Independent Science Advisory Committee (ISAC)

Responses to ISAC Discussion Questions for the February 2024 Science Plan Reporting Session

Platte River, September 15, 2022, Michal Tal

Prepared by the ISAC

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Overview
The Platte River Recovery Implementation Program (PRRIP) requested a report from the Independent Science Advisory Committee (ISAC), addressing eight questions related to the 2024 Science Plan Reporting Session (SPRS), held February 20-24, 2024 in Omaha, Nebraska. The ISAC responses below generally have three parts: synthesis in prose form (with key points **bolded**), detailed recommendations in point form, and detailed suggestions.

ISAC Discussion Questions Related to Specific PRRIP Scientific/Technical Issues

ISAC Question 1: Do the format and content of the 2024 SoPR appropriately communicate Program progress toward addressing the Extension Big Questions (EBQs) for the intended audience (primarily the GC)?

Synthesis
The State of the Platte Report (SoPR) has an appropriate format and content for the GC and is well written. We're pleased to see this progress. We have eight recommendations for further improving the document, described below.

Recommendations
1a. Broaden the audience of the SoPR throughout and include an overview of the Program at the start.
1b. Acknowledge factors outside of the Platte Program which may contribute to observed trends, particularly in the front section ("Key Observations and Progress"), as described under ISAC question 3.
1d. Provide citations or endnotes to key documents supporting results and conclusions, including hyperlinks in your citations so they are easy to find.
1e. For "?" assessments, give more details in Table 3 of the SoPR "Basis for Assessment" (i.e., need longer time period of data collection, need additional types of data to answer question, question as stated isn't answerable). In the detailed text, explain why the current assessment is a "?".
1f. Replace "we estimate with confidence" with "current information indicates" or "best available information indicates". The phrase "we estimate with confidence" opens up a lot of questions about what level of confidence is implied.
1g. Move the ISAC and TAC sections to the appendix. This will improve document flow and clarify who wrote what (e.g., EDO wrote the first part of the SoPR).
1h. Finally, and most importantly, there is a problem with the phrasing of the EBQs. Only EBQ #3 is answerable with the thumbs up / thumbs down approach. There are at least two solutions to this problem:
    1) Rephrase the EBQs to be answerable with thumbs up / thumbs down, focusing on the key management actions of interest (e.g., flow) - suggested phrasing below; and / or
    2) Reference the associated management hypothesis from Table 1 of the Extension Science Plan, and clarify that the thumbs up / thumbs down evaluation refers to the management hypothesis - an awkward solution, but an alternative if it's not possible to rephrase the EBQs. See Table 1 below.

Table 1. 2024 Extension Big Questions (EBQs), Management Hypotheses, and Assessment. EBQs 7-10 do not have a management hypothesis, only learning objectives, so are not included

PPRIP Extension Big Question	Management Hypothesis	2024 Assessment
1. How effective is it to use Program water to maintain suitable WC roosting habitat?	Releases to achieve a 30-day minimum flow target of 1,500 cfs between June 1 – July 15 will suppress germination, slow vegetation expansion into the channel, and increase the percent of AHR channel that remains highly suitable for whooping crane roosting (germination suppression release).	👍
2. How effective is it to use Program water to maintain suitable WC roosting habitat?	Releases to achieve a 30-day minimum flow target of 1,500 cfs between June 1 – July 15 will suppress germination, slow vegetation expansion into the channel, and increase the percent of AHR channel that remains highly suitable for whooping crane roosting (germination suppression release).	?
3. Is sediment augmentation necessary to create and/or maintain suitable whooping crane habitat?	Sediment augmentation is necessary to halt narrowing and incision in the south channel downstream of the J-2 Return.	?
4. What factors influence WC decision to stop or fly over the AHR?	Table EBQs-MHS Assessment which gives EBQS, MHs and 2024 Assessment	?
5. What factors influence WC stopover length within the AHR?	Length of WC stopover within the AHR is a function of discharge.	?
6. Why is spring WC use of the AHR greater than fall WC use?	WC use of the AHR in the Spring is greater than during the Fall due to higher flows during the Spring.	?

Detailed Suggestions

Phrasing of EBQs: EBQ #3 is amenable to the thumbs up and thumbs down approach. There are some remedies to the problems for other EBQs:

- For EBQ #1, you could rephrase it to: “Can the use of Program water maintain suitable WC roosting habitat?”
- For EBQ #2, you could rephrase it to: “Is the Program effective in managing Phragmites for maintaining suitable whooping crane roosting habitat?”
- For EBQ #4, the Extension Science Plan phrasing was: “Does flow influence WC decisions to stop or fly over the AHR?”. It apparently was changed to “What factors influence WC decisions to stop or fly over the AHR”. The latter phrasing is a more academic question with less management relevance (e.g., the Program cannot influence time of day, even though it may be a primary factor affecting stopovers), and with less ability to be answered with thumbs up or down, but it will deepen understanding. An alternative phrasing would be: “What factors influence WC decisions to stop or fly over the AHR, and are these factors within Program control (e.g., channel width, flow) or outside Program control (e.g., time of day)?”
- For EBQ #5, it would also be better to return to the phrasing in the Extension Science Plan: “Does flow influence stopover length within the AHR?”
- For EBQ #6, you could rephrase it to mimic the management hypothesis: “Is spring WC use of the AHR greater than fall WC use due to higher flows in the Spring?” This would make it easier to apply the thumbs up and down approach.
- For EBQ #7, it would be better to rephrase the question as: “Does Program flow management affect pallid sturgeon use of the lower Platte River?”.
- For EBQ #8, 9, and 10 (maintenance learning), you could rephrase these questions as: “Did we accomplish the stated learning objectives for [understanding PP predation]; [measuring effectiveness of predator deterrent action]; [wet meadows research]?”

Terminology: Avoid the terms “desktop analysis” and “desktop exercise” in the SoPR and elsewhere. “Desktop exercise” undersells the sophisticated modeling efforts undertaken by EDO staff.

ISAC Question 2: Are the 2024 EBQ assessments logical based on your understanding of Program data and consistent with what you have learned during your involvement with the Program? If not, why (e.g., assessment not supported by accumulated data)? The Program requests the ISAC respond to this Discussion Question for each of the 10 EBQs.

Synthesis

Answers vary with each EBQ and are provided below. More detailed comments and suggested edits are provided in an annotated version of the SoPR edited jointly by all members of the ISAC.

EBQ #1. How effective is it to use Program water to maintain suitable WC roosting habitat?

- **It’s worth exploring whether the AHR is truly “habitat limited” or “crane limited”.** Species at risk are often limited more by survival rates than habitat. A reasonable hypothesis is that there is plenty of WC habitat available in the AHR for more WCs, but there aren’t yet enough birds to occupy this available habitat. The adjusted proportion of WC population varies considerably from year to year in both spring and fall (Figure 10 in SoPR), but there isn’t a clear upward trend. If there were an increase in the adjusted

proportion of the overall WC population, that might suggest Program habitat creation is benefitting the population. Alternatively, it may be that WC use of the AHR is growing proportionally with the overall WC population and that AHR WC habitat isn't limiting. It's worth assessing how much roosting and feeding habitat is required to support WCs, and the basis for those assessments, building on the revised WC Recovery Plan.

- **Answering EBQ1 should also address mechanical removal and spraying along with suppression release flows or some combination of these three actions**.
    - Add a measure of mechanical management effort (e.g., area disked by year) to Figure 5 (channel width over time). This will enhance the GC's understanding.
- The valuable insights gained through spatial contrasts described on pg 17 of the SoPR report should be mentioned on pg 5.
- Channel Width
    - There are at least four possible factors affecting trends over time in Total Unobstructed Channel Width (TUCW) and Maximum Unobstructed Channel Width (MUCW): 1) year to year variability in flow beyond management control (especially high flows in 2015 and 2019); 2) inundation flows; 3) mechanical management; and 4) herbicide spraying (addressed under EBQ #2). How can you assess the relative importance of each factor in affecting trends in TUCW? Would factors 2-4 (within management control) be as effective under a different sequence of natural flows (factor 1, largely outside management control)? Could you use the machine-learning model to explore these questions? The mean TUCW over the entire AHR (Figure 1) may hide spatial variation that helps to reveal the relative importance of each factor.
    - It's worth understanding trends in MUCW as well as TUCW. The summary assessment addressing EBQ #1 on page 5 examines trends in TUCW, while the detailed assessment on pages 18-19 looks at trends in MUCW. It seems like the detailed assessment should show both metrics together. They show similar trends but describe different attributes of the channel. It would also be valuable to explore how the ratio of MUCW to TUCW changes in different locations along the AHR. This issue is further discussed under ISAC question 5c.
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EBQ #2. How effective is Program management of Phragmites for maintaining suitable whooping crane roosting habitat?

