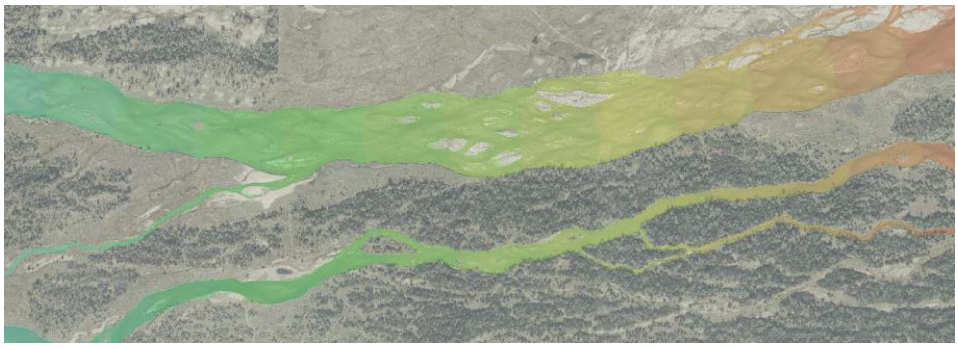
Independent Scientific Advisory Committee Comments and Recommendations on the Platte River Recovery Implementation Committee's 2019 Adaptive Management Plan Reporting Session, 8-11 October 2019, Omaha, NE



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Platte River Recovery Implementation Program
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GLOSSARY OF ACRONYMS

2-D model: Two-dimensional model

AMP: Adaptive Management Plan

AMP v2: 2020-2032 Extension Adaptive Management Plan (6 August 2019 draft)

AHR: Associated Habitat Reach

BQ: Big Question

EDO: Executive Director's Office

DDQs Deeper-Dive Questions

GC: Governance Committee

GPS: Global Positioning System

ISAC: Independent Science Advisory Committee

MUCW: Maximum Unobstructed Channel Width

OCSW: Off-channel Sand and Water Habitat

UOCW Unobstructed Channel Width

PPRIP: Platte River Recover Implementation Program

Program: Platte River Recover Implementation Program

PSPAP: Pallid Sturgeon Population Assessment Program

Draft Report: Draft 2019 State of the Platte Report

SDHF: Short-duration Flow

SOP: State of the Platte

TAC: Technical Advisory Committee

TUCW: Total Unobstructed Channel Width

TUCW-Main: Main Channel Total Unobstructed Channel Width

WC: Whooping crane

ISAC RECOMMENDATIONS

The following summarizes our recommendations on the 2019 Adaptive Management Plan (AMP) Reporting Session arranged by our report section and topic within each Section. Supporting text from our report is included for some recommendations to provide clarifying context.

1. DRAFT 2019 STATE OF THE PLATTE REPORT

Big Question Assessments for 2019 and First Increment.

BQ1: Clarify the use of two criteria: sandbar height 1.5' above 1200 cfs (primary criterion); and sandbar height relative to peak flow.

Clarify the expected frequency of 15K cfs flows, their ecological benefits and flood risks.

> ***EDO Response:*** Edits made in 2019 State of the Platte Report text.

BQ2: Figure 3 shows a large departure between observed versus predicted median Unobstructed Channel Width (UOCW) in 2016-2018. This departure is explained by, *"there appears to be an additional driver (e.g., growing season flows, etc.) for maintaining channel widths once channels are wide."* **We recommend additional text briefly explaining how this departure may be addressed through the new 2-D modeling tool and other models presented during the AMP Reporting Session. Add text explaining how the new 2-D model can help to improve the ability to predict UOCW. The ISAC has suggestions for revising the structure of the decision tree model (see Section 2).**

> ***EDO Response:*** Edits made in 2019 State of the Platte Report text.
>
> "Due to the degraded model performance from 2016-2018, the EDO has started to utilize machine learning random forest models that better incorporate hydrologic metrics, physical channel characteristics, and management activities to predict the cumulative effects of these metrics on channel attributes over time. Two-dimensional (2-D) modeling will parallel statistical modeling, providing improved predictions of physical channel characteristics such as inundated channel area, velocity, and shear stress over a range of flow conditions. Taken together, these modeling approaches will provide a more robust basis for development and testing of flow-habitat hypotheses during the Extension." (BQ2 - 2019 Assessment)

BQ3: We recommend BQ3 be carried forward to the Extension AMP for WC in parts of the system with sediment deficit, so as to maintain wide channels. Clarify that *you can* measure changes in bathymetry for a few miles downstream, but that it becomes more difficult as you move further downstream due to increasing uncertainty.

Recommendation: Ensure that statements of conclusions and management implications (pg. 15, SOP) are consistent with a one thumb up assessment or revise the assessment to reflect the reported high uncertainty of effectiveness of sediment augmentation to offset the deficit and halt channel degradation.

EDO Response: Edits made in 2019 State of the Platte Report text to make conclusions and management implications consisted with the one-thumb up assessment for this Big Question. This Big Question is currently under consideration for evaluation during the Extension as part of the revised Adaptive Management Plan (AMP).

BQ9: Whatever is decided for BQ9 in the 2019 assessment, we recommend that the authors be consistent in the evidence among BQs for assigning assessments.

To start the process of reconsidering BQ9, we reiterate our 2018 recommendation: "*The PRRIP should have clear expectations with respect to Program related benefits of proposed research on pallid sturgeon use of the Lower Platte River.* This can be best accomplished in the short term by implementing the three tasks identified by Compass (2018, pg. 2) under The 2019 Decision: "*What methods of reducing uncertainty should the Program pursue during the Extension to (a) better understand the role of the Platte in pallid recovery and (b) inform the connection between potential management alternatives and likely consequences on pallids?*" For the longer term, the ISAC supports the 2030 decision step also described in Compass (2018, pg. 2): *"What management actions should the Program undertake to best fulfill its obligations to pallid sturgeon in the Program's Second Increment?*

We also recommend that Lower Platte River pallid flow issues be embedded as a high-priority subset of the broader target flows topic when updating the AMP v2 during the First Increment Extension.

EDO Response: This Big Question and the associated issues are under consideration as part of the development of the revised AMP. As of March 2020, the Governance Committee (GC) is undergoing a process of discussing target flows and how, or if, to treat them as part of implementation of the revised AMP during the Extension. This includes discussion of the linkage between Program flow management actions and pallid sturgeon use and occurrence in the lower Platte River. The EDO recommends the GC consider these ISAC recommendations as they debate and decide on next steps for pallid sturgeon in the PRRIP.

BQ10: The Draft 2019 On-Channel Whooping Crane habitat assessment needs to better explain the evidence for changes in BQ rating to two-thumbs up, given that results shown in Figure 10 have changed little in the intervening 2 years and hypothesis S1c remains*: "not yet answered - ongoing implementation, analysis and synthesis."*

EDO Response: Edits were made to the State of the Platte Report to indicate that an analysis of variance with post-hoc comparisons was used to compare distributions of annual maximum unobstructed channel width from 2007 – 2018 and indicated Program lands had significantly wider channel widths than non-Program lands since 2013. Pearson's Rank Correlation showed a statistically significant increase in whooping crane use on Program Lands since 2016.

Additional Incremental Learning;

Least Terns and Piping Plovers. **There is a need to more fully explain the scientific rationale for discontinuing efforts to construct in-river islands for tern and plover nesting and brood rearing habitat. Reference publications that provide such a rationale.**

EDO Response: Edits made in 2019 State of the Platte Report text and citations added. Specific reasons were added, along with a primary reference source.

Appendix A. 2019 State of the Platte Priority Hypotheses Status Table

Because BQ8 P2 or BQ10 S1c are conclusively answered as two-thumbs up or down, why don't their priority hypotheses also receive a corresponding green-up or red-down triangle?

EDO Response:
P2 – this hypothesis has not been directly addressed through a study of plover forage (invertebrates) so as a distinct hypothesis it remains unanswered. However, there are no data suggesting declines in plover productivity or fitness related to forage. The PRRIP decided to forego further investigation into forage-related impacts for both terns and plovers.

S1c – this hypothesis has not been directly addressed via creation of additional wet meadow acres during the First Increment. Because Program monitoring does not suggest a selection preference for wet meadows by whooping cranes, this issue is not a high priority of concern for the Program during the Extension.

2. MODELING TOOLS

It is important to state the specific purpose of each tool and how it complements and links to the other tools each time it is presented.

EDO Response: As part of the AMP Update for the PRRIP Extension, we will incorporate a section to address the utility and connection between modeling tools to address important uncertainties during the Extension.

ISAC comments and recommendations on the purpose of the unvegetated Channel Width Decision-tree Model: **ISAC recommends a segment-based approach instead of an overall mean channel width.** One approach is to create a binary variable for each segment where 1 indicates TUCW or MUCW >650 for each segment. The analysis may be best done on individual segments

and then you can compare segments from year-to-year. A segment-based approach addresses the problems with mean change and is repeatable from year-to-year if you use the same reaches, Alternatively, for a single number you could compute the fraction of AHR segments where TUCW or MUCW >650'.

EDO Response: The EDO is working to develop a machine learning, random forest model to address issues of the simplistic decision tree model presented at the October 2019 AMP reporting session. This model will be transect-based and designed to incorporate a variety of probable important variables influencing unobstructed channel widths.

