PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM (PRRIP)

ISAC Report on February 2023 PRRIP Science Plan Reporting Session (SPRS)

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Executive Summary

As part of the annual Science Plan Reporting Session (SPRS), held February 14-16, 2023 in Omaha NE, the ISAC was asked several detailed questions about Program components. The second part of this report "ISAC Responses to Detailed Questions'' deals with that charge. This Executive Summary provides high level ISAC responses regarding each of the Program components, their strengths and weaknesses, and recommendations for future directions.

Pallid Sturgeon

Work from University of Nebraska – Lincoln (UNL)

Given the formidable challenges setting up a field research project on the Lower Platte River (LPR), significant accomplishments were made in the first year: developing and implementing telemetry, characterizing spawning habitat, and identifying potential spawning areas.

The Principal Investigators (PIs) from UNL and Nebraska Games and Parks Commission (NGPC) provide excellent knowledge, skills, and abilities to achieve project objectives and provide highly useful information to the Program. The graduate students are enthusiastic, highly motivated, and determined to accomplish this effort. Their draft research projects are relevant to Program needs, and have the potential to make significant contributions to the Program.

The documented Methods and Results in the Progress Report provide a firm foundation for making further refinements and improvements to meet Project objectives. What's needed next is a detailed description of exactly what methods (i.e., testable hypotheses, quantitative metrics, data analyses, sampling design, monitoring program) will be used to accomplish the stated objectives. For example, an essential aspect of Objective 1 is relating LPR hydrology and temperature to the movement of pallid sturgeon into and out of the LPR and its tributaries. The project needs a detailed plan for how relevant physical variables (e.g., flow, velocity, depth, temperature) will be related to the movement of pallid sturgeon. Some variables currently monitored (e.g., pH, conductivity) aren't relevant and can be dropped. Figures 10 to 12 in the Progress Report provide a general overview of observed movement patterns, which is an excellent start to thinking through a detailed data analysis plan. Pilot analyses of the data collected so far will help to refine the data analysis plans for each study objective.

Objectives 2 and 3 (identifying pallid sturgeon spawning habitat, verifying successful spawning) are challenging. At present the project is only able to diagnose 'potential spawning'. To convincingly verify successful spawning, the project needs to consider improvements to the field program, such as: implementing methods used in the Missouri River Recovery Program (MRRP) to assess reproductive state of pallid sturgeon and confirm 'actual spawning' of female pallid sturgeon; increasing the intensity of sampling for free-embryos downstream of potential or actual spawning sites; and/or increasing the intensity of sampling for age-0 sturgeon These and other potential improvements to the field program will be discussed at a meeting on 5 April between the EDO, UNL and two ISAC members. Without improvements in methods, skills, capacity and support, the project may end up with habitat correlates of 'potential spawning sites', and won't thoroughly address objectives 2 and 3 as stated.

Recommendations. Given the many challenges of this applied research, the ISAC recommends a continuing high level of involvement of the PIs from UNL (Mark Pegg and Jon Spurgeon) and NGPC (Kirk Steffensen) with their graduate students (Chris Pullano and Jenna Rouss). Project success could benefit from PI's providing more guidance to their graduate students to refine the methods and analyses used to meet the study objectives, and possibly reevaluating if all objectives are achievable as stated. It's also essential for the project team to work more closely with USGS and NGPC scientists involved with the MRRP and do a thorough pallid sturgeon literature review, including relevant MRRP products (e.g., Fall Science Meeting presentations, Adaptive Management and Compliance Reports (AMCRs)). The most important tasks in the short term are to: 1) improve the study plan for the 2023 field season; 2) develop a detailed data analysis plan for all four objectives; and 3) assess the capacity of the UNL team to accomplish Project objectives given current time and resources. Three members of the ISAC will join the EDO and UNL team for a meeting on April 5 to explore what improvements are possible.

Work from Southern Illinois University (SIU)

Considerable progress was made in the first year of the project. Dr. Heist and his team were able to get their new Illumina MiSeq DNA sequencer or GTseq working well. The GTseq technology allows SIU to classify sturgeon more accurately and rapidly as either shovelnose, pure pallid sturgeon, or various types of hybrids. Knowing the genetically confirmed species of sturgeon in the Platte River is essential for addressing the steps outlined in the PRRIP pallid sturgeon Framing Document. Dr. Heist and his colleagues were able to successfully validate the results of GTseq genetic sequences by comparing outcomes with results from a previous study, and they also discovered important differences with earlier approaches to species discrimination used in the Missouri River. The advances made by Dr. Heist should improve the accuracy of both broodstock collection for hatcheries and estimates of natural reproduction.

The SIU team is well placed to support the UNL team over the next four years of the study. The GTseq technology allowed Dr. Heist and his team to rapidly process field samples of age-0, juvenile and adult sturgeon submitted by the UNL team for genetic identification, and to identify the exact parentage of some larvae if the parents were of hatchery origin. Dr. Heist was also able to get a new Ph.D. student on board – Junman Huang. Dr. Heist is making good progress towards determining the *effective population size* of pallid sturgeon in the Lower Missouri River. Effective population size is a metric of genetic diversity which is relevant to tracking progress towards ESA recovery objectives for pallid sturgeon, and is of great interest to the USFWS.

The ISAC is impressed with the progress that's been made. Our only concern is in the communication of the results of the work to Program participants who are not geneticists. Most of the progress report, and much of the presentation at the SPRS was incomprehensible to non-specialists. Two ISAC members who have worked for a long time on the Missouri River pallid sturgeon program (and heard previous presentations by Dr. Heist) also found the progress report very hard to follow.

Recommendations. We recommend the following steps to overcome communication challenges:

1) prepare progress reports and presentations for non-technical audiences, with simple explanations of all terms and acronyms in the text (with a glossary in an Appendix), and a clear explanation of *why* each task was done. Include an Introduction that (in part) repeats salient portions of the SIU proposal and adds further detail as needed to outline:
    a. how genetics is used to identify and classify species, particularly fish;

   b. a primer on sturgeon genetics including how pallid and shovelnose sturgeon differ in form and genetics;
   c. how genetics in general and specifically how GT – Seq helps to discriminate between different species of sturgeon as well as different types of hybrids; and
   d. explain *effective population size* and how assessing it through results of this research will contribute to assessing progress towards recovery of pallid sturgeon.
2) test-drive progress reports and presentations on non-technical audiences (e.g., a freshman college student from a different field who is not studying genetics) before submitting / presenting them to the Program; and
3) present a non-specialist primer on the above topics at next year's SPRS.

Target flows, herbicides and *Phragmites*

A strength of this work is that it provides useful data to determine the likelihood that specific flow conditions will or won't be effective at limiting the spread of a *Phragmites* patch and identifying thresholds below which they will have no impact. Another positive aspect of this work is that 2D models using LiDAR bathymetry can be used to predict with good accuracy which areas will or won't be inundated at a given flow.

However, this work also has several challenges. First, the effect of target flows on vegetation patches depends on site-specific attributes, which vary considerably with channel hydraulic geometry (depth, velocity, width, drag force, shear stress) as well as biological variables like seed immersion time. As a consequence, the effectiveness of 'target flow treatment' will vary considerably along the length of the study area. Similarly, the 'herbicide treatment' is uncertain, as spraying may or may not cover areas that were designated to be sprayed. Therefore, it's difficult to determine just what flow and herbicide treatments were applied to each patch of *Phragmites*. The current sampling approach is designed with the idea that it is possible to determine whether inundation flows are universally effective along the entire study area, yet the reality is that there is a patchwork of no, partial or full treatments of both flows and herbicides.

Recommendations. Going forward, the ISAC recommends the following steps. First, rethink and possibly reframe the key management decision driving this research as follows: "*Can the Program use inundation flows instead of herbicide (or reduced herbicide) to control Phragmites and other unwanted plants?"*, OR "*Where are target flows insufficient to prevent the expansion of Phragmites and other unwanted plants, requiring the additional application of herbicide?"* Reframing the purpose of the study in either manner leads logically to a simple, deliberate experiment focusing on the largest contrasts in the two management actions (inundation flows and herbicides), as described in the ISAC's detailed responses to SPRS Session #3 on Phragmites.

Other ISAC recommendations:

- The EDO may find it useful to fit a regression-type model to field data and modeled metrics. The response variable could be the annual change in Phragmites patch size. The covariates might include herbicide (whether or not the site received herbicide), various descriptors of the site's channel geometry (perhaps model-predicted inundation level), and year. This would allow you

to understand how different site characteristics impact annual changes in patch size. The suggested model is just a starting point - a more sophisticated model may be required.

- Use a combination of hydraulic modeling, remote sensing, and field measurements (sensors and census), to quantify the flow conditions that are effective at limiting patch expansion. Thermographs are an inexpensive tool for distinguishing areas that were or were not inundated, since air temperatures are much more variable than water temperatures.
- Seek guidance from outside experts for your work. For example, "Kettenring's lab discovered the best way to control the invasive grass is to first control the seed production by mowing the grass mid-summer to keep it from spreading. Then in the fall spraying the area with herbicide three years in a row. " Source: https://wildaboututah.org/invasive-phragmites/. Work from other areas may or may not be directly applicable to the Platte, where downstream transport of seeds is likely a major source of re-seeding.

Sediment Augmentation

Due to the development of upstream storage and flow diversions, the supply of sediment to the Central Platte River is somewhat less than the downstream transport. Sediment augmentation (Big Question #3) is a necessary action to mitigate channel degradation and limit the development of a single thread channel pattern downstream of the clear water J-2 return flows. A full-scale sediment augmentation program initiated in 2017 supplies approximately 60,000 to 80,000 tons of sediment annually to the South Channel near the J-2 outfall.

Investigations of river channel change and sediment transport by the PRRIP provide a comprehensive and consistent understanding of the effects of sediment augmentation. Geomorphic analyses of changes in channel bed elevation, longitudinal profile, and pattern show that the instabilities resulting from the clear water inflows are progressing downstream significantly more slowly than was originally anticipated. Sediment augmentation has significantly slowed the downstream progression of channel degradation and the development of a single-thread, sinuous channel. Other factors, in addition to the Program's sediment augmentation, may contribute to slowing the downstream migration of channel instabilities. Diverting a larger portion of relatively high flows from the North to the South channel may contribute to offsetting the annual sediment deficit in the South Channel but could however increase the North Channel deficit.