- **Answering EBQ2 should also address mechanical removal along with spraying and suppression release flows or some combination of them.** If the GC would like to know what level of implementation is required for each action (e.g., same as the current Program, more, less), then the EDO and TAC will need to estimate the relative importance of each action in maintaining suitable channel conditions for whooping cranes, as discussed above under EBQ #1.
- Will the 2025 multi-year evaluation address how past inconsistencies in herbicide application have made it difficult to assess the effect of herbicide application, and how this will be resolved in the future?
- See additional discussion of Phragmites in ISAC question #5.

EBQ #3. Is sediment augmentation necessary to create and/or maintain suitable whooping crane habitat?

- *High level comments.*
    - As noted by the ISAC in our memo of October 29, 2023, the data synthesis report was excellent. Comments from peer reviewers on the sediment augmentation data synthesis report will no doubt be helpful and need to be considered together with the following comments from the ISAC.
    - The ISAC recommends looking at EBQ #3 for specific locations. **The Program needs to decide where specifically you want to maintain suitable WC habitat.** Along the J2 channel? Downstream of Overton? Both? How much risk is the GC willing to take that WC habitats might become less suitable at different locations (e.g., might be OK in the J2 channel and not OK below Overton)?
    - **The ISAC recommends more exploration of a dynamic approach to tracking the need for augmentation (and the amount of sediment required) annually** (illustrated by the equation on slide 28 in document 09 - Flow Split & Sed Aug PPT). This will entail completing geomorphic change detection and sediment budgeting annually to determine whether, and to what degree, sediment deficit exists through the J2 return and augmenting sediment to eliminate that deficit. Are there other terms in the equation that need to be accounted for?
    - The ISAC generally agrees with part of the conclusions in the first bullet under "Management Implications" on page 24. We think that more analyses are required to quantify sediment / water ratios arriving at Overton from different parts of the channel (North channel, J2, Jeffrey Island) as well as how changes in channel planform are affecting lateral erosion rates. It's worth defining durations quantitatively (e.g., 3-5 years, 10-20 years) rather than referring to more qualitative terms like "short term" and "long term".
    - The ISAC recommends additional data analyses and/or controlled experiments to determine what level and frequency of sediment augmentation is necessary to create and/or maintain suitable whooping crane habitat downstream of the J2 return.
    - We recommend teasing out natural variability in bed elevation from a deficit signal.
    - How reliable is a stage gauge (Overton) on a braided river channel?
- *Sand dam.*
    - The net decrease in sediment transport capacity detailed in the preliminary HEC-RAS modeling adds to a body of evidence that, from our perspective, casts doubt on whether the sand dam is the most effective management technique for offsetting scour in the J2 return. As detailed in the ISAC report from the October 2023 ISAC meeting, concerns surrounding the sand dam proposal also include:
        - 1) the very rough nature of the connecting channel, which might entirely preclude sediment arriving in the J2 in the short-term without substantial channel clearing,
        - 2) the potential for creating a compounding problem of knickpoint propagation and subsequent incision in the North Channel; this is likely the dominant source of sediment to the Platte near Overton, but the current sediment budget and flux are unknown, and
        - 3) the fact that downstream propagation of incision past Overton appears to have been prevented in the near-term via direct sediment augmentation, a method with far fewer unknowns and less uncertainty than those included in the sand dam proposal.

- *Sediment budget analyses:*
    - A sediment budget analysis (based on DEMs of difference or "DoD"along the length of J2 and down to Overton with 0 sediment input assumed at upstream end of J2) would be very useful to determine how far the sediment deficit induced by the J2 clear water return extends and whether and at what distance downstream the channel is able to make up the deficit by mobilizing other readily available sediment sources (e.g., bed and banks)
    - **We emphasize the importance of examining sub-reach sediment budgets rather than the J2 reach as a whole**, along with what's available in terms of remote sensing data (Program air photos, daily satellite imagery) to estimate sediment concentration and see what's coming from augmentation sites versus what's being recruited from the banks throughout the reach. That's also true of the North Channel - an estimate of sediment supply being sourced from the North Channel on an annual basis and how it lines up with the deficit from the J2 channel would be very useful. If there's substantial sediment being supplied from the North Channel, the "what if incision progresses downstream of Overton" is a moot point entirely and a lot of money and effort can be saved.
    - Estimate how sediment flux has evolved through time to determine whether the channel is recovering from the initial incision that the J2 channel triggered (e.g. through increased sinuosity).
- *Lateral channel migration:*
    - **We recommend testing the hypothesis that lateral channel migration recruits sediment into the channel** and provides a way to offset the sediment deficit by tying the sediment budget analysis to the amount of lateral channel migration. At present, sediment budgeting is being binned into 900-foot segments, and so DEMs-of-difference are available at this finer resolution throughout the J2 reach.
    - One way to consider the impact of lateral migration on sediment recruitment/supply is to correlate the distance of lateral channel migration with a sub-reach's overall sediment budget: what do the sediment budgets look like in the 900 foot sub reaches depending on the average distance of lateral migration there? This would take the form of a scatterplot, on the x-axis is the distance of lateral migration in each 900 foot reach, and on the y-axis that reach's sediment budget (+/-, with "0" at the midpoint of the y-axis). It would also be useful to plot "distance of lateral migration" for each 900 foot reach against "sediment budget of the 3 (or 4, 5, or n) downstream sub reaches".
    - Ensure that local deepening ("incision") is not a case of downstream migration of bedforms.

- *Side channel reactivation:*
    - Determine how frequently the channel will overtop the banks using a stage / discharge analysis of transects in order to ensure that devegetation of the side channels would in fact be self-maintaining.
- *Figures to elucidate patterns in channel form:*
    - We recommend including an aerial photo of the augmentation reach, i.e., 0 to ca. 80,000 ft downriver from the boundary with transverse lines matching those in Figure 7 on page 23 of the SoPR. This will enable the reader to better understand references to locations and see where the channel changes from 'braided' to 'wandering', etc.

- *Channel planform and slope*
    - Keep in mind that a sinuous thalweg at low flow is very common for weakly braided channels and does not necessarily constitute a change in planform. The channel can still braid at high flow. It would be worth searching for any as-built bridge diagrams of the Overton bridge, given that channel incision there is a key metric of J2 impacts. If these are available, determining whether channel bed incision has occurred (either now, or at some time in the future) at the bridge is straightforward.
    - Compare analyses of mean bed elevation and thalweg elevation to determine if channel is deepening due to a planform change versus global incision of the entire active channel.
    - Ensure that decrease in incision is due to sediment augmentation and not a decrease in slope.
    - Revisit transect analyses and ensure that lateral migration and incision are properly distinguished.

EBQ #4. What factors influence WC decision to stop or fly over the AHR?

- **We're entering a period of reduced number of telemetered WCs as that study concludes. It will become increasingly difficult to test the effect of experimentally altered or naturally varying flows on WC stopovers.** If there is a desire to manipulate flow (or just assess the effect of flow variability) , the next few migration seasons will be the best time to do so for questions that telemetry data are best suited to answer.
- When the ISAC originally proposed getting corridor-wide telemetry data, we weren't proposing that you abandon your current AHR Program data and analyses. **Use existing non-telemetry data to address this question in addition to noting that you plan to analyze any available broader telemetry data.** (These comments also apply to EBQ #4-6).
- Response largely focuses on flow as the primary factor, but the current phrasing of EBQ #4 asks more generally about factors. Time of day and UOCW are treated cursorily. It's worth describing the relative strengths of correlations with WC stopovers from <u>all</u> hypothesized factors that have been investigated to date (including flow, but not just flow).

EBQ #5. What factors influence WC stopover length within the AHR?

- Cranes groups can have complex patterns with changing group membership and size over time. Thus, defining groups will be complex in some instances. As most of the data that will be used for this question is already in hand, **the EDO should engage the TAC on ways to define WC groups and their stopover length.** Consider group size as a predictor of stopover length.
- Common to EBQ#4 and EBQ#5 – **Do WC's respond to flow *per se* or is flow a Program management action that affects ecologically more relevant variables like UOCW and water depth?** It seems important to identify the cause (flow) and effect (e.g., water depth) so that Program management actions are linked with what WCs are likely responding to.

EBQ #6. Why is spring WC use of the AHR greater than fall WC use?

