Independent Science Advisory Panel Evaluation of the Draft *2020 ESA Adaptive Management Compliance Report for Endangered Species Act Compliance, Adaptive Management Implementation, and Fish and Wildlife Mitigation*

Submitted on 20 April 2021

Introduction

The Independent Scientific Advisory Panel (ISAP)[1] was tasked with reviewing the draft *2020 ESA Adaptive Management Compliance Report for Endangered Species Act Compliance, Adaptive Management Implementation, and Fish and Wildlife Mitigation* (AMCR) in a memo from the USACE on 7 February 2020. Attached to the memo, the Corps provided the ISAP with four documents for review – 1) the *Draft 2020 ESA Adaptive Management Compliance Report for Endangered Species Act Compliance, Adaptive Management Implementation, and Fish & Wildlife Mitigation,* 2) *Appendices to the report,* 3) *Appendix attachment 1a (in reference to RPM #3),* and 4) *Appendix attachment 3a re: IRC monitoring.* This is the third review of an annual report on USACE activities in support of adaptive resource management (AM) on the Missouri River in compliance with requirements under the U.S. Fish and Wildlife Service's 2018 *Biological Opinion concerning the Operation of the Missouri River Mainstem Reservoir System, the Operation and Maintenance of the Bank Stabilization and Navigation Project, the Operation of Kansas River Reservoir System, and the Implementation of the Missouri River Recovery Management Plan*.

Consistent with previous report-review practices, the US Army Corps of Engineers (USACE) received input from external sources in crafting five task questions that are intended to guide this ISAP review. The questions provide the organizing structure to this review, however, the ISAP does not strictly hew to these questions, offering additional observations and recommendations pertinent to the maturing adaptive management program targeting pallid sturgeon and piping plovers. The questions include --

1) Does the draft Adaptive Management and Compliance Report (AMCR) provide the information necessary to evaluate the effectiveness of each management action given each action's (current) status in the adaptive management cycle (that is, in plan and

[1] For this review, the ISAP included Drs. Steve Chipps (co-chair), Dennis Murphy (co-chair), Steve Dinsmore, Melinda Daniels, John Loomis, and Bill Warren-Hicks. Steve Bartell served as Third Party Science Neutral.

design, implement, or monitoring phases of the cycle)? For each individual management action please identify any analyses, modeling outputs, or data summaries that should receive more or less emphasis or explanatory detail in the report, given the current status of the management action in the AM cycle.

2) Does the draft AMCR adequately forecast expected (future) outcomes of ongoing or potential management actions for purposes of decision making in the adaptive management process?
3) Does the draft AMCR describe ongoing and potential management actions and their implications, including challenges and uncertainties likely to be encountered, as they pertain to: 1) status and trends of the listed species and their habitats; 2) agency staff and partners who will implement selected actions and monitor them; and 3) stakeholders who may have concerns regarding the effects of those actions on "human considerations"?
4) Does the draft AMCR provide an updated review of the (current) status of the listed species and their habitats, and the adequacy of information from research, modeling, and monitoring to make real time decisions in an adaptive management framework (including information from published and unpublished sources)? Does the draft AMCR describe how the available scientific information has been and will be used in programmatic adaptive management decision-making?
5) Does the draft 2020 AMCR adequately address issues that were daylighted in ISAP's review comments on the draft 2019 AMCR? Are there further refinements to the structure of the 2020 report which would better serve the information needs of programmatic adaptive management targeting the listed species and their habitats? (Note that the bird chapter in the draft 2020 AMCR does not incorporate all of the ISAP's recommendations in its review of the 2019 AMCR; they will be addressed in next year's AMCR.)

The ISAP recognizes that the AMCR should 1) provide analyses of available monitoring, research, and habitat-condition data and relate the available data to the performance of management actions that have been undertaken, 2) relate findings drawn from those analyses to whether program targets and objectives are being achieved, and provide a forecast of outcomes of potential future management-action scenarios, thereby informing the adaptive management component of the program's decision-making process, 3) describe candidate management options under consideration and their implications for the listed species and their habitats, for agency staff who will implement selected actions, and for stakeholders who may have concerns regarding the effects of those actions on "human considerations." The ISAP understands that the evolving adaptive management program is not yet fully operational and has not advanced to full implementation for either of the targeted species, hence the 2020 AMCR cannot be expected to meet those three criteria in full. Accordingly, the ISAP in this review is looking for progress by the USACE toward a transparent, structured adaptive resource management program that is responsive to the species' immediate and long-term ecological needs, with presentation of new information developed under the Missouri River Recovery Program, reflecting where appropriate the concerns of the many stakeholders in the Missouri River basin.

The ISAP in its task statement was reminded by the USACE of the sourcing and objectives of the annual AMCR -- "The Technical Team performs necessary data analysis and synthesis to evaluate action effectiveness," conducting "additional analyses as directed by the ISP Manager and as approved by the Senior Program Manager," with results intended to meet four primary report objectives. They are to "(1) provide an analysis of monitoring data, especially pertaining to performance of actions relative to the targets, objectives and goals of the MRRP; (2) provide a forecast of outcomes of future management scenarios; (3) outline recommendations for managers and stakeholders; and (4) provide a review of the status of the science, including current published and unpublished research results relevant to management."

That noted, consequential information beyond the documents provided to the ISAP for review has been presented in multiple web-based meetings that focused on the ongoing adaptive management efforts. The draft 2020 Adaptive Management Compliance Report was accompanied by three webinars held on 9 and 12 March 2021, focusing on lower Missouri River basin pallid sturgeon, upper Missouri River basin pallid sturgeon, and piping plover, which provided opportunities "to hear about the draft 2020 AMCR structure, selected findings with strategic implications, and possible strategic questions for the AM Workshop; and to raise clarification questions on the draft AMCR content and identify additional potential key topics and strategic questions for consideration during the AM Workshop" (from RESOLVE emails announcing the webinars). Those webinars were helpful to the ISAP in pointing to essential components of the AMCR, identifying points of emphasis, and providing an opportunity for the ISAP to get clarification on a number of AMCR issues. Questions posed to the webinar presenters by engaged MRRIC participants were valuable in conveying stakeholder interests, which were considered in this review.

Additional information related to adaptive resource management under the Missouri River Recovery Program was offered in three MRRIC-hosted workshops labeled *Upper Basin Fish and HC Discussions, Lower Basin Fish and HC Discussions Targets, PSPAP, and Tradeoffs/Priorities Discussions* convened as the Adaptive Management Workshop, 7-9 April 2021. Those meetings were intended to **"**Explore management options building on the draft 2020 Adaptive Management Compliance Report (AMCR); assess implications for the MRRP's strategic direction (particularly for 23 and beyond), and for defining the priority information that would support future decision-making; discuss tradeoffs and priorities for implementation and strategic direction given current budget context; and provide opportunity for ISAP (and other participants as time permits) to ask technical questions of USACE and Technical Team based on review of draft 2020 AMCR" (from the Resolve workshops agenda).

That set of meetings was preceded by an *AM Workshop Pre-Session: IRC Conceptual Effects Pathways Discussion* on 29 March 2021, described as "One of several responses to ongoing stakeholder concerns about potential impacts of IRC projects on HCs"… in particular "2019 MRRIC HC WG Strategic Plan Recommendations 16, 17 from MRRIC and ISAP to explore hypothesized effects of IRC projects on HCs." The meeting's purpose was to allow the USACE to "more explicitly describe the links between monitoring activities and specific HC concerns," with the intent of providing "transparency and improved quality of discussions with HC Work Group," and consistent with adaptive management promising "periodic improvements over time following ongoing stakeholder engagement and technical discussions."

The USACE set the draft 2020 AMCR in context for the 2021 review – "Following the ISAP's review of the 2019 AMCR, the Technical Team and agency staff restructured the AMCR and discussed the revised structure with the ISAP and MRRIC and those changes are reflected in the draft 2020 AMCR. Revisions included organizing the report by management action, integrating HC information by management action, increasing clarity on current location in the AM cycle for each action, and in clearly distinguishing information specifically related to adaptive management needs from the broader ESA compliance reporting. In addition, beginning with the 2020 AMCR, reporting has an alternating year focus beginning with pallid sturgeon. Therefore, the draft 2020 AMCR will be focused on information to support programmatic AM decision-making for pallid sturgeon and information to support strategic plan level decision-making for management actions for the piping plover; the reviews will consider the full report each year in this context."

Whereas the 2019 AMCR challenged the ISAP's review process with its formatting and emphasis on compliance, the 2020 AMCR organizationally is on point. The 2020 AMCR is arranged into three sections -- a compliance section, and "adaptive management for birds" and "adaptive management for fish" sections. The two species sections are organized by management actions, catalogue ongoing scientific efforts, offer model predictions, and describe the "state of the science" and learning that is pertinent to the adaptive management effort. The information and order that is conveyed in the 2020 AMCR made addressing the USACE task questions reasonably straightforward. The USACE has made the 2020 AMCR accessible and readily reviewable. And, as noted above, the 2020 AMCR initiates an every-other-year emphasis on each of the two species – this year the pallid sturgeon is emphasized. The ISAP supports the annual bifurcation of adaptive management reporting but acknowledges that it is not yet clear how the material presentations should accommodate species information transfer differently in the "on years" and the "off years." Moving ahead, the ISAP requires a clearer understanding of what information to expect (and not expect) in the report for each of the species for "on" and "off" years.