Based on the EDO's comprehensive analyses of an excellent data set, the ISAC believes that sediment augmentation of 60,000 to 80,000 tons per year is necessary and sufficient to offset the imbalance created by the J-2 clear water release. To date, the augmentation of sediment has focused primarily on mechanically pushing bank material into the channel. While this has been an effective approach, various alternative approaches and/or sources have been suggested to supply sediment more simply and cost-effectively to the South Channel. For example, bank erosion downstream along the South Channel has been considerable. Perhaps removal or suppression of bank vegetation could increase the rate of bank erosion and supply of sediment to the channel.

Recommendations. In terms of future work, we recommend the following steps:

- Focus data analyses on the key endpoint: has sediment augmentation ensured the braid plain downstream of Overton bridge remains wide enough to create suitable Whooping Crane habitat?

- State clear questions and hypotheses about the co-evolution of the channel and sediment transport along the study reach, both pre and post sediment augmentation
- For the 'change since augmentation', analyze bed morphology and bed evolution using the best available data for the time period prior to sediment augmentation
- While it was useful to do the detailed analyses in the sediment augmentation report, how often does the EDO need to do such in-depth data analyses? Certainly not annually.
- Consider alternative sources of sediment that can offset the J-2 sediment deficit. Are there ways to accelerate bank erosion?
- Determine whether head-cutting into the breakthrough channel from the North channel is serving as a sediment source.

Whooping Cranes

The ISAC values the check-in process provided by the re-analysis of whooping crane roosting site selection data. Put in folksy terms, is what we think we know still so? River characteristics selected by roosting whooping cranes form the primary basis for current management activities. We believe the GC will find great value in increasing certainty regarding fundamental relationships with nearly twice as much data.

The ISAC also supports the additional consideration of factors not looked at previously, so called off-channel metrics. It is acknowledged that most of these metrics are not under management control. Nevertheless, these factors may indirectly affect Program success. Incorporating these metrics into crane roosting selection analyses could be used to prioritize where river management efforts are conducted or if land swaps/acquisition may help to overcome factors out of the Program's control.

Recommendations. The ISAC recommends that the EDO continue with the data analysis, and has a few suggestions to improve the analysis:

- The EDO should consider including data from the first iteration of the whooping crane telemetry project (2010-2018). The Program has this dataset in hand and it is publicly available for use. How best to integrate the telemetry data with standard Program data sets requires further thought.
- A recent publication on whooping crane use (Baasch et al. 2022) used the USFWS public sightings database (which is different from both the Program database and the telemetry database), and a different method of land classification. Understanding the effects of different datasets on management-relevant insights is a high priority for the Program.
- Unit discharge (cms/m) was included in the analysis and had a modest effect on whooping crane roost site selection. The ISAC and others found this metric difficult to interpret. We suggest a re-thinking of how attributes of flow like water depth, channel morphology, and wetted width can be accounted for as surrogates of discharge in roost site selection. Can a metric with greater interpretability, management relevance, or biological importance be included?
- It would be valuable to engage the TAC as to how on- and off-channel metrics might interact in a way that could affect management actions and recommendations. For example, does the

channel need to be wider at locations near development (like a river bridge) compared to sites far from development, to have equal attractiveness to cranes?

Wet Meadows

The Wet Meadows Report is a fine, well-written publication, with informative tables and figures. The Report provides reliable, comprehensive, and complete information to PRRIP management of wet meadows, and fulfills the goals outlined in the Science Plan. The report includes both detailed quantitative modeling at intensively monitored wet meadows, as well as a simple qualitative approach (using the difference between modeled river stage and LiDAR-estimated ground elevations). There are many potential applications of the tools and analyses presented in the report:

- The simple qualitative ranking could be used to prioritize areas for habitat work (if it appears that more wet meadows are needed for whooping cranes, or just to maintain wet meadows for their own sake). Some areas are likely fine as they are, while other areas would require too much restoration to become viable wet meadows.
- An index applied in the report (the Growing Season 7 Day Moving Average Maximum Water Level) could be used for management of existing wet meadow sites, as well as targeting high priority sites for possible future acquisition.
- Quantifying groundwater - vegetation links could enable the Program to better establish targets for what is a 'wet meadow' and assess what changes in hydrology could improve wet meadow habitat.
- The simple model that predicts groundwater elevation and expected vegetation types can assist the Program in predicting what Platte River discharge would be necessary to improve wet meadow habitat, a starting point for assessing the feasibility of maintaining various wet meadows. For example, looking at Elm Creek and Fox sites, what flows would be required to get the Depth To Ground Water (DTGW) to the required level to maintain a substantial portion of the area (say 30%) as wet meadows? If this is not possible, then perhaps consider removing them and other sites currently identified as wet meadows.

Study limitations constrain what can be learned from the detailed studies of wet meadows. There are only two sites, there is limited information on what vegetation and soils were there originally, and the meadows appear to have been drained, cultivated, and fallowed over time. Simpler models that can be applied extensively hold more promise of being helpful in management decisions.

Recommendations. We understand that the EDO would like to wrap up the work on Wet Meadows, consistent with the Science Plan. Before doing so, it's worth asking if we now know enough to aid the GC in better defining for the 2nd Increment the role of wet meadows on Platte River recovery – both for WCs and broader ecological benefits. If there are remaining questions to be answered (either within the Program or outside of it – e.g., by a graduate student), then some of the above potential applications could be considered, as well as the following ideas:

- clarify the value of wet meadows to the Program, particularly for Whooping Cranes;
- synthesize the various recent efforts on this issue which used different landcover and whooping crane datasets, as described above in the section on Whooping Cranes;

- ground truth and use 2005 land cover classes to determine how well the model results predict vegetation cover; and
- walk around the sites and become more familiar with them.

Non-Program Science

Summary of the Process for Science Funded by the Program. The PRRIP has developed a strong collaborative process to ensure high quality applied science that directly addresses big questions and management hypotheses linked to Program decisions. This process involves review of science proposals, reports and draft manuscripts by various entities, potentially including the TAC, ISAC, outside experts and peer reviewers selected by journal editors. Some applied science products (e.g., modeling analyses of the effects of different combinations of management actions on habitat metrics) may be very relevant to Program decisions, and have been reviewed by the ISAC, but due to their content or length aren't suitable for publication in peer-reviewed journals. The ISAC (2013) provided some guidance to the PRRIP in how to determine which documents require peer review, and which are / aren't suitable for journal articles (Figure 1). Our recommendations have generally been followed by the Program. State of the Platte Reports have provided the GC, TAC, ISAC and public with a concise synthesis of applied science related directly to big questions, and the ISAC has performed multiple reviews of each State of the Platte Report as well as key component publications cited therein.

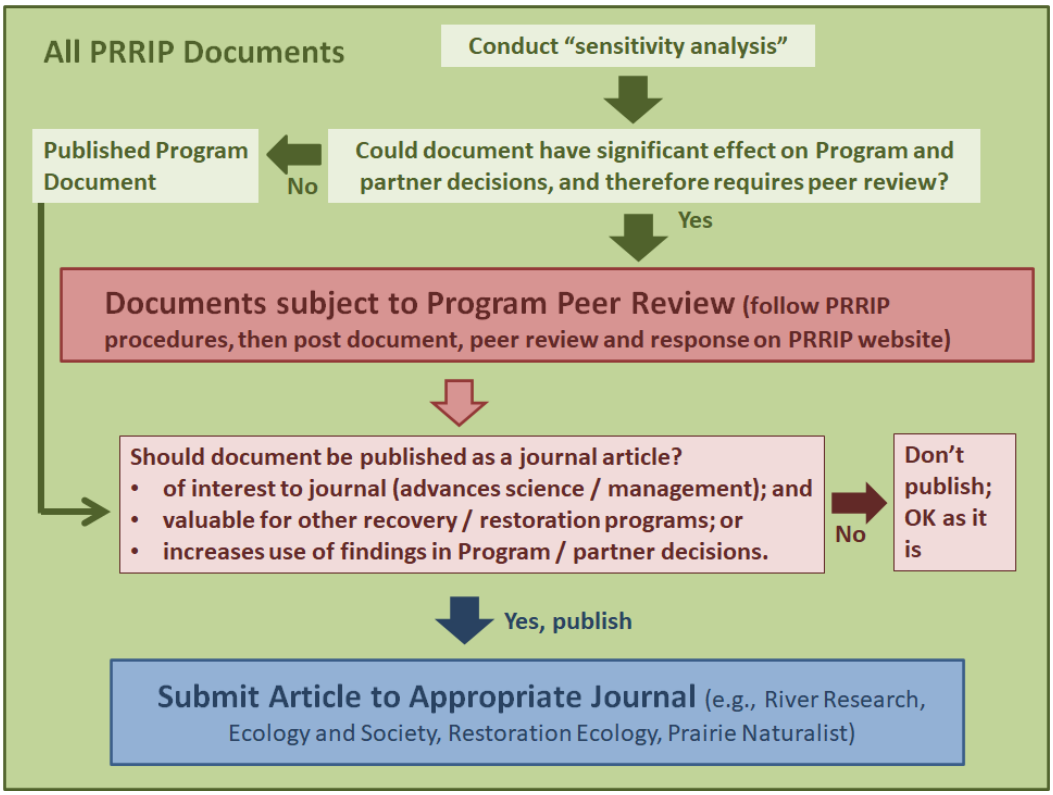


Figure 1. ISAC's recommended framework for thinking about the different types of Program documents, and the criteria for deciding if they warrant Program review or publishing. Slightly modified from ISAC (2013) for clarity.

Concerns. The Program is now wrestling with how to meld science funded by the Program with other science developed and published outside of the Program ("non-Program science"). There are at least three concerns which have emerged: how to determine the relevance to the PRRIP of non-Program science, how to deal with multiple competing data sets and analytical approaches, and lack of collaboration. With respect to the issue of relevance, there are concerns that non-Program science may not have proceeded through the same set of collaborative scoping and review steps as Program science, may not be well integrated with Program science, and may consequently be less relevant to PRRIP decisions. The second concern is that while some non-Program science may address questions that are directly relevant to Program management decisions, scientists outside the Program may have used different datasets and analytical approaches to address these questions, so the GC may be presented with a confusing array of competing datasets, models and conclusions. The third concern is that science efforts outside the Program which proceeded without collaboration may have misinterpreted or misapplied Program data, methods and conclusions. The overarching consequence of these concerns is the GC may be reluctant to make a decision because the science is not unanimous or certain. As in the past, it may be helpful for the GC to apply Structured Decision Making to reconcile competing recommendations. Often, differing assumptions, data sets and analyses affect the magnitude of predicted outcomes across all actions, but don't affect the relative performance of different actions (e.g., Marmorek and Peters 2001).