- Seasonality could also be considered under EBQ#4 and EBQ #5. Once that's done, you may already have answered EBQ #6.
- It appears that variability in both WC metrics is increasing over time (Figure 10 in SoPR). It's worth understanding why that's occurring.
- **The two main WC metrics are complementary.** The adjusted proportion of the population (top of Figure 10) reflects the relative role of the Platte in the overall WC population, and is scaled to that population. Use days will increase with increases in the overall WC population, and with the attractiveness of AHR habitat for WCs. The average length of stay in the AHR may be worth considering as an additional indicator of habitat quality.

EBQ #7. What effect do Program flow management actions to benefit WC, PP, and LT in the central Platte River have on pallid sturgeon use of the lower Platte River?

- As discussed at the SPRS, objectives 2 and 3 of the PS research project related to spawning habitat and verification of spawning (respectively) appear to demand a level of effort beyond the capacity of the UNL / NGPC team. This is acknowledged in the last bullet under "UNL Habitat and Spawning Research" but is not discussed under "Management Implications". It appears that the most feasible linkages between physical factors (e.g., flow, temperature) and PS responses are for objective 1: migration into and out of the lower Platte River and its tributaries. That is an important result which should be mentioned under "Management Implications", and also under "Answering EBQ #7 during the Extension".
- What the science says in 2024: This summary is dominated by what UNL caught and where. Summarize their preliminary analyses and results to date relating environmental variables (temp, flow, month) to immigration and emigration.
- **Based on discussions during the SPRS it seems appropriate to emphasize that UNL's Objective 1 is the highest priority to aid the Program in answering EBQ#7**
- Temperature is a very important factor in affecting PS movement and spawning. **It is critical that hydrologic modeling completed for the Program by a subcontractor include predictions of temperature in the LPR, ideally in 2D.**
- Why doesn't EBQ#7 have a Management Hypothesis like the other six Priority EBQs, but only has a Learning Objective? You could either rephrase EBQ #7 to say "Does Program flow management affect pallid sturgeon use of the lower Platte River?" (as suggested under ISAC question 1), or add an appropriate management hypothesis to EBQ #7 (e.g., Program flow management does / does not affect pallid sturgeon use of the lower Platte River.)
- Please see the detailed synthesis of comments on EBQ #7 in the file "SoPR EBQ7 Response_DG".

EBQ #8. How much of an effect does predation have on PP productivity (fledging)?

- You could rephrase the question as: "Did we accomplish the learning objectives for understanding effects of predation on PP productivity?" which is more amenable to thumb responses. Alternatively, you could keep the current phrasing because it is useful to quantify the extent of predation, or organize responses with respect to specific hypotheses.

- The text under “Answering EBQ #8 during the Extension” should include key implications from the bullets listed under “What the science says in 2024” and the SPRS PowerPoint presentation. This report should be comprehensive for 2024.
- **It’s important to put Program findings in context of other studies** (e.g., how does the average 25% loss of PP due to predation over 2021-2023 compare with results from the Missouri River Recovery Program during that same time period, and to other peer-reviewed studies?).
- **Will the scheduled 2024 multi-year evaluation of predator management examine a wider range of factors affecting PP fledging besides nest predation?** Will it compare the cost and effectiveness of the various predation control measures that were implemented? Will other approaches also be evaluated, like building additional off-channel enclosures to boost PP productivity to compensate for predation losses?

EBQ #9. How effective is Program management at mitigating losses of PP productivity due to predation?

- Data that the Program is collecting should be very helpful for answering EBQ #9, even though control-treatment comparisons are across sand pits with many varying attributes.
- It would be valuable for the analysis to consider measures of predator pressure, PP nests per year, study effort and observer effect (see detailed comments in ISAC version of SoPR).

EBQ #10. Wet meadows research (This is a carryover task from the First Increment to specifically address the physical processes involved in wet meadow hydrology)

- **It’s important to finish the peer-review process that has been started and see the wet meadows report converge to a final finished and GC-approved product.**
- The Program has used machines to move sediment and remove channel border trees. Given what the Program has learned from the Wet Meadow Hydrology Report, should you consider evaluating mechanical means to sculpt wet meadow topography at existing and potential sites? Would this benefit WCs? What would the costs and benefits be to additional mechanical enhancements?

ISAC Question 3: Does the 2024 SoPR provide the appropriate underlying support or foundation for key ideas and conclusions, as well as the justification for or reasoning behind those conclusions?

Synthesis

Overall, the 2024 SoPR provides a comprehensive synthesis of key findings. The SoPR text (especially in the summary of “Key Observations and Progress”) attributes positive trends almost entirely to the effectiveness of Program actions. **The SoPR should include more qualifiers and caveats with respect to factors outside of Program control that could also have affected the observed trends in habitat and species metrics.** For example, rangewide increases in PP or declines in habitats outside the Platte could be partly responsible for positive

trends in the number of PP nests in the AHR, not just the habitat that the Program created (which certainly has helped the species).

The Program should continue to apply a Structured Decision Making framework which allows for changes in management based on learning as was done in the first increment. Program members should continue to be willing to adjust AHR management strategies as new information becomes available.

The sections entitled 'What the Science Says' give an assessment sufficient for the GC, but not for more technical audiences (TAC, ISAC, external Program reviewers). The SoPR needs to add more citations of program documents and other literature (plus hyperlinks to these citations) to back up your conclusions. For additional detailed feedback, please see ISAC comments in the SoPR.

ISAC Question 4: Based on the content of the 2024 SoPR and your understanding of the Program, is the Program implementing Extension Science Plan management actions, research and monitoring, and data analysis and synthesis in a way that facilitates EBQ assessment throughout the remainder of the Extension?

Synthesis

Generally, yes, the Program is implementing the Extension in a way that facilitates EBQ assessment. We have concerns over the phrasing of the EBQs, as described above under ISAC question 1. For additional feedback on specific EBQs, please see ISAC comments under ISAC question 2, and in our comments on the SoPR.

Recommendations

4a. When possible (e.g., EBQ 1-3), test management hypotheses using contrasts in actions over space and time.

Despite its long-term design, the Extension only spans a decade or so, which isn't a long time in terms of river processes. **Wherever possible, it's worth looking at an array of channel reaches, segments, or even individual braids of the Platte to contrast processes and outcomes, rather than relying on time as the independent variable.**

ISAC Discussion Questions Related to Specific PRRIP Scientific and Technical Issues

ISAC Question 5: Germination suppression and *Phragmites:* Are the approaches for evaluating the effectiveness of germination suppression flow releases appropriate for quantifying the costs and benefits of using Program water as a reach-wide vegetation management tool? Are there other approaches we should consider?

Synthesis

The program is using an appropriately broad range of approaches (remote sensing, field measurements, modeling) to evaluate the effectiveness of germination suppression flow releases. Preliminary findings are well presented and summarized. An abundance of new insight is expected from a detailed multi-year analysis of the data that is underway.
Moving forward, **it is important to clarify management objectives and pose specific questions regarding the use of program water to meet these objectives.** For example, if the goal is to maintain channel width, then inundation flows might be adequate. However, if the goal is to increase channel width, then hydraulic shear stress capable of scouring existing vegetation needs to be explored, potentially by examining known areas of vegetation scour during inundation flows in the context of existing 2D hydraulic modeling efforts. Furthermore, the use of program water needs to be assessed relative to the other suppression actions: mechanical removal and spraying. Is one approach more effective than another? Are there situations where flow suppression is preferable to inundation flows and may drive the dewatering of existing vegetation? What is the relative benefit among the components of this suite of control actions?

Vegetation needs to be managed annually. However, it is also impacted by multi-year trends. Therefore it is important to determine cumulative effects of water availability on vegetation. Do more naturally dry years versus annual inundation flows (using program water) result in a net gain or loss of vegetation? The worst-case scenario for vegetation encroachment is a) a year of high flow, which creates lots of bare sand surfaces, followed by b) a year of low flow, which provides a disturbance-free environment for new plants to establish. One of the downsides of the pulse-flow approach is that it needs to happen annually at relatively high magnitudes, otherwise plants will establish. Once established, they are almost impossible to get rid of (e.g., Figure 6 in the SoPR). Thus, continuation of an effective flow augmentation program is contingent on regular availability of Program water to conduct releases.

To address these questions and test hypotheses, **the Program should make greater use of a space-for-time study approach based on inter-reach variability in both vegetation coverage and hydraulic impacts of inundation flows.** Spatial contrasts between reaches are particularly useful for determining the effects of drying on plants. The dry channel at Chapman is an example of a natural experiment that provides useful information on the effect of water availability on plants. The machine learning and state-change models are welcome additions to the modeling arsenal. A comparison amongst model results can lead to useful insights.