The ISAP has not met in person as a panel in more than a year and a half. Given the lack of face-to-face interaction on this work product and time constraints in providing this AMCR review, the ISAP acknowledges that this report is not a fully resolved consensus document. It should be understood that some of the material observations in both species sections of the review may not have been agreed to by the panel as a whole. In that light, the observations herein are offered as points of departure for further discussion in this pathbreaking and evergreen adaptive management planning process under the Missouri River Recovery Program (MRRP). The issues advanced in this review should be considered as part of an ongoing dialogue between the ISAP and the USACE and its technical teams. In that light, material observations in his review report, as in previous reports, should be viewed as advisory, not prescriptive. The ISAP understands that at least a few of the observations and recommendations below may not be actionable, at least in the near term, due to staffing and/or budgetary constraints.

Piping plover – questions and responses

1. *Does the draft Adaptive Management and Compliance Report (AMCR) provide the information necessary to evaluate the effectiveness of each management action given each action's (current) status in the adaptive management cycle (that is, in plan and design, implement, or monitoring phases of the cycle)? For each individual management action please identify any analyses, modeling outputs, or data summaries that should receive more or less emphasis or explanatory detail in the report, given the current status of the management action in the AM cycle.*

The 2020 AMCR, a product of even-numbered-year reporting, is limited to summary information on piping plover (in its Chapter 2) accompanied by monitoring results and related analyses (in appendices). The prescription for adaptive management for piping plover is for a *process*, not specific actions, because, the program is itself adaptive. To evaluate adaptive management efforts targeting the plover, we need to know what was done, why it was done (linking to the SAMP), and what benefits were realized from actions undertaken. The authors of the AMCR have not clearly stuck to that tasking in the bird sections of the report; we encourage additional discussion with the ISAP to make this AMCR, and importantly the next AMCR, even more on task. The listing of hypotheses found in the Appendices to the 2020 AMCR (section 2.1.3.2) is useful. The hypotheses are referred to in the data analysis sections of the document and provide an essential link from the data analysis section to explanations of hypotheses under consideration. In the same light, the section on uncertainties (Table 2.5), and linking actions with certainty, are also useful and provide the reader with an informative narrative describing the difficulties of assessing AM approaches for plovers and terns. The summary of performance metrics (Table 2-1) is likewise helpful in summarizing the basic habitat, population growth, and fledge ratio compliance metrics.

Those text sections stop short of making a clear link to adaptive management needs. Specifically, linkages between Emergent Sandbar Habitat (ESH), population trends, and management actions are not fully developed in the AMCR text and no integrated analyses are presented. The relationships between ESH, population growth, and fledge ratio are not explored in an AM context. Furthermore, those three metrics suggest that population growth rate is responsive to ESH via immigration/emigration rather than local reproductive success (manifested as low fledge ratio). For example, the ESH targets are met and that indicates that habitat management is not needed in the near future. The population growth rate was met in 2020, but is still below the 3-year target, and the notion that lambda more than doubled in a single year suggests that immigration played a substantial role. The fledge-ratio was not met during any year in the reporting period, which indicates a need for some management action -- perhaps predator control -- to reverse trending low ratios. The findings suggest immediate AM attention should be directed to local reproductive support in the forms of nest predation control and human access restrictions to prevent nest disturbance. Uncertainties for both predator control and human restrictions are substantial given large gaps in knowledge resulting from the limited monitoring/monitoring effectiveness in both cases. A single table where benchmarks are clearly linked to AM needs is needed. That link is addressed in Table 2-2.

The adaptive management material for piping plover (Section 2.3) summarizes the basic AM process, actions completed in 2020, details about each management action, and impacts to Human Considerations (HCs). The primary function of the AMCR is to describe how monitoring data specifically link to one or more planned management actions. That essential summary in Table 2-3 is useful but is incomplete and does not clearly link each specific management action to a species need that is identified during monitoring. Note that that summary is redundant with the somewhat more useful summary in Table ES-1 that is presented in the report introduction. More specifically, the lack of need for sandbar construction and augmentation actions is justified because ESH targets were exceeded. But justification for vegetation management in two river segments and for nest and chick relocation and predator removal is missing. Also missing are the specific monitoring findings that prompted those management actions. An effective and transparent AM plan should describe specific links between monitoring data and management actions. The 2020 report doesn't meet that objective.

The individual management actions for the piping plover are unevenly described in the report. The information on ESH is covered well, including the current state of ESH, projections for future ESH needs (from models), and an evaluation of ESH future conditions under different hydrological scenarios. However, comparable levels of detail are missing for other management actions, including mechanical and herbicide treatments to maintain ESH, nest relocation, and predator management. A balanced presentation of all management actions is needed in the report. The main AMCR report should include essential information necessary to understand the AM actions that were taken and why they were taken. Some essential material information on piping plover that is relevant to AM reporting is currently sequestered in the appendices.

The ISAP observes that monitoring of potential HC implications received minimal specific coverage in the report. The primary management action undertaken for birds in 2020 was vegetation management using herbicides. Associated monitoring with HC implications focused on related water quality. This monitoring is done annually and shared with stakeholders. The monitoring this year, as in past years, found no significant difference in water quality before and after herbicides were sprayed. The post-herbicide application water quality metrics were substantially below the water quality standards developed to protect human health and aquatic life. Continuing that water quality monitoring and reporting is recommended.

2. *Does the draft AMCR adequately forecast expected (future) outcomes of ongoing or potential management actions for purposes of decision making in the adaptive management process?*

Expected future outcomes of management actions are addressed in the AMCR in Section 2.5. The focus is on the need for ESH construction using period of record (POR) hydrological conditions to determine the amount (in acres) of ESH construction needed during a seven-year period. Forecasting under four water scenarios indicates no immediate need for ESH construction; however, some construction may be needed in the (near) future if dry regional conditions persist. The AMCR might provide a clearer link between the need to create degraded ESH and when to create new ESH. If models indicate that conditions do not require creation of new ESH -- as in 2020 -- what conditions call for herbicide or other treatments to be used on degraded ESH? Can conditions be identified (decision criteria) when mechanical treatments to restore degraded ESH might be used instead of creating new ESH, and incorporate that information into the report? Forecasting for other management actions is not summarized in this section, leaving relevant questions unaddressed – for example, what motivates the need to manage flows for plovers? What key parameters are being monitored and discussed during weekly calls? And, what are the decision points that result in (a) a decision to leave flows as they are, versus (b) a decision to move nests? Effective AM can only occur when there are clear and objective decision criteria; in the absence of clearly articulated decision criteria the management can only be described as *ad hoc*.

Implementation of the "hybrid monitoring plan" (Section 2.4.3 in Appendix) has been delayed with a revised plan to implement it in 2022. That delay in planned implementation is unfortunate, because a well-designed monitoring plan is the cornerstone of adaptive management. The ISAP reviewed the *Monitoring Plan for Piping Plovers* (*Charadrius melodus*) *on the Missouri River* (dated 15 October 2019) and received no response to any of the panel's observations, suggestions, and recommendations in that review. Furthermore, no methodological changes were made to the tern and plover monitoring protocol in 2020. The panel is concerned that a monitoring re-design is underway that is not addressing concerns registered by the ISAP more than a year ago. That ISAP review needs a response in some MRRIC program venue. In the meantime, the panel notes a large variance component associated with fledging counts that is inconsistent over measures of plover and tern density (adult pairs/acre), possibly resulting in some underlying statistical issues with model fitting and prediction. The panel is uncertain if the hybrid monitoring plan will address the inconsistency. The ISAP looks forward to a technical discussion of the planned hybrid monitoring approach and questions in advance whether the approach is likely to increase the sample of fledging pairs at high density. The ISAP further observes that the plover and tern AMCR section does not provide a discussion related to the effectiveness and efficacy of current monitoring methods in supporting AM goals. A discussion of survey design aspects that can be improved, data needs to support the AM process, and sample-size sufficiency belongs in the AMCR.

Without delving deeply into the data-collection methods, the panel has discussed several points pertinent to monitoring that would offer potentially valuable subjects for discussions with the piping plover technical team. As an example of issues of concern, the panel observes that the plover and tern negative binomial models in AMCR Figures 2-16 and 2-17 show a decreasing relationship of production versus density. Examining the graphics, it appears that that decreasing trend may be due to 3 or 4 observations in the high-density range. Removing these influential observations could result in a relatively flat relationship between density and production, and therefore would change the conclusions in the text. From a statistical perspective, when the data set has a highly varying variance over the range of the independent variable (in this case density) there could be issues with quantifying parameter uncertainty (see the confidence limits on the graphics) and accuracy of parameter estimation. Examining the graphics, clearly there are more observations at lower density, which display a large variance. At issue is one of sample size at high density, and whether the actual variance in fledging production is captured with a small number of observations. We understand that the model parameter P_i is useful in that it addresses the number of pairs observed at each site, but the parameter does not account for a lack of sufficient sample size or possibly representative samples at high density. The technical team should address these issues as a monitoring design challenge and examine the ability to obtain representative and consistent adult and fledging counts over the full range of bird densities.