Recommendations. The EDO, in collaboration with the TAC, proposed that the best way to deal with the above concerns is to have non-Program science proceed through the same systematic process as Program science. The ISAC feels strongly that this is an infeasible solution to the above-described concerns, and would likely backfire, leading to accusations that the Program is attempting to control how science is done outside of the Program. Instead, each potentially relevant peer-reviewed publication should be judged for its actual relevance, data quality, analytical methods and defensibility of its conclusions, *regardless of its origin.* The PRRIP should strongly encourage (but not attempt to force) strong collaboration between Program and non-Program scientists, including data sharing agreements, systematic comparisons of alternative data sets and analytical approaches, joint conferences, and co-authorship of journal papers and reports. The Governance Committee should ask all program entities to make the Program aware of new scientific endeavors and products that may have value and relevance to Program activities, science, and decisions, and to provide periodic updates. All Program products (e.g., technical reports, journal papers, State of the Platte Reports) should systematically consider and review **all** relevant peer-reviewed publications, regardless of their origin, and rigorously weigh the strengths and weaknesses of each publication (or reference a recently completed literature review). In particular, the State of the Platte Report should be a comprehensive synthesis of all published science directly relevant to PRRIP Big Questions and management hypotheses. This will provide a helpful synthesis for other entities, including the U.S. Fish and Wildlife Service when they prepare their Biological Opinions. Remaining uncertainties generated by competing analyses that may affect management decisions can form alternative hypotheses to be systematically evaluated by Program science and/or structured decision making.

Useful Guidelines. Meffe et al. (1998, cited in ISAC 2013) identified seven criteria of an independent scientific review to ensure that decisions and policy making reflect the best scientific knowledge available: 1) the best available scientific knowledge is brought into the decision- or policy making process; 2) the influences of bias and special interests are minimized in environmentally relevant decisions or policy making; 3) science is separated clearly from nonscientific issues; 4) decisions or policies are achieved in an open and transparent manner; 5) all relevant information is considered and

evaluated; 6) all conclusions drawn are consistent with the available scientific information, and assumptions are made explicit; and 7) the risks associated with different interpretations of data or alternative management decisions are articulated. These criteria are also helpful in guiding how Program scientists synthesize all available information for Program management decisions. Ideally, non-Program scientists would also follow these criteria.

State of the Platte Report

This topic was not discussed at the SPRS. The ISAC nevertheless has the following recommendations:

- Issue State of the Platte (SoP) Report in early 2024
- Don't change the format. You are wasting time changing the format instead of working on the most important thing which is to produce a SoP.
- The GC should require the EDO to publish regular State of the Platte Reports, perhaps biennially.
- The SoP report should incorporate a comprehensive synthesis of all decision-relevant science, whether produced by the PRRIP or outside of the Program. To keep the report short and digestible, some of that synthesis could be in an Appendix to the report.
- The key thing that the EDO must do is to anticipate how the GC may be presented with multiple competing publications, hypotheses, analyses and conclusions, and to guide the GC through the reasons for differences between these publications (e.g., different definitions of habitat, habitat data sets, WC datasets, methods of analysis).

Conclusions

The EDO has first-rate staff who produce high-quality scientific research that is relevant to Program management. For this SPRS, EDO staff posed detailed questions to the ISAC on the analytical methods used for various program components. Most of these detailed questions were of little interest to the GC. At future reporting sessions, it would be valuable to have the ISAC focus primarily on big picture questions of interest to the GC, while also responding to a few detailed questions that are critical to EDO analyses. In addition, presentations at future reporting sessions should more directly address big questions and management hypotheses in the Science Plan and State of the Platte Report.

ISAC Responses to Detailed Questions

This section of the ISAC report is complementary to the high-level points presented in the Executive Summary. For some detailed comments, we have included the ISAC member who made them to allow for follow-up dialogue (EDA = Ned Andrews; DG = David Galat; JH = Jennifer Hoeting; DM = David Marmorek; AP = Aaron Pearse; MT = Michal Tal).

2023 SPRS Agenda Session #2 – Target Species: Pallid Sturgeon (PS)

Detailed comments on the pallid sturgeon progress reports from UNL and SIU, and responses to specific pallid sturgeon questions have all been provided to the EDO. Major responses are summarized below, with a few key points noted in red.

General Comments

- Communication. The SIU report needs a much simpler explanation of why / how various activities were undertaken that can be understood by people who are not geneticists (see Executive Summary).
- Data analysis plans. The UNL report lacks a detailed description of how the data that are being collected will be analyzed. The analytical methods should drive the organization of the field program, not the converse. Now that the first field season is complete and general field methods established it is essential to identify how methods proposed and described will achieve Objectives 1-3, if they are sufficient, or if adjustments are necessary to improve outcomes.
- Objectives vs. project scope. The UNL Platte project for PS is less comprehensive and precise than what's done by USGS and USACE on the Missouri River. With the current structure of the program, it will be difficult to credibly connect water management to habitat conditions to *actual* PS spawning sites. It's more likely that the endpoint will be *potential* PS spawning sites.
- Hydrology. It would be helpful for this Report to include summary figures of LPR and tributary hydrology (USGS gage discharge) at all or some of the USGS gages they have identified in the LPR basin. This could be in the form of figures that show daily flow over a calendar year for the preceding 5 years including the current study year. Results would briefly report on how the current year's discharge compares with the 4 previous years. This would help to put potential issues in context both spatially (e.g., are there sufficient flows for receiver placement in the Loup River and in the LPR above the Loup River?), and temporally (e.g., how did this year differ from past years?). The team might also consider applying the Indicators of Hydrological Alteration (IHA) summary statistics to flow records as a suite of relevant hydrological variables to establish baseline conditions prior to this study, to be compared with flow conditions during the study. That effort might link well with some of the objectives of Jenna Rouss' thesis.

- Environmental variables for Objective 1. It's worth adding a brief section in Results under Objective 1 that summarizes trends over time in environmental variables such as temperature, turbidity and discharge, and also how temperature and turbidity vary with discharge. This will provide context for later figures (e.g., Figures 10-12) and text that shows PS movement in relation to these variables.
- Linking environmental variables to movement for Objective 1. What are the specific river discharge and temperature variables that will be linked with pallid sturgeon movements? What analytical approaches will be used to assess if and how temperature and discharge variables are associated with timing and extent of PS movements in-out of and within the LPR? Hundreds of individual PS movement traces will be produced and associated environmental variables measured for each fish. How will UNL determine if any patterns and statistical associations exist between movement (e.g., timing, frequency, rate, direction) and physical variables (i.e., magnitude and rate of change in discharge, temperature)? Testable hypotheses need to be described based on a thorough review of past literature, with analytical methods outlined that can feasibly evaluate these hypotheses. Enough thinking on these issues needs to be done before the 2023 field season to ensure that critical adjustments are made to sampling designs and monitoring protocols.
- Linking micro- mesoscale habitat variables to locations for Objective 1. Objective 1 examines relations between environmental conditions and PS movement. Methods (*Habitat measures at Pallid Sturgeon detection locations*) report that micro- and meso-scale habitat information will be collected at PS detection locations. Doing this at capture locations is informative, but is insufficient to address Objective 1. Are you measuring both micro- and meso-scale habitat variables where and when PS are actively located? This is unclear in the Methods. Results report that 40 detections were made during active tracking, and Table 11 summarizes micro-scale measurements at active detection locations. Ideally both meso-scale and micro-scale measurements would be integrated together in a manner more relevant to Objective 1 than what is in Table 11. Sharing these results and assessing if patterns in PS detection locations and habitat variables is an essential element of this Project. Methods need to be defined prior to the 2023 field season.
- Assessing Objective 2. Results from 2022 raise several concerns: can enough reproductively mature male and female PS (i.e., likely to spawn during current season) be captured under the current level of effort? How many are sufficient for a robust analysis? How do you confirm that individual fish are reproductively ready? It's worth exploring options to increase the number of reproductively mature PS captured and implanted with transmitters now, and to define how reproductive readiness is assessed - before the 2023 season.
- Assessing Objective 3. Will the project only be able to define "potential spawning locations," or will there be sufficient information to determine "actual spawning locations" and reproduction? Possible improvements to the existing program might include more captures of embryos below suspected spawning sites, recaptures of spawning females to determine if they've released their eggs, and extensive captures of age-0 sturgeon - at least 1000 fish, of which on average 1 will be a pallid sturgeon and 999 will be shovelnose.

Detailed Comments

(Report references refer to Pallid Sturgeon Biology in the Platte River and its Tributaries – Annual Progress Report, January 2023)

OBJECTIVE 1.

1. *Life History Overview.* This is satisfactory for a Progress Report, but not comprehensive – need it be at this stage? Perhaps not. However, UNL students need to review and digest the rich *Scaphirhynchus* literature, including MRRP products (e.g., Annual AM Compliance Reports, Science Meeting presentations) to better implement and evaluate their research. NGPC should be more engaged as they have access to everything on pallid sturgeon in the MRRP. It would be good to access the USGS_CERC Rivers Studies Center's *Scaphirhynchus* literature digital data base (contact Dr. Robb Jacobson, USGS, Columbia Environmental Research Center).

2. *Substantially more in-depth statistical analyses are ongoing and will be presented as additional data are collected and analyzed (Pg.5).* The ISAC maintains that sampling design and accompanying statistical methods to test hypotheses should be established before collecting data. The most efficient method of doing this prior to the 2023 field season might be for the UNL team to lay out candidate methods of data analysis that are under consideration and assess if current field methods would be adequate to apply these analytical methods, considering what adjustments to field monitoring would be required to apply each method. Test driving candidate analytical methods on field data from 2022 would be the next logical step for winnowing down candidate methods to preferred methods.