Recommendations

5a. Shear stress and phragmites:

- The State of the Platte mentions that “deep, fast-flowing water” will preclude Phragmites expansion, however this has not been quantified. We recommend coupling the 2D hydraulic model and remote sensing to determine the range of depths and velocities that

have been effective at limiting Phragmites encroachment and quantifying the role of phragmites in reducing shear stress through decreased flow velocity.

- The program could then use the model to design flow releases that would mobilize the bed and prevent establishment of *Phragmites.* Earlier research (Bankhead et al. 2016) has shown that it's not feasible to scour *Phragmites*.

5b. The Program could assess vegetation management by functional groups in terms of relative responsiveness to shear stress, elevation above baseflow and other geomorphic attributes. The imagery that is available should allow for this using supervised classification methods of pixel reflectance in all four spectral bands.

5c. Metrics:

- ISAC continues to be confused about the Program's use of different channel width metrics throughout Program documents and studies. We recommend the Program create a short summary of which metric to use when so everyone can reference it in the future. For example, explain how MUCW relates to UOCW (the term used in numerous Program publications) and why MUCW appears specific to EBQ1.
- Ensure that different unvegetated channel width metrics are used appropriately and consistently.
    - MUCW is an appropriate habitat metric while TUCW constitutes an interesting geomorphic metric.
    - We understand that MUCW is a tricky measure to use long-term because of the presence of small transient islands. One option is to not count those islands if they're less than some height on the LiDAR, e.g. 2.5 feet. That way channels can still be considered wide, since a bird could see over them. Another option is to treat the 500-foot increments as polygons/segments instead of cross sections and determine the maximum width within each of those 500-foot segments, which allows for the presence of transient islands/bars as is expected in a dynamic braided river.
    - The ratio of MUCW / TUCW is a particularly useful non-dimensional metric of how split or consolidated flow is at different reaches and at a single reach through time.

5d. Machine learning model:

The ISAC recommends using the machine learning model more rigorously to understand the effects of control factors, inter-reach variability, and guiding management decisions.

- Compare model predictions at the subreach scale.
- Determine the role of the relative contribution of different control factors in differences between predicted vs. observed changes in MUCW.
- Explore additional explanatory variables in the model including instantaneous peak Q and vegetation type (broad categories by functional groups that relate to geomorphology, not by species).
- Use the machine learning model to conduct cost-benefit analyses of different management scenarios. For example, use the model to determine how much MUCW is gained by consolidating flow in areas where flow is split (e.g. Rowe Sanctuary).

5e. What are the appropriate targets for MUCW (or UOCW)?

Habitat use (relative to availability) does increase with maximum channel width (Figure 1), but there isn't a clear threshold at 650'. There are many roosts that occur in areas with unobstructed channel widths less than 650'; by a quick count, 36% of all roosts were in these narrower channel segments. If that interpretation is correct, it's not clear why 650' is being used as a threshold when narrower channel segments also support WC roosts. It's worth considering how best to provide metrics of habitat use that are both accurate and helpful to decision making. See discussion under ISAC question 6. One option would be to fit a model for % of river segments with MUCW >650 ft (or something similar).

The key management decision is what actions to take to maintain certain channel widths, and to undertake those action in a cost-effective manner. The analyses of WC use vs. MUCW (or UOCW) should provide useful inputs to those decisions, balancing the risks of not maintaining high quality habitat and wasting money on building very wide channels that aren't required.

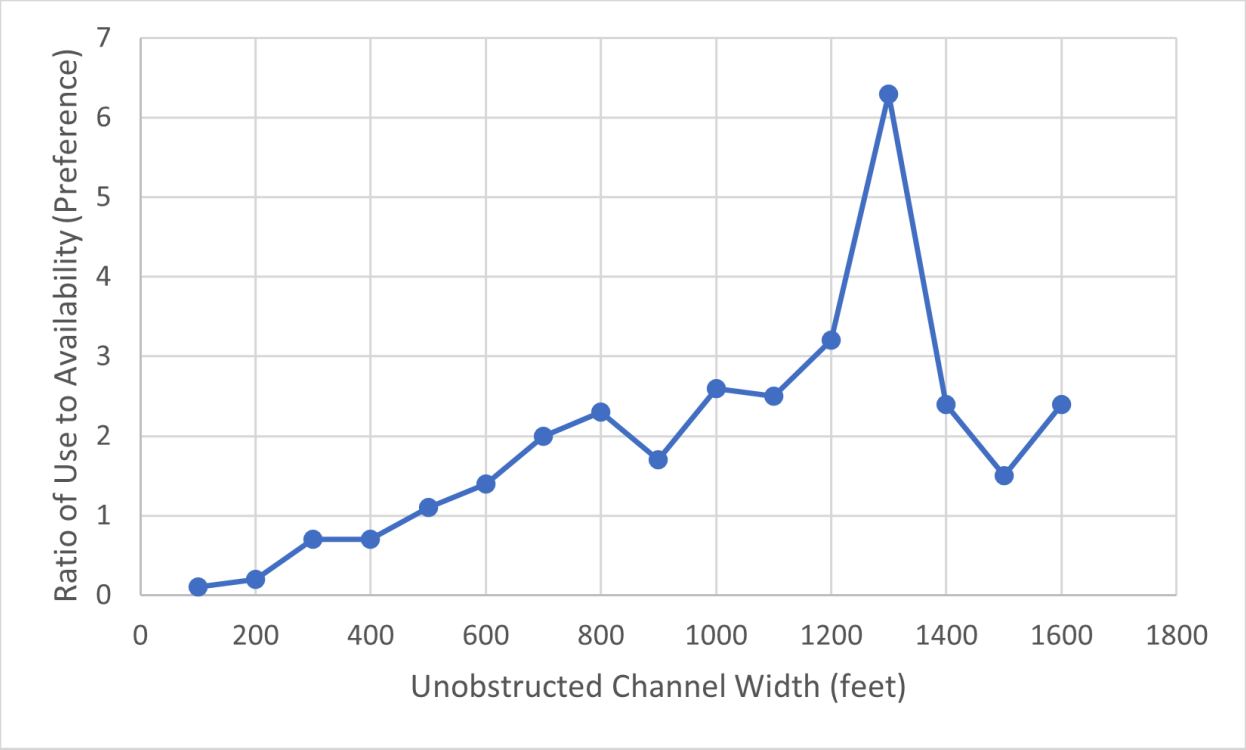


Figure 1: Unobstructed Channel Width (UOCW; ft) vs ratio of use to availability (preference). Based on data from Appendix 4 of document '10 - WC Roost Site Selection Report SPRS - FINAL.docx'. [Note: The ISAC is not recommending this ratio as a metric, as a spike may occur when there is some use of rare habitat (potential outliers). That said, this is an example of a potentially useful statistic to consider because the pattern above does not appear to be random.]

5f. Test hypotheses:

- Pose clear hypotheses for control variables and test these by comparing planform amongst subreaches.

- The current Program management hypothesis is that channel inundation flows of 1,500 cfs are an effective way to reduce *Phragmites.* A second hypothesis is that channel drying (as occurred at Chapman in September 2023) is also an effective way to reduce *Phragmites.* A third hypothesis is that channel drying has only a temporary benefit, and that seeds lead to propagation of *Phragmites* during the next inundation. The Program should consider these hypotheses as management actions move forward, and seek to evaluate them.
    - Take advantage of spatial contrast in the level of inundation, using variation in channel widths, morphology, and tributary inputs. Dry conditions at Chapman and flow splitting at Rowe provide good tests for this hypothesis.
    - Using available imagery, along with historic air photos (like NAIP, back to the early 2000s), can you identify channels which have been dry for one year? For 5, 10, or 20 years? What are the vegetation communities there like? It's possible that drying will affect *Phragmites*, but it might take years for that to happen. The legacy of imagery that's available might help determine how long a channel has been dry and how that drying has impacted plants.

5g. State change model:

Use the state change model to assess whether management is preventing vegetation transitions between states.

- Add a category of <2ft to >2ft transitions.
- Create a 3 x 3 (or 4 x 4) table of transitions to allow for transitions between different states.

5h. Leverage results from multiple models:

Compare predictions amongst 2D hydraulic model, machine learning, and vegetation state change models to highlight differences in program actions based on process and/or vegetation type. For example, does the machine learning model highlight the effects of inundation flows on germination - suppression of cottonwoods and willows, and state change? Does the 2D hydraulic model highlight the effects of shear stress on *Phragmites*?