Decision-tree model; Specific questions/comments from the ISAC: Problems with the current model.

We recommend redeveloping the decision-tree model, using all of the data from individual transects in a mixed statistical and mechanistic model, rather than using average main channel width.

EDO Response: See above response.

Clarity of Terms. **The Decision-tree Model identifies Maximum Unobstructed Channel Width (MUCW), Total Unobstructed Channel Width (TUCW), and Main Channel Total Unobstructed Channel Width (TUCW-Main). We recommend developing a visual that relates these terms along with the often-used Unobstructed Channel Width (UOCW), explaining the differences among them, how each is used, and the rationale for so many potentially confusing terms. It appears that the criterion of 650' is applied to each of these terms as suitable habitat for Whooping Cranes, yet (based on the assessments for BQ4 and BQ5) the 650' criterion appears to apply only to UOCW.**

EDO Response: A visual description of channel width metrics will be included in the revised AMP.

3. <u>DEEPER-DIVE QUESTIONS</u> (DDQs)

1) **The GC directed the Program to use adaptive management in the Extension to explore issues related to flow, river form and function, and target species. Are we building a rigorous AM approach to the right questions, and to questions that would benefit from reducing uncertainty for the purposes of decision making?**

The ISAC is satisfied with the current approach to using rigorous adaptive management by the Program. We have several recommendations under the DDQs related to how the Program might consider revising First Increment and AMP v2 BQs in the Extension.

2) As we develop a revised AMP for the Extension, how should we set priorities among outstanding uncertainties and key testable hypotheses?

The ISAC identified several challenges to revising the AMP including one recommendation: 5) **We recommend linking prioritization/sequencing to design of flow experiments under DDQ2, including turn-taking optimization in response to state of habitat and species, and recent actions over past years (Alexander et al. 2018).** A process is suggested for accomplishing this prioritization or sequencing.

EDO Response: The EDO agrees on the need to link prioritization and sequencing to the design of flow experiments in the revised AMP. This will be considered as the revised AMP is developed and as the GC continues to discuss issues related to target flows and if/how to address target flows through AMP flow experiments. This will include consideration of the utility of turn-taking optimization for the Program.

3) Are the current management objectives in the Program's AMP an adequate means of assessing progress and communicating with the GC about Program success or failure?

Piping Plover, Least Tern

Trying to impose stability for a dynamic system like the Central Platte River where habitat availability can vary greatly from year to year might create problems (e.g., ever increasing predation losses and a Lambda <1). **If predation losses (and Lambda <1) continue into the future, the Program should address methods to reintroduce variability back into the system of creating and maintaining habitat as a means of sustaining source bird populations over the long-term.**

EDO Response: This approach is possible but additional management means (turtle trapping, turtle exclusion fencing, and predator deterrent lights) will be utilize as initial methods to address productivity issues at OCSW sites. Based on effectiveness of these techniques, the Program could consider this alternative in the future.

Whooping Cranes

We recommend, if possible, the Program revise the AMP v2 whooping crane Management Objective to more accurately reflect what it is measuring.

EDO Response: The GC made a policy decision to keep the AMP management objectives unchanged for the Extension. The associated Biological Assessment (BA) and amended Biological Opinion (BO) developed for the Extension were built on this premise of keeping the underlying goals and objectives of the Program the same during the Extension. At this time, the Program does not intend to alter the AMP management objectives for the Extension but the GC will be advised of this ISAC recommendation and may provide further direction.

Pallid Sturgeon

BQ5. Are Program flow management actions detectable in the LPR? **We recommend following our guidance under Section 3, DDQ 6 in this ISAC AMP report and deleting or revising BQ5 accordingly.**

BQ6. Do Program flow management actions influence pallid sturgeon spawning habitat in the LPR? **We recommend following our guidance under Section 3, DDQs 6 and 7 in this ISAC AMP report and revising BQ6 accordingly.**

EDO Response: These issues are under consideration as part of the development of the revised AMP. As of March 2020, the Governance Committee (GC) is undergoing a process of discussing target flows and how, or if, to treat them as part of implementation of the revised AMP during the Extension. This includes discussion of the linkage between Program flow management actions and pallid sturgeon use and occurrence in the lower Platte River. The EDO recommends the GC consider this ISAC recommendation as they debate and decide on next steps for pallid sturgeon in the PRRIP.

4) ***How do your experiences in other systems (e.g., Missouri River) inform what we should be thinking about in designing flow management actions to learn and reduce uncertainty (i.e. "experimental design")?*** We listed several ideas to explore but made no formal recommendations.

5) ***How do we address the issue of whether the GC needs to invest in acquiring and managing an additional 10,000 acre-feet (go from 120,000 acre-feet to 130,000 acre-feet) of water?***

Exploring the ability to opportunistically buy water leases from irrigation districts and others seems a prudent action. This will give the Program more flexibility to undertake desired water management actions for maintaining channel widths for whooping cranes, particularly in drier water years**. Rather than selecting somewhat arbitrary numbers like 10,000 acre-feet of water we recommend emphasis on future Program water acquisitions be more opportunistic, grounded on an understanding of the system and what breaks it.**

EDO Response: The 10,000 acre-feet quantity is a negotiated number related to the Water Objective of the First Increment and the GC's objectives for the 13-year Extension that began in 2020. The ISAC's recommendation of being more opportunistic with water acquisition will be considered as a path forward is developed related to target flows, the AMP, and the expenditure of Program financial resources on Program water and associated management.

6) ***How does the ISAC suggest we revise/re-organize the stage change study relative to an expert elicitation and the potential habitat/use questions we might address if we can detect Program flow management actions in the lower Platte?***

Without greater consensus on the habitat needs of various life-history stages of pallid sturgeon in the Missouri and Platte Rivers, it doesn't make sense to proceed with an expanded Stage Change Study.

The Program should acknowledge that all of its members do not, and probably will never, agree on what the stage change study was, what it says, and what it should have been. Rather than dragging on this debate, the ISAC believes it is time to move forward from the Stage Change Study to a new approach…

A new approach to the Stage Change Study should involve gathering data on the distribution of pallid sturgeon in the Lower Platte River, as discussed in previous reports (Compass 2017, 2018; EDO 2018). Monitoring the movement and reproductive activities of telemetered reproductively ready adults is likely the most feasible activity.

EDO Response: These issues are under consideration as part of the development of the revised AMP. As of March 2020, the Governance Committee (GC) is undergoing a process of discussing target flows and how, or if, to treat them as part of implementation of the revised AMP during the Extension. This includes discussion of the linkage between Program flow management actions and pallid sturgeon use and occurrence in the lower Platte River. The EDO recommends the GC consider this ISAC recommendation as they debate and decide on next steps for pallid sturgeon in

7) ***How do aspects of morphology, flow detection, etc. influence the Program's ability to have an effect on pallid sturgeon habitat and use in the lower Platte River?***

We recommend that the Program implement research activities agreed to at the 2017 workshop on pallid sturgeon (Compass 2017), focusing on spawning adults, and using methods and tracking technology implemented on the Lower Missouri River, with associated monitoring/modeling of flows, temperatures and turbidity.

EDO Response: These issues are under consideration as part of the development of the revised AMP. As of March 2020, the Governance Committee (GC) is undergoing a process of discussing target flows and how, or if, to treat them as part of implementation of the revised AMP during the Extension. This includes discussion of the linkage between Program flow management actions and pallid sturgeon use and occurrence in the lower Platte River. The EDO recommends the GC consider this ISAC recommendation as they debate and decide on next steps for pallid sturgeon in the PRRIP.

8) ***Should the Program consider undertaking predator trapping/strobe light experiments beginning in 2020 to increase productivity or are their other measures that should be considered first? If so, is the experimental design robust enough to capture differences in productivity or should another design be considered?***

The ISAC recommends that staff biologists be engaged to help design options for an appropriate pilot study.

We recommend that you develop rigorous data collection approaches as you may wish to use the data for formal hypothesis testing in the future.

EDO Response: The EDO has collaboratively developed a detailed plan of study to learn about the effectiveness of additional predator management techniques to increase productivity. A power analysis predicted 8 years of implementation was necessary to observe the effectiveness of these tactics. Given the knowledge of the system and productivity rates we developed a randomized treatment design to be fully executed at PRRIP off-channel nesting sites from 2021-2017 after a pilot year in 2020.

INTRODUCTION

This report constitutes the Independent Scientific Advisory Committee's (ISAC) comments and recommendations on the Platte River Recovery Implementation Program's (PPRIP or Program) 2019 Adaptive Management Plan (AMP) Reporting Session, 8-11 October 2019, Omaha, NE. Following the AMP Reporting Sessions, the ISAC circulated member notes, draft comments and recommendations internally, and held two conference calls to clarify and revise our observations. Topics that have engendered lively debate among Program participants over the years, (e.g., Stage Change Study, Target Flows, pallid sturgeon) also provoked energetic exchanges among the ISAC. In several instances we refer the Governance Committee (GC), Executive Director's Office (EDO) and Technical Advisory Committee (TAC) back to our previous recommendations to remind you of our positions, acknowledge that they have not always been consistent, and to reinforce those we hope you will revisit as you implement the 2020-2032 PPRIP Extension.

