missing elements will be included in the eventual discussion of means objectives, also to be defined as the effects analysis progresses. The conceptual ecological models are well presented, and can fairly be described as state-of-the-art. They provide a level of formalization, transparency, and specification of the current understanding of the listed species and their habitats that has been lacking to date.

In our answers to the questions below we recommend several revisions to the objectives and CEMs, document a few factual errors in the review materials, and make a number of

suggested changes to improve clarity. Additionally, we suggest standardizing the technical terms that were used to label the columns in the CEM diagrams – including defining the terms drivers, independent drivers, controlling factors, and primary ecological factors – which will contribute clarity to the planning products.

Questions related to Draft Species Objectives

1. Are the species objectives useful for informing an adaptive management strategy?

They are not complete in their current form – species objectives without specifically defined targets and the means for achieving them would be difficult to use for adaptive management. The ISAP understands that the species objectives statements will be further refined and expanded as the effects analysis process moves forward. We recommend additional text be included, acknowledging that the fundamental objectives and sub-objectives, as well as the to-be-defined means objectives, may evolve as information is developed in the effects analysis and, subsequently, implementation of adaptive management. For pallid sturgeon, for example, recruitment to age 1 is identified as a fundamental sub-objective, but that objective may be adjusted should emerging data shed new light on the extent to which recruitment of age-1 pallid sturgeon is in fact a limiting factor.

Some of the currently defined objectives are near-term or temporary in nature; the time frames associated with achievement of those objectives should be specified. For the pallid sturgeon, sub-objective 1 should refer to natural recruitment, and sub-objective 2 should reference hatchery-reared fish. It will be useful in the species objective statements to have a visualization (graphic) to illustrate the linkages from management and restoration to the means objectives and targets (sometimes referred to as a means-ends diagram, Gregory et al. 2012). Making such additions will increase the clarity of sub-objective statements and link explicitly to the CEMs, as well as to steps of the effects analysis, PrOACT, and adaptive management efforts.

2. Are they (species objectives) consistent with the direction of the CEMs?

The species objectives are consistent with the direction of the CEMs, but make little reference to habitat[1] for the three species and the physical and biotic processes that contribute to habitat extent, distribution, and condition – attributes of the Missouri River system that are crucial to avoiding jeopardy and contributing to recovery of the species. Again, we anticipate these aspects will be captured as means objectives are developed.

Some inconsistencies should be addressed. Pallid sturgeon sub-objective 1 is based on recruitment to "age 1," which is inconsistent with the terms used in the pallid sturgeon CEM document, which references "exogenously feeding larvae and age-0" and "juvenile" pallid sturgeon. The CEM document goes on to state that the end point for exogenously feeding larvae and age 0 is the first winter, and that the juvenile stage extends from the first winter until a fish reaches the first reproductive cycle. There are numerous ways to define recruitment and age-1 fish, but the most common definition of a fish's birthday is 1 January in the Northern Hemisphere. The sub-objective's life stage stops on 1 January ("…to age 1"), but the pallid sturgeon CEM takes the fish through the winter ("...age-0 fish through their first winter"). While we recognize that both documents imply survival past the first winter, it is appropriate for both documents to use the same terminology, and that it be consistent with generally accepted terms used in fishery science (and see Wildhaber et al. 2007, 2011).

Additionally, we note that the pallid sturgeon Sub-objective 1 (increase pallid sturgeon recruitment to age 1) is inconsistent with its metric (catch rate of naturally-produced age-2 and -3 pallid sturgeon). Sub-objectives, their measurement metrics, and life stages presented in the pallid CEM ideally should be congruent. Performance metrics should, if possible, closely reflect the life stages where recruitment failure is hypothesized to occur,

[1] Habitat can be broadly defined as a species-specific, spatially and temporally explicit concept that delineates the area that is or can be occupied by a species during some time interval, and the biotic and abiotic attributes (resources and resource conditions) that contribute to the area's suitability to individuals of the species. For example, habitat for pallid sturgeon includes portions of the river channel, the hydrological regime there (including natural or managed flows), locations of food availability, and water-quality in areas the fish use. Habitat is very much a multi-dimensional and dynamic concept, operating on spatial scales of meters, to reaches, to the entire river and on temporal scales of minutes, to days, to years.

and where causal links can be constructed to inform future management actions. Potential indirect metrics, if needed, could be described at this stage but should be well justified if proposed as a primary metric.