5j. Wyoming flow split project (Presentation 9):

Investigate the characteristics (slope, discharge partitioning, etc.) of the flow split between the main channel and the north channel further upstream to determine the relative impacts of the different flow splits on discharge at Rowe Sanctuary and whether the proposed berm is the most effective way to increase discharge at Rowe.

Detailed Points

- In the figure from the EDO presentation on the machine learning model, we note that the model predicts that no matter the base flow, channel width declines in the future. What is the explanation and is this a concern?
- The 2025 multi-year evaluation should describe how past inconsistencies in herbicide application have made it difficult to assess the effect of herbicide application, and how this challenge will be addressed in the future.
- See also comments in document 8 from Marmorek (DM) and Hoeting (JH) (e,g, "08 - Germination Suppression Data Analysis Outline 2.1.2024 DM comments .docx")

Reference for Question 5

Bankhead, Natasha L., Robert E. Thomas, and Andrew Simon. "A combined field, laboratory and numerical study of the forces applied to, and the potential for removal of, bar top vegetation in a braided river." Earth Surface Processes and Landforms 42.3 (2017): 439-459.

ISAC Question 6: Whooping crane (WC) roost site selection

a) Are the conclusions regarding factors that impact WC roost site selection within the Associated Habitat Reach (AHR) well-supported by the data, methods, analyses, and model selection techniques detailed in the WC Roost Site Selection Technical Report?

Synthesis

The ISAC enjoyed reading the roost site report. As with any scientific manuscript or report, we have comments and questions that may assist in clarifying certain elements. The goals and objectives of this report were clearly stated. The relevance of the information regarding the Program's goals and objectives was well articulated and supported by introductory information. The described field methods and data handling procedures were generally appropriate for the questions developed. The analyses were appropriate to identify factors that influence selection of river roost sites along the Platte River by whooping cranes.

One primary question of note relates to use of initial and subsequent roost sites for model selection, prediction, and inference. Our understanding from the methods was that initial roost locations were used in the model selection process, resulting in the identification of a single model for which to make inferences. Analysts then used all data and estimated predicted values from that single model, which were then interpreted. We understand the issue of lack of complete independence (i.e., initial roost site selection affects subsequent roost site selection), although it could be characterized as partial rather than complete dependence, and a desire to shield oneself from pseudoreplication. However, **there are reasons to wonder why first roosts were given greater importance compared to later ones in model selection.** A crane might stop at the Platte at a reasonable site and, after flying around the next day, discover better sites and choose one of those the following night. In that thought exercise, we might consider the second roost as resulting from a more informed decision.

Most interpretations of presented results were appropriate and supported by data. One main exception was the use of 90% confidence intervals of predicted relationships. We are curious to understand more about the process in which these were generated. Our guess is that they are related to the uncertainty in the overall curve/line fit rather than for individual locations on that curve. If so, interpretations regarding comparison of different locations on the line may not be entirely valid. There are differences between confidence intervals and prediction intervals, the latter which may be more appropriate for the interpretations attempted. Moreover, given the analysis used, making inference of equivalence requires more evidence than overlapping confidence or prediction intervals. Currently, **we are not inclined to support the conclusions made using the confidence interval comparisons and the claims of 'statistical similarity'.**

We noted a desire to make interpretations to inform management targets. **We encourage authors to identify the multiple sources of information presented in this report when considering modifying management targets.** Table 5, Appendix 3, and Appendix 4 provide a wealth of information, along with the predicted relationships, that could be of use to the Program. One example is the observation that approximately half of roost observations occurred in channels less than the current target width. The report considers targets as identifying 'highly suitable habitat', yet current targets seemingly correspond to median use. Existence of thresholds from predicted relationships along with other pieces of information will be of value in considering management targets.

Recommendations

6a. Explore ramifications and provide better justification of the chosen analytical methods (e.g., using just the initial roost site, vs. using the initial and subsequent roost sites for model selection, prediction, and inference). Are there substantial or interesting differences in characteristics of initial and subsequent roost locations? How do results change if all data or only first roosts were used for model selection and inference? Could you consider a criterion that you could use to declare independence, for example, if birds select a new roost greater than 'X' km from their subsequent one?

6b. The use of overlapping confidence intervals to make conclusions about 'statistical similarity' is not good statistical practice. Potential remedies include alternative methods (Bayesian), including additional results (equivalency testing; http://dx.doi.org/10.2106/JBJS.K.00568), or modifying inferences made from predicted relationships.

6c. Focus on a greater wealth of information that is presented in the report to provide decision makers with information they could consider if they wish to revisit management targets. Although GAM models can be useful at identifying thresholds, there are other methods that could be used for comparison (for example, doi: 10.1111/j.1600-0587.2009.05571.x).

Detailed Points

- For figures like Figure 7 in document 10 that have hash plots along that top and bottom: you should consider using density plots instead of hash marks. This suggestion is only for cases when you have a lot of data (e.g., Figures 7-9), not for Fig 8 in the SoPR, for example. This will allow the reader to better understand patterns of presence and absence.
- Suggestions for the report ("10 - WC Roost Site Selection Report SPRS – FINAL.docx")
    - Line 288. For all roost sites, what happens if the group/individual used the same location for multiple nights? Are roosts included in the dataset on a per night or per location basis?
    - Table 5 includes used locations with UOCW of zero. Is this a river reach that has vegetation >2ft tall across the entire channel? If so, this seems like an odd place for a whooping crane to roost. Can you provide more detail for these extremely narrow sites?
    - Line 646 and elsewhere. "Top model"
        - We support the use of model 21 for inference. It is the simplest nested model of among the competing models. Yet, we would not call it the 'top' model. It is the model used for inference.

        - Given that there were multiple competing models, did you consider presenting model-averaged predictions, which would have included model uncertainty into predictions? An alternate ISAC view is that the current approach is fine.
    - Line 663 – This statement is incorrect as written. Relative selection of roost sites increased at the greatest rate up to 514 ft. As stated in the next sentence, it continued to increase, albeit at a reduced rate up to the top of the relationship at 1100 ft. You correctly identified an inflection point, but I think additional clarification is needed.

Other predictor variables that may be useful:

- Development – There was consideration of two development variables, wherein the proportional variable better fit the data in a single-variable model. We support this general approach to winnowing down correlated variables. Given that the proportional variable had little variation (~0-6%), you could consider a distance-based development metric that includes more development features – roads, or even any development, rather than the limited one tested. Such a variable might be more useful than the distance-based one tested and potentially more sensitive than the proportional one used.
- Group dynamic – Group size (continuous or categorical) for instance, might interact with some of the physical roost features. One might hypothesize that larger groups might select wider channels, or small groups may not 'need' such large channels.
- Presence of sandhill cranes – A large concentration of sandhill cranes might lead to use of wider channels by associated whooping cranes, simply to accommodate the large mixed species group.
- Explore interactions with weather – 25% of roosts were at sites with channel widths <500 ft. Are there additional factors related to use of these sites, other than few available sites >500 ft? Do these 'small' sites have some value for whooping cranes in specific instances, like protection from the wind, especially during cold and/or precipitation?
- Multi-scale effects. The report includes good reasoning for the scale of summarizing land use around roost sites, yet no one really knows if that is the scale at which cranes perceive the world. Calculating predictor variables at multiple scales, even if exploratory and winnowed down as you did other correlated variables, adds to your case that the scale chosen was the 'correct' one.

ISAC Question 6: Whooping crane (WC) roost site selection
b) Would you review this report favorably for publication?

The roost-selection report is well-done and should be useful to the Program, but it may be challenging to convince a peer-reviewed journal that enough new knowledge is being presented to warrant acceptance. Corroboration of the findings of previous studies are not usually published in top tier journals. Nonetheless, there are an increasing number of journals that consider only scientific rigor, without regard to novelty or impact. "Ecology and Evolution" and "PLoS One" are two journals that fit this mold.

To be accepted by a peer-reviewed journal the report would need to be revised to more general and less Program-specific. It would be important to emphasize in the Introduction and Discussion how this study is a significant step forward from Howlin and Nasman (2017) and Baasch et al. (2019a) versus largely reinforcing their conclusions.

ISAC Question 7: Pallid sturgeon (PS)

The ISAC responds to the four pallid sturgeon related questions below. The ISAC is impressed by how much work has been done since October on the data analyses. We look forward to the continuing refinement of these analyses. Two ISAC members provided detailed comments on documents 13 and 14 to be shared with the UNL and SIU groups.

ISAC Question 7: Pallid sturgeon (PS)

a) What contribution are the data collected upstream of the Elkhorn River likely to make to answering EBQ#7?