Another challenge in managing piping plovers under the MRRP is the disconnect between the species' life history attributes and the program's planning area. Life-history theory provides a valuable lens through which species can be examined, including its basic survival and reproductive strategies, and its potential for persistence. The plover is a relatively long-lived shorebird (the mean lifespan of an adult is >5 years), thus it has multiple opportunities to reproduce during its lifetime. The cumulative breeding attempts of each adult require that the number of young reaching adulthood is ≥1 to maintain or increase the size of the population. During the lifespan of an adult there can be multiple years when breeding is unsuccessful, or not attempted, and yet birds still replace themselves, a strategy that is well adapted to a stochastic riverine sandbar system like the MRRP region. Such a view of the species and its persistence on the landscape has not been well represented in discussions about bird-focused AM actions and that has led to the view that static population benchmarks (fledge ratio, lambda) are sufficient to characterize status of piping plovers on the Missouri River. Future conversations on this topic, including new information on the species' movements in the Northern Great Plains (NGP) region, would prove insightful.

The ability of the draft AMCR to forecast expected future outcomes and needs for potential management actions remains limited by the lack of future climate-change and land-use-change-driven flow scenarios. The five modeled management scenarios in Section 2.5.2 provide useful ESH management need predictions for categorical flow conditions (wet, dry), but the probable occurrence of these categorical conditions is unknown given the lack of any climate change/land use change driven flow scenarios for the basin. In essence, the AMCR forecasts what to do if a year is wet or dry but does not forecast the relative frequency or magnitude of these categorical states. The forecasting does not consider scenarios, such as (a) a basin-wide shift to increased flow magnitudes that require less frequent ESH intervention, (b) conditions with prolonged droughts forecast that would require more ESH interventions, and (c) how either scenario would be offset by or interact with flow regime consequences for lake shoreline habitat versus in-channel ESH. The lack of future-casting prohibits longer-term strategic management resource positioning. Section 2.5.3 outlines how management resource planning could happen if a better understanding of flow regime probabilities was available. For example, no sandbar construction, augmentation or modification was planned for 2020 given the ESH by high flows (a wet scenario) in 2018 and 2019 (see Section 2.3.1). What is needed to support this decision is the probable frequency and duration of dry intervals that would trigger ESH interventions. It is important to emphasize that the POR is largely representative of conditions no longer present in the basin, given dramatic land use changes (including tile drainage) and climate changes that have occurred during the POR, and particularly because it excludes observed flow regimes from 2012 onwards, the time period most representative of current and likely future conditions.

3. *Does the draft AMCR describe ongoing and potential management actions and their implications, including challenges and uncertainties likely to be encountered, as they*

pertain to: 1) status and trends of the listed species and their habitats; 2) agency staff and partners who will implement selected actions and monitor them; and 3) stakeholders who may have concerns regarding the effects of those actions on "human considerations"?

Response comments regarding program ongoing and potential management actions and their implications are presented as follows:

(1) Regarding the status and trends of the listed species and their habitats -- the report includes a reasonably detailed summary of the status and trends of the plover and also for ESH; however, there are no clear links between them. Performance metrics are presented in Section 2-2, while management actions are in Section 2-3. The only mention of a link is in Table 2-4 under "Current state of knowledge," where the general relationship between a management action and a population metric is stated. Uncertainties are not addressed.

(2) Concerning agency staff and partners who will implement selected actions and monitor them, the topic does not appear to be addressed in the AMCR or supporting appendices.

(3) In reference to stakeholder concerns regarding the effects of those actions on "human considerations" -- the topic is only briefly addressed (Section 2.3.8) in the context of each management action and implications for HCs, although this is possibly due to the lighter reporting for birds in an even-numbered year. As outlined in this section, in the absence of adequate monitoring, adaptive management cannot proceed effectively. There appears to be a significant disconnect between recreation interests and species management strategies. Greater coordination between agencies is required to develop adequate AM strategies regarding human-generated disturbance/destruction of nests and to assess the effectiveness of alternative strategies and impacts on both birds and recreational access. Signage restricting human entry into tern and plover nesting areas was posted in all river sections in 2020, but its effectiveness in preventing or discouraging visitor use was not formally monitored. Anecdotal information based on bird and fish work-crew observations indicates that signs had little effect on visitor use – signs are ignored. Thus, human impacts are likely to occur, but their magnitude remains to be quantified.

Model predictions can be presented in a number of forms. Incorporating uncertainty in model predictions, including using the probability of meeting or exceeding a target, is a defensible approach. However, presenting in the AMCR additional detail on how the probability of exceedance is computed would be valuable. That presentation should include information on (a) what is represented by the probability, and does it include model parameter uncertainty, (b) whether the probability is derived from simple scenario testing, and (c) whether Monte Carlo approaches are used. While using the probability of exceedance is useful and informative, it is difficult to understand without further explanation what is behind the concept of a "chance exceedance." The AMCR should identify the variance components that are included and specifically excluded in these computations. The technical team should identify the key model parameters that are dominating the resulting exceedance probabilities and indicate whether those parameters can be accurately estimated in an AM framework.

4. *Does the draft AMCR provide an updated review of the (current) status of the listed species and their habitats, and the adequacy of information from research, modeling, and monitoring to make real time decisions in an adaptive management framework (including information from published and unpublished sources)? Does the draft AMCR describe how the available scientific information has been and will be used in programmatic adaptive management decision-making?*

The AMCR provides a brief account of the species' current status, as well as updates on recent research activities. The most important new finding is that plover movements exceed previously estimated rates. Until recently the Missouri River has been assumed to involve a mostly "closed" population of piping plovers with limited rates of emigration and immigration from adjacent alkaline wetlands. As such, the adequacy of information to guide management actions on the river largely depend on local (riverine) monitoring data. A recent mark-recapture study of plovers has revealed greater rates of immigration and emigration than previously documented. Those findings have important implications for AM actions that might be undertaken on the river and for interpreting piping plover monitoring data from the river and reservoirs. Data indicate that plovers may emigrate from the Missouri River during periods of poor habitat conditions and immigrate to the river when habitat becomes abundant. It will be critical for the technical team to determine how to best account for this net migration in annual trend data. For example, what are the relative contributions of immigration and *in situ* reproduction to population growth in the years following a major flood event? Similarly, how will plover population "declines" several years after major flood events be interpreted – as a true decline in the local population, or as a temporary decline until the next flood event? The implications of the USGS piping plover movement study in the NGP are evident throughout the report. The 35% increase in adult plovers in river habitat from 2019 cannot easily be explained on the basis of local reproduction, and a similar argument can be made for the more than 3-fold increase in population growth rate during the same time period. This indicates that future AMCR reports will need to consider the implications of plover movements to and from elsewhere in the NGP when interpreting demographic changes on the Missouri River. Note that if habitat metrics are good, as represented in Table 2-1, why then is the population not meeting recovery goals for both lambda and fledge ratio?

The choice of a negative binomial distribution for the sampling distribution of observed numbers of fledglings might be reconsidered. Generally, a negative binomial is used for highly variable count data, as noted in the AMCR, or to address issues associated with a high proportion of zeros in the data set. Samples resulting in zero fledglings are not seen frequently in the illustrations (e.g., Figures 2-16 and 2-27), which stimulates the question of selecting the negative binomial. Is there evidence that the expected mean and variance are not equal (that is, assumptions from the Poisson distribution)? The technical team should provide the biological reasoning for this conclusion. The choice of the underlying distribution could change the resulting model and possibly change model predictions and their interpretation.

5. *Does the draft 2020 AMCR adequately address issues that were daylighted in ISAP's review comments on the draft 2019 AMCR? Are there further refinements to the structure of the 2020 report which would better serve the information needs of programmatic adaptive management targeting the listed species and their habitats?*

(Note that the bird chapter in the draft 2020 AMCR does not incorporate all of the ISAP's recommendations in its review of the 2019 AMCR; they will be addressed in next year's AMCR.)

Ideally, the AMCR should be a concise, stand-alone report that presents all essential information for a reader to readily access including (a) the current status of the affected populations, (b) recent trends in those populations, (c) the suite of management actions that was considered, and, importantly, (d) what management actions are planned on the basis of specific population criteria. The current AMCR is still too lengthy to meet this goal, and some essential information is buried in appendices. Continued refinements to the structure of the report are needed.

The panel's 2019 AMCR review provided some explicit suggestions for the 2020 AMCR (see page 4 of the review for details). The 2020 AMCR structure reflects some, but not all, of the ISAP suggestions. The current report organizes the adaptive management reporting by management action -- eight of them documented in Table 2-3 -- although as noted previously, that table is missing essential information for some actions. This review recognizes that the 2020 AMCR is an even-numbered year report and lacks certain information on the AM cycle for the piping plover that should be more fully reported in 2021. Material information on adaptive management for piping plover was found in two sections of the report, which was confusing and seems unnecessary. The primary material was in Section 2, especially on pages 31-37, while a concise summary of the AM actions was found earlier in the report in Table ES-1. This presentation should be consolidated to a single section in future reports (executive summary information might be repeated, leading off the bird section itself). The AMCR should include a single table that links basic reporting metrics -- ESH, fledge ratio, population growth -- to planned AM actions and activities in the coming year. If this had been done in Table 2-1, the need to create ESH could have been eliminated and the focus of the text shifted to management actions to maintain habitat and meet predator control needs in 2021. The Panel recommends meeting with the authors of the AMCR to revise, refine, and streamline future AMCRs.

