TO: ISAC AND UNL

FROM: EDO

SUBJECT: FALL SCIENCE MEETING DISCUSSION SESSION OUTLINE: LOWER PLATTE RIVER MODELING AND HYDROLOGY

DATE: SEPTEMBER 4, 2025

At the September Fall Science Meeting, the EDO anticipates a 1 1/2-hr block allocated to discussing technical points relevant to lower Platte River hydrology and utilization of the lower Platte River 2D hydraulic model to better understand how PRRIP water management in the central Platte River may affect lower Platte River hydrology and in turn alter conditions ("habitat") experienced by pallid sturgeon along the lower Platte River system. The work here stems from a request from the ISAC asking the EDO to provide a rough sketch of what PRRIP water management actions in the central Platte might look like in the lower Platte.

WHY: This is a critical moment for discussion/brainstorming prior to jumping off into detailed data analyses. The EDO would like to discuss potential limitations of the 2D model due to LiDAR voids in deeper portions of the river at the time of acquisition. The result is high uncertainty from the 2D model about conditions in the deepest portions of the river.

We are also providing valuable context on lower Platte River hydrology, geomorphology, and the timing and extent to which PRRIP flow management actions contribute. Keeping this information in mind will be helpful during the September workshop as we discuss UNL research to address PRRIP information needs.

HOW: The Lower Platte River Hydraulic Modeling Services Report from HDR was sent previously and is not contained within this compendium. It will be resent as an appendix to this memo.

Here we have taken a look at contributions of Program water releases as well as potential impacts from Program water diversions for recharge on lower Platte River hydrology both above and below the Elkhorn River. We plot variables of interest such as discharge, stage, and water temperature across time and space. We also plot actively tracked fish locations received from UNL in relation to these variables.

EDO Overview presentation (30-40 minutes of content - anticipate extended discussion)

- **2D Model – Discussion of LiDAR voids, gaps in the 2D model, and limitations imposed.**
    - Are there better ways to fill those gaps?
    - How might we deal with the uncertainty in those areas?
    - Can we develop relationships in areas with higher confidence?
    - Limits to modeling under very low flow conditions when central Platte water might make more of a contribution
- **Review of current Program management actions and projected scale and timing in relation to lower Platte River hydrology.**
    - Provide further clarification on information provided
    - What else would be useful?
    - Discussion of ways to formally analyze and present this information

- **Patterns in lower Platte River flow, stage, temperature, and distribution of actively tracked pallid sturgeon**
    - Any opportunities for testing hypotheses?
    - Any clues for adding or revising explanatory variables?
    - Any suggestions for revising analyses to account for patterns seen?
- **Important takeaways**
    - For Program water management
    - For UNL research

ISAC Focus areas for discussion and advice

- **2D Model –** Consider how gaps in the 2D model might be dealt with and how to appropriately use the model with deeper areas having higher uncertainty.
- **Integration of information into UNL research strategies**
    - **Explanatory Variables –** Considering information needed for Program water management and patterns in lower Platte River hydrology, which explanatory variables and suites of variables might be priorities for inclusion in model selection?
    - **Analytical Strategies –** Given patterns in lower Platte River hydrology, geomorphology, and pallid sampling and detections, discuss benefits and limitations of various analytical strategies
        - How might reach-level differences in environmental conditions and pallid sampling/detections to be accounted for in analyses.
- **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?**
    - How likely is the Program to be able to answer EBQ#7?
    - Which important pieces of the puzzle is UNL going to be able to provide to help address Program questions and decisions
    - What information are we not likely to get? Why?

The remainder of this PDF is comprised of a compendium of information previously provided to the ISAC. Figures and accompanying information provided by the EDO have been combined with relevant excerpts from conversations between the ISAC and the EDO about those materials. This information is followed by UNL cited barriers to analyses relevant to gaps in LPR hydrology data. The final section compiles ISAC questions and feedback on the 2D hydraulic model and LPR hydrology figures provided by the EDO. Consider it an easy reference guide for reviewing past information relevant

LOWER PLATTE RIVER MODELING AND HYDROLOGY

The remainder of this PDF is comprised of a compendium of information previously provided to the ISAC. Figures and accompanying information provided by the EDO have been combined with relevant excerpts from conversations between the ISAC and the EDO about those materials. This information is followed by UNL cited barriers to analyses relevant to gaps in LPR hydrology data. The final section compiles ISAC questions and feedback on the 2D hydraulic model and LPR hydrology figures provided by the EDO. Consider it an easy reference guide for reviewing past information relevant to this session of the September ISAC workshop.