This report is divided into three sections that consider topics and questions from the five 2019 AMP Reporting Sessions (EDO 2019a): **1. DRAFT 2019 STATE OF THE PLATTE REPORT** (hereafter Draft Report), **2. MODELING TOOLS**, and **3. DEEPER-DIVE QUESTIONS** (DDQs). Previous and 2019 ISAC recommendations are highlighted in **bold blue**.

1. DRAFT 2019 STATE OF THE PLATTE REPORT

ISAC Responses to EDO Questions

1) Does the 2019 State of the Platte Report capture what the ISAC envisioned for summarizing learning from the First Increment? In general, yes with a few issues that need to be clarified. We made **recommendations** in two previous ISAC reports relevant to this question:

ISAC 2016 Report (ISAC 2017, pg. 7). *"Over the next two years, complete a detailed assessment of the Big Questions and hypotheses building on what's been learned, in preparation for an extension of the First Increment in 2020. The main output would be a proposed set of revised hypotheses, without proposing any new actions."*

ISAC 2018 Report (ISAC 2018, pg. 1). *"Complete the State of the Platte Report for the First Increment (to be completed in 2019), providing a summary of what's been learned during the First Increment for each Big Question, with more detail on the still unresolved Big Questions (BQ 3, BQ9, BQ10). This will provide a large part of the scientific basis for new target flows."*

These recommendations are concisely and well addressed in **Table 2. Big Question assessments, PRRIP First Increment (2007-2019)** and the section **Additional First Increment Learning** of the Draft Report. The Draft Report section, **Answering BQ #X during the First Increment** provides specifics for each BQ.

Details on the still unanswered Big Questions BQ3, BQ9 and BQ10 appear relatively unchanged from the Program's 2016 Report. We have additional comments and questions on the 2019 Reports' First Increment assessments of BQ3, BQ9 and BQ10; see below.

Our 2018 Report (ISAC 2018) recommended to: *"Include a section of the State of Platte Report which summarizes what has been learned in the form of conceptual models of the three bird species, pallid sturgeon and their habitats. To help set the stage for an examination of target flows, these conceptual models should be organized around the life cycle of each species when present in the Central Platte, showing what flows and other actions are required to support the species, their prey and their habitats in dry, average and wet years*." We concur that including these conceptual models in the 2020-2032 Extension Adaptive Management Plan (hereafter AMP v2; EDO 2019a) is more appropriate and informative than presenting them in the 2019 State of Platte Report.

The question remains for the EDO and GC: Does the 2019 State of the Platte Report provide sufficient evidence for First Increment outcomes to satisfactorily inform preparation of AMP v2 for the Extension?

Big Question Assessments for 2019 and First Increment. ISAC suggested text edits in **orange**.

Summary of Key Learning from AMP Version 1.0 and the First Increment: "*Whooping crane use of the AHR* [Associated Habitat Reach*] **in spring** has increased significantly and proportionally to increases in habitat suitability that are in part due to Program management actions*." The increase appears to have occurred only in spring, not in fall and up until 2018. Moreover, the whooping crane increases occurred up until 2018, but there was a drop in the percent population using Platte in spring 2019. Reasons for the recent drop are currently unknown. Where in the Draft Report can the reader confirm this "significant" increase in whooping crane use of the AHR?

Table 2 Big Question assessments, PRRIP First Increment (2007-2019). This table summarizes assessments of First Increment management actions. Is it a sufficient stand-alone document to tee-up the Extension AMP v2 and satisfy the 2016 ISAC recommendation: *Over the next two years, complete a detailed assessment of the Big Questions and hypotheses building on what's been learned, in preparation for an extension of the First Increment in 2020?*

It would be helpful in the caption for Table 2 to direct the reader to the sections, **Answering BQ #X during the First Increment** included in the Draft Report under each BQ**.**

BQ1: Will implementation of SDHF [short duration high flow] **produce suitable tern and plover riverine nesting habitat on an annual or near-annual basis?**

Clarify the use of two criteria: sandbar height 1.5' above 1200 cfs (primary criterion); and sandbar height relative to peak flow.

It could be argued that 5 or 6 acres/mile of sandbars coming from a 15K cfs natural flow is more consistent with species recovery objectives than relying on constructed off-channel habitat. To address such interests, you might inform the reader: What is the historical frequency of a 15k cfs flow, and how might this frequency be altered in the future with climate change? (see USEPA 2016 for a summary of predicted changes in Nebraska's climate). How often would sandbars at the targeted elevation be created? Are there any downsides (in terms of either ecological objectives or human considerations) to a flow of 15k cfs that might compromise or negate its creation of sandbar habitat? A key point to emphasize if valid, is that the historical frequency of such natural high-flow events would not be enough to maintain in-river habitat, and hence the need for off-channel habitat. As an aside, if global warming and big storms from the Gulf of Mexico increase the frequency of such events, the use of in-river habitats could increase, but perhaps also the risk of nest flooding, as occurred in 2019 in the Missouri River. **Clarify the expected frequency of 15K cfs flows, their ecological benefits and flood risks.**

BQ2: Will implementation of SDHF produce and/or maintain suitable whooping crane riverine roosting habitat on an annual or near-annual basis?

Figure 3 under BQ2 in the Draft Report shows a large departure between observed versus predicted median Unobstructed Channel Width (UOCW) in 2016-2018. This departure is explained by, *"there appears to be an additional driver (e.g., growing season flows, etc.) for maintaining channel widths once channels are wide."* **We recommend additional text briefly explaining how this departure may be addressed through the new 2-D modeling tool and other models presented during the AMP Reporting Session. Add text explaining how the new 2-D model can help to improve the ability to predict UOCW. The ISAC has suggestions for revising the structure of the decision tree model (see Section 2).**

"Mechanical management actions like disking and herbicide application do not provide the system-scale beneficial effects of natural peak flow events, **though site specific efforts to disk and apply herbicide can still provide benefits to whooping cranes at habitat complexes."**

The ISAC discussed the possibility that an additional BQ be considered for the Extension that did not come to the fore under First Increment BQ2. *Do cranes use mechanically treated in-channel habitats in the same way that they use in-channel habitats with substrates reworked by flow in the context of climate change and increasing drought risks?* Fluvial features and substrates reworked by flow may look very different from those cleared purely by mechanical means. This relates the question of acceptable inter-event times for high flows during periods of water scarcity in the future. Is any unobstructed channel 650 ft wide the same to a crane such that, in

a pinch, mechanical widening is good enough for several consecutive years without using water for high flows?

BQ3: Is sediment augmentation necessary for the creation and/or maintenance of suitable riverine tern, plover, and whooping crane habitat?

Despite three additional years of data the Draft Report text for BQ3 remains nearly identical to that from the 2016 Report. Does this imply that little has been learned since full-scale sediment augmentation began in the fall of 2017?

Preliminary evidence is sufficient for one thumb up for whooping cranes (WCs), but not required for PP and LT. **We recommend BQ3 be carried forward to the Extension AMP for WC in parts of the system with sediment deficit, so as to maintain wide channels. Clarify that *you can* measure changes in bathymetry for a few miles downstream, but that it becomes more difficult as you move further downstream due to increasing uncertainty.**

Preliminary evidence is appropriate for one thumb up for whooping cranes (WCs), but not required for PP and LT. Where sediment supply is less than sediment transport by the available discharge, the riverbed will degrade and narrow. In other words, sediment balance or aggradation is a necessary, but not sufficient condition for achieving habitat objectives. Consider revising BQ3 to something like: *Is sediment augmentation necessary to maintain bed elevation and channel width and thereby maintain the related dimensions of suitable riverine tern, plover, and whooping crane habitat?* (see our response to Deeper-Dive Question 2 on revising First Increment BQs)

Given the following statement (pg. 14, SOP): *"It will be challenging to measure the effectiveness of augmentation given the desired beneficial effect is slowing and ultimately halting a long-term degradational trend to prevent degradation downstream of the Overton bridge."*, what evidence will justify moving BQ3 from a one to two thumbs up? What options are being considered if the existing performance metric is unable to adequately assess effects of the management action? You might also clarify that the Program can measure changes in bathymetry for a few miles downstream of an augmentation site, but that it becomes more difficult as you move further downstream due to increasing uncertainty.

Recommendation: Ensure that statements of conclusions and management implications (pg. 15, SOP Draft Report) are consistent with a one thumb up assessment or revise the assessment to reflect the reported high uncertainty of effectiveness of sediment augmentation to offset the deficit and halt channel degradation.

BQ4: Are mechanical channel alterations (channel widening and flow consolidation) necessary for the creation and/or maintenance of suitable riverine tern, plover, and whooping crane habitat?

It will be important in the next phase to consider *where* to prioritize disking – equally distributed across all habitat complexes in the AHR, or prioritized according to where data show WC tend to congregate? Relative to this statement the ISAC has several questions for the Program to consider addressing in their revision. Is there a long-term budget for disking and herbicide treatments? How is this work allocated spatially along the river? Do WC's have fidelity to past use locations and if so, is it important to maintain the UOCW in those places?