3. *Implanting transmitters into Pallid Sturgeon:* The report is missing details of the operational methods used to implant transmitters, and a clear explanation of what tagging PS is intended to accomplish. Some of this material is in the project proposal, but a concise summary would clarify how the selected transmitters and telemetry methods will accomplish Objective 1.

4. *Active Tacking.* Does extensive tracking on a monthly frequency provide sufficient resolution of movement to meet Objective 1 relative to information obtained from the passive array? Meeting Objective 1 requires tagging and tracking a large sample of PS to assess their movement and habitat correlates of that movement.

5. *Habitat measures at initial PS capture locations (Table 6).* This information is interesting, but is not very relevant to the study Objectives. The primary value of these data is to inform future field efforts at capturing PS for implanting transmitters. Site selection for effective PS capture by trotlines largely determines the values of the habitat variables observed. Since PS are mobile these values reflect the instantaneous pH, temperature, DO, etc. at the time of trotline set and retrieval. It's highly unlikely that pH, DO, or conductivity affect PS movement in a flowing water system, except for DO when the water is warm (e.g., >25^{o} C). Bottom velocity and water temperature are useful as are the mesoscale habitat measurements (if they can be more standardized). If substrate composition is variable (i.e., not just uniform particle size sand) this would be a more useful metric to replace pH and conductivity.

6. *Acoustic Range Testing Results.* It would be helpful to translate these data into a probability of detection along a distance gradient from the receiver. This would help to identify no detection zones for passive receivers, aid in determining the number and location of receivers under the likely ranges of discharge and channel geomorphology encountered during the sampling season, and help

establish confidence intervals on the accuracy of reported PS locations.

7. *Passive and Active Tracking Results.* Detection data collected in 2022 should be condensed and synthesized. Converting multiple detections at a single location to time spent at a location (e.g., minutes, hours, days) and then comparing PS locations to environmental conditions (e.g., temperature, discharge over that interval) would yield information useful to Objective 1. There are many possible questions of interest, which need to be prioritized. Are environmental variables relatively constant or do they fluctuate, and if so, how much during a stationary location? Do environmental variables show a marked change (e.g., flow increase, temperature decrease during and/or following a large precipitation event) coinciding with a fish moving from a stationary location, or is there no association between fluctuations of environmental variables and fish movement? Are there aggregations of tagged fish at a stationary location? Are some individual fish always on the move and others more stationary and if so, does this relate to sex, size, or reproductive stage? There are lots of possible topics to investigate once the mass of detections are consolidated into relevant formats. With respect to movement in / out of the Platte and various tributaries, it would be helpful to see the response surface of detections, plotted against axes of flow (or change in flow) and temperature. This could be shown in 3D form, with the z-axis indicating the # of detections of the behavior of interest, the x-axis as flow, and the y-axis as temperature. The students and PIs should be taking the lead now on prioritizing the questions / hypotheses / forms of data synthesis that are most relevant to the Science Plan and project objectives. Waiting until there are more data risks failing to adapt the telemetry effort to maximize objective-relevant outcomes.

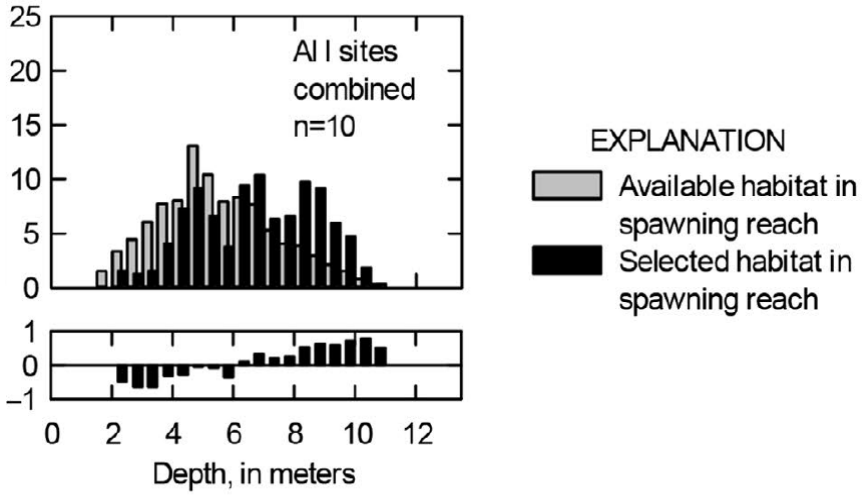
8. *Potential for developing habitat preference models.* As a complementary effort to the current UNL project, it may be worth developing statistical instream habitat models (e.g., Lamouroux and Capra 2002, Lamouroux and Souchon 2002, Plichard et al. 2020) based on existing data (on the Missouri) and then use these models in conjunction with field data and 2D hydraulic modeling to predict where fish might be found in the Platte. The main tenet of this approach is that fish are very sensitive to hydraulics (depth and velocity). You can use statistical models to quantify their preferences and then use 2D hydraulic models to quantify and predict potential habitat over much larger reaches and scenarios than what field data alone allows for. Habitat models could also be used to quantify habitat loss in response to past hydrological and morphological changes and predict the impacts on habitat (loss or gain) in response to future changes.

OBJECTIVES 2 and 3.

9. *Are there sufficient numbers of tagged, reproductively ready fish for Objectives 2 and 3?* Objectives 2 and 3 necessitate tagging enough reproductively mature fish – and especially females - to identify spawning habitat and successful spawning. The UNL project can utilize both pallid sturgeon that they implant with transmitters (16 in 2022) and PS previously tagged in the MRRP which enter the Platte River (26 in 2022). Of the approximately 33 tagged PS reported as tagged in 2022 (Table 4), only 5 were identified as reproductive: 4 Males (origin - 1W, 1U, 2 HOPS) and 1 Female (origin - U). Active tracking of telemetered PSs for Objective 2 should emphasize reproductively mature fish, particularly females. In the MRRP, various methods are routinely applied to screen PS captured for transmitter implantation (e.g., ultrasound and endoscopic imaging, application of the blood sex hormone polarity index). Fish that are considered likely to spawn in the current season are implanted. This greatly increases the probability that PS implanted and tracked will spawn and

provide information helpful to LPR objectives 2 and 3. Should / can these approaches be applied to previously untagged adult PS that are caught in the LPR? Would more training and field technical support be required? Since 61% of the adult pallid sturgeon detected in 2022 in the LPR were originally implanted through the MRRP (i.e., 26 out of 42), the most cost-effective approach after capturing MRRP-tagged fish would be to check the USGS PS database (maintained by Kim Chojnacki of USGS) to determine if detected adults are likely to be reproductive in the current field season. These topics should be a high priority for discussion prior to the 2023 field season. Access to MRRP PS data (methods, results, etc.) via a data sharing agreement is a very high priority and needs to be in place ASAP.

10. *Habitat measures at Pallid Sturgeon potential spawning locations:* Will the study generate habitat correlations of *potential* spawning sites, or *actual* spawning sites, as discussed above? After a fish has potentially or actually spawned, the characteristics of bottom substrate at and near probable spawning locations need to be assessed and reported. The UNL team should mirror the methods used by USGS on the Lower Missouri River, as described in Elliott et al. (2020), that have been refined over many years. It may not be financially feasible to apply all of these methods; a detailed discussion with USGS scientists would be helpful to determine the most critical habitat measurements. Figure 3 in Elliott et al. (2020), excerpt below, would be a more helpful method of displaying the attributes of habitats where PS are observed / suspected to have spawned versus what habitats are available. It would be best to focus on a few key variables which prior studies have shown to be important (i.e., depth, velocity, substrate).



2023 SPRS Agenda Session #3 – *Phragmites*

ISAC Discussion Questions:

Study design

1) What adjustments should be made to the field sampling methods, specifically what number, type, and location of patches should be added/subtracted from the sample?

It's a big problem that "most patches in the herbicide zone did not receive herbicide." It seems that you have little experimental control over your herbicide treatment. Also, shouldn't you incorporate the type of herbicide and timing of treatment into the hypothesis? From the September 2022 field trip we learned that different chemicals have different impacts on *Phragmites*. Similarly, you only have model-based estimates of the percent of a patch area that has been inundated during a 30-day period, so you have only a weak idea of the "flow treatment". Using a modeled "percent patch area inundated" will be a lot of work, introduce a lot of error and be less accurate than getting field data on the actual inundation which occurred. Further work is required to determine which metrics of *Phragmites* spread are most appropriate (e.g., shoreline transects, LiDAR), based on a good understanding of *Phragmites* dynamics.

Dealing with these challenges starts by reconsidering the big management decisions driving this research: *Should the Program use inundation flows instead of herbicide (or reduced herbicide) to control Phragmites?* OR "*Where are target flows insufficient to prevent the expansion of a Phragmites patch, requiring the additional application of herbicide?"* The next step is to think about the simplest possible conceptual design to provide information for these decisions. One approach would be to create as much contrast as possible along two axes of interest - inundation and herbicide treatment. Design the study to test the effectiveness of these two treatments both solely and in combination. The simplest conceptual design is a 2 x 2 table (see below) with two flow treatments (no inundation flows / dry June (NF); full inundation flows (FF)) and two herbicide treatments (no herbicide (NH); full herbicide (FH)). There would then be four treatments in total: NF * NH, FF * NH, NF * FH, FF * FH. You could then evaluate the relative effectiveness of each combination in reducing *Phragmites* expansion. The "full treatments" will provide the greatest amount of contrast - if full inundation flow (FF) doesn't show much benefit, then partial inundation won't work either.

Inundation Flow Treatment	**Herbicide Treatment**	
	No Herbicide (NH)	**Full Herbicide (FH)**
No Inundation Flow (NF)	NF * NH	NF * FH
Full Inundation Flow (FF)	FF * NH	FF * FH

If Inundation Flows work better than herbicides, one would expect less *Phragmites* expansion with FF * NH than with NF * FH (bottom left vs. top right in table). If the combination of Inundation Flows and Herbicides work better than either treatment alone, one would expect less Phragmites expansion with FF * FH (bottom right) than with NF * FH (top right), or FF * NH (lower left). The effects of each treatment alone (i.e., NF * FH, FF * NH) can be compared to the control combination (NF*NH). Having just two levels for each factor allows for more replication over both time and space.