Pallid sturgeon – questions and responses

1. *Does the draft Adaptive Management and Compliance Report (AMCR) provide the information necessary to evaluate the effectiveness of each management action given each action's (current) status in the adaptive management cycle (that is, in plan and design, implement, or monitoring phases of the cycle)? For each individual management action please identify any analyses, modeling outputs, or data summaries that should receive more or less emphasis or explanatory detail in the report, given the current status of the management action in the AM cycle.*

An emerging concern among the ISAP involves the implementation design of IRCs and their spatial juxtaposition to spawning habitat; spatial considerations in the placement of Interception and Rearing Complexes (IRCs) have not been fully integrated with the life-history attributes of age-0 pallid sturgeon. IRC related hypotheses should be revisited in light of recent scientific studies and ongoing hydro-geomorphic and biological sampling efforts that identified natural “hot spots” for pallid embryo collection. For example, Hypothesis 19 (H19), states that IRCs “… serve specifically to intercept and retain drifting free embryos in areas with sufficient prey for first feeding.” Recent studies, in both the field and laboratory, show that survival and growth during the free-embryo stage is strongly dependent on remaining in the drift during growth and development, prior to exogenous feeding. During the negative rheotactic phase of larval development, larvae orient head-first as they drift downstream at rates congruent with water velocities (Braaten et. 2008). As larvae develop feeding functions and (actively) settle to the river bottom, they change their behavior by orienting head-first upstream (in positive rheotaxis) to begin searching for and feeding on prey (Mrnak et al. 2020). In fact, in extremely low- to no-velocity environments, free embryos will increase their swimming activity in an effort to re-enter (or maintain their position in) the drift. The acts of drifting and settling are distinct behavioral phases of larval sturgeon and by linking spawning and IRC channel habitats to the life-history attributes of age-0 pallid sturgeon, these important management actions will be better served.

The functional role provided by IRCs and how IRCs should be oriented or placed adjacent to known natural or constructed upstream spawning areas requires further discussion. Information highlighted in the AMCR and discussions during the AM workshop seem to be steering IRCs in a different and better direction as management actions. With just 2 of 12 planned IRC structures implemented at this point in the MRRP, discussions toward strategic refinement of spatial considerations for this management action is timely. Efforts to learn more about the hydrologic circumstances and habitat conditions where exogenously feeding age-0 sturgeon are collected (so-called “hot spots”) will provide foundational information toward improving IRC design and help elucidate why IRCs should be included as an important, targeted management action that is spatially linked to known or constructed spawning habitat. The challenge will be in determining where and how to construct them and how to refine the implementation design. IRCs should be located so they align with [known] upstream spawning areas where embryos first emerge and begin their downstream drift phase. Information on temperature-dependent development can be combined with mean water velocity downstream of spawning areas to estimate drift distance (km) as a means for identifying approximate settling areas for exogenous-feeding larvae (Bratten et al. 2008). Similarly, upper basin and lower basin larval drift studies can provide important insights into the spatial relationship between spawning locations (e.g., in this case, release sites of 1-2 dph fish) and downstream rearing locations where EFL are collected. ISAP also notes that ongoing advection/dispersion modeling efforts has high potential to inform effective IRC placements.

While anticipating further discussion of spatial issues in identifying IRC locations, the ISAP recognizes that the programmatic assumptions, enabling equations, model descriptions, and approach to assessing the utility of IRCs as currently considered are well written and readily understood. Many of the issues that arose during the Fall Science Meetings in 2020 are discussed and addressed in the AMCR narrative. Table 3-16 is informative, displaying the overall survival rate from EFL to age 1 (S_1). It should be possible to take a successful scenario (defined as achieving an S_1 of 22%), and expert judgement (noting that data are not currently available) to establish a confidence range on the value. At issue is whether the estimates are conservative or not. While a relatively high interception rate is required to achieve the 22% overall survival-rate goal with 12 IRCs, depending on uncertainties and based on best professional judgement, a smaller number of IRCs might be sufficient to meet program goals. The AMCR mentions that it would be valuable to reduce uncertainty in the estimated fraction of EFL intercepted at each IRC, possibly through additional modeling or monitoring. The ISAP agrees that such an effort could be useful and could aid in an uncertainty analysis of this key demographic parameter.

Just two of the 12 planned IRC sites – at Moberly Bend and Searcys Bend -- have been constructed and no construction occurred in 2020 given the prohibition in Section 1226 of America's Water Infrastructure Act of 2018. No new spawning habitat projects were planned or constructed in the 2020 reporting year. The USACE and USFWS are in discussions to determine whether spawning habitat construction remains a priority given evidence of successful, albeit limited, pallid reproduction in the lower Missouri River. However, the AMCR provides a detailed description of the plan for evaluating IRC effectiveness (see Section 3.3.3 Channel Reconfigurations for IRCs, Lower River) as well as HC impact evaluation using a study design with control-treatment comparison reaches. Regardless, evaluating the effectiveness of management actions in the Missouri River is likely to be presently limited and may require using shovelnose sturgeon as a surrogate species in assessing IRC performance, although the validity of a surrogate relationship between the two sturgeon species has not been fully tested (but see Gosch et al. 2018). This surrogate issue requires an examination of the existing survey design, with the objective of optimizing sampling effort to provide the greatest return per investment. Statistically, this means exploring survey designs that maximize the ability to catch 0/1 age fish and adults, if they are in fact located in the sampling area.

The AMCR would be strengthened with discussion of the sufficiency of current monitoring and modeling activities to support the AM decision-making process. The monitoring in support of the AM program attempts to provide data in support of statistical descriptions of population status and to some extent trends; the monitoring also provides data to support the development and implementation of population models. It remains to be demonstrated that current survey designs are equally effective in supporting both statistical descriptions and modeling. If the emphasis is on statistical characterization of population dynamics, current monitoring should further consider and possibly revise and refine survey design in relation to sampling uncertainty, minimizing non-detects (where, for example, fish occupy the sampled area, but are not collected by current sampling procedures), representative sampling of known habitat, and alterations in environmental conditions that can influence sampling effectiveness.

If the emphasis of monitoring is to provide data to support the population modeling effort, further attention needs to be given to survey designs informed by specific parameter estimation requirements and directed towards increasing accuracy and precision in estimated parameters. The main point is that a single survey design might not prove sufficient to support statistical and modeling descriptions of population dynamics, particularly dynamics in relation to implemented management actions. The monitoring might realistically require multiple sampling approaches and methods of data analysis, each focused on specific questions including for example trend detection or spatial distribution and abundance.

Continuing this line of inquiry, the ISAP has previously suggested that stratified random sampling may be a useful approach for improving pallid sturgeon monitoring. However, after extended reflection, the ISAP believes the stratified design may have underlying statistical properties that should be considered and studied prior to implementation. Stratification serves to minimize overall sampling variance associated with the population mean. However, if appropriate strata are not selected, and the statistical weighting of these strata is in error, the resulting population estimated mean will be biased and the estimated population variance will be incorrect. For example, the Missouri River CPUE sampling could stratify on the lower and upper basins. But that stratification implies complete random sampling over a large span of river miles. The current approach of sampling bends is inefficient, and can produce zero-dominated data sets, either by incorrect location selection or inadequate sampling methods. Resulting population estimates are difficult to interpret; for example, is a zero representative of no catch, but the fish are in fact present, or is zero an accurate measure of true fish absence? For stratified random sampling, underlying theory concerning unbiased conversion of the sample mean to the population mean does not hold. In stratified random sampling, each fish in a stratum must have the same probability of detection, or again the population estimates will be statistically biased. For a rare event (e.g., catching an age-0 pallid sturgeon), the underlying theory of a stratified random sample again does not hold. A panel survey was outlined as a possible alternative approach in the AMCR. While this approach reduces effort and cost, the panel survey does not directly overcome the above statistical issues.

Finding an ideal survey design that is sufficient for all of the AM questions of interest will be difficult. It's possible that each question of interest may require a separate approach, which may include surveys designed to estimate specific parameters in a population model(s). Or, for a specific statistical model, a formal model-based survey may be optimal. The ISAP recommends a technical working group be created to work through these design issues. To facilitate discussions, the ISAP recommends that monitoring data used to support population analyses and conclusions in the AMCR be made readily available, either as an appendix to the AMCR or electronically.

