TO: Pallid Sturgeon Condition Assessment Authors, MRRP Integrated Science Program Leadership, and MRRIC

FROM: Independent Science Advisory Panel (ISAP)

RE: ISAP Comments on Draft Pallid Sturgeon Condition Assessment

DATE: October 12, 2016

NOTE: This memo builds on and reemphasizes comments provided by ISAP during the Pallid Health Assessment Report Webinar on September 29, 2016. It reflects ISAP thoughts subsequent to webinar discussion and an ISAP phone discussion October 6. These comments address both the assessment and the "new information" process.

Concern regarding low body condition of pallid sturgeon in the Missouri River was expressed by biologists for Nebraska Game and Parks after their inspection of fish collected during recent sampling activities. The MRRP science leads responded to that concern following the pilot procedure for "new information" outlined in the draft AM Plan by directing the pallid sturgeon Effects Analysis Team to convene an issue team that would assess whether a "skinny fish" phenomenon (a troubling occurrence of fish with lower than expected body condition) was occurring in the lower river, and its likely cause or causes. Guiding questions were posed to the issue team from the MRRP—Is there evidence that pallid sturgeon in the lower Missouri River are in poor and/or declining condition? And, what is the likely cause of the poor condition? Each question also asked what is the level of uncertainty in the conclusion?

The ISAP appreciates the efforts of Randall et al. (2016) to explore quantitatively the reported "skinny fish" phenomenon. However, the panel is not convinced that the most appropriate methods for assessing the available data were used in developing the results presented in the draft report. Correspondingly, the panel concludes that the reported analyses do not unequivocally substantiate the existence of a "skinny fish" phenomenon for pallid sturgeon in the lower Missouri River. The absence of a significant population-level trend in the body condition of pallid sturgeon in the lower river and the observation that river-segment and year effects might explain the occurrences of pallid sturgeon in low condition indicate that the analytical method presented in the report does not accurately characterize deviation from a baseline "healthy" condition.

The analyses presented in the draft report suggest that pallid sturgeon body condition has declined system-wide (see Figures 7 and 8), and particularly in river segment 9. That suggestion is based on application of the Shuman et al. (2011) K_n formula as a reference model for pallid sturgeon body condition. The Shuman et al. model was constructed from data on 2,268 pallid sturgeon collected from 1998-2007. It is possible that the system-wide body condition of >12,000 pallid sturgeon that measured between 200 and 1200 mm FL in the current analysis does not fit the Shuman et al. model. That is, the model does not accurately reflect the length-weight relationship for pallid sturgeon throughout its range in the Missouri River, because of the limited

sample size of fish used to develop the model, and the potential bias in deriving the model given that it was based largely on fish sampled from the upper basin. Most fish in the size class 600-1200 mm in the samples used in Randall et al. occur below the curve. As pallid lengths approach 1200 mm, body condition deviates farther from the modeled line, suggesting that as pallid sturgeon grow in length K_n declines (Figure 5). However, most fish >1200 mm are above the Shuman et al. line, suggesting higher observed K_n values than those predicted by the model; those fish were excluded from the analyses due to presumed reproductive condition. Thus, it appears that the use of the Shuman et al. model along with the capture of more, larger fish through time could be the cause of the posited range-wide decline in condition in K_n. The discernable decline might be an artifact of pallid sturgeon reaching a length near the inflection point in the Shuman et al. length-weight model (see Figures 4 and 5 in Randall et al.).

To determine whether the spatially and temporally dispersed fish with low body condition reflect a biotic phenomenon, rather than an artifact of the analytical procedure, it is worth analyzing the data using additional methods. A first approach might be to create a new K_n using all lengths of pallid sturgeon in the PSPAP and HAMP databases (and/or separated by upper and lower basins). The K_n values could be compared among years to determine if the condition factors for recent years consistently fall below the mean (that is, 1.0). Another approach would be to use Analysis of Covariance (ANCOVA) and compare slopes among years by basin to see if the slopes differ significantly. This approach avoids the comparison of body condition measures against a (perhaps inappropriate) baseline or reference model. The investigators might also consider the ontogenetic switch point of pallid sturgeon to piscivory or to sexual maturity in the analysis of K_n. Those two ontogenetic changes often have a substantial influence on allocation of resources to growth in length versus weight. Thus, a corresponding statistical comparison might be undertaken as a two-way ANOVA, with year and ontogenetic stage as factors. To avoid ambiguity in the report's conclusions, the ISAP suggests rigorous use of inferential statistics (with p-values) to make comparisons of pallid condition among years. It would also be useful to compute the probability of making a Type II error (i.e., a false finding of no difference) by conducting an appropriate power analysis.

The analyses presented in the Randall et al. report potentially mask variation among individual pallid sturgeon, which by ignoring the inherent variability among individuals, can lead to misleading conclusions. An analysis to address variability among individual pallid sturgeon might include quantile regression as described by Cade et al. (2011). This approach explicitly incorporates individual variation, and the resulting analyses of body condition need not rely on comparison to a baseline model.