Pallid sturgeon sub-objective 2 focuses on artificial propagation, but the current pallid sturgeon CEM(s) have little or no consideration of propagation. Hatchery-propagated fish should be acknowledged throughout the pallid sturgeon CEM(s); the metric should be modified therein to indicate how hatchery fish are separated from naturally recruited fish.

3. Are they reflective of the latest knowledge of the species life history needs and their current status relative to the form and function of the contemporary Missouri River System?

The species objectives developed during and subsequent to the workshops appear to reflect the latest knowledge of the species' needs and the contemporary conditions of the Missouri River System; however, the objective statements are not complete. Demographic targets, means objectives, and metrics have yet to be identified. These components of the objectives will benefit from the analyses, model outputs, and new perspectives regarding the three species and their habitats that will be synthesized and articulated during the effects analysis that is currently underway. The notes accompanying the species objectives are helpful in understanding the context of the objectives as stated.

4. Do they have a direct relationship with USACE effects on the species from operation of the Missouri River System?

Yes. However, it is important to acknowledge the limitations of considering only species objectives that have a direct relationship with management actions under the direct purview of the USACE. The sub-objectives are consistent with the fundamental objectives, but the extent to which achieving the fundamental objectives will be constrained by controlling factors that occur outside of the USACE's operations on the Missouri River hydrological system – for example, those factors that affect winter survival of adult birds – is not acknowledged in the objectives statements. The objectives statements must address all substantive system attributes that affect the population dynamics (performances) of the

three species.

As the MRRMP planning process, organizational framework, and decision process become clearer, it will be possible to more clearly describe the species objectives and their context. There currently may be some confusion about how these species objectives relate to agencies', MRRIC's, and stakeholders' strategic objectives, priorities, and directions (see also Gregory et al. 2012).

Questions related to Draft Conceptual Ecological Models (CEMs)

1. Is the strategy for using the CEMs in the planning process (e.g. formulating hypotheses, developing means objectives) sound?

The strategy of using the CEMs to formulate hypotheses and develop means objectives is key to the overall planning process. The CEMs provide a basis for the quantitative models that will be used to test the hypotheses and guide selection of means objectives and management actions that are intended to achieve the species objectives. Furthermore, the CEMs, objectives, hypotheses, and management actions are all subject to iterative adjustment based on new insights from the effects analysis process and through implementation of adaptive management. The ISAP is encouraged by the examples of hypothesis development that it has seen to date, and looks forward to further evidence that the CEMs will lead to the development of testable hypotheses, a slate of potential means objectives, and corresponding alternative management actions, with quantification of their likelihoods of achieving the species objectives.

2. Are the CEMs detailed enough to facilitate the identification of objectives and metrics that can be useful for Adaptive Management?

The CEMs have gained substantial detail over the past eight months. As mentioned below, there are elements that should be added or refined, but the models are now developed sufficiently to achieve their intended purposes. For the pallid sturgeon especially, there have been significant advancements regarding the nexus of the CEMs, species objectives,

and metrics. Robb Jacobson's presentation on January 17 offered examples of how specific objectives lead to different metrics, and how each trace through the CEMs.

Those insights notwithstanding, the CEMs continue to focus on a palette of USACE management activities, which may prove inadequate to avoid jeopardy or contribute to recovery of the three listed species. The CEMs should consider all potential limiting environmental factors that likely affect the survival and recovery of the three species, regardless of agency responsibility for management responses to them [for example see USFWS Draft Revised Recovery Plan for the Pallid Sturgeon (U.S. Fish and Wildlife Service. 2013) for threats to the pallid sturgeon]. The MRRP is a multi-agency and multi-stakeholder enterprise, and the USACE should expect to find MRRIC partners to help achieve goals outside of its purview. The 2007 Water Resources Development Act Section 5018 (b)(3)(B)(iii and v) anticipates such needs and instructs MRRIC to "…provide guidance to the Secretary…including recommendations relating to…exchange of information regarding…activities of the agencies…to promote the goals of the Missouri River recovery and mitigation plan…and…facilitating the resolution of interagency and intergovernmental conflicts associated with the…plan…"

The ISAP recognizes that it is not feasible to require any model to incorporate all factors potentially affecting population dynamics. Such a modeling effort would become bogged down in detail, and the model would inevitably not be useful for making planning decisions. Moreover, we recognize that the modeling effort is an ongoing process, and that the concepts modelled may change as more experience and knowledge is gained. That noted, we encourage the EA team to continue striving to incorporate those factors that are likely to affect the species of concern, including those outside of the USACE's management authorities, which may prove useful in adaptive management efforts. Such possible extensions could involve a fuller elaboration of pathways involving contaminants, competition, and productivity in the pallid sturgeon CEM, as discussed in the next section.