2. *Does the draft AMCR adequately forecast expected (future) outcomes of ongoing or potential management actions for purposes of decision making in the adaptive management process?*

The ability of the draft AMCR to forecast expected future outcomes of ongoing or potential management actions for purposes of decision making in the adaptive management process remains limited by the lack of flow scenarios that account for past and projected future climate and land use changes in the watershed. The 2020 AMCR begins with a discussion of basin conditions in the Missouri River noting that 2020 started with wetter-than-average conditions for the reporting year. Runoff into the reservoir system above Sioux City, Iowa was 31.3 million acre-feet (MAF) or about ~121% of average. Figure ES-1 illustrates that over the last 120 years, the four wettest years on record have occurred in the last nine years. Although not obvious from Figure ES-1, there is an important point to be made about the frequency and magnitude of high/low runoff events, which appear to be increasing in the Missouri River basin (Livneh et al. 2016; Figure 1). High flow conditions can constrain implementation of the MRRP and as pointed out in previous AMCR reviews by ISAP, may represent a new "normal" characterized by frequent wet and dry conditions owing to a changing climate (Cai et al. 2014; 2015; Wise et al. 2018). Conditions associated with high or low runoff events are important, as they can affect our ability to detect changes in monitoring metrics related to management actions.

While unpredictable, variable hydrologic conditions present an opportunity to learn about the role of environmental variation on pallid sturgeon growth, reproduction, and survival. Although not explicitly discussed in the AMCR, it is important to consider recent hydrological patterns in

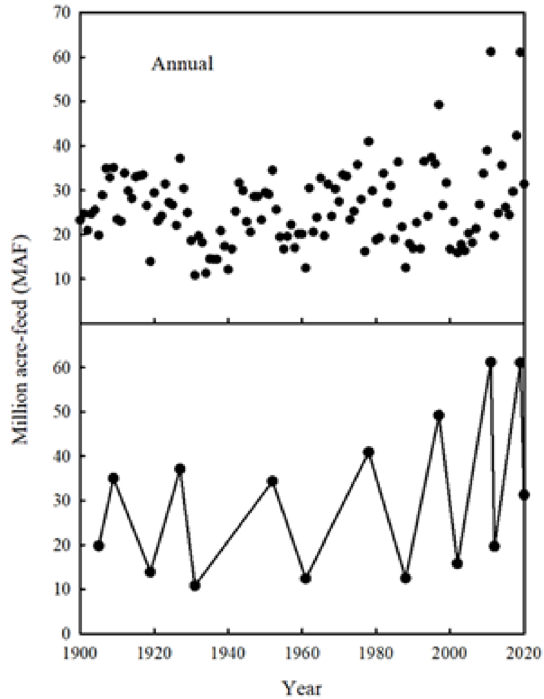

***Figure 1** -- Annual runoff from 1989 to 2020 above Sioux City (upper panel; data from Figure ES-1, AMCR report). Successive low and high annual runoff from 1900-2020 showing increased frequency and magnitude of annual runoff since the mid-1980s (lower panel).*

relation to the AM cycle. Consideration of how wet or dry conditions may influence effects analysis and decision-making should be included in describing each management action.

3. *Does the draft AMCR describe ongoing and potential management actions and their implications, including challenges and uncertainties likely to be encountered, as they pertain to: 1) status and trends of the listed species and their habitats; 2) agency staff and partners who will implement selected actions and monitor them; and 3) stakeholders who may have concerns regarding the effects of those actions on "human considerations"?*

Status-and-trend monitoring has a vital role in addressing pallid sturgeon management actions as they relate to Sub-objectives 1 and 2 of the MRRP. As pointed out in the AMCR, important challenges in adaptive management of the fish lie in identifying limiting factors associated with natural recruitment and the uncertainty associated with monitoring criteria (particularly CPUE of age-0/1 fish). Recent collections of age-0 pallid sturgeon document that natural reproduction is occurring in the lower Missouri River, although there is only indirect evidence of natural recruitment to age-1 in the lower river and no evidence in the upper river. The rarity of age-0/1 pallid sturgeon, combined with the challenge of collecting small fish in a large river system, make it difficult to quantify the abundance of pallid sturgeon at that age. The collection of naturally produced age-0 pallid sturgeon in the Missouri River provides evidence of reproduction, but because collection methods have varied over the years, the abundance of age-0 pallid sturgeon remains unknown. As outlined in PSPAP v.2, the standardized collection of age-0 and age-1 sturgeon should remedy this problem moving forward. The ongoing (successful) collection of age-0 pallid sturgeon, and the ability to monitor annual variability in their abundance is important. Abundance of age-0 pallid sturgeon could represent a precursor for recruitment to age-1, providing information beyond documenting natural production in any given year.

A proof-of-concept for the IPSPM in PSPAP v2 established that that model could be an important tool in reducing uncertainty around estimated essential population parameters. The model can also provide survival estimates and identifying sustainable population size and other population attributes that could help refine MRRP targets for pallid sturgeon recovery. Currently the IPSPM is in early stages of testing and, as with all models, it is only as robust as the data used to drive it. In order to estimate survival and abundance for young pallid sturgeon (< age-4), the model will require input from on-going monitoring data related to the catch and abundance of age-0 to age-4 fish. Beginning in 2020, recaptures of hatchery-released free-embryos in the lower and upper Missouri River will be used to estimate survival to age-1 for pallid and shovelnose sturgeon (see AMCR line 1539). This approach could provide reasonable survival rates to age-1, with the caveat that survival estimates are based on early life-stage fish (1-2 days post hatch -- dph). Previous efforts using 1 to 17 dph fish have been confounded by using genetically similar fish from the same parental stocks, bringing into question the relationship between age at release (dph) and survival to age-1. Until naturally produced age-1 to age-4 fish are collected from the Missouri River, the relative (or absolute) abundance of those pallid sturgeon needs to be monitored by trawl sampling (see SAMP Appendix D). The ISAP agrees with the statement in the AMCR (line 1434) that "…further work needs to be done on applying the IPSPM to PSPAP data."

An important attribute of the current monitoring index (CPUE) is that it represents a real-time measure of relative pallid sturgeon abundance; however, as pointed out in the AMCR (line 1903), CPUE can be affected by sampling conditions (e.g., water flow and temperature), which may mask actual changes in absolute fish abundance due to changes in the catchability of fish (q), defined as the proportion of fish captured per unit of fishing effort. High water flows, for example, can reduce capture efficiency owing to increased water resistance in the net and(or) greater trawling speeds in swift water. As a result, relative fish abundance (CPUE) can vary even though actual fish abundance remains unchanged (Figure 2). High uncertainty in CPUE is not a desirable trait for a monitoring metric aimed at evaluating management actions. Although there is uncertainty in all measures of fish abundance, absolute abundance would be a more desirable metric than CPUE as a population monitoring index. Correspondingly, PSPAP (v.2.0) outlines replacing legacy CPUE data with absolute abundance estimates for juvenile and adult pallid

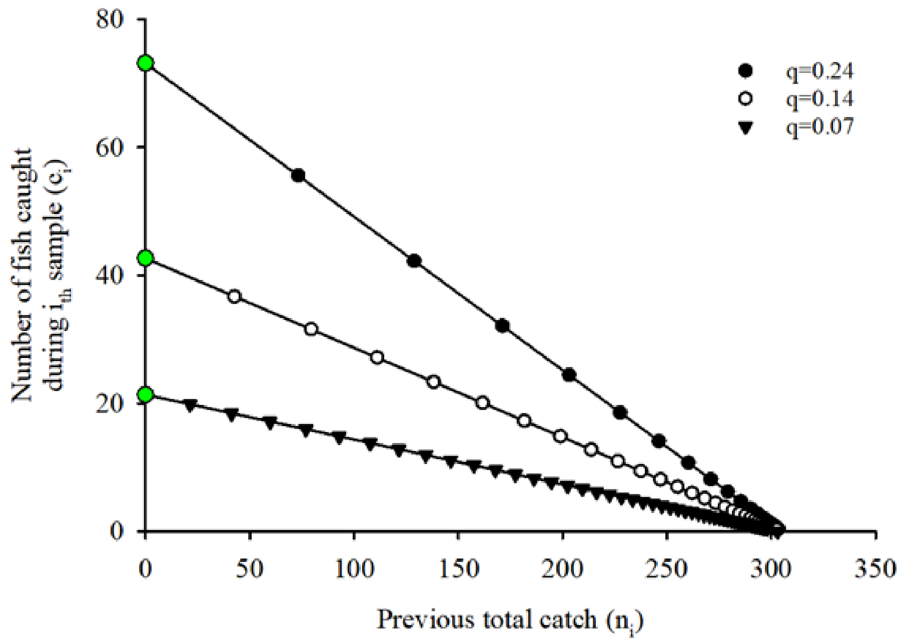

Figure 2 -- *Influence of catchability on catch-per-unit-effort (CPUE). The above graph shows hypothetical CPUE estimates of 73, 43 or 22 (green circles on y-axis) based on catchability coefficients of 0.24, 0.14, or 0.07 respectively. These CPUE estimates might be derived from a single trawl sample during three different years with varying flow conditions. Without knowing catchability, we would conclude that our estimate of fish abundance (CPUE) varied 3.3-fold, ranging from 22 to 73 fish/km trawled, despite the fact that absolute abundance of fish at this site (N_t=305) did not change over the three sample years.*

sturgeon based on mark-recapture and telemetry data. Given the importance of sub-objective 1, the same should be considered for age-0/1 pallid sturgeon sampling. Knowing the relationship between age-0 and age-1 sturgeon abundance has important implications for factors affecting recruitment (e.g., depensatory/compensatory effects). There are a number of methods that might be considered for estimating absolute abundance of age-0/1 fish. Traditional approaches with trawling gear rely on depletion-based sampling. The Leslie method, among others, provides a simple approach based the relationship between catch (Y_t), q, and initial population size N_t that can be expressed as a linear regression model

$$Y_t = qN_1 - qX_{t-1,}$$

where Y_t is catch at time t, the intercept value (a) is given by qN_1, and the slope (b) given by -q (or catchability). The X variable (X_{t-1}) represents the cumulative catch taken prior to time t. Absolute fish abundance at a site can then be derived as qN_1 / q (see Hilborn and Walters 1992). Other approaches for estimating catchability might rely on the use of hatchery fish where a known number of exogenously feeding age-0 pallid sturgeon (~20-25 mm) are released and subsequently resampled, as in the age-0 survival studies but with older fish. Because these fish can be identified from genetic markers, their abundance (and catchability) could and should be estimated during different flow conditions using a mark-recapture approach.