BQ5: Do whooping cranes select suitable riverine roosting habitat in proportions equal to its availability?

See above comment for BQ4. The Program First Increment assessment for BQ5 in 2016 (EDO 2018a) was also two thumbs down, so we don't understand the "change" in the conclusion on page 19: *Program staff consider results of these analyses to be sufficient evidence to change the assessment for this Big Question to 2 thumbs down."*

BQ6: Does availability of suitable nesting habitat limit tern and plover use and reproductive success on the central Platte River?

It would be useful to have a sentence in the BQ6, Figure 7 caption (or in an endnote) explaining what assumptions underlie the Lutey (2002) criterion.

BQ7: Are both suitable in-channel and off-channel nesting habitats required to maintain central Platte River tern and plover populations? No comments.

BQ8: Does forage availability limit tern and plover productivity on the central Platte River?

No comments.

BQ9: Do Program flow management actions in the central Platte River avoid adverse impacts to pallid sturgeon in the lower Platte River?

Our report to the GC on the 2016 State of the Platte (ISAC 2017) summarized the Program's assessments on this BQ, going from a one-thumb up in 2012 and 2013 to two-thumbs up in 2014 and then to a scratchy head in 2015 and 2016. The ISAC supported a two-thumbs up status for BQ9 below the Elkhorn River in 2015 and 2016. Which of these assessments, if any, did the GC support?

The ISAC concurred in our discussions on BQ9 that there is a scientific consensus the hydraulic influence of PRRIP flow management actions below the Elkhorn cannot be detected with standard streamflow monitoring and multi-dimensional hydrodynamic modeling tools. Additionally, any confidence intervals on modeled changes in habitat suitability in the study reach will contain zero change as a result of both hydraulic modeling uncertainty and deep uncertainty in habitat suitability criteria. This evidence supports at least a one thumb up assessment.

It's puzzling to the ISAC that BQ3 (necessity of sediment augmentation for the creation and/or maintenance of suitable riverine tern, plover and whooping crane habitat) received a one thumb up while BQ9 received only a scratchy head. **Whatever is decided for BQ9 in the 2019 assessment, we recommend that the authors be consistent in the evidence among BQs for assigning assessments.**

The ISAC has been divided on the necessity for additional stage change studies. Some members have supported additional study above the Elkhorn based upon observations of adult pallid sturgeon above the Elkhorn and the recent collection of an adult pallid in the Loup River 29 river miles upstream from its confluence with the Platte (K. Steffensen, NGPC personal communication 29Oct2019). In contrast, other members conclude that there will not be any significant changes to the predicted effects of Program actions on either hydraulic characteristics or pallid sturgeon metrics from expanding the stage change study over a larger spatial scale, and doing so is unlikely to move the Program forward. See our responses to DDQs 6 and 7 in Section 3 for a consensus ISAC position on the Stage Change Study.

Whatever is decided on thumb(s) vs. a scratchy head we believe it is important in the Extension to revise BQ9, given that no one knows what future flow management actions will be, or move on to a new question which contributes knowledge helpful to pallid sturgeon recovery in the collective Missouri River Basin. **To start the process of reconsidering BQ9, we reiterate our 2018 recommendation: "*The PRRIP should have clear expectations with respect to Program related benefits of proposed research on pallid sturgeon use of the Lower Platte River.* This can be best accomplished in the short term by implementing the three tasks identified by Compass (2018) under the 2019 Decision: "*What methods of reducing uncertainty should the Program pursue during the Extension to (a) better understand the role of the Platte in pallid recovery and (b) inform the connection between potential management alternatives and likely consequences on pallids?*" For the longer term, the ISAC supports the 2030 decision step also described in Compass (2018): *"What management actions should the Program undertake to best fulfill its obligations to pallid sturgeon in the Program's Second Increment?***

We also recommend that Lower Platte River pallid flow issues be embedded as a high-priority subset of the broader target flows topic when updating the AMP v2 during the First Increment Extension.

BQ10: Do Program management actions in the central Platte River cumulatively 1) produce detectable changes in the physical environment (i.e. habitat) and 2) result in a detectable increase in turn, plover, and whooping crane use of the Associated Habitats?

The 2016 Assessment for On-Channel Whooping Crane Habitat has been revised from a one-thumbs up to two-thumbs up and species response changed from a scratchy head to two- thumbs up. Additionally, hypothesis S1b went from one to two green triangles. **The Draft 2019 On-**

Channel Whooping Crane habitat assessment needs to better explain the evidence for changes in BQ rating to two-thumbs up, given that results shown in Figure 10 have changed little in the intervening 2 years and hypothesis S1c remains: "*not yet answered - ongoing implementation, analysis and synthesis*."

Where under this BQ assessment or references can the reader confirm the important conclusion: *There has been a significant increase in whooping crane use of Program lands since 2016?*

Additional Incremental Learning

Least Terns and Piping Plovers. **There is a need to more fully explain the scientific rationale for discontinuing efforts to construct in-river islands for tern and plover nesting and brood rearing habitat. Reference publications that provide such a rationale.**

Appendix A. 2019 State of the Platte Priority Hypotheses Status Table

This is a comprehensive summary of priority hypotheses that speaks to our 2016 recommendation (ISAC 2017) to more clearly link hypotheses and suitability criteria to the Big Questions in the Draft Report. Including the status of selected priority hypotheses as a text box in each BQ **What the Science says…** photo reinforces this connection and the final First Increment assessment for each BQ.

It remains uncertain if or how the two inconclusive hypothesis test result indicators will be considered in the Extension: *"Hypothesis not yet answered – ongoing implementation, analysis, and synthesis"* and *"Not currently being addressed through implementation of the AMP and related data analysis and synthesis"* ?

Format, editorial comments and minor text revisions. The 2019 Program Draft Report incorporated most of the ISAC recommendations made on our previous 2016 Report (ISAC 2017, see Table 1). The EDO is referred to individual ISAC member sticky-note comments on copies of the Draft Report. Recommendations from ISAC to GC, based on meetings held Oct. 16-18, 2018.

441 *Table 1. Summary of the Draft 2019 State of the Platte Report's responses to ISAC*
442 *recommendations made on their review of the 2016 State of the Platte Report (ISAC 2017).*

ISAC Recommendations on 2016 State of the Platte Report	Draft 2019 Report	ISAC Comments
Format: Include the following in…future State of the Platte Reports to help the reader and improve clarity: 1) captions summarizing the bottom line messages below each figure; 2) a glossary of Acronyms; 3) a list of all peer reviewed papers and reports published by the Program by year; and 4) an appendix which shows progress on land and water.	1) Yes 2) Yes 3) Yes 4) Yes	
Expand the audience. Ensure that the State of the Platte Report is understandable to multiple audiences (decision makers, the well-informed public, scientists, engineers), but with no particular knowledge of the PRRIP.	Yes	Comprehension of complex results and figures by non-scientists will remain a challenge. Preceding the BQ section with a **Summary of Key Learning from AMP Version 1.0 and the First Increment** and **Table 2** along with **Additional First Increment Learning** for each species after BQ text summarizes major findings and conclusions in an easily understandable format.
TABLE 1. 2016 Big Question Assessments. Improve the consistency of the contents under the column 'Basis for Assessment' in Table 1.	Yes	Replacing brief text under **Basis for 2016 assessment** in Table 1 with a **Summary of Key Learning from AMP Version 1.0 and the First Increment** is appropriate and effective.
Format for BQ 2-pagers. Please carefully consider how to more clearly link the hypotheses and suitability criteria to the Big Questions in the 2019 Report. Over the next two years, complete a detailed assessment of the Big Questions and hypotheses building on what's been learned, in preparation for an extension of the First Increment in 2020.	Yes Somewhat; good synthesis in Draft AMP v2.	Appendix A summarizes status of all hypotheses, links them to BQs X-Y graphs and data sources. 2019 SOP Format is largely unchanged from 2016. **Table 2** at the beginning, **Additional First Increment Learning** text at the end and **Appendix A** serve to *summarize* assessments of First Increment outcomes.

The main output would be a proposed set of revised hypotheses, without proposing any new actions.	See Extension Draft AMP v2	
The EDO provide responses to all ISAC recommendations, as was done in the final 2014 State of the Platte Report (but has not been done since then).	No for ISAC Comments on the 2016 SOP Report or 2018 recommendations	Recommendations from the ISAC 2018 Report are being addressed in the Extension AMP v2 draft.

2) Based on First Increment learning, what is the logical jumping off point for next steps with adaptive management in the Extension?

- Complete the Extension AMP v2 using the June and August 2019 drafts. As part of this revision:
    - Decide what to do with 1st increment BQs that are not two thumbs up or down - #3 and #9 (see our comments above on BQ10). Some options include: (1) continue answering the existing BQs; (2) revise/refine unresolved BQs language to reflect First Increment learning and future management options (see our comments and recommendations on this option earlier in this report); (3) discontinue answering these BQs and start over with new BQs.