Synthesis

There are 6 passive receivers in the LPR above the Elkhorn-Platte confluence and 1 above the Loup River. Only 2 of the 80 individual PS detected were from above the Elkhorn, However, UNL SPRS PP slide #4 (doc 14) shows numerous active detections above the Elkhorn confluence. This question appears to be asking: Is it worth the effort to maintain passive receivers above the Elkhorn confluence or to actively track PS above the Elkhorn given the information gained? Here are the pros and cons we've identified:

Pros:

1. Documenting maximum upstream movement, particularly as it relates to temperature (T) and flow (Q), may yield insights into how PS respond to extremes of T and Q affected by the Loup River Diversion return above North Bend. Is the furthest upstream movement associated with the highest flow pulses? If passive receivers are abandoned above the Elkhorn, you won't know if more PS migrate above the Elkhorn in high flow years given that 2022 and 2023 were low flow years.
2. Having 3-4 years of PS movement data that show little use above the Elkhorn, perhaps over a wider range of annual discharges, vs. just 2 years, will provide stronger support to discount future assessments of PS above the Elkhorn. The point here is that zeros are important to define limits.
3. The Loup River is a large source of water to the LPR. Discharge of the LPR increases by about 59% below its confluence, see Table 7.a. below, compiled for this report). Additionally, the Loup canal diverts a large portion of the river's flow for hydropower generation and its return to the LPR about one mile below the Loup-LPR confluence

greatly modifies LPR stage and discharge patterns (see Fig. 5, after pg. 8 in HDR 2009). Pallid sturgeon advocates might argue that Program flows could benefit PS use upstream of the Loup diversion return. More data on PS use or lack of use above the Elkhorn will aid in evaluating such a hypothesis. Finally, how PS movement responds as the impact of the Loup diversion diminishes moving downriver may have important implications for future Program flow management.

4. If drift netting of age-0 PS is discontinued as proposed, will the time saved be sufficient to offset the cons described next?
5. It's useful to know which areas are being used by PS. If pallid sturgeon were primarily using the Elkhorn River, rather than the Platte River, then Program water management actions will have less effect on pallid sturgeon, unless there's an effect while they move upstream.

Cons:

1. Reducing receiver maintenance and travel time above the Elkhorn would free up resources, which could be used for other priorities (e.g., active tracking of reproductively mature PS - would they be tracked if they migrated above the Elkhorn?).
2. Reducing work above the Elkhorn confluence could allow researchers to improve passive detection of PS below the Elkhorn (e.g., moving the receivers from above the Elkhorn to increase receiver 'gates' and improve detectability below the Elkhorn where over 95% of PS have been detected).

Conclusion. Is the scientific knowledge gained worth the resource investment? Maintaining the passive array above the Elkhorn is more important to the science needs of the EDO PS Framing Document than continuing larval trawling. Discontinuing larval trawling will free up sufficient resources to address the cons listed above. However, this is a question that UNL and the EDO should carefully consider.

Recommendations

7a-1. UNL should continue to maintain the passive receiver array and active tracking above the Elkhorn as it is important to the science needs of the EDO PS Framing Document.

Table 7.a. Discharge statistics of the Loup and Elkhorn rivers relative to the Lower Platte River (LPR) and the LPR to the Missouri River (MOR). The difference in discharge between the two gages divided by the downriver gage is an estimate of the percent mean annual discharge each tributary contributes to its receiving river (% Contribution). Discharge data (cfs) from the nearest USGS gages above and below the confluence of each river over the same 28-year period of record when all gages consistently reported annual data (1995-2022).

	Loup River to LPR		Elkhorn River to LPR		LPR to MOR	
	LPR Above Confluence	LPR Below Confluence	LPR Above Confluence	LPR Below Confluence	LPR	MOR
gage #	6774000	6796000	6796500	6801000	6805500	6610000
Location	Duncan	North Bend	Leshara	Ashland	Louisville	Omaha
mean	1,964	4,815	5,294	7,375	8,573	38,950
median	1,693	4,758	5,317	8,127	9,153	33,485
max	4,706	9,381	9,890	14,750	17,230	83,920
min	354	2,442	2,600	3,530	4,173	23,490
% Contribution		59		28	22	

ISAC Question 7: Pallid sturgeon.

b) Do you think a good understanding of the factors associated with immigration/occurrence and emigration into/out of the lower Platte River (based upon data from the Platte River confluence with the Missouri River alone) will be enough to inform Program water management in the central Platte River?

Synthesis

Understanding the correlates of immigration and emigration will improve our understanding of how fluctuations in discharge and temperature may affect movement and habitat use of pallid sturgeon in the Lower Platte River. These correlations may be strongly driven by natural year to year fluctuations in meteorology, the Loup River hydropower return, and possibly Program water management. However, the 2012 Program Stage Change Study concluded, "…the present water management scheme for the lower Platte River predicts …there would be little change to the amount of habitat available to pallid sturgeon in this reach of the river."

Knowing PS movement into and out of the Platte River is critical information, but insufficient for the following reasons:

- Immigration/emigration limited to just the Platte-MOR confluence will not meet Program needs identified in the EDO's PS Framing Document.
- UNL study Objective #1 is explicit to: "Identify relations among environmental conditions (i.e., river discharge and temperature) with the timing and extent of PS movement into and within the lower Platte River and its tributaries."

- Interannual and spatial fluctuations in flow and temperature are large in the Platte River. Results after 2 low-flow field seasons may not be indicative of movement during higher water years.
- If effort were restricted to just the confluence, it would not be possible to learn how environmental variables might influence movement upstream of the confluence. Lacking this knowledge would severely limit the Program's ability to evaluate the effect of flow management on PS habitat in the LPR.

Recommendations

7b-1. Continue full implementation of the UNL study plan for Objective 1, identifying relationships among river discharge and temperature with the timing and extent of PS movement into and within the lower Platte River and its tributaries.

ISAC Question 7c: Pallid sturgeon.

c) Given the data presented, what do you think the Program will learn about pallid sturgeon movement into, through, and out of the lower Platte River?

Synthesis

It is outside of our charge to speculate on learning outcomes of the UNL study to avoid any appearance of influencing the independence of their results. However, it is within our charge to highlight where results/discussion from the UNL 2023 Progress Report, their PowerPoint presentation, and our interactions at the SPRS meeting will contribute to informing the EDO's PS Framing Document objectives. Also, we take this opportunity to identify information needs not necessarily being addressed by the UNL study but are topics for the Program to consider.

Apparently, the EDO instructed UNL to, "…focus largely on preliminary analyses for Objective 1 related to immigration [into] and emigration [out of] …the lower Platte River at its confluence with the Missouri River." Consequently, UNL provided only General Telemetry Results on movement 'through' the LPR. These results add to previous evidence that PS migrate up the LPR into the Elkhorn, and further upriver into and slightly past the Loup River. Also, PS likely spawned in the LPR based on departure time and no eggs present of one tagged gravid female in the LPR in 2023. This reinforces previous evidence for PS spawning in the LPR. Most significant is that large numbers of adult PS (94 to date) have been identified using the LPR during 2022-2023 – "This number accounts for 31% of all telemetry tagged PS in the Lower Missouri River as of spring 2023." **These results conclusively establish that a sizable proportion of tagged Missouri River PS use the LPR.** Tagged PS tend to be concentrated in the upper part of the Lower Missouri River (Aaron Delonay, USGS, 2023 MRRP Fall Science Meeting), so the tagged PS are not spatially representative of the entire population.

UNL results will yield insights on how many PS enter and exit the LPR; and correlations of entry and exit with date, discharge, water temperature and life history attributes (e.g., sex, age, size, reproductive condition). For example, midsummer water temperatures recorded in the LPR during 2022-2023 are reported to be lethal for juvenile PS. Results documenting immigration, emigration and individual occurrence (fish detected only at the LPR-MOR confluence, not

further upriver in the LPR) should enable the Program to better understand if environmental factors like mean discharge, mean temperature, photoperiod and season are correlated with movement of reproductively mature PS into and out of the lower Platte River, and the variability in those correlations across years and among individual fish.

Discharge and temperature are critical variables affecting sturgeon migration and spawning. The UNL Progress report results to date confirm both are highly variable in the shallow LPR. Research may reveal the complexity of flow and temperature dynamics throughout the LPR; how these dynamics are affected by major tributaries (Loup, Elkhorn, Salt Creek); how Missouri River temperatures and discharge might influence mixing at the confluence; and how all of these factors affect PS immigration, emigration and occurrence at the confluence. UNL may find it helpful to explore how variability in the fundamental characteristics of hydrological regimes affects PS migration. We compiled Table 7.a. to illustrate flow complexity by summarizing the magnitude of mean annual Loup and Elkhorn flow to the LPR, and of the LPR to Missouri River discharge.