A subset of the Missouri River pallid sturgeon population is well-known as individual fish due to multiple captures of tagged individuals over time and monitoring of telemetered individuals. Apparently, more than 2000 different fish have been captured and measured on multiple occasions. It would be useful to compute body condition for those individuals for comparison among basins, segments, sites, bends, hatchery versus wild individuals, and other attributes that might affect pallid sturgeon body condition. Such detailed analysis of individual pallid sturgeon might better characterize individual body condition that would be obscured in aggregated analyses, and possibly reveal patterns related to fish-stocking origin. Related to this, as Randall et al. point out, a better record of handling of hatchery-reared pallid sturgeon (considering

hatchery origin and exchanges) might provide information on questions of fitness and genetics as they may influence body condition.

Further and more detailed analyses of the kinds suggested above might help to clarify whether a systemic or localized deterioration of body condition in pallid sturgeon is occurring in the Missouri River and, if so, where it is occurring. Additional analyses could allow the investigators to answer the first question posed to the team. Do note that the relevance of the second question is contingent on the answer to the first question. Following further analysis, if a "skinny fish" phenomenon is merely an artifact of the Shuman et al. formula, subsequent efforts that speculate on causal mechanisms are unnecessary. However, if additional analyses demonstrate that the condition of pallid sturgeon is declining in the lower Missouri River, inferences about the influence of habitat quality need to be drawn from data beyond point measures of hydrodynamics and bed elevation as developed in the current document. Useful characterization of pallid sturgeon habitat requires a more comprehensive consideration of resources (and resource conditions) used by the fish. Such analysis of habitat conditions using an ecosystem-based approach that addresses, for example food resources using an energetics-based food web analysis, appears beyond the scope and intent of the current examination of pallid sturgeon condition in the Missouri River and is likely constrained by available data. However, any discussion of habitat quality as a potential cause of low body condition based on limited hydrology data (as in the current document) remains highly speculative—unless river hydrodynamics can be shown to serve as a valid proxy measure in lieu of a more realistic, multi-dimensional description of habitat.

The purpose of the Randall et al. report was to assess new information that might prove essential to managing pallid sturgeon in an adaptive framework. Accordingly, the report could benefit from an introductory discussion of how the body condition of pallid sturgeon relates to or influences the metrics outlined in the Adaptive Management Plan. It is important for river managers to consider any new information pertaining to trends in the body condition of pallid sturgeon with reference to the Effects Analysis (EA), specifically the Conceptual Ecological Models (CEMs), and to determine how information on body condition fits into the ecological state of the MRRP action area, the primary management hypotheses for pallid sturgeon, and the larger-scale programmatic components of the AMP. While there is some discussion of the effects of body condition on recruitment at the end of the Randall et al. report, it is not clear how the new information would (or should) influence the metrics outlined in the AMP. Ultimately, any new information on body condition should be evaluated in relation to the critical issue of pallid sturgeon recruitment in the Missouri River.

The lack of a clearly stated connection between new information (here the report by Randall et al.) and the data-driven efforts already undertaken under the MRRP suggests that a revised approach to vetting and conveying new information into the MRRP is advisable. The following paragraphs offer some guidance for addressing new information in the context of CEMs, the EA, and the program's hypothesis testing framework:

Any concerned party is encouraged to bring to the MRRP new data or other information on the ecology and behavior of the listed species, resources and habitat attributes that affect those species including environmental stressors, ecosystem processes that are known or suspected to

contribute to the survival and recovery of those species, and human-considerations factors that may affect the listed species or be impacted by efforts to protect the species. That new information may include survey data that contribute to time series; analyses that show linkages among the species, their habitats, and the river ecosystem, including its human uses; interpretation of monitoring data; and model outputs presented with mechanistic explanations for phenomena of conservation concern. That new information should be accompanied with an explanation of its management relevance, describing the pertinence of the information in addressing the priority management hypotheses that guide the Missouri River Recovery Program Adaptive Management Plan (and may include any non-priority hypotheses that can be linked to the survival and recovery of the listed species).

The AMP Technical Team in consultation with the Bird Team, Fish Team, and/or HC Team (as appropriate), and in consultation with ISAP/ISETR, will consider whether the new information provided is reliable (constitutes best available science) that warrants consideration in the AM program planning process. Only if so, then the Technical Team decides whether more data should be gathered or if directed studies to substantiate the phenomenon of concern are warranted, or whether initiating deliberations to identify a management response is necessary. The ISAP/ISETR should be engaged early, either upon the Technical Team receiving the new information (and provide a complementary assessment of that information), or review the written response of the Technical Team to that new information. The Technical Team may propose new or supplementing studies, suggest adjustments to monitoring protocols, or propose new or amended management actions in the Work Plan update process. The expert panel(s) should be engaged at appropriate stages in review of such studies, protocols, or actions.

References

Cade, B. S., J. W. Terrell, and B. C. Neely. 2011. Estimating geographic variation in allometric growth and body condition of blue suckers with quantile regression. Transactions of the American Fisheries Society 140:1657-1669.

Randall, M., M. Colvin, K. Steffensen, T. Welker, L. Pierce, R. Jacobson. 2016. Assessment of adult pallid sturgeon fish condition, lower Missouri River: application of new information to the Missouri River Recovery Program.

Shuman, D. A., and 11 others. 2011. Pallid sturgeon size structure, condition, and growth in the Missouri River Basin. Journal of Applied Ichthyology 27:269-281.