To make the 'cleanest' experiment possible (above table), that means making sure the treatments are applied as evenly and equally as possible. Ground spraying rather than relying on aerial spraying would provide more certainty. Another consideration would be to think about using patches that are as similar in other characteristics as possible (an experimental best practice) or accounting for differences with measured covariates when that is not possible. One potential covariate might be the relative density

and size of patches. The field visits and photographs have reinforced to the ISAC that all 'patches' are not created equal. Many were a mix of *Phragmites* with other vegetation. That may have created part of the disconnect between patches Malia identified vs. which were aerial sprayed. A common definition of what constitutes a patch of *Phragmites* might be useful.

In addition to the simple 2x2 study suggested above, the EDO may find it useful to fit a regression-type model to field data and modeled metrics. This model would more directly acknowledge that each patch will experience "inundation flow" differently. The response variable could be the annual change in Phragmites patch size. The covariates might include herbicide (whether or not the site received herbicide), various descriptors of the site's channel geometry (perhaps model-predicted inundation level), and year. This would allow you to understand how different site characteristics impact annual changes in patch size. The suggested model is just a starting point - a more sophisticated model may be required.

Why is there such good WC habitat at the eastern end of the AHR, where we visited in September downstream of Chapman (a wide braided channel)? Is it because it's drier down there?

> EDA: My comments here apply to both Questions # 4 & # 5 and touch on our comments in discussion Question # 1 regarding an alternative hypothesis for droughts. Our visit to the Chapman Complex was an eye-opener and raised a number of questions. Michal and I had a very helpful conversation, which led to the hypothesis developed below. The Platte River between Chapman and the Loup River confluence appears to have many reaches that are more than 1000 ft wide, some to almost 1500 ft. I have looked at Google Earth images as well as the site we visited. I understand, however, that this segment is not prime crane habitat. (Is that correct?) The Program has some interest in the Chapman to Loup River segment, though this portion of the Platte does not seem to get as much attention from either cranes or the Program. The Chapman to Loup River segment has plenty of wide reaches, (i.e., vegetation encroachment does not appear to be so aggressive in this segment compared to the North Platte to Kearney segment). Why? Is it that the Chapman to Loup River segment is dry (mostly) for a few months each year? See our comments about drought under Question # 1.
>
> Given that the channel width seems to make the Chapman to Loup River segment ideal WC habitat, why is this reach not used by cranes? The answer might be the same, it is dry during crane migration time. Is this correct? An effort to understand why the Chapman to Loup River has many wide reaches but does not attract cranes seems to offer two opportunities, one scientific and one practical. If the Chapman to Loup River reach is too dry for much encroachment of vegetation and too shallow (i.e., dry) for cranes, then there is a long channel gradient of channel widths and water depths from Kearney to below Chapman that encompasses the conditions central to Questions # 1, 4 and 5. It would appear that there is a natural experiment to observe. I expect that the Program is already well aware of the downstream trend to a drier channel, however the opportunity to investigate 1) the effects of inundation depth and duration on germination, and 2) water depths preferred by cranes is, perhaps, being overlooked.
>
> Turning to the practical opportunity. If the generally greater unobstructed channel widths are, in fact, the result of a drier channel, then one may hypothesize that there is a hydrograph, i.e., distribution of flow magnitude through the year that, will minimize vegetation encroachment,

maximize channel width, and provides sufficient depth of flow during the crane migration. The characteristics of such a hydrograph should be observable through the Kearney to Loup River reach, and there may be an opportunity to design and "engineer" a favorable hydrograph that will expand crane habitat, i.e., a somewhat drier channel downstream from Cottonwood Ranch, but with sufficient flow during the crane migration.

MT: Thank you, Ned, for summarizing this perfectly. I fully agree that there is a natural experiment here that is worth making full use of and that it behooves the program to consider the availability of water from all aspects in terms of vegetation dynamics. There may very well be a Goldilocks "just right" condition that permits it to thrive and that both too much and/or too little prevent colonization. We touched on this idea in a study on braided rivers draining Mount Pinatubo in which there is an extreme difference in water availability between wet and dry season (see Gran et al. 2015). Rivers in deserts are all braided!

Herbicide

2) Given the lack of patches treated with herbicide during June and September 2022, how do we evaluate the effectiveness of the herbicide treatments moving forward? Do we continue with the established protocol, or do we specifically target study patches with herbicide?

As indicated in our response to question 1, it makes sense to specifically target study patches with herbicide in areas both with and without inundation flows, and specifically target study patches to have no herbicide, both with and without inundation flows. A potential side question is to understand more about what the aerial crews spray and don't spray. It seems likely that aerial spraying will be the only viable way to apply spray extensively/operationally in the long term; therefore, getting a general and maybe quantitative understanding of what they spray and what they don't might be insightful. At the SPRS, it was mentioned that non-target plants turn brown after spraying, but it's harder to tell with *Phragmites*. Hand spraying would provide the strongest control for a deliberate experiment.

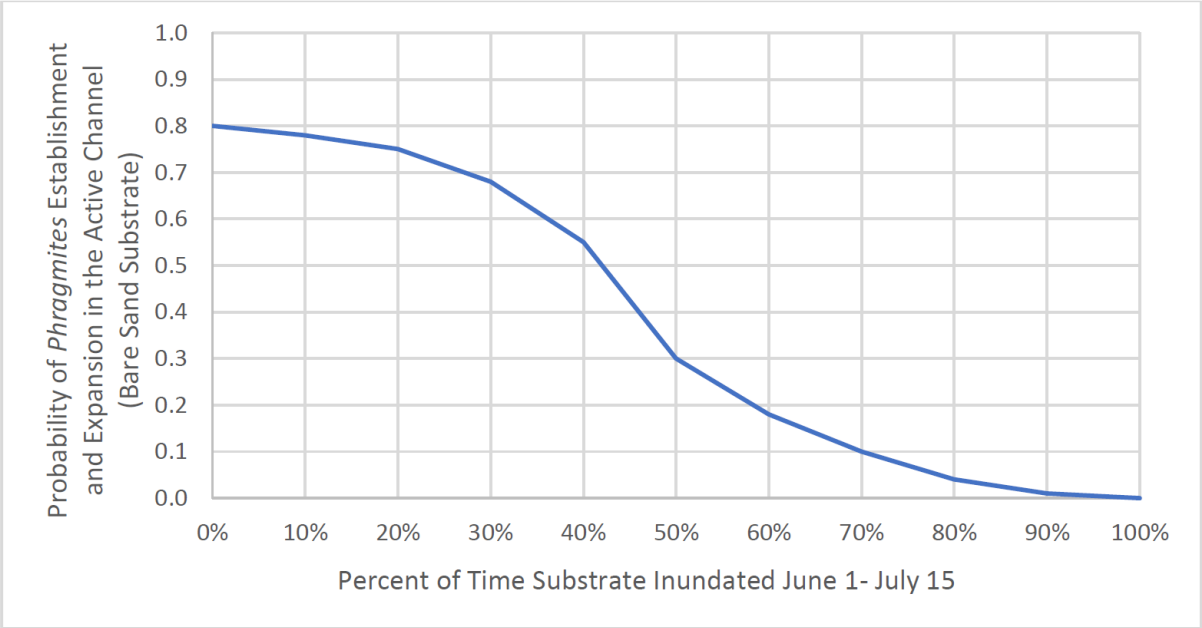
Inundation flow release

3) What would convince you that the June inundation flows are working to control the expansion of Phragmites patches into the channel, and are we collecting the right metrics to test for that?

In the above table, convincing evidence of the success of inundation flows would be less *Phragmites* expansion with FF * NH than with NF * FH (bottom left vs. top right in table). Further evidence of the benefits of flow would be less *Phragmites* expansion with FF * FH (bottom right) than with NF * FH (top right). Perhaps the least amount of *Phragmites* expansion will occur with NF * FH - full herbicide treatment under dry conditions when the plants are stressed.

A remaining challenge is determining which vegetation response variable is most important. It would be helpful to have a conceptual (or quantitative) model at the plot / plant scale with hypotheses about particular hydraulic variables that are important (depth, velocity, duration). Vegetation statistics are always messy. Assessing multiple vegetation metrics in a deliberate small-scale experiment with strong inundation and herbicide treatments is a useful pilot step before spending lots of time and money monitoring vegetation metrics on an extensive scale.

Though it would be convincing to see data confirming (roughly) the shape of the curve in the graph of Phragmites vs. % Inundation (figure below), that would require many more categories of inundation (e.g., 0%, 20%, 40%, 60%, 80%, 100%), and on its own doesn't consider the interaction with herbicide treatments. I think that more replication of fewer treatments (FULL ON / OFF of Flow and Herbicide - see table above) is a more statistically powerful design than fewer replication of many treatments. Years ago, the PRRIP applied a similar 2 x 2 experimental design, creating combinations of big or small / high or low sandbars in the river.



It is also important to keep in mind that channel hydraulic geometry and in turn specific discharge (discharge per unit width) and shear stress are controlled by channel morphology. The inherent morphological variability along a braided river will result in large variations in the strength of flow a patch of vegetation will experience along a reach for the same total discharge (e.g., target flow): In some places water will tickle *Phragmites*, in other areas it will knock it down. In other words, the effects of "Full inundation" will be site specific. A more relevant question to ask might be "*Where is 1500 cfs effective?".* You can use a combination of models and onsite measurements to focus in on areas where hydraulic geometry is going to help make inundation flow more effective.

A combination of flow measurements and hydraulic modeling coupled with observations in the field and remote sensing can be used to: 1) determine empirical relationships between specific discharge and *Phragmites* expansion; and 2) identify thresholds above / below which flow will be successful / unsuccessful at preventing a *Phragmites* patch from expanding. These thresholds can then be used either predictively to design a generalized herbicide treatment strategy or annually using LiDAR and hydraulic modeling to identify a post-inundation herbicide strategy.

Ned Andrews mentioned at the SPRS the idea of using cheap thermographs (you can buy 100 for $2,000) to confirm areas which were inundated vs those which were not. Malinda Henry mentioned the idea of measuring whether or not areas are inundated when field folks are out monitoring plants. Some

combination of those approaches would be valuable for documenting what level of inundation each vegetation patch experienced. Such empirical information may also be helpful for calibrating 2D models.

4) How do we isolate the effects of June inundation flows from intra- and interannual variability in hydrology?