Recommendations

7.c.1. The EDO should request progress on all UNL Objectives in subsequent interim Progress Reports.

7.c.2. The EDO should analyze seasonal and diel longitudinal patterns in LPR discharge and temperature including how the Loup River, Elkhorn River and Salt Creek affect variability in LPR discharge and temperature. Additionally, they should investigate mixing of LPR and Missouri River (MOR) water at the confluence particularly when seasonally high MOR flows back-up LPR water at their confluence.

7.c.3. Understanding patterns of past, present and future hydrological conditions of the LPR is necessary if PS use is to be effectively managed. The EDO should calculate a suite of hydrological variables for each LPR gauge from mean daily flow data using the Indicators of Hydrologic Alteration (IHA) methodology (Richter et al., 1996). See Galat and Lipkin (2000) and Pegg and Pierce (2002) for how the IHA has been used on the Missouri and Yellowstone rivers to assess historical flows and how future flow changes might affect PS use.

7.c.3. Temperature is an important driver for PS and needs to be added to modeling of the LPR (not currently included in HDR work); a 1D model of temperature might be sufficient, a 2D model would be better (see Detailed Suggestions).

7c.4. The PPRIP Water Management Study (Step 2 of PS Framing Document) should model how much Program water would be required to change the water temperature in the LPR by one or more degree C during the PS spawning season (to be defined).

Detailed Suggestions

There is fundamental baseline information that should occur in every UNL Progress Report that is absent from the 2023 Progress Report. These include:

1. Numbers and locations of passive receivers as these likely change from year to year. Include a Table (#1) similar to Table 1 in the 2022 Progress Report that gives the location, (absent from 2022, but add hereafter) river mi/km, and summary stats for each year's passive receivers.

2. Hydrologic information necessary to meet Objective 1, such as multi-panel figures that show daily Q and temperature for each study year at 6 representative USGS gages or appropriate UNL temperature loggers along the LPR study area (e.g., LPR above Loup (Duncan) , LPR below Loup (North Bend), LPR above Elkhorn (Leshara) , LPR below Elkhorn (Ashland), LPR below Salt Creek, and LPR above confluence with MOR (Louisville, NE)).
3. A summary table that reports for each study year the five fundamental characteristics of hydrological regimes (i.e., Indicators of Hydrologic Alterations (IHA, Richter et al. 1996): discharge magnitude, timing, frequency, duration and rate of change for each gage).

Rising vs. falling temperatures. Temperature and to a lesser extent discharge generally show a distribution with rising T or Q in the spring and then falling T (maybe not Q) in the fall. Q is much more dynamic with multiple pulses but typically the largest occurring in the spring. Thus, a given rising temperature (e.g., 15 C) will occur both in the spring (e.g., April) and 15 C again in the fall (e.g., Oct). However, PS behavior (immigration/emigration) is typically very different at the same temperature (discharge) between spring and fall. The present UNL model does not distinguish between a given temperature rising in the spring or declining in the fall. Would it be possible to code temps as rising, stable or falling (e.g., using a 3–5-day interval) and then reanalyze identifying an individual daily mean temp as rising, stable or falling? Temperature may not show up as being an important predictor for PS migration because the fish respond differently to rising or falling temperatures.

Hydrologic and temperature interactions between the MOR and LPR. There is a lot of variability in timing of immigration relative to T and Q in the LPR. Is it possible that the T and Q of the adjacent MOR relative to the mouth of the LPR influences when PS enter the LPR? Could UNL graphically and statistically compare patterns of T and Q (perhaps normalized for each system e.g., daily T/annual mean) between the two closest gages in each system (e.g., Louisville on LPR and Omaha on the MOR)? Assuming they are not the same, then consider including T and Q of the closest MOR monitoring location as a variable in your candidate models for immigration into the LPR. The question here is: does T and/or Q in the MOR relative to that of the LPR mouth influence when PS immigrate up the LPR?

Occurrences vs. Immigration. Can you assess if MOR-LPR T mixing occurs in the mouth of the LPR? Fish migrating up tributaries (e.g., MOR to LPR, LPR to Elkhorn R) often hold briefly in the tributary mouth (staging), perhaps assessing whether signals from the tributary (Q, T, pheromones?) make it 'worth' migrating up the tributary or exiting back to their source river. Your 'individual occurrence' fish appear to represent those that entered the mouth but did not migrate further upriver, whereas immigrants elected to migrate into the LPR or tributary of LPR. Have you, or might you examine frequency of individual occurrences relative to month, T and Q?

Month as a surrogate for something else. Temperature(T) and discharge (Q) relative to month. Since T and Q are the 2 primary environmental variables being considered, at some point UNL or EDO will need to independently dissect their similarities and differences within and among years and compare with longer-term patterns. That month pops out as the primary driver is reason to consider further partitioning T and Q.

UNL does a good job on this in analyses reported in Figs.13 and 14. However, I question whether month should be a model variable at all unless you can more expressly examine how month is a surrogate that logically links to PS migratory behavior? Fish reproductive development is driven by hormonal changes, and these are affected by several environmental variables, including temperature. The environmental variable known to affect fish reproductive development (for which month is likely a surrogate) is photoperiod (represented by daylength). Try replacing month with daylength in your analysis – recognizing that daylength, like temperature, increases in spring and decreases in fall, so that the same daylength has different physiological effect on fish behavior in spring vs fall. Code them to distinguish between increasing day length in spring and decreasing daylength in fall which can be achieved via an interaction between daylength and season, for example.

The same T or Q in let's say June or October might elicit a very different behavioral response from PS since these months are a different time in the fish's life history. Accurately identifying environmental aspects of month (season) that are relevant to movement patterns of PS might make your analyses more powerful predictors. Increasing and decreasing T (predictable) daylength (highly predictable) and Q (more stochastic, but also evaluating long term Q records should reveal patterns) are the most obvious. Simplest is to plot 10, 25, 50, 75 and 90%tiles of mean daily Q for a long period of record as has been done for the MOR by Jacobson and Galat (2006, 2008) and then do a pattern analysis like IHA (Galat and Lipkin 2000). You might consider some or all the key hydrological variables: timing, magnitude, frequency, duration, rate of change that might be potentially important (to PS) descriptors as model input in the future?

Movement within the LPR. The 2-D models will yield detailed information on frequencies of water depths and velocities across a range of discharges over the study area. UNL measurements of depth and velocity at GPS coordinates where PS are actively located will yield the depths and velocities of habitats the fish have used. Collectively, these results can be applied to develop depth and velocity selection curves for actively tracked PS. Such information can then be fed into Program models estimating water losses as flow moves from the AHR to the LPR and how a range of Program water additions at Grand Island might affect depth and velocity frequencies in the LPR and depth and velocity habitat use by PS.

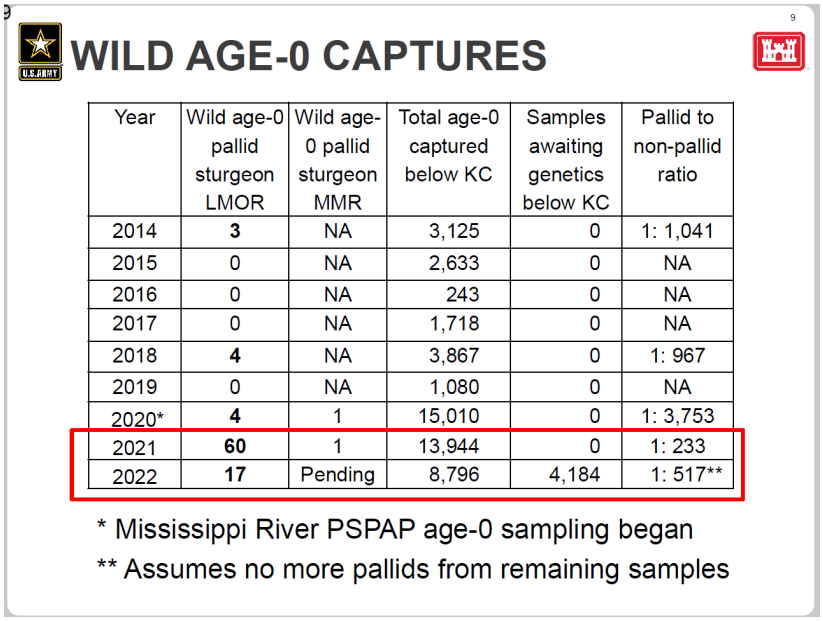
HDR Modeling. As noted above, it's essential to connect Program flow management to LPR hydraulics and LPR temperatures. Variability in temperature across the channel will be significant, and so a 2D model would be more valuable. A 1D model might suggest there's no change in temperature from water management. Will HDR be able to parse bathymetry into water depths bins that vary with discharge and time? Can you use these depth distributions as 'available' depths to relate to what UNL active telemetry will report as PS depth "use"?