      The ISAC agreed that quality of research questions is critical. "Good questions, lead to good answers." First Increment learning should make for much better questions than were possible 13 years ago. Consequently, there was little support for retaining original wording of First Increment BQs that were unfocused or scientifically unanswerable. ISAC members offered support for options (2) and (3) or a hybrid. Option (2) would ensure retaining continuity of key datasets and unanswered questions that are truly BIG and reasonably well posed, but could be further refined (i.e., they are unanswered, not because they are poorly focused or suffer from inadequate statistical design). Option (3) focuses attention on a thorough revise/rewrite of unresolved First Increment BQs to reflect what is now known, including current realities. The argument here is to begin the Extension with a clean slate; take a fresh look at each of the critical issues and formulate new BQ's where First Increment BQs are clearly inadequate.

- Consider how much management-relevant learning is likely to be stimulated by each of the proposed BQs during the Extension, and how investigations of each BQ can maximally benefit from contrasts created by natural variability.

Refer to the ISAC's (ISAC 2018) recommendations to the GC [particularly g) and h) under **1. State of the Platte Report, AM Plan and Target Flows**] and consider if or how Target Flows will be addressed in AMP v2.

3) Do TAC and ISAC members have any suggestions for how to improve presentation of material in the State of the Platte in 2020 and beyond? The ISAC did not collectively have additional suggestions for improving presentation of future State of the Platte Reports beyond our recommendations made in previously (ISAC 2017,2018) which have largely been addressed – we're pleased with the excellent progress that's been made on the State of the Platte Report. The Program has also made great strides in publishing the results of its work, and these peer-reviewed publications should be thoroughly referenced through endnotes (done partially, but not comprehensively). See individual ISAC member's text comments on the draft 2019 Report for specific editorial and content suggestions.

2. MODELING TOOLS

The ISAC agrees with the overall objective of the suite of modeling tools, namely, to better answer the question "How can we best use Program water to address species objectives?" [slide 121 in 2019 AMP Reporting Session presentations]. The EDO has made good progress on developing models and synthesizing field observations for use in the suite of modeling tools. Testing model predictions within a strong experimental design is a good way to practice AM. **It is important to state the specific purpose of each tool and how it complements and links to the other tools each time it is presented.** Our comments below reflect the need to carefully think about the specific decisions each tool is meant to serve in the Extension and Second Increment, the space and time scales of those decisions, and the most defensible methods of tool development to serve those decision needs.

AMP Read Ahead 2019 AMP Reporting Session (EDO 2019b) Discussion

Discussion Questions posed to ISAC:

1) Are the assumptions and level of complexity underlying these tools accurate and provide a robust means of developing and assessing flow scenarios?
2) These tools are fairly coarse in terms of their use for decision-making. Do we need to go deeper (for example, river sub-reaches)?

3) What flow scenarios and potential flow management actions should we consider for evaluation purposes?

Introductory Remarks. At the October 2019 AMP the EDO reported on three models to assist preparing the Extension AMP. We're pleased to see this work, which begins to address our 2018 recommendation*: d) Conduct analyses which explore how to meet the three bird species' needs for water during an extended period of drought over several years, identifying critical management uncertainties for the AM Plan*.

These tools are an excellent start. As we've had only a limited amount of time to review the tools (primarily at the AMP Symposium in October 2019) some of our comments may reflect an incomplete understanding of the work that has been completed. Our intent in summarizing our understanding of the tools is to ensure that we correctly grasped their purpose, scope and form, and to allow the EDO to correct any misunderstandings that we may have. We hope that our comments will stimulate more two-way conversations with the EDO to both clarify various issues and review progress on the tools as they develop. We hope that the suite of tools can be used in a decision-oriented exercise to evaluate tradeoffs among competing objectives for water when developing Target Flows, particularly in dry years when there may not be enough water for all species objectives and competing uses.

We've addressed all of the above three questions in our remarks but have organized our responses differently. Our comments are organized into two themes: **a) Clarify the Purposes of Each Tool**, and **b) Model Development Process**.

a) Clarify the Purposes of Each Tool

- **2-D models.** The stated purposes of the six 2-D models [page 1, Combined Read Aheads] are to: "*predict depth, velocity and corresponding inundation area across a range of in-channel (non-flood) flows to a finer level than previous efforts could reliably produce*", "*serve as reporting tool*", "*make informed decisions*" and "*provide boundary conditions for finer scale studies*". More specifically, the improved spatial resolution of hydraulic variables provided by the 2-D models serves to determine what flows would be required to maintain a total unvegetated channel width (TUCW) of 650', and to scour <1-year old cotton seedlings, all in aid of determining the best use of water to maintain habitat for whooping cranes. Useful, high quality predictions of "depth, velocity and area of inundation' can only be obtained by providing spatially and temporarily detailed topography and water surface elevation vs. discharge as inputs. The information value of model results will be determined/limited by the uncertainty of the topography and water surface elevation. The 2-D models may also

prove useful for informing future decisions about sediment augmentation. **ISAC comments and questions on the purpose of the 2-D modeling tool:**

- Are the above-listed decisions/applications the main focus, or are there other decisions/applications that are also of interest? What is the space/time scale of each intended application? Which applications are "must have" vs. "nice to have"?
- What habitat descriptor(s) do we ultimately want to extract from the 2-D models? For example, the ISAC has several questions on WC habitat descriptors. Does Total Unobstructed Channel Width (TUCW) really matter to whooping cranes, or is Unobstructed Channel Width (UOCW) the variable of interest? UOCW could be much less than TUCW, and the relationship between the two metrics has a lot of variability (Figure 5 in Farnsworth et al. 2018a). Does the 650' criterion only apply to UOCW, or also to TUCW?
- With respect to the spatial domain, are all areas within the AHR of equal interest, or are some areas more important than others, and therefore deserve more attention?

- **Flow Experiment Scenario Tool.** As described in the Program's Combined Read Aheads [page 5], the flow experiment scenario tool seeks to evaluate how much water would be available to test four potential Program flow management actions (a spring whooping crane release, a germination season flow release, a fall short-duration flow release, and a fall whooping crane season release), given two historical time periods (1998-2007 [wet to dry transition] and 2008-2018 [dry to wet transition]). More simply [slide 146 in AMP Reporting Session presentation], the purposes are to quantify the EA water needed for a release and to evaluate the feasibility of a combination of releases. **ISAC comments and questions on the purpose of the Flow Experiment Scenario Tool:**
  - Is it of interest to explore the range of potential hydrologic conditions beyond those experienced in 1998-2018 (including carefully designed "stress tests" as described in the Climate Risk Informed Decision Analysis framework), so as to determine the limitations/resilience of different flow management strategies with climate change? The Program should avoid, as much as possible, assuming, explicitly or implicitly, that the next ten years will be similar to the past 13 years. Perhaps, the hydrology will be similar in many aspects, however you should expect and prepare for major surprises. See further comments on these ideas below under Model Development Process.

- Is it of interest to explore sets of priorities different from those used in this first version of the model? Summer germination release was the highest priority in this version but may not be the only prioritization of interest. It would be valuable to explore tradeoffs in the ability to achieve various objectives.

- **Unvegetated Channel Width Decision-tree Model.** The purpose of the decision-tree model [page 14 of Combined Read Aheads] is to predict how flows and channel maintenance activities (spraying and disking) affect the time sequence of annual changes in TUCW, so as to determine the best set of actions (e.g., when and where to spray, disk and/or release water) to maintain TUCW. Together with the other two tools, the decision-tree model can be used to explore various scenarios of hydrology and decision priorities for different types of flows (including multi-year sequences of flows), thereby converging on the best way to manage program water at Lake McConaughy. The decision-tree model was motivated by evidence that a previous empirical model (in Farnsworth et al. 2018b) under-predicted Maximum Unobstructed Channel Width (MUCW) during 2016-2018 [slide 159 – blue vs. red lines]. **ISAC comments and recommendations on the purpose of the unvegetated Channel Width Decision-tree Model:**
    - What is the performance metric of interest to whooping cranes? Here are some suggestions and pros/cons for performance metrics:
        - A better measure than mean channel width: The Program currently uses mean channel width computed annually (e.g., TUCW or MUCW) in plots and some models. Examples: (1) Figure 1 on page 15 in 09 Combined Read-aheads shows average annual main channel total unvegetated channel width; (2) Unvegetated Channel Width Decision Tree Model on page 16 in 09 Combined Read-aheads; (3) the plot of "June -July 15 Mean Discharge**"** on page 165 of the AMP Reporting presentations shows the relationship between mean discharge and change in (mean) TUCW from the previous year. Developing empirical relationships for mean TUCW or MUCW across the entire AHR may hide changes of interest (e.g., some channel widths may shrink while others expand in a given year); ignores variability of individual segments, and; may be less relevant to whooping cranes (who are just looking to quickly find a safe place to roost.
        - **ISAC recommends a segment-based approach instead of an overall mean channel width.** One approach is to create a binary variable for each segment where 1 indicates channel width >650' for each segment. The analysis may be best done on individual segments and then you can compare segments from year-to-year. A segment-based approach addresses the problems with mean

change and is repeatable from year-to-year if you use the same reaches. Alternatively, when a single number is required to summarize one year you could compute the fraction of AHR segments where channel width >650'.