Trend analysis should focus on changes in fish abundance or relative occurrence over time. When the survey design does not produce consistent and reproduceable catch rates, the ability to adequately quantify trend and separate it from background variability (noise) is dramatically reduced. However, the same issues that plague the survey design also effect model-based estimates of trend. Models rely on survey-produced data (e.g., survival rate) for estimating population estimates over time. Although expert judgement and assumptions can be incorporated into models, thereby making them easier to use for trend analysis, the certainty of the model predictions can be questioned without hard survey-specific evidence. As pointed out in the AMCR, any data collection for trend estimation is scale critical, and long-term population cycles require many years of data. One resolution for these issues is to create a specific and focused survey design for the purpose of collecting data specifically for trend detection. A historical evaluation of river segments and bends, with the purpose of detailing those areas with the most consistent catch, might be useful for identifying sites which can be sampled multiple times per year, and consistently over time. The "hot spots" already identified may suffice and increasing sampling frequency and effort at these locations may be useful in accumulating data for robust estimates of trends. Focused sampling may provide insight into actual trend. In any case, the practical aspects of implementing such an approach should be discussed and evaluated by a technical sub-group.

Occupancy and spatial distribution of age-0 fish: In the occupancy estimator example provided in Section 3.2.2.6, the 2019 occupancy estimate for Segment 4 ranged from 0.02 to 0.74 with a median of 0.21, but increased in 2020 (median of 0.61, with a range of 0.04 – 0.97). However, pallid sturgeon were not captured in the lower basin in 2019, even though the model prediction was non-zero. The text notes that in Segment 4 sturgeon were common in 2020, even though the expected occupancy ranges from almost zero to nearly 1. This issue is an example of the difference between model-based outputs and data-based estimates. And, this example points toward the need for the data-based estimates and the model-estimates to be simultaneously considered in the context of adaptive management. For example, positive model estimates of occupancy may provide insight into the selection of sampling sites for occupancy surveys. Positive catches of sturgeon should provide data for the continued refinement of model parameters and to decrease model prediction uncertainty. More to this point, discrepancies between occupancy and abundance approaches can be important. Environmental predictors of occupancy probability should not be assumed to be predictors of population abundance. Rather, understanding differences between factors controlling occupancy and those related to abundance can aid in identifying habitat needs of endangered species (Dibner et al. 2017).

Throughout the AMCR, there is a lack of coordination and interaction among models and data, and there is little discussion of decision-making from those two perspectives and approaches for resolving differences in findings. Long-term occupancy estimation may, like trend detection, require a focused set of sampling sites with increased sampling intensity and frequency than is currently undertaken. Whether or not trend sampling sites and occupancy sampling locations should be the same is an important question for the technical team to consider.

The 2020 AMCR is a substantial improvement over the previous 2019 AMCR in terms of describing the effects of current and potential management actions on human considerations (HCs). The accompanying Attachment 3A echoes much of the information in the main AMCR but provides more detailed information and evaluation concerning HC impacts. Attachment 3A also provides the basis for some of the conclusions reached in the main AMCR. The inclusion of summary IRC related information in tabular form in the AMCR (Tables 3-11, 3-13 and 3-13) greatly improves accessibility to the reader and the ISAP encourages development of similar tables for all HC concerns. Uncertainties in assessing impacts to HCs are acknowledged by the USACE in the AMCR tables or discussed in the text. The Panel commends the improved presentation and discussion of management actions in relation to HCs evident in the 2020 AMCR.

IRCs and Human Considerations

Section 3.3.3.3.2 within the AMCR evaluates HCs associated with IRCs. The section presents an improvement over the previous AMCR in describing the potential effects of current and future IRCs on HCs. Figure 3-26 provides a useful conceptual model of the potential impacts of the IRC management action on HCs and authorized purposes. The physical process assumptions that drive the relationships in this model are based on well-established river science. The AMCR clearly outlines the status of on-going investigations and monitoring regarding IRC impacts on HCs (Tables 3-11, 3-12 and 3-13). Continued monitoring as outlined in the AMCR is critical to understanding IRC implementation and will permit differentiation between the impacts of broader river dynamics versus HC impacts attributed to specific IRCs. For example, navigation restriction occurred at Searcys Bend in 2020, but it remains to be determined if this restriction resulted from IRC structures or other potential causes (e.g. 2019-2020 flood damage to the IRC and/or other river control structures in the reach). Related uncertainties are acknowledged on the contribution, if any, of the river training structure modifications at the Searcys Bend IRC to the narrowing of the navigation channel in 2020 below the required 300-foot minimum. There was also shoaling at the Searcys Bend control site, although not to the degree that it resulted in navigation concerns.

The AMCR and Attachment 3A focus on the physical properties that are the precursors to the HC's. Section 3.3.3.3.2 suggests that physical monitoring of the IRC treatment and control sites provides useful information for understanding HC impacts that could be occurring at constructed IRC's or that might occur at planned IRC sites. The USACE monitors river hydraulics, but not navigation itself. Similarly, the USACE monitors land erosion or water surface elevations, rather than their associated HCs. This focus appears justified. If there are no measurable changes to the physical factors associated with the IRCs, then there will be no change in HCs attributable to IRCs. If there is evidence of HC impacts at IRCs, then the USACE will assess the magnitude of the impacts. If the impacts appear significant, the USACE would "consider options for ameliorating the impacts." The Panel supports the continued examination of physical and hydrodynamic forces as they might impact HCs in relation to the implementation of IRCs.

The remainder of the ISAP review on potential impacts of IRCs on HCs is discussed in the following:

(1) The AMCR (Table 3-8) identifies the known structures (levees, agricultural drains, water intakes) and authorized purposes (navigation, recreation resources) at the two current and two planned IRCs. Each project has levees on one or both banks. There are fifteen agricultural gravity drain lines with flap gates on the levees, and two recreational boat ramps. There are no known cultural resources and no water intake structures. The current level of understanding is that IRCs will have no effects on these structures.

(2) The USACE recognizes the navigation restrictions observed for Searcys Bend in one occasion. However, the contribution of the IRC to navigation issues at Searcys Bend remains "unclear." The USACE is undertaking a detailed investigation to determine if there were other non-IRC features in Searcys Bend that might have contributed to this restriction. In addition, there has been one instance at Searcys Bend where channel velocity ("swift water") might have been problematic to navigation. The USACE is uncertain regarding the contribution of the IRC to these velocities and is investigating this potential impact as well.

(3) Table 3-12 indicates for river bends with IRCs that "erosion has been altered to an extent *beyond* those envisioned in the project designs". However, the specific contribution of IRCs to erosion appears to be minimal with a medium degree of confidence. There is no "anecdotal evidence of erosion causing problems for HCs." The USACE plans to use aerial photography in the future to measure changes in erosion. Table 3-12 also lists water quality factors that might be affected by erosion, especially if IRCs are determined to be one of the sources of this problem.

(4) Potential short-term impacts of IRCs on other species might occur during construction. No impacts are anticipated for piping plovers or least terns based on the MRRP-EIS. Brief increases in turbidity might negatively impact aquatic species. Potential short-term negative impacts on bald eagles and one species of bats might result from the removal of mature trees (Attachment 3A). Long term benefits to wildlife might accrue through land acquisition adjacent to IRCs and management of acquired lands to enhance wildlife habitat. One of the criteria for selecting IRC sites is to locate them adjacent to public lands where possible (Attachment 3A). Thus, there might be minimal land acquisition associated with IRCs. The overall conclusion is that IRCs will not significantly impact other fish and wildlife.

(5) The omission of hydropower and reservoir levels (and associated reservoir recreation) in Figure 3-26 reflects the fact that IRCs do not influence the quantity and timing of water releases from Gavins Point Dam.

Flow Management at Gavins Point Dam

The assessment of flow management at Gavins Point Dam provides an excellent example of anticipatory thinking in estimating the effects of a March and May pulse flow on HCs. In particular, AMCR Section 3.3.6.3.2 describes the opportunity to learn about potential HC impacts of these managed pulse flows based on similar sized actual high flows in the summer and fall of 2018. The discussion suggests how obtaining the 2018 data on flood damages might provide valuable insights on the potential HC impacts of similar-sized managed flows. Further, the 2018 data could be used to help calibrate the flood risk management models to build confidence with stakeholders about the adequacy of the models for predicting future flood related impacts. The AMCR also describes proposed meetings of the Technical Team and the HC Work Group to identify monitoring data (and data gaps) important in evaluating the impacts of flow management at Gavins Point Dam. The Panel encourages the continued evaluation of potential HC impacts based on insightful analysis of historical flow data. At the same time, the USACE should explore the implications of future alterations to historical flow patterns driven by the current climate crisis in relation to defining future opportunities to manage flows from Gavins Point Dam or assessing associated HC impacts.