You can't. All you have is a certain flow during June. It doesn't matter whether it was created by a management action or natural precipitation / groundwater flow. You want to compare full inundation vs no inundation, regardless of the source of the water. Documenting actual levels of inundation is critical.

5) How do we best evaluate the effects of elevated groundwater (potential root interaction/sub-irrigated conditions) versus inundation by surface water (direct root and stem interaction)?

That's a deep rabbit hole requiring intensive research, monitoring and modeling. It seems simpler to just test the inundation flow management action. Groundwater tables will likely rise with the inundation flow, so that's just part of the treatment. Monitoring wells would likely be required if you really wanted to quantify the rise and fall of groundwater. If this level of data collection were necessary, I would scrutinize the need to decouple ground and surface water influences before proceeding. Is the juice worth the squeeze? It's better to use simple measurements of actual inundation over an extensive area than to get drawn into intensive monitoring of groundwater similar to the wet meadow work.

2023 SPRS Agenda Session #4 – Sediment Augmentation

Ideas for Further Data Analyses

- **Learning.** What are the EDO's interesting analyses teaching us about the efficacy of sediment augmentation? What hypotheses can be generated from the analyses so far?
- **Focus.** Don't get caught up in analyzing general braided river dynamics (however interesting these may be). Rather, focus data analyses on determining the impacts of sediment augmentation and the creation / maintenance of suitable whooping crane habitat.
- **Morphodynamics.** Questions to consider asking for reach - scale morphodynamics, pre- and post-augmentation:
    - Which part of the reach downstream of J2 and Cottonwood Ranch is storing sediment (deposition) versus contributing sediment (erosion) to the overall sediment budget and which part of the reach is serving as a bypass?
    - How does the balance between erosion / deposition / bypass change as you move downstream from the augmentation site?

    - What is affecting this balance (i.e., transport capacity (slope, morphology) versus sediment input into the subreach). If transport capacity exceeds sediment input you can expect erosion. If transport capacity is lower than sediment input you can expect deposition. If they are in balance you can expect no net change.

- **Mass balance.** It would be useful to conduct a mass balance along subreaches based on the morphological approach ($\Delta Volume = Volume_{in} - Volume_{out}$). You can assume zero sediment input into the upstream of the study reach (immediately downstream of J2 return). $Volume_{out}$ of the most upstream subreach is the $Volume_{in}$ to the subsequent downstream subreach, and so on and so forth…
- **Suspended sediment.** It may be necessary to make some assumption about how much sediment is going into suspension, making use of data from suspended sediment samples. EDO staff thought that about 25% of the sediment transport was in the form of suspended sediment. One ISAC member (Ned Andrews) felt that the focus should be on bed-material:

  "Within the distribution of bed particle sizes some particles will be suspended. while others will be transported as bedload, and some particles will be a bit of both, depending on the discharge. A particle that is primarily bedload at a given flow will likely be suspended at some high flow. For your analysis, the mode of transport does not seem to be so important. If a given particle size is found in the bed, it needs to be considered. If a given particle size is finer than the bed, it can be excluded."
- **Papers.** Some relevant papers (sent to EDO staff) which might be helpful to further data analyses: Vericat et al. (2017), Peirce et al. (2018a, 2018b), Anderson (2019), Wheaten et al. (2010, 2013), Bakker et al. (2019), Ashmore (2022), Antoniazza et al. (2019).

Detailed comments

(Report references refer to Sediment Augmentation Evaluation, February 7, 2023)

- Figure 1: what is the significance of comparing channel width below J2 return to channel width downstream of Overton (confluence). The channel is of course expected to be larger downstream.
- What are the hypotheses about why actual incision propagation is much less than estimates?
- Shear stress decreases with an increase in width as well as decrease in channel slope. What would maps of shear stress look like in Figures 13 and 14?
- Figures 15 – 17: Very little change occurred between 2016 – 2021. How do these compare with pre-augmentation elevations?
- Figure 21 (report) / slide 80 ppt (cumulative volume change) – what is the cause of degradation at Cottonwood Ranch?
- For Sarah's work:
    - Focus on your question of interest: Is there a difference in elevation change between years and is that moving through space?
    - Drop the GLMM model, since the results are not likely to be useful. Instead, focus on modeling differences:

- Take the year-to-year difference over space (like page 66 but compute annual differences). Before you model that, does a 'movie' of the plots change over time in some smooth manner?
- Model the results to get general trends over the river model (use some sort of a non-linear time series model. Your 'time' is river mile).
- Do a change point analysis to find areas of significant differences: where on the river are the differences between years significant? However, not significantly different from 0. Instead, you want elevation changes that are scientifically relevant.

Questions posed to the ISAC by the EDO

Volume Change

1. Is it reasonable to consider the total volume change leaving an upstream reach as volume delivered (input) to the downstream reach?

EDA / MT – In general, yes, see notes above on the morphodynamics approach. However, regarding changes in the South Channel and inferring processes, one should be very careful. Bank erosion and bed erosion need to be measured and evaluated separately and independently, which may not always be easy or straightforward, (e.g., channel migration into a bank, involves both bank erosion and a scour hole). Let's assume that there is a net loss from a given reach during a given year, would that be good or bad? Broadly, bank erosion would be good channel change, while bed erosion would be bad channel change.

2. Is there any way we can normalize our results by annual flow?

EDA/MT - Assuming that you are looking for a way to represent year-to-year differences in sediment transport. If you have a record of daily discharge, you can raise each daily discharge to a power of 2-2.5 and sum the total. Sand transport varies with about $Q^{2 \text{ to } 2.5}$. This approach gives an approximate weighting to the higher discharges. You could also estimate a sediment flux by dividing your volumes by the duration of the flow (time) and the wetted surface (area); see references.

3. What might be causing the high swings of aggradation and degradation downstream of Overton Bridge?

MT - If this is referring to temporal variability I concur with EDA. If it is referring to spatial variability, it may be the result of differences in transport capacity at each subreach (morphology, slope, discharge) relative to sediment input into the subreach.

EDA- Only some guesses. I suspect that there is low amplitude, large scale "waves" of sediment in the Platte that are very difficult to resolve. Is it aggradation/degradation or a low amplitude, long wavelength bed feature? Variation of inflows of water and sediment from the North and South channel could lead to localized changes. Also, here and with other parts of your analysis, LiDAR is great, but it is not perfect. There is, of course, considerable literature here that you should review. For example,

investigators have found that atmospheric moisture affects the GPS signal received at base stations in a reliable way and are applying it to map real-time relative humidity across California.

4. We've seen that lateral erosion is a major source of sediment, what are some pros and cons of relying on lateral erosion for sediment augmentation?

MT - The boundaries of the area available to the program?

EDA- Overall available supply is something to consider, for sure. That said, first and foremost, lateral erosion increases channel width, and, potentially, crane habitat. Clear water releases of J-2 create a sediment deficit and associated channel instability. There is no escape. The deficit must be made up somehow. There are a variety of sediment sources that might be exploited. PRRIP has demonstrated that 60,000 to 80,000 tons per year are sufficient and effective. Now, it is appropriate to consider how best to supply the required quantity in an efficient manner.

Wetted width

1. Would a lower, more common flow (e.g., 1,200 cfs) be more appropriate to assess change?

MT - I think both high and low wetted widths are interesting to compare as well as the ratio of the two (high flow width / low flow width). You can expect that a braided channel will have a higher ratio than a channel that is single thread or transitioning towards a single thread.

EDA- Here and elsewhere, I suggest that you view your analysis from the perspective of crane habitat; a flow 800 ft wide, 0.5 ft deep, with an average velocity of 1.5 ft/s is 600 ft^3/s. It would appear that flows considerably less than 1,200 cfs may be sufficient for crane habitat.

2. How do we quantitatively reconcile channel planform with slope or other variables?

MT - it is typical for a braided channel to have a single-thread sinuous planform at low flow. I wouldn't be too concerned. You can compare sinuosity and channel slope between low flow and high flow to convince yourself that the former is decreasing and the latter is increasing at high flow.

EDA- I concur. Regarding the previous question, at what discharge does the meandering pattern transition to a braided pattern?

3. Generally, how do we quantify inflection points or thresholds so that we can examine change through time?

MT - In general, I find accumulating a variable downstream (wetted width, slope, transport capacity, sediment output…etc.) very effective (as you have done with cumulative volumetric change).
EDA- A classic question for fluvial geomorphology, however I am not sure it will be useful information for you because of year-to-year variability and a relatively slow period of adjustment as you have demonstrated.

4. We are in the process of quantifying braid index and BRI. What other habitat metrics should we consider?

MT - BRI is a robust measure of the "health" (i.e., transport capacity relative to sediment supply) of a braided reach (see Liebault et al. 2013). I agree with EDA that BI is not necessarily useful unless you know what you are targeting.

EDA- Can you show that cranes select a particular pattern, spacing, morphology of river sand bars? If not, will a braid index be useful? It appears that unobstructed channel width is the best indicator.

2023 SPRS Agenda Session #6 – Target Species: Whooping Crane (WC)

Detailed Comments

(Report references refer to Whooping Crane Riverine Habitat Selection Update - Brief, January 26, 2023)

JH: explain left, right cut-offs in Figure 4 (e.g., based on the 0/1 data for Nearest forest, it seems like the curve should bend downwards for large nearest forest).

ISAC Discussion Questions:

6) Given the results from analysis step 2, what are next steps to explain similarities/differences seen in whooping crane selection patterns?

DM: Add in off-channel variables. Attempt a similar analysis to Baasch et al. 2022 using finer resolution of land types (i.e., using same land classification as Baasch et al. 2022).

AP: A simple visual comparison of the relationships seems like a good start (as you have done). My guess is that there may be some difficulty in comparing predicted values at specific points of channel width, for example, because of the scaling that was done. The predicted relative selection ratio value of 0.5 may not mean the same thing for each model. Another consideration might be to compare where inflection points occur for the old and new results. My general suggestion would be to consider the larger picture rather than try to devise methods for quantifying changes to specific aspects of the relationships. Have the fundamental relationships changed? It doesn't appear so.

7) How do on-channel and off-channel metrics influence each other (e.g., is there a relationship between, say, more corn and higher channel width)?