- Revealing critical uncertainties in functional relationships (i.e., those that affect management decisions) should be one of the purposes of developing the model, as it will help to choose strategies which are most robust to uncertainties and to focus research efforts.

b) Model Development Process

This section includes comments on how to develop each model, how to test model predictions, and how to summarize output. Three types of models were presented: 2-D models, a flow-experiment scenario tool, and a decision-tree model. Changes in one model may have implications for the structure and design of the other two models, since the three models are linked, and are meant to jointly improve decision making.

- **2-D models.** The ISAC was generally impressed with the method by which the 2-D model was developed. **Specific questions/comments from the ISAC:**
  - Can the suite of six models be run within a reasonable length of time to permit runs under various scenarios; or will it be necessary to pre-run the model and develop look-up tables that can be used by the other tools?
  - The river needs to completely inundate the area of channel which is to be maintained to clear the channel(s). Performance of the model at channel margins during high flows is therefore quite important. Testing this aspect of model performance should receive special attention.
  - While we realize that it's impractical to propagate all parameter uncertainties through the suite of models, it would be good to determine through sensitivity analysis which uncertainties (e.g., Figure 1) have the greatest impact on water management decisions.
  - The 2-D model demonstrates that in the absence of mechanical creation of TUCW large flows are needed to create the wide channel for TUCW, but lower flows are necessary to maintain them. What combination of high and low flows can create and maintain a mosaic of TUCWs that contributes to increasing WC use of the AHR? What is the intended spatial extent for application of the model: entire AHR or selected reaches that WC's use most often? There will likely be limitations in how long a reach can be simulated with the 2-D model.

- It may be useful to fly LiDAR after every large flow event that creates substantial changes in river geometry to refine the 2-D model, get updated estimates of TUCW and MUCW, and update calculations of aggradation/degradation. Alternatively, do you just use air photos to get annual estimates of TUCW and MUCW? It's possible that sand berms could create a sight barrier for whooping cranes that isn't visible on air photos, but would be distinguishable from LiDAR; therefore, having both is best whenever possible.

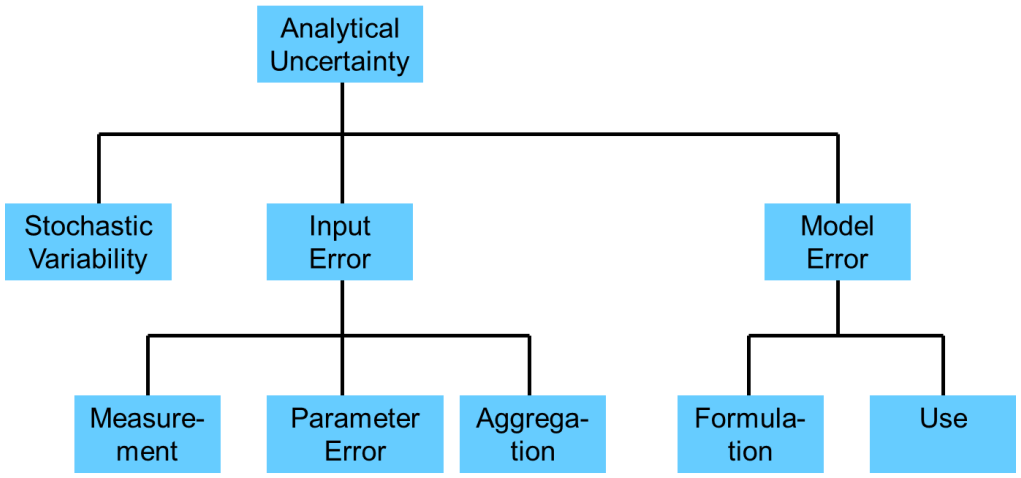

Figure 1. Taxonomy of Uncertainty (simplified from Suter et al. 1987)

- **Flow Experiment Scenario Tool.**
  - It may not be necessary to do every one of the four releases in every year. Perhaps as part of the target flow exercise, it's worth considering the idea of Turn-Taking Optimization (Alexander et al. 2018). Each objective is set up to be met either annually, once every two years, once every three years, etc. Once a particular objective has been met in a given year, the priority of that objective is lowered so that other objectives can be satisfied.
  - To make the flow experiment scenario tool into a useful operational model, it will be important to include the various diversions and water uses which occur between Lake McConaughy and Overton.
  - Consider applying climate stress tests using the methods of Climate Risk Informed Decision Analysis (CRIDA)[1], to determine under what conditions the EA account can or cannot generate the required channel flows.

[1] See https://agwaguide.org/about/CRIDA/ and https://agwaguide.org/docs/CRIDA_Sept_2019.pdf

- **Decision-tree model.** One key principle to consider in development of the decision-tree model is how to best incorporate various forms of variability and uncertainty (e.g., long-lasting effects of extreme years on channel condition, spatial variability in the responses of different transects to both flows and management actions). Doing so will yield insights not revealed from only examining average conditions. ***Specific questions/comments from the ISAC:***
    - ***Problems with the current model.*** The ISAC is concerned about the hand-made decision-tree model [Combined Read Aheads for tools and modelling session]. For example:
        - "*We incorporated simple linear regression relationships of annual change in main channel total unvegetated channel width (ΔTUCW-Main) and average 1 June – 15 July flows, as well as 14-day, 1 September – 15 October mean peak flows, to predict ΔTUCW-Main resulting from each seasonal flow using data from 1998-2018*." (pg. 14 of #09 Combined Read-aheads): It is ill-advised to assume linear, univariate relationships to describe a system with complex interdependencies.
        - Simple linear regression is inadequate even for the simple models you fit: For example, there are two problems with the simple linear regression between ΔTUCW and discharge [on slide 165 of the AMP Reporting Session Presentations]: 1) the slope of the regression line is entirely dependent upon a single data point from 2015; 2) the y-axis is the sum of changes in TUCW over all of the transects. The use of the mean mixes gains and losses and also ignores variability (see comments above about mean channel width). **We recommend redeveloping the decision-tree model, using all of the data from individual transects in a mixed statistical and mechanistic model, rather than using average main channel width.** Model predictions would then be for the distribution of TUCW or MUCW across all transects within the reach of interest, rather than simply mean values of these metrics, taking advantage of existing contrasts, such as transects that were disked (flow-mechanical) vs. not-disked (flow only). If you're spraying everywhere, then you don't really need a decision tool for that action.
        - To address the problem that univariate models ignore complex relationships, you need to use more sophisticated statistical models. One possibility to consider is a Random Forest[2] model approach to generate an empirically-

[2] https://en.wikipedia.org/wiki/Random_forest

based decision tree. If selected, it would be worthwhile forcing the algorithm to split on nodes which are under management control (e.g., spraying, disking) to see how much difference these actions make to the attributes of the channel cross-section. Random forest or other modelling approaches are available that would avoid the problem of assuming linear, univariate relationships to describe a system with complex interdependencies.

- It may be helpful to draw up a table of combinations of actions that might be taken, and then ensure that the Random Forest or other empirical method is structured to be able to provide guidance on when each combination is most appropriate.
- Predictor variables could be drawn from the 2-D model, as well as categorical variables such as spraying and disking (for which data exist going back to 1998). However, if spraying is done everywhere every year it's unlikely to be helpful in explaining variability in the annual changes in TUCW.
- Historical flows from 15 years ago (not just the previous year's flow) may affect the ability of the channel to widen under various flows. For example, the 2000-2005 drought would have caused vegetation to re-establish which can only be removed through disking. One possible way to deal with such lag effects might be to use cumulative flow from the last 15 years in a regression model, or to use a weighting approach for past years.
- If the predictors in the statistical model include output from mechanistic models (e.g., the 2-D model, Bank-Stem models), you can run various scenarios in the mechanistic model and feed each scenario's predictors into the statistical model to assess the effect of the scenario on TUCW/MUCW.
- Key output from the decision tree should be the fraction of the distribution of MUCW >650'. This would be a useful performance measure of the overall effectiveness of actions for whooping cranes given different sequences of water years. Keeping the distribution allows for whole variability to be represented.
- As for the other two models, it's important to consider various forms of uncertainty (Figure 1), including the uncertainty in being able to implement an intended action.

- **Model Testing.** Using all the data (i.e., all cross-sections) to develop the model leads to an over-estimate of model accuracy. It is important to do some cross-

validation[3] where some data are held out in the modeling framework. With only six years of data it is challenging to do cross-validation, but it is possible. For example, cross-validation is possible if you model individual AHR segment data. Exact methods will depend on the type of the model. Cross-validation for correlated data is challenging. Seek advice from a statistician for specifics once a new modeling framework has been selected.

- **Clarity of Terms.** The Decision-tree Model identifies Maximum Unobstructed Channel Width (MUCW), Total Unobstructed Channel Width (TUCW), and Main Channel Total Unobstructed Channel Width (TUCW-Main). **We recommend developing a visual that relates these terms along with the often-used Unobstructed Channel Width (UOCW), explaining the differences among them, how each is used, and the rationale for needing so many potentially confusing terms. It appears that the criterion of 650' is applied to each of these terms as suitable habitat for Whooping Cranes, yet (based on the assessments for BQ4 and BQ5) the 650' criterion appears to apply only to UOCW.**

3. DEEPER-DIVE QUESTIONS

The EDO shared a series of Deeper-Dive Questions (DDQs) prior to the 2019 AMP Reporting Session to provoke the ISAC to reflect on critical issues the Program will face undertaking the Extension and to stimulate discussion among the ISAC, TAC, and EDO. Knowing these questions ahead of the AMP Reporting Session offered us an opportunity to review them in advance and arrive prepared to respond with specifics. Individual ISAC members were tasked to prime the discussion by circulation notes on their perspectives prior to the Session. We hope our comments and recommendations will aid you in the next chapter of the PPRIP.