ISAC Question 7: Pallid Sturgeon

d) What contribution does larval trawling make to answering EBQ#7? How important is it to Program objectives to maintain larval trawling at the Platte River confluence with the Missouri River?

Synthesis

Only 6 free embryos/eggs have been collected and submitted for genetic analysis over the two years of study despite extensive and intensive sampling by UNL. The MRRP has found that they generally need to collect more than 10,000 age-0 fish to have a good chance of finding more than zero pallid sturgeon. These collections are conducted by experienced crews who are very good at finding age-0 sturgeon. See table below from Nate Gosch talk at Nov 2023 MRRP Fall Science Meeting for the Lower Missouri River. Note the ratios in the rightmost column. How many age-0 fish can be caught by the UNL-NGPC team? Do they have the capacity to catch enough sturgeon to find 1 or more pallids? It seems much more practical to abandon the UNL collection of age-0 fish from the lower Platte River, and to just rely on the MRRP to catch the fish, and on Ed Heist (SIU) to determine their genetics. For captures of siblings, the SIU genetic information and the PRRIP telemetry may be sufficient to document that reproduction may have occurred in the Platte / did occur in the Platte, and perhaps to document the general location of spawning in the Platte River (for those fish which produced age-0 offspring that had genetics matching one or more parents that were tracked as moving through the Platte). Drawing a conclusion about the location of reproduction will be more uncertain for those fish which move in and out of the Platte during the spawning period. The MRRP is likely to increase its sampling of age-0 fish in the Missouri R, as they attempt to develop an index of year-class strength.



WILD AGE-0 CAPTURES

Year	Wild age-0 pallid sturgeon LMOR	Wild age-0 pallid sturgeon MMR	Total age-0 captured below KC	Samples awaiting genetics below KC	Pallid to non-pallid ratio
2014	**3**	NA	3,125	0	1: 1,041
2015	0	NA	2,633	0	NA
2016	0	NA	243	0	NA
2017	0	NA	1,718	0	NA
2018	**4**	NA	3,867	0	1: 967
2019	0	NA	1,080	0	NA
2020*	**4**	1	15,010	0	1: 3,753
2021	**60**	1	13,944	0	1: 233
2022	**17**	Pending	8,796	4,184	1: 517**

* Mississippi River PSPAP age-0 sampling began

** Assumes no more pallids from remaining samples

Recommendations

7.d.1. The ISAC supports the decision of the EDO and UNL to cease sampling for age-0 sturgeon, but to continue deploying and sampling egg mats to collect embryos for genetic analysis by SIU, and to make use of inferences about Platte River spawning from MRRP age-0 sampling and genetic analyses.

Detailed Suggestions

- Some of the UNL plots show values for June when June when you didn't have any fish in June.

- Consider adding photoperiod to simplify some of your models. Hormone production and thus gonad development in *Scaphirhynchus* is tied to photoperiod (Papoulias et al. 2011)
- Can you examine the interaction of month and temperature?
- EBQ-7 addresses "use of the Platte". PS use might include staging before moving further up the MOR, feeding to benefit growth, resting to conserve energy, and reproduction -- but reproductive success is not explicit in EBQ#7. Therefore, it's more important to spend effort on assessing use. It may be worth considering deleting the deployment of egg mats if the time saved would improve responses to Question 1.
- IF Program flows can be statistically detected in the LPR and the Step 2 modeling shows they affect availability of habitat occupied by PS, then an important question for the Second Increment is *how do PS use these flows?*
- Any one of four types of evidence could conclusively demonstrate reproduction in the LPR: 1) initially gravid female recaptured in the LPR and eggs have been dropped; 2) egg mats collect PS embryos; 3) age-0 PS captured in the LPR; and 4) age-0 PS captured in the Lower Missouri and genetically related to fish that spawned in the Platte.

References for Question 7

Galat D.L. and R. Lipkin 2000. Restoring ecological integrity of great rivers: historical hydrographs aid in defining reference conditions for the Missouri River. Hydrobiologia 422/423: 29–48.

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Jacobson, R.B., and D. L. Galat. 2008, Design of a naturalized flow regime-an example from the Lower Missouri River, U.S.A.: Ecohydrology, 1:81–104.

Papoulias, D.M., A. J. DeLonay, M.L. Annis, M.L. Wildhaber and D.E. Tillitt, D.E., 2011, Characterization of environmental cues for initiation of reproductive cycling and spawning in shovelnose sturgeon (*Scaphirhynchus platorynchus*) in the Lower Missouri River, U.S.A.: Journal of Applied Ichthyology 27: 335–342.

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Richter BD, J.V. Baumgartner J. Powell and D. Braun. 1996. A method for assessing hydrologic alteration within ecosystems. Conservation Biology 10: 1163–1174.

ISAC Question 8: Piping plovers (PP) and predator management:

a) Are the approaches for evaluating the effectiveness of predator management appropriate for the experimental design, sample sizes, and the variability in the data across sites and years?

Synthesis

Overall, this is an impressive data analysis proposal with multiple state-of-the-art statistical methods. EDO clearly gave careful thought to the data and provided a clear proposal which outlines both the goals and the proposed models for each analysis.

The ISAC is concerned that some of the proposed statistical approaches require larger data sites than the 10-site analysis allows (7 "control" and 3 "treatment" sites). Since this study was first proposed, the Program has recognized important limitations: there are few sites, inferences are about these sites only, and each 'treatment' is applied slightly differently based on site-specific characteristics. **The ISAC recommends that the EDO start with the simplest possible analyses and then proceed from there as a data set of this size allows.**

Recommendations

- Analysis 1: The generalized linear mixed-effects model is a solid proposal. Is there an even simpler analysis that you could try for your small data set? What is the simplest BACI analysis available that is suitable for these data?
- Analysis 2: The Bayesian multinomial logistic exposure nest survival model is a state-of-the-art suggestion. Unfortunately, this model typically requires a much larger data set. The analysis is worth a try if you have time but abandon it if you don't.
- Analysis 3: Same comment as for analysis 2, the proposed modeling might be overkill.
- Analysis 4: Seems reasonable.
- Analysis 5: Hold off on the simulation study for now. Wait to see the Piping Plover population model that Kate Buenau is going to produce for the MRRP.

Detailed Suggestions

- As much as possible, please be consistent across Program documents using the same abbreviations. For example, in document 16 use PP for piping plover instead of plover. Refer to the abbreviations list in the SoPR so that everyone is consistent.
- Comments on document 16 "16 - PRRIP Piping plover data analysis outline.docx"
    - Line 28: Give date of predator management implementation since that hasn't been done since 2010, right?
    - Line 99: Do you need average, or absolute maximum and minimum? If there was an unusually cold or hot day, would that be an important predictor?
    - Figure 1: Do the October goals need to become July given the new meeting schedule?
    - Line 269 "We will use data from our three years of remote camera monitoring efforts at the six OCSW sites to evaluate spatial, temporal, and site differences in avian, mammalian, and reptilian and amphibian predator communities, and the effectiveness of predator deterrents."
        - Too ambitious of a goal given the data that you have. For example, it isn't worth considering spatial differences, as your data set is too small.

ISAC Question 8: Piping plovers (PP) and predator management:

b) Regardless of management effectiveness, is it worth continuing camera work beyond 2024 to monitor both plover nests and predators?

Synthesis

Nest cameras – The EDO mentioned evidence that presence of nest cameras did not affect survival of nests. If one assumes the presence of cameras does not affect plover reproduction overall (number of breeding adults, nest survival, chick survival), then the only down-side of continuing the effort is staff time and resources. The benefits of nest cameras were identified as providing more certainty in identifying nest fates – the proportion of uncertain fates decreased with use of cameras. Given the considerable up-side and little down-side risk, we suggest continuing deploying nest cameras as resources and time allow.

Predator cameras – The usefulness of this monitoring is less immediately clear than for nest cameras. We suggest assessing the quality and quantity of information that is being gathered across the three years already collected - detailed separately in existing reports. Specifically, are there consistent and noticeable differences between treatments? Are there considerable differences temporally that would make more years of data necessary? These analyses can be done with simple graphs for starters, before attempting the more complex data analyses proposed in the data analysis outline (Document 16) .

Recommendations

- Continue to use nest cameras which allow the Program to identify more nest fates.
- Assess the usefulness of predator cameras based on existing data.