AP: I believe we agreed that this question was about if and how main effects might be thought of as interacting with one another. After you have a full model with low-correlation covariates, I would develop some hypotheses for any interaction that seems reasonable. Focusing on interactions with channel width and near forest seem like the most useful, as they seem to have strong signals and can be affected by management actions. One example that we came up with in the meeting is how the selection of UOCW might be modified by proportion development. Could crane selection in areas with greater development have a different relationship than UOCW compared to areas with less

development? I attempted (likely poorly) something like this for roosting sandhill cranes. 10.1002/jwmg.21215

DM: Correlate % buffer area off-channel metrics with the on-channel metrics. For example, I would expect that the proportion of buffer area covered by forest (off-channel metric) is likely to be negatively correlated with UOCW (in-channel metric).

DG - An important question relative to off-channel metrics is, are they dominant factors influencing WC in-channel roosting vs. diurnal habitat use? Off-channel metrics may be relevant to EBQ #4: What factors influence WC decision to stop or fly over the AHR? One could postulate and perhaps test (Question 7 below) if infrastructure like bridges across the PR were associated with changes in TCW, UOCW and discharge. Similarly, one could examine if agriculture affected on-channel metrics. Analyses to date (slide 31 of WC PP) do not seem to show a large effect of off-channel metrics on WC riverine roost site selection. Unless further analyses refute this conclusion, future use of Program resources might be more productively directed towards relating off-channel habitat on diurnal WC habitat use and EBQs 4-6.

DG: WC Mean predicted relative selection went from ~0.7 to 0.1 with the proportion of buffer area (circle with radius of 0.77 mi from WC channel use location) covered by anthropogenic development (roads, parking lots, buildings, infrastructure, etc.) going from 0% to 4% (fig. 4). This implies that any development (using guidelines of analysis) will result in a large reduction of WC use. Am I interpreting this correctly or not? If yes, how important might this be to Program WC management? Should you further analyze the proportion of area developed for the entire AHR – and identify 'hot spots' (Program defined)? Should the Program consider a different level of WC habitat management in 'hot spots', e.g., less mechanical action?

8) Can you suggest an appropriate way to integrate all explanatory variables into the model selection process? A way to observe how on and off-channel metrics may influence each other?

   a. A previous investigation considered a suite of on-channel and off-channel metrics and only combined important variables from separate model selection processes (https://platteriverprogram.org/document/correlates-whooping-crane-habitat-selection-and-trends-use-central-platte-river).
   b. What valid methods (exploratory analysis) would be appropriate to inform variable combinations in model development for selection?

AP: I suggest the following:

- Step 1 - identify correlated predictor variables (use whatever criterion you find appropriate or ask Jennifer).
- Step 2 - group correlated predators and decide which one to include in the final model. You could do this by looking for ones that make the most sense to interpret, ones that best fit the data (compete them as single variable models), and/or use one that has a positive relationship (Jennifer's excellent advice).
- Step 3 - Fit a full model with low-correlation predictors. An alternative might be to fit an in-channel model, an off-channel model, and a combined model. This would be more of an

academic exercise, but potentially interesting. My guess is the combined one will beat the simpler models.

- Step 4 - use the best/full model for inference. Derive confidence intervals for each predictor beta. I also like to look at the AIC change of the model comparing the full model to one that removes each predictor variable (one at a time).

DM: My guess is that correlated variables may substitute for one another in the various models. Seeing a series of models with similar AIC scores but different metrics would reflect correlated metrics.

2023 SPRS Agenda Session #7 – Wet Meadows

Detailed Comments

(Report references refer to DRAFT Wet Meadow Hydrology Report, January 20, 2023)

AP: I found this report to be very instructive for my understanding of what Program participants consider to be a wet meadow. My impression is that wet meadows are a mosaic of ephemeral wetlands and grasslands, with shallow groundwater, and generally near an active river channel. Thus, wet meadows contain a gradient of vegetation communities from emergent wetland to upland grassland. The report provides a detailed perspective based on elevation and groundwater information as to how much of each site is potentially in different vegetative states. I focused on the definition of a wet meadow, not because I am hung up on definitions, but because I believe that differing understandings of what a wet meadow is may have led to disconnects with understanding how whooping cranes might use these sites. Considering all riparian grasslands as wet meadows isn't a problem unless whooping cranes select for wetlands and grasslands differently. Moreover, I believe some participants define only wetlands embedded in riparian grasslands as wet meadows. From the perspective of a primary species of interest, I suggest that the Program reconsider their earlier work on diurnal habitat selection, specifically by using a more detailed representation of landcover that specifically separates wetlands from grasslands, both of which are embedded in what is locally described as a wet meadow. A habitat selection signal of one or both components may have been missed by lumping the two features of wet meadows together. Whooping cranes are waterbirds. My experience across the larger migration corridor suggests that cranes use both wetland and upland sites but have more affinity to wetlands.

EDA/JH: use vegetation coverage (used by Army Corp of Engineers). Vegetation integrates soils, and water. If you are going to manage the sites for wet meadows, then the vegetation that is there is really important. Kristin answered that they didn't have that information and so she investigated the data they did have.

MT: Would it be worth doing ground vegetation checks at the sites to see if your L7 models are being predictive? Perhaps discuss the impact of soil type on wet meadows. You could at least mention that this is a factor that you haven't considered here.

Questions posed to the ISAC by the EDO

Hydroregime (Section 3)

9) Is there a better way to summarize area-based statistics? The current method calculates relevant statistics for points and then interpolate to generate areas on which subsequent statistics are calculated. Another option would be to interpolate the surface for each timeseries value and calculate statistics for each interpolated grid-cell.

JH: It is better to interpolate the surface for each time series value and then calculate the statistics for each interpolated grid-cell. This way you can compute uncertainty and other statistics for each grid cell. Can you demonstrate the linear interpolation is appropriate for ground water?

10) Previous studies on wet meadow hydroregimes have lacked datasets that incorporate high-spatiotemporal coverage. Is there anything obvious we can do with this data (i.e., hourly groundwater levels) that we haven't already to learn something about wet meadow hydroregimes? Statistically or otherwise?

The work that you have done seems to squeeze all the juice out of the available information.

11) Is there anything in this section that seems novel enough for publication?

DM: Publications often involve either intensive, quantitative modeling at a small scale, or statistical relationships established at a regional scale. Combining the intensive work (sections 3-5) with the extensive work (section 6) seems worthy of publication (more ideas below under question 16).

Vegetation-Groundwater Links (Section 4)

12) This section uses results from a previous study (Henszey et al. 2004) to evaluate hydrology and vegetation at two Program managed study sites. Are there any aspects of methodology that could be improved?

DM: The application of Henszey et al. was appropriate, creative and scientifically defensible.

13) Does this seem like a useful management screening tool? If so, what would be a way to package it? White paper?

The combined suite of tools has definite potential for management questions. See the Executive Summary and responses to question 16).

Modeling (Section 5)

14) The model described in this section is most useful for deriving calibrated hydraulic parameters that can be used to make predictions. Calibration results include a series of calibrated K and S values that can be input for predictions about how stage changes will affect groundwater levels. It probably shouldn't be used to predict groundwater response to precipitation because it lacks even basic accounting for surface drainage or variably saturated flow, though model results through time show

decent fits. If this were to be published, it would require more detailed calibration information and testing. [Additional info from Chad: Kristen Cognac wants to know whether ISAC has any thoughts on the utility of the model for her purposes.]

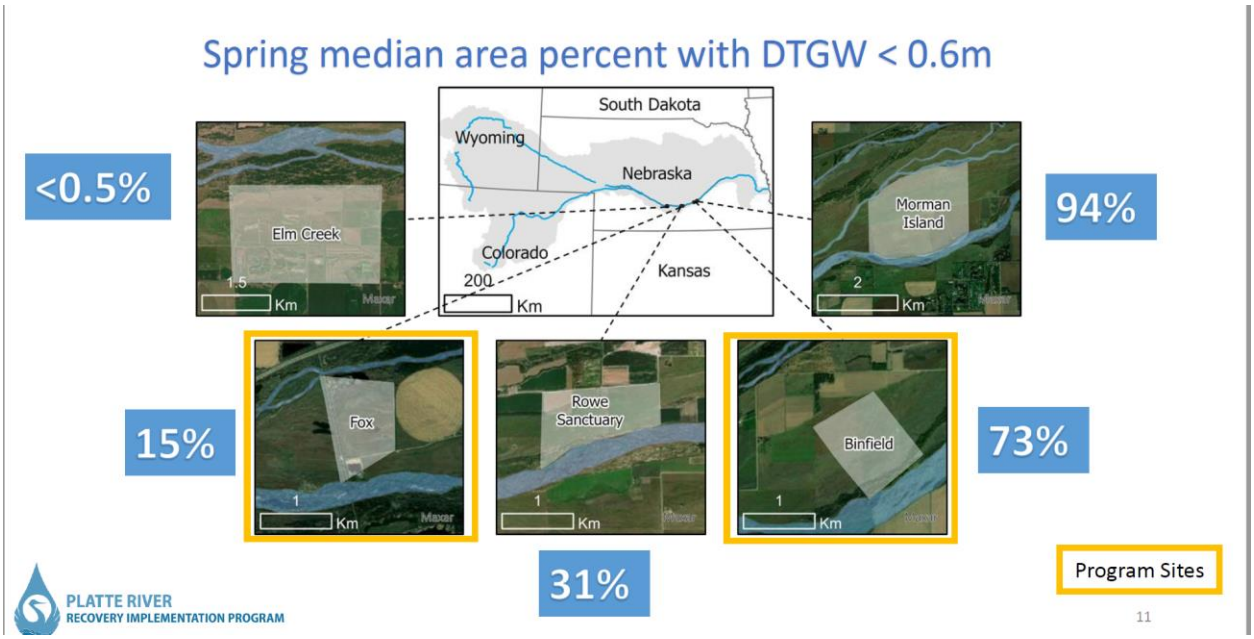
The ISAC felt that the model described in Section 5 had a useful structure and was applied appropriately for its intended purpose.

River-Ground surface elevation analysis (Section 6)

15) This method came about from intuition that the elevation of the river surface relative to wet meadow topography was an important control for water levels. [No ISAC comments required].

16) Is there a way to quantify relationships between elevation difference and L7th surface rasters? Perhaps a cell-by-cell regression?

DM: It's less critical to get spatial variation precisely correct within a site (or to make comparison of cells within Fox and Binfield sites for sections 4 and 6), and it's more important to do relative comparisons AMONG sites of the overall suitability of sites (e.g., does the river-ground surface elevation method rank the 5 sites correctly that are shown on your slide 11? [inserted below]).