Discussion Questions:

1) ***The GC directed the Program to use adaptive management in the Extension to explore issues related to flow, river form and function, and target species. Are we building a rigorous AM approach to the right questions, and to questions that would benefit from reducing uncertainty for the purposes of decision-making?***

   ISAC Overall Response: Yes. The ISAC made detailed comments on earlier versions of AMP v2 and are pleased to see that these comments have been addressed. In general, we feel that the Program is moving forward in the right direction. We have several thoughts on AMP v2 BQs 5, 6 and 7, which appear below.

[3] https://en.wikipedia.org/wiki/Cross-validation_(statistics)

Specific ISAC Comments on CEMs:

- Distinguishing levels of uncertainty and levels of control is very helpful in prioritization of research, monitoring and management actions.
- It's great to have the hyper-links to relevant documents for each link in the CEM.

2) *As we develop a revised AMP for the Extension, how should we set priorities among outstanding uncertainties and key testable hypotheses?*

We've identified several challenges to revising the AMP:

1) Sequencing is likely to be more productive than prioritizing, as nobody wants their hypothesis test to be "low priority", but it can be "contingent upon…", and appear later in the sequence.
2) It is important to prioritize/sequence monitoring activities at the same time as research as it all comes from one budget. For example, you need to consider the relative priority of monitoring birds and researching sturgeon.
3) There is a need to consider a hierarchy of functions:
    - Program goals and objectives,
        - Program actions to meet goals,
            - Critical management uncertainties and associated hypotheses, and
                - Research to reduce critical management uncertainties
4) Self-interest of researchers can bias prioritization; multiple experts should participate in ranking alternatives, being as neutral as possible.
5) **We recommend linking prioritization/sequencing to design of flow experiments under DDQ4, including turn-taking optimization in response to state of habitat and species, and recent actions over past years (Alexander et al. 2018).**
6) Here is a suggested process for prioritizing or sequencing:

    Use a process like the Table 2 (refined to be simpler and focusing on hypotheses) to serve as a starting point for discussions about prioritization. Recognize that any scoring system can be gamed, and that the purpose is to stimulate collaborative discussions. The process would include the following steps:

    - TAC and EDO members each *independently* score a proposed list of research activities, organized hierarchically according to the management objectives, limiting factors and uncertainties that the research is meant to serve.

- Examine distribution of scores and discuss:
  - What research activities are clearly high priority/early in sequence? Low priority/later in sequence?
  - Why is there a wide distribution of responses for some activities? Did most folks miss something important that only one person considered or is that person strongly recommending research that they've been doing for two decades because it's really neat?
- Redo ranking after a good discussion, and hopefully converge on a logical sequence, including low-hanging, inexpensive fruit.

To some extent, the resolution of priority and sequence will/can be determined by unexpected conditions and events beyond the control of the Program (e.g., floods, a series of dry years, variations populations due to factors outside the AHR). During the extension, the Program will be dealt a hand to play and should be prepared for such stochastic events. To date, they have done quite well. It has been and will continue to important to be opportunistic. As with most research, opportunities appear and will you be prepared to adjust your approach or plans to take advantage of them? A good strategy would be to consider how sequencing and prioritization might change during a sequence of dry years vs. a sequence of wet years.

Table 2. A suggested process as a starting point for discussions about prioritizing or sequencing uncertainties and hypotheses.

	Level of Confidence (or Likelihood)				
	Very Low (1)	Low (2)	Possible (3)	High (4)	Very High (5)
Q1. …the *limiting factor(s) underlying the hypothesis being researched* is limiting the survival, growth or reproduction of one or more target species?					
Q2. … Program *management actions* could potentially influence the limiting factor(s) being researched and have species benefits?					
Q3. …*testing this hypothesis* is critical to annual PRRIP decisions, or to long term achievement of PRRIP objectives?					
Q4. …work on this hypothesis would provide good value for its cost?					
Q5. …work on this hypothesis should happen early in the next phase of the Program, as it's foundational for other work.					

3) Are the current management objectives in the Program's AMP an adequate means of assessing progress and communicating with the GC about Program success or failure?

<u>Piping Plover, Least Tern</u>

1. The stated Program objective is to improve production. It's worth continuing the First Increment management objectives during the Extension to provide a long-term record of performance and continued evaluation.

2. Breeding populations of terns and plovers in the AHR increased several-fold during the First Increment largely through habitat creation and management of off-channel sand and water habitat (OCSW) associated with sand and gravel operations. We support continuing the First Increment's management focus in the Extension to increase off-channel habitat availability by an additional 60 acres as recommended in the 2019 State of the Platte Report. However, additional potential sand and gravel sites are becoming limited.

3. As potential sand and gravel sites become limited, the Program Extension will have to focus instead on managing existing OCSW habitat rather than creating new habitat to ensure both species continue to be productive as source populations [i.e., lambda $\geq$ 1; e.g., Lutey (2002) criterion as a proxy indicator of fledgling rates supportive of positive rates of population growth].

4. Trying to manage a stable habitat base may not be the best long-term management strategy for a dynamic system where habitat availability can vary greatly from year to year and the bird species are adapted to this annual uncertainty. Trying to impose stability on such a system might continually create problems (e.g., ever increasing predation losses and a Lambda <1). **If predation losses (and Lambda <1) continue into the future, the Program should address methods to reintroduce variability back into the habitat creation system as a means of maintaining source bird populations over the long-term.** It's possible that birds are attracted to newly created habitats, since that's what they're adapted to exploit and such habitats are less likely to have predators in them. Perhaps it's worth experimentally re-sculpting some existing sand pits so as to both confuse predators and attract birds.

5. Achieving Program tern and plover objectives over the long term will require an emphasis on understanding factors that affect predation losses and intervening in cases where predation losses become excessive. This might include creating more year-to-year variability in locations of habitat to undercut predator acclimation to stable habitats, as well as other methods being explored by EDO staff. The Program's focus on predation is appropriate. Pilot tests may be helpful to support progress, as formal hypothesis tests may take too long to achieve high statistical power. Capitalize on knowledge and ideas from Program tern and plover biologists for site-specific approaches to predator control.

<u>Whooping Cranes</u>

1. The stated Program Management Objective is to: C*ontribute to the survival of whooping cranes during migration*. It is not possible to directly measure changes in migration survival associated with management actions on the Platte. Thus, the Program has been using several proxy measures known to be related to individual survival.

    a. There is strong evidence for many migratory species that *length-of-stay* at migration stopovers is correlated with habitat quality and reproductive fitness. Data show that whooping crane length-of-stay at the Platte River has increased during the First Increment. If there were sufficient GPS tagged birds it would be worthwhile to explore whether length-of-stay at AHR sites is correlated with

nesting success on the breeding grounds and annual survival. However, this may be difficult as we understand that the number of GPS tagged birds is declining.

b. Additionally, the *proportion of the whooping crane population* that uses the Platte River during spring has generally increased during the First Increment (except for 2019, slide 45 in AMP Reporting Session Presentations). Should the Program identify a quantitative target for this or leave it qualitative? While this might be appealing, the denominator of the proportion (total population) is largely beyond Program control.

c. There are three ways in which channel width can be created: flow, mechanical, and flow-mechanical. Is mechanically created habitat used at the same rate by whooping cranes as a river reworked by flows? It's important to test model predictions over time to assess if whooping cranes differentially use mechanically-created or flow-created channels.

2. **We recommend, if possible, the Program revise the AMP v2 whooping crane Management Objective to more accurately reflect what it is measuring.** If this is not possible, the Program should continue to use proxy measures a. and b. listed above and perhaps others as indicators of management success during the Extension. Also see our earlier suggestion in this report for carrying forward or revising First Increment BQ3 under **DRAFT 2019 STATE OF THE PLATTE REPORT, Big Question Assessments for 2019 and First Increment, BQ3.**

Pallid Sturgeon (also see our responses to DDQs 6 and 7)

We reviewed the three Big Questions related to pallid sturgeon proposed in The Draft AMP v2 (EDO 2019b; Table 3).

Table 3. ISAC comments and recommendations on proposed pallid sturgeon Big Questions (BQ) and underlying priority management hypotheses and alternate hypotheses form the Adaptive Management Plan v2 (EDO 2019b) for the PPRIP Extension.