Flow Management from Fort Peck Dam

The draft AMCR describes potential challenges and uncertainties associated with characterizing the potential economic damages to irrigation intakes from proposed flow management at Fort Peck Dam. There is greater uncertainty about overall effects of high flows on side channel intakes, because the number of intakes can change over time with natural or planned high flow events. The economic damages of a given intake pump being out of commission depend on the timing. If the pump is out of commission during a critical time when the crop needs irrigation, the economic losses would be high. The AMCR notes that "several opportunities exist to gather more information to reduce these uncertainties in the short term," including studying irrigation impacts during the 2019 season, when flows were similar in magnitude to flows proposed in the Fort Peck test flow DEIS. Similar in concept to Gavins Point, historical flow data should be used to the extent possible in characterizing the potential impacts of managed flows for Fort Peck. Cautions concerning the impacts of climate change described for Gavins Point apply similarly to managed flows from Fort Peck.

4. *Does the draft AMCR provide an updated review of the (current) status of the listed species and their habitats, and the adequacy of information from research, modeling, and monitoring to make real time decisions in an adaptive management framework (including information from published and unpublished sources)? Does the draft AMCR describe how the available scientific information has been and will be used in programmatic adaptive management decision-making*

Collection of age-0 fish in the lower Missouri River was successful in 2020 and, importantly, two out of 850 fish genetically tested so far have been confirmed as pallid sturgeon. Given that 4,000 fish were submitted for testing, it is conceivable that (0.235% x 4000) or about nine age-0 pallid sturgeon were collected this year, notably exceeding numbers collected in recent years. A couple of minor points pertain to this finding. First, it is not clear in Table 3.3 of the AMCR what is meant by the statement "[age-0] counts represent actual observations and are an estimate of the minimum number (i.e., there are at least this many)". Including an example or more detailed explanation in the text would help clarify this. Other minor edits include errors in Table 3.3 showing year "2009-2019" collections for the Lower River that should be included in the data summary for the Upper River. Also, the numbers of age-0 fish discussed in section 3.2.2.5 do not align with those in Table 3.3. Line 1907 in the AMCR reports n=13 free embryos have been collected from the Upper River, while Table 3.3 reports n=14. Similarly, line 1910 in the AMCR reports n=4 free embryos collected from the Lower River, but Table 3.3 reports n=6 (if 2020 are included). Second, the approximate number of age-0 sturgeon collected in 2020 was not clear. It is reported as ~9,500 (page vii), ~12,850 (line 1416), and ~15,000 (Table 3.3). During the AM Workshop, the panel learned that some of those fish were collected from the middle Mississippi River, which was not conveyed in the AMCR or supplementary information. Similarly, it is not clear how many fish are pending genetic analysis; the report states ~4,000 (line 135) and ~12,000 (line 1416). While we recognize these are approximations, it would help if the number of age-0 pallid sturgeon collected and submitted for genetic testing were consistent throughout the report; it is important information, made more so by the successful collection of age-0 pallid sturgeon in 2020.

Experimental release of age-0 fish in the upper river (2019) and lower river (2020) has the potential to generate critical information on distribution and survival of age-0/1 sturgeon. ISAP commends the field teams for those efforts and for taking a proactive approach to better understand factors affecting first-year survival of pallid sturgeon. It was valuable to learn that collection of 5-dph fish in the upper basin (released in 2019) survived to age-1 (n=11) in 2020. And while 5-dph fish were further along developmentally when they were released, their survival to age-1 supports earlier findings that 2-9 dph free-embryos survive to age-1+ in the upper Missouri River (Bratten et al. 2008; 2012). It was also encouraging that there is ‘some’ evidence that age-1 recruitment may be occurring in the lower Missouri River basin. As the adaptive management program moves forward, continued collection of age-1+ fish and their demonstrated association with the Missouri River will be critical for effective application of the IPSPM and for meeting requirements of MRRP Sub-objective 1.

An issue brought up by ISAP in the 2019 AMCR review that was not reflected in the 2020 catch data is understanding why wild pallid sturgeon were increasingly represented in the lower basin from 2010-2019 in the absence of any management action. Last years’ review pointed out a relevant question by asking if increased abundance of wild fish in the lower basin could be associated with the Similarity of Appearance provision of 2010 (SA). The SA, by eliminating commercial harvest of shovelnose sturgeon and incidental take of pallid sturgeon (~2% total commercial harvest; Betolli et al. 2009), could enhance natural reproduction for both species since harvest restrictions were enacted. Whether there is sufficient bycatch and harvest data beyond that presented in Betolli et al. (2009) to evaluate this question is unknown. Importantly though, catch data from 2020 appears to have negated the increasing trend of wild pallid sturgeon abundance in the lower Missouri River, given that it was the lowest reported catch rate since 2010. If future catches of wild fish increase, the population model may be an effective tool to evaluate effects of adult harvest on population response prior to and after the SA went into effect.

Emerging scientific information about pallid sturgeon was effectively integrated into the AMCR. New insight on phenotypic variation between upper- and lower-basin pallid sturgeon (Hamel et al. 2020) was summarized in section 3.2.2.8; it describes how the new information will be important for refining age and growth data in the pallid population models. Correspondingly, the proposed decision to sample for young pallid sturgeon in the middle Mississippi River (PSPAP 2.0; also, the AMCR) is a good example of making real-time decisions in an AM framework based on new knowledge. Similarly, new insights on effects of water velocity and temperature on drifting and settling behavior of larval pallid sturgeon (Mrnak et al. 2020) was discussed in 3.4.5 (Cross-cutting science activities) with useful remarks regarding how the information is relevant across all management actions.

While the AMCR presents telemetry coverage in the targeted management areas, equivalent information regarding temperature- and turbidity-sensor coverage is not provided. Information on temperature and turbidity sensor networks should be presented in similar fashion to how telemetry coverage is communicated in Figures 3.15 and 3.16. Without this information, ISAP cannot assess the adequacy of the monitoring networks for temperature and turbidity, both of which feature prominently in adaptive management hypotheses (see 3.1.4.1 and 3.1.4.2 in 2020 AMCR Appendices_030121-ISAP). Successful testing of those hypotheses via monitoring of both experimental management actions and natural events remains critical to the AM process.

5. *Does the draft 2020 AMCR adequately address issues that were daylighted in ISAP's review comments on the draft 2019 AMCR? Are there further refinements to the structure of the 2020 report which would better serve the information needs of programmatic adaptive management targeting the listed species and their habitats? (Note that the bird chapter in the draft 2020 AMCR does not incorporate all of the ISAP's recommendations in its review of the 2019 AMCR; they will be addressed in next year's AMCR.)*

The dashboard of progress toward pallid sturgeon objectives (Figure ES-4) was helpful in providing a quick synopsis of recent and ongoing activities and progress. Unfortunately, font sizes <4 pt rendered the text illegible until rectified by 1.75 x reading glasses and 300% zoom. A more effective presentation of this data could be made by using landscape rather than a portrait orientation and perhaps separating information into two tables for the sub-objectives -- metric and location data -- one table summarizing 2020 targets and 10-year trends, the other table summarizing compliance responses.

In addition to the annual dashboard reporting, the evidentiary framework outlined in section 3.1.3 of the AMCR provides a reasonable approach to address uncertainties and track progress toward meeting program objectives. With the exception of population augmentation, management actions for pallid sturgeon are in early stages of the AM process. While adaptive management for pallid sturgeon awaits, it does not preclude the utility of the evidentiary framework as a 'road-map' for interpreting the accumulated observational and(or) experimental evidence.

The evidentiary framework highlights important new information and observations that could be included in the annual AMCR. Although information is incomplete, given the status of current management actions, outlining the evidentiary framework in a fashion as below would provide a quick (and comprehensive) update of what was learned from evidentiary sources that include science activities, effectiveness monitoring, population monitoring, and modeling. Information pertaining to different evidentiary sources are highlighted in various sections of the report, but could be assembled collectively and reflected in the evidentiary framework. An example for the 2020 AMCR could be as follows --

Science activities -- Including research that addresses uncertainty more effectively or efficiently than monitoring. [This section should highlight recent, peer-reviewed publications and their relevance to specific management actions or processes].

(1) The study by Hamel et al. 2020 (3.2 Status and trends of Pallid Sturgeon; section 3.2.2.8) documented phenotypic variation between upper- and lower-basin pallid sturgeon. New information from this study will be important for refining age and growth data in population models.

(2) The study by Mrnak et al. 2020 (3.4 Cross-cutting science activities; section 3.4.5) documented the influence of water temperature and water velocity on growth, energy depletion, survival, and settling time of free-embryos. Information from this work can be used to evaluate drift dynamics related to flows and channel re-configuration that inform management actions.

Effectiveness monitoring -- Applied to management actions to determine if the action achieves desired outcome.