3. Do the CEMs consider all aspects of life stage transitions and population dynamics likely to be important?

The CEMs appear comprehensive in their depictions of life-stage transitions and population

dynamics for all three species. There are some factual details that may require modification in the pallid sturgeon CEM, as discussed below.

Competition was acknowledged in several places as being a potential factor affecting survival (e.g., pg. 28 – free embryo). We suggest adding Competitors as a colored box within Aquatic community composition and dynamics, and arrows into and out for relevant life stages. Is the arrow going from Productivity under Secondary Ecological Factors to Competition under Primary Biotic Response correct? The same comment applies to subsequent life stages in lower Missouri River basin CEMs. We recommend adding an arrow from contaminants to toxicity under "Free Embryo" and for "Gametes and Developing Embryos." Arrows of varying uncertainty and importance from the contaminants to toxicity link may also be appropriate for subsequent life stages in Upper and Lower basin CEMs.

In reference to gametes and developing embryos, the term "eggs" (egg) is synonymous with "ova" (ovum) – that is, a female fish gamete. Once the egg is fertilized and begins development, it becomes an "embryo." Correct and consistent use of these terms throughout the narrative would assist with clarity.

Regarding exogenously-feeding larvae and fish at age 0 to juvenile transition, it is common that age (e.g., age 0, age 1, age 2...) is confused with life stage (e.g., egg, free embryo, larva, juvenile...). A convention in fisheries is that all fishes have their birthday on 1 January in the Northern Hemisphere. Thus on 1 January a formerly age-0 (also referred to as young-of-year or YOY) larval or juvenile pallid sturgeon becomes an age-1 juvenile (a yearling). Fish life-stage transitions generally do not coincide with calendar age. For example, the larval to juvenile transition for pallid sturgeon occurs during age 0 (e.g., <140 days post hatch) not at age 1 as stated. Thus, the evidence suggests that all exogenously feeding larval pallid sturgeon are age-0, and all age-1 pallid sturgeon are juveniles. These idiosyncrasies in the CEM render the link to the species objectives unclear (see above). Furthermore, the beginning and end of a life stage needs to match the secondary biotic response in the CEM. We encourage use of conventional fisheries terminology, but realize terminology can vary among scientists, so definitions of terms within the CEMs and objectives would be helpful.

However, it is essential that the species objectives statements, the CEMs, the EA process, and the adaptive management efforts to come all use the same terminology (same definitions) to facilitate cross-walking among analyses, models, and documents.

In the larval and juvenile life stages narrative the following hypothesis is articulated – productivity is thought to be linked to flow regime and channel morphology factors that stimulate floodplain food production and help flush food into pallid sturgeon habitats. This is a valid hypothesis, but the CEM narrative should also include in-channel effects of flow and morphology on production and subsequent pallid sturgeon food resources as an alternative or additional hypothesis. We suggest expanding the present hypothesis to read: productivity is hypothesized to be linked to flow regime and channel morphology, factors that stimulate in-channel and floodplain food production and may mobilize food in and to pallid sturgeon habitats. These may be competing or complimentary hypotheses (both with substantial uncertainty), but both are equally pertinent to the CEM.

4. Do the CEMs consider all relevant drivers?

The CEMs provide a hierarchical structure that incorporates relevant drivers in a generic sense, and allows nesting them specifically as they become better known. The structure works well. Some confusion is created by the use of different terms to define the hierarchy of driver/stressor columns in the different CEMs. There may be something to be gained in clarity, understanding, and communication by using the same or similar terms to define the logic hierarchies of drivers/stressors for all the species.

In the pallid sturgeon model, we recommend a third bounding box titled “Propagation” be included under Management and Restoration for this major MRRP activity (as propagation is neither channel management and restoration nor reservoir engineering and operations). This bounding box should include relevant colored boxes within (for broodstock, parental genetics, stocking, etc.) and arrow morphologies representing varying levels of uncertainty and importance as appropriate for subsequent life stages in upper and lower Missouri River basin CEMs.

5. Are the CEMS of sufficient detail to provide guidance to the Effects Analysis?

Yes, except as noted in the preceding comments. The current detail of the CEMs should assist the EA team in identifying and testing hypotheses, or in making appropriate adjustments to the CEMs if modeling results or analyses of existing data suggest that different relationships or levels of detail are needed.

References Cited

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