Proposed Big Questions for pallid sturgeon in AMP v2	ISAC Comments
BQ5. Are Program flow management actions detectable in the LPR?	This question has been answered for current flow management actions. **We recommend following our guidance under Section 3, DDQ 6 in this ISAC AMP report and deleting or revising BQ5 accordingly.**
BQ6. Do Program flow management actions influence pallid sturgeon spawning habitat in the LPR?	We don't know the characteristics of spawning habitat in the LPR. **We recommend following our guidance under Section 3, DDQs 6 and 7 in this ISAC AMP report and revising BQ6 accordingly.** Once the attributes of spawning habitat are better understood, then the Program's 2-D model could be applied to selected reaches to evaluate the degree of influence of Program flow management actions.
BQ7. Do Program flow management actions influence pallid sturgeon foraging habitat in the LPR?	We concur with the GC's general sense in their September 2017 Workshop (Compass 2017) that pallid habitat use of the LPR, particularly in the early part of the First Increment Extension, should focus on better understanding spawning. Juvenile and non-reproductive adult life stages, those most likely to forage over time in the LPR, received the lowest priority. Addressing if BQ7 should remain an AMP v2 BQ should be revisited once the Next Steps identified in the September 2017 Pallid Sturgeon Workshop (Compass 2017) and further developed in the EDO's Pallid Sturgeon Discussion Summary's (EDO 2018b) potential research investment scenarios are completed.

4) ***How do your experiences in other systems (e.g., Missouri River) inform what we should be thinking about in designing flow management actions to learn and reduce uncertainty (i.e. "experimental design")?***

1. Use the available toolbox, information synthesis, statistical methods and decision analysis to simulate different AM flow experiments.

2. Explore how to best:

   a. get enough contrast in flow variables and other covariates of importance to a target species

   b. track the relevant habitat and species metrics with sufficient precision to get usable flow – response functional relationships

   c. monitor habitat/species' responses to take advantage of natural flow events which will likely provide more contrast in flows than management actions can feasibly create

   d. determine if/how flow management actions can provide incremental benefits to habitat/species and reduce critical uncertainties, considering potential future flow conditions outside of the historical record

   e. utilize turn-taking strategies to practically meet multiple objectives over multiple years.

5) *How do we address the issue of whether the GC needs to invest in acquiring and managing an additional 10,000 acre-feet (go from 120,000 acre-feet to 130,000 acre-feet) of water?*

Exploring the ability to opportunistically buy water leases from irrigation districts and others seems a prudent action. This will give the Program more flexibility to undertake desired water management actions for maintaining channel widths for whooping cranes, particularly in drier water years.

Rather than selecting somewhat arbitrary numbers like 10,000 acre-feet of water we recommend emphasis on future Program water acquisitions be more opportunistic, grounded on an understanding of the system and what breaks it. That is, where are the tipping points in your ability to deliver the necessary water? Identification of thresholds and tipping points must account for climate uncertainty and acknowledge that you are likely shifting into a different operating environment.

6) *How does the ISAC suggest we revise/re-organize the stage change study relative to an expert elicitation and the potential habitat/use questions we might address if we can detect Program flow management actions in the lower Platte?*

Deep Dive Questions 6 and 7 arose from long-standing differences among program participants concerning the substance of First Increment BQ9 *("Do Program flow management actions in the central Platte River avoid adverse impacts to pallid sturgeon in the lower Platte River?"*) and one's interpretation of the LPR Stage Change Study. Past ISAC recommendations as well as the Program's conclusions regarding BQ 9 have reflected these

differences. Our report to the GC on the 2016 State of the Platte (ISAC 2017) summarized the Program's assessments on this BQ, going from a one thumb up in 2012 and 2013 to two thumbs up in 2014 and then to a scratchy head in 2015 and 2016. Which of these assessments, if any, did the GC support? The ISAC supported (2015 and 2016) a two thumbs up conclusion on this BQ below the Elkhorn River. Over the past three years, the Program has been unable to reach a consensus, despite a focused and productive in-depth assessment of pallid sturgeon occurrence, use, and probable habitat in the Lower Platte River. Given this impasse we recommend the following:

Without greater consensus on the habitat needs of various life-history stages of pallid sturgeon in the Missouri and Platte Rivers, it doesn't make sense to proceed with an expanded Stage Change Study.

The Program should acknowledge that all of its members do not, and probably will never, agree on what the stage change study was, what it says, and what it should have been. Rather than dragging on this debate, the ISAC believes it is time to move forward from the Stage Change Study to a new approach (see below).

These recommendations originated from several considerations. Was the intent of the Stage Change Study to answer a narrowly focused question, that is "Would the Program's water management activities have a detectible effect on river stage, flow velocity, and flow depth?" or was the Stage Change Study intended to be a much broader evaluation of pallid sturgeon habitat? Unfortunately, support for both interpretations can be found in the Stage Change Study. The Introduction includes the following statement, *"The Study objective was to develop information needed to evaluate the potential effects of Program water management activities on water stage and how those stage changes might affect the physical characteristics of the lower Platte River."* The Study Report, however, concludes with an analysis and summary figure of how pallid sturgeon habitats might vary with river discharge. It has been established that pallid sturgeon do use the Lower Platte and recent (October 2019) observations indicate that pallid sampling has improved and/or their range in the Platte River is expanding. Nevertheless, the number of recorded pallids is very small and it is not possible to say with any confidence what their habitat selection might be. Given the significant uncertainty in the hydrology and hydraulic characteristics, and the poorly known habitat, different interpretations of the Stage Change Study are not surprising. The adaptive management process depends on program participates agreeing, at least, broadly on the meaning and results of studies. Yet, a consensus remains elusive after a considerable length of time (the Stage Change Study was first released in Dec. 2009).

Despite substantial investments in research in the Missouri River Recovery Program, the definition of habitat requirements for all life stages of pallid sturgeon also remains elusive and fluid. For example, recent work in the Lower Missouri River (USACOE 2019) has found

that age-0 sturgeon use a much broader range of depths and velocities than was previously believed. Ongoing work by USGS scientists suggests that velocity gradients may be as important as actual velocities, so the definition of habitat preferences for age-0 fish is likely to further evolve. With respect to adult pallid sturgeon, much data has been and will be gathered in the Missouri River on how movements, aggregation and reproduction are affected by flow, temperature and turbidity. To date it appears that in the Upper Missouri River only large natural events much greater than the scope of dam operations (like the flood of 2011) create a clear signal in adult movement and reproduction (USACE and USFWS 2018). Even if an expanded Stage Change Study were able to document small changes in depths and velocities in the Lower Platte River due to Program operations, Program participants would likely be unable to reach consensus on whether such changes would or wouldn't make any difference to various life-history stages of pallid sturgeon, given the uncertainties and fluidity in the definitions of habitat requirements.

We agree with a key point of discussion at the September 2017 Platte River Recovery Implementation Program Pallid Workshop (Compass 2017) that there is a need to improve or consolidate the Program's understanding of its effects on pallids, but that an enhancement or expansion of the Stage Change Study may not be the best way to do it.

A new approach to the Stage Change Study should involve gathering data on the distribution of pallid sturgeon in the Lower Platte River, as discussed in previous reports (Compass 2017, 2018; EDO 2018). Monitoring the movement and reproductive activities of telemetered reproductively-ready adults is likely the most feasible activity. It may also be worth considering applying methods used by the Missouri Pallid Sturgeon Population Assessment Program (PSPAP 2.0) to sample for age-0 pallid sturgeon as an indicator of successful reproduction in the Platte River, but only if spawning of adults in the Lower Platte River is confirmed. Improved understanding of the use of the Lower Platte River by adult pallid sturgeon will inform DDQ 7 and be a valuable contribution to the recovery of pallid sturgeon in the Missouri River Basin.

7) ***How do aspects of morphology, flow detection, etc. influence the Program's ability to have an effect on pallid sturgeon habitat and use in the lower Platte River?***

We recommend that the Program implement research activities agreed to at the 2017 workshop on pallid sturgeon (Compass 2017), focusing on spawning adults, and using methods and tracking technology implemented on the Lower Missouri River, with associated monitoring/modeling of flows, temperatures and turbidity. We concur with and further specify the GC's first objective for pallid research during the First Increment Extension. *The Program's should research when, where, and how reproductively-ready pallids are using*

hydrologic, hydraulic and geomorphic river features for migration and spawning. Results of this research will help determine the range of habitats used by adult pallid sturgeon in the Lower Platte River. Additionally, it will create a foundational context for assessing the potential influence of Program water management activities on adult pallid sturgeon and determining what further forms of physical data may be required for further analyses (e.g., channel topography, flow resistance, stage recorders).

8) ***Should the Program consider undertaking predator trapping/strobe light experiments beginning in 2020 to increase productivity or are their other measures that should be considered first? If so, is the experimental design robust enough to capture differences in productivity or should another design be considered?***

At the meeting there was some opposition to avian trapping. Alternatives were discussed to discourage the interest of predators including adding an exclosure to keep out turtles and rotating the use of sites to discourage predators. **The ISAC recommends that staff biologists be engaged to help design options for an appropriate pilot study.** We recognize that you may not be able to collect sufficient data to do a powerful hypothesis test. **We recommend that you develop rigorous data collection approaches as you may wish to use the data for formal hypothesis testing in the future.** For example, you might consider developing approaches to collect data on a 'catch-per-unit-effort' basis to account "number of days of camera trap use" in your accounting. The draft experimental designs for nest and sandbar level studies from the Missouri River (Schwarz et al. 2019a, 2019b) have additional ideas about experimental design and models for analysis. The proposed approach for the Missouri River was similar to the power analysis presented during the Fall 2019 AMP Reporting Session [slide 185].

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