Population monitoring -- To determine if the population shows signs of improved reproductive or recruitment success (i.e. PSPAP v. 2.0).

(1) Natural reproduction documented by collection of age-0 pallid sturgeon in the lower Missouri River

(2) Catch of wild pallid sturgeon in the lower Missouri River was less than previous years. An apparent trend in increasing catch of wild fish (2010-2019) is questionable.

(3) Indirect evidence that age-1 pallid sturgeon may be recruiting from the Missouri River.

(4) Evidence of survival and habitat of age-1 fish from the 2019 drift study in the upper Missouri River.

Modeling -- Of action effectiveness and pallid sturgeon populations. Provides a quantitative framework for integrating information sources leading to hypotheses and related uncertainties on management decisions.

(1) Growth chronology data derived from age-1 fish (2019 drift study) will provide important input to population models.

Summary observations, a coda, and conclusions

In closing the review of the 2019 AMCR, the ISAP advanced "recommendations for continuing the MRRP AM process and developing future AMCR documents derived from the review and evaluation of the AMCR and supporting appendices…" (Appendix 1 to this report). Those recommendations should be viewed as evergreen; they are as pertinent to MRRP success as the program enters 2021 as they were entering 2020. The headway made by the USACE in responding to most of the areas of concern in the 2019 review report is laudable. Several of the recommendations in last year's review attend to issues that can only be addressed as adaptive management advances into full implementation. For pallid sturgeon, adaptive management will be realized as the planned IRCs become implemented and Fort Peck management actions are initiated. Regarding management planning and actions targeting the piping plover, the ISAP can be fairly described as frustrated that despite its previous requests to advance adaptive resource management for piping plovers, the program has not matured. And that situation persists despite an operational understanding of the dynamics of the plover-habitat relationship on the Missouri River, the role of environmental stressors acting on plover life stages on the river, and emerging information on the demographic interactions between birds on the river and those in upland habitats under the widely varying habitat-availability circumstances on the river. (We refer MRRP participants to the ISAP memo regarding the state of the piping plover management agenda and monitoring scheme to Joe Bonneau and Mark Harberg, dated 8 November 2020, which presents the concern that the Bird Technical Team, as constituted, lacks sufficient expertise and practical experience necessary to design and implement adaptive management for the species.)

The ISAP reiterates its overarching observation conveyed at meetings and in written communications with MRRP entities and participants over the past two years. Development of implementation-ready population monitoring programs – for both pallid sturgeon and piping plover -- should be the priority of the program's Technical Teams and the Agency staff. MRRP veteran Craig Fischenich, long the recognized USACE expert on adaptive management, describes well-designed monitoring schema as the litmus test of functional adaptive resource management plans. The uneasy monitoring design processes for both species in part reflect the desire of some technical team members to continue ongoing survey and monitoring activities so that historical time-series data sets can be conserved. While that is a reasonable objective, the ISAP encourages participants in monitoring design discussions to refer to the ERDC publication *A Systems Approach to Ecosystem Adaptive Management* (November 2019), pages 50-59, to appreciate the formative steps in monitoring design, which were not explicitly exercised in development of previous and ongoing data-collection schemes. It is essential that the current monitoring designs that are in development, for both species, follow the Agency's procedural guidance.

The ISAP acknowledges that it had ample opportunity to provide input into the question set that enabled and directed this review report. But the ISAP found that a number of its deliberative observations and comments relevant to the 2020 AMCR had to be shoehorned into responses to the questions as stated. It is unclear whether this third (annual) round of AMCR questions is prompting replies from this panel that will be effective in advancing the ability of the USACE to meet MRRP objectives and related obligations in the biological opinion. A worthy discussion involving the USACE, MRRIC, and the ISAP could clarify what is desired in terms of both the content of annual AMCRs and the panel reviews of them, with the targeted outcome being a better-informed question set, answers to which can best service both the Agency and MRRIC's information needs.

Acknowledging that the AMCR is reporting on a path-breaking program pushing forward into the unknown in terms of resource management in an adaptive framework, the MRRP should take time to remind itself where it is going and ask if it actually is following the agreed upon guidance in the *Science and Adaptive Management Plan*. The program should appreciate that adaptive management is an elusive concept and no model exists for taking on conservation planning in a highly modified and complex river system using adaptive methods. Similarly, it is important to recognize that institutional forces, legal obligations, and even certain stakeholder concerns conspire to undermine the adaptive management approach and draw resource management on the Missouri River back towards its command-and-control roots.

The ISAP applauds the advances in HC analysis and reporting underscored by the conceptual model advanced in the AMCR. Support should continue for the embellishment of the functionality of the conceptual model in support of the overall adaptive management program. However, it is to determine in real time if sufficient leverage of proposed management actions constrained by HC limitations will provide for measurable progress towards management objectives for the birds and particularly for pallid sturgeon. If an HC-constrained management and decision space precludes meaningful implementation of management actions (IRCs, managed flows), the AM process could well fail to achieve its objectives. It is important to determine if this is a likely outcome of the MRRP, sooner than later.

The ISAP noted that Native American Tribal Interests are not included in the AMCR discussion of HCs. While ISAP recognizes that efforts are underway (and have been slowed by the pandemic) to improve outreach to and inclusion of Tribal interests in the MRRIC process, the ISAP expects the next iteration of the AMCR to reflect increased engagement in this area, similar to the improved consideration of irrigator concerns in the 2020 AMCR cycle.

Anticipating that MRRIC in-person meetings will occur in 2021, the ISAP suggests that once-a-year refresher tutorial on adaptive management in a TED-talk-style presentation from experts from within and beyond the Missouri River basin be introduced into the plenary agenda at MRRIC meetings. Everybody involved in the MRRP effort can use a frequent formal reminder of how we all got to this third AMCR, why it requires independent scientific review, and how the program needs sustained commitment to research, modeling, and monitoring in this grand experiment in adaptive resource management on the Missouri River.

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Appendix 1

[From the *ISAP Evaluation of Draft 2019 ESA Adaptive Management Compliance Report* pages 29-30]

The following summary and recommendations for continuing the MRRP AM process and developing future AMCR documents derive from the review and evaluation of the 2019 AMCR and supporting appendices, as well as from presentations and discussion at the AM Workshop in Nebraska City.

1. The continuing AM process and the publication of future AMCRs should be consistent with the concepts expressed in the SAMP and by Conroy and Peterson (2013) in conducting adaptive resource management: *"When management decisions reoccur over space or time (e.g., annual harvest regulations), model probabilities are updated by comparing model-specific predictions to observed (actual) future conditions. The adjusted model probabilities can then be used to predict future conditions and choose the optimal decision for the following time step. This adaptive feedback explicitly provides for learning through time and, ideally, the resolution of competing hypotheses with monitoring data."*

2. The AM process should require projected outcomes for all management actions with results that directly pertain to management targets for the sub-objectives for plovers and pallid sturgeon and hypothesized impacts to HCs. This forecasting should be a key priority for strategic planning, because the projected outcomes can focus resource allocation towards implementing and monitoring the most promising management actions while minimizing impacts to HCs.

3. Model-based predictions and presentation included in the AM process should include a measure of statistical uncertainty. In addition, model projections should carry through to estimates of metrics specific to the sub-objectives for plovers (e.g., fledge ratio), pallid sturgeon (e.g., lambda), and HC effects (e.g., cost to irrigators to move water intakes).

4. The USACE should fully embrace an AM framework for the plover and pallid sturgeon. That should include a full treatment of *all* management options being considered, transparent decision criteria, and a prioritization of potential options/action(s).

5. Information (research) needs should be discussed and prioritized as part of the Fall Science Meeting. In turn, those needs should be addressed preferably through the piping plover and pallid sturgeon monitoring programs, or, if needed, through additional research efforts.

6. Future work should examine the possible mechanisms underlying the reported increase in wild pallid sturgeon in the lower Missouri River. Those mechanisms should be reviewed and evaluated in relation to the Big Questions for lower river pallid sturgeon and related management actions.

7. Reevaluation of the benefit of IRCs in relation to sub-objective 1 should include estimation of anticipated increases in recruitment of age-0 pallid sturgeon to be produced by IRCs. The estimated increases in recruitment should be extrapolated using the population model to corresponding projections of lambda and population size in relation to the Nc of 5,000

8. Future work should consider focused large-scale experimental and management efforts comparable to the drift study in the upper river. For example, a drift study could be undertaken in the Yellowstone River to develop forecasting and management capabilities for the Intake Management Action.

9. HC impact modeling and monitoring data presentation, analysis, and evaluation should be reported in bird and fish sections and the resulting decision space for bird and fish actions compared with the bird and fish management needs. The extent of overlap of management needs and HC concerns should stimulate discussion at the AM Workshop regarding options for meeting species needs and/or options for expanding the management decision space in a manner acceptable to HC interests.

10. Model-based predictions and presentation included in the AM process should include a measure of statistical uncertainty. In addition, model projections should carry through to estimates of metrics specific to the sub-objectives for plovers (e.g., fledge ratio) and pallid sturgeon (e.g., lambda).

11. Information (research) needs should be discussed and prioritized as part of the Fall Science Meeting. In turn, these needs should be included in the piping plover monitoring program, which is the appropriate source of new information needed for plover management.