DM: As Kristen noted in her presentation, it would be interesting to compare this simpler qualitative method in section 6 with the detailed approach used in section 4 to assess the biases in the simpler method, and then to apply the section 6 method more broadly throughout the Program area to get a qualitative ranking of wetness of different areas at different flows. You could then use this wetness *index* to assess if there's any relationship between relative wetness and WC use (unless that analysis has already been done). Perhaps this qualitative ranking be used to prioritize areas for habitat work (if it

appears that more wet meadows are needed for WC, or just to maintain wet meadows for their own sake). Some areas are likely fine as they are, while other areas would require too much restoration work to become viable wet meadows. The Goldilocks locations would be areas where a small amount of restoration effort would make them more consistently wet and therefore more usable by WC (if indeed the data show wet areas are preferentially used). This is not my area of specialty, but combining the intensive work in section 4 and the extensive work in section 6 seems both publishable and valuable to PRRIP.

17) Is there another standalone analysis that we could perform with the data that could be used to evaluate river-ground surface relationships with respect to wet meadows? Perhaps a simple method that could go hand in hand with this one to support / verify the general findings.

DM: As discussed above, the simple model in section 6 seems to have the most relevance to management decisions over the entire AHR.

2023 SPRS Agenda Session #8 – Non-Program Science [All ISAC members]

- Draft Non-Program Science On-Boarding Framework (with Non-Program Science Review Template) is provided for review.
- Three examples of recent publications (combined into a single PDF file) are provided for review.
- Discussion to get general ISAC input:
    - How can we best make this work?
    - How do you integrate science that is not done the same way (different methods, non-comparable variables, etc.) into what we are doing within the structure of the Program?
    - Do you have experience with (or examples of) this kind of issue in other large-scale adaptive management programs?

The Executive Summary provides a synopsis of the ISAC's overall perspective, which is also summarized in tabular form below.

Things the Program Should Do	Things the Program Should Not Do
Encourage collaboration between scientists inside and outside the PRRIP, including data sharing agreements, systematic comparisons of competing data sets and models, and joint conferences or publications.	**Don't force non-Program scientists and science to go through the same process applied to Program science.** That approach would backfire, creating the impression of deliberate bias by the EDO.
Cite, scrutinize and carefully evaluate all relevant peer-reviewed publications (regardless of their source) in the Program's science plan, State of the Platte Reports and the literature review section of PRRIP journal articles and	**Don't blindly accept all science just because it's been published in a peer-reviewed journal.** Peer-review is valuable, but it's not a guarantee of truth. Errors

Things the Program Should Do	Things the Program Should Not Do
technical reports. For critical issues affecting Program decisions, it may be worth replicating past studies, using their data and methods. This can detect errors in data, methods or logic.	occur. Peer reviewers rarely replicate the work presented in a paper to ensure it's accurate.
Determine the reasons for differing results / conclusions in different publications and assess if this might lead to AM adjustments in the set of tenable hypotheses, candidate management actions or methods of research and monitoring.	**Don't confuse the GC with dueling papers, datasets and models.** Decision makers need a distilled synthesis of current understanding, based on a thorough analysis of competing hypotheses and analyses.
Consider using SDM to assist the GC in reconciling competing recommendations (e.g. COMPASS 2015 Workshop on tern on-vs. off channel habitat creation)	**Don't expect the science to give the GC solutions to their policy issues.** There are no 'right' answers, science provides alternatives that inform decision makers of the range of consequences of different decisions.

The ISAC agreed on the above ideas. However, each ISAC member had valuable thoughts to contribute to this issue, so these are included separately below, with some dialogue between ISAC members as we assembled our ideas into one joint document.

JH:

- What is the problem you are trying to solve here? Is there actually evidence that the EDO has ignored peer-reviewed work? For example, the pubs you provided are very recent. Does the problem actually need solving? Are you creating an administrative nightmare for no benefit for the program?
- This proposal seems like a lot of work for not much gain. What was wrong with the old system or citing peer-reviewed research in your own work? What will you do when the EDO is flooded with outside work submissions to review? How to manage the workload?
- One practical suggestion: see that the EDO (and ideally other Program partners) follow basic good science citation practices, (e.g., the "Ten simple rules for responsible referencing," Penders, 2018). Include a summary of previous research (e.g., see page 7 of the SedAug report).
- References: Bahadoran et al. 2020; Penders (2018).

EDA: It is not apparent what the problem is, as Jennifer noted above. Overall, I think this is not a productive idea and could well have some very negative results. Scientific publications have literature review sections that summarize and discuss previous work. This is the proper way to proceed. It could be very damaging to the program, if the activity was viewed, perhaps only by a few, that the program was attempting to control or regulate Platte River science.

DM: I agree with Jennifer, and we reached our conclusions independently. I also agree with Ned, and we discussed this together. Please see my comments on the Non-Program Framework document. It's reasonable to have criteria on what are potentially relevant publications to the Platte Program, and it's appropriate that all potentially relevant publications should be assessed for the quality of the work and the defensibility of the conclusions. However, those criteria and assessments should be applied in exactly the same manner to both Program and non-Program publications - no double standard.

MT - I wholeheartedly agree with all of your comments both here and in the document.

DG. I concur with my colleague's thoughts and opinions and am not in support of the approach proposed. Here is a straw-dog alternative should the Program wish to pursue formalizing this topic

1. EDO could request the GC to consider enacting the following policy: All PRRIP 'stakeholders'[1] are strongly encouraged to undergo the existing PRRIP internal review process prior to publication of any manuscript that includes Program generated data on target species (whooping crane, piping plover, pallid sturgeon), river processes (e.g., geomorphology, sediment transport, vegetation scour), and overall PRRIP implementation (e.g., adaptive management (AM), adaptive governance (AG), decision-making). Review recommendations are non-binding for non-EDO entities.

2. The Program should continue to evaluate products relevant to Program objectives, research and/or management actions generated by PRRIP stakeholders and entities outside the structure of the PRRIP as for any published information relevant to Program science, policy, or management actions. The EDO encourages these entities to share their published products with the Program. If results or conclusions of such products are inconsistent with existing Program knowledge such that they might affect Program management decisions they should be considered as alternative hypotheses to be examined and tested following established Program AM procedures and good science. Results and conclusions from this process can be communicated through existing Program outlets (e.g., State of the Platte Report).

AP: I suggest incorporating all science into the Program's science plan, scientific endeavors, and decisions. Work done outside of the Program's framework can be summarized and folded into products for the GC, an annotated bibliography for example. To not consider all information is foolish. To blindly accept all science without scrutiny is equally so. I gathered there may be concerns about differing quality/rigor of products. Post-publication peer review is not a method I would advise. It would be a waste of time and could create the impression that the Program was going to discount results contrary to current narratives the Program adopts. Confirmation bias is an insidious tendency to which we all unfortunately susceptible.

Considering the example most used during the meeting might be instructive. Past Program research suggested that whooping cranes did not select for 'wet meadow' habitat in their diurnal activities. More recent work using different use data and more detailed land cover categories suggested that whooping cranes selected for wetlands in 'wet meadows'. Thus, the Program had a high level of certainty about

[1] A PRRIP stakeholder is defined as any person or entity that participates in, or contributes to, Program science, management actions, or policy. Stakeholders include participants in and members of the GC, EDO, TAC, ISAC, and PRRIP contractors.

the role of wet meadows for whooping cranes and new outside research swings us back to uncertainty again. I would suggest the next action to be taken would be to consider Program data again with the more detailed landcover, after advice from TAC and ISAC. Now for a hypothetical – Patrick provided initial results for a check-in of nocturnal roost habitat selection. He found that in-channel factors were similar to what had been found earlier. What if he had found that the new Program data suggest no relationship of whooping crane use and UOCW? I contend the Program would be in the exact same position, although this time both efforts were Program science. The Program was certain about something and after more data, they were (hypothetically) not certain anymore. All information should be considered, given due consideration, and appropriate actions taken based on the specific situation.

Please be mindful of engaging authors directly, as good of an idea as that sounds initially. Authors can provide great insights into their data, methods, and thought processes. Depending on their individual personalities, you may get a range of responses if you want to 'debate' or challenge their work. Some may acquiesce to any challenge, whereas others may become defensive. Both extremes will be a waste of time. My guess is that most (>80%) of the time, engaging authors is unnecessary. It will look from the outside and inside as if you are bringing in an author to the principal's office. I have been on the author-side of this situation before, being asked to present work to an organization when it was clear that the results I presented were inconvenient to them (i.e., not aligned with their current management plan). I left the conversation with a poor impression of them, and I do not believe they found the discussion useful either.

I can understand how science produced by Program partners without prior knowledge that has relevance to Program activities and decisions might erode trust within the partnership. I suggest a 'no surprises' agreement for Program members when it comes to research and scientific products that might have direct or potential implications to the Program. Specifically, if someone affiliated with the Program is planning on preparing a scientific study or product, they could provide a courtesy heads-up to the Program, providing whatever details they have at the time – and with the intent to keep the Program aware of progress. I would consider this communication a courtesy to other program members, but not a mechanism to request permission to proceed. Asking a Program partner to submit to full review for efforts that they are doing individually could be perceived as overbearing and controlling. Asking others to provide notice of activities seems reasonable for a high-functioning partnership. I would offer that this courtesy would be asked of ISAC members as well.

2023 SPRS Agenda Session #9 – PRRIP Science Reporting [All ISAC members]

This topic was not discussed at the SPRS. The ISAC nevertheless has the following recommendations:

- Issue State of the Platte Report (SoP) in early 2024
- Don't change the format. You are wasting time changing the format instead of working on the most important thing which is to produce a SOP.
- The GC should require the EDO to publish biennial State of the Platte Reports

- The SoP report should incorporate a comprehensive synthesis of all decision-relevant science, whether produced by the PRRIP or outside of the Program. To keep the report short and digestible, some of that synthesis could be in an Appendix to the report.
- The key thing that the EDO must do is to anticipate how the GC may be presented with multiple competing publications, hypotheses, analyses and conclusions, and to guide the GC through the reasons for differences between these publications (e.g., different definitions of habitat, habitat data sets, WC datasets, methods of analysis).

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