Table of Contents

I: LOWER PLATTE HYDROLOGY AND MAGNITUDE OF EA RELEASES RELATIVE TO FLOW IN THE LOWER PLATTE

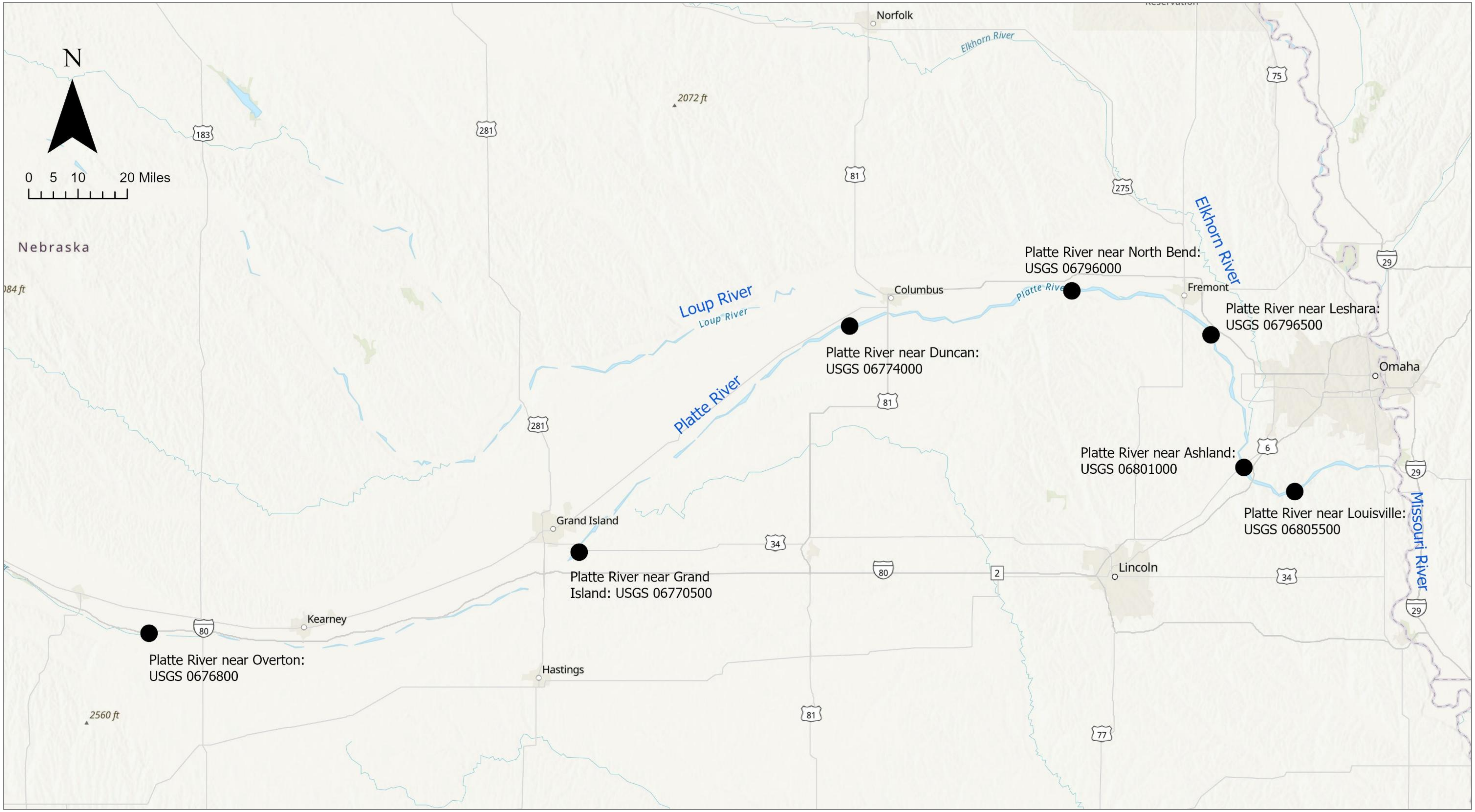


Figure 1. United States Geological Survey (USGS) stream gage locations of relevance. Most of the flow in the central Platte River returned to the river just upstream of the Overton gage. Deficits to target flows and Environmental Account (EA) water measured at the Grand Island gage. Duncan gage is located just upstream of the Loup River confluence near Columbus. North Bend gage is the first lower Platte River gage that includes flow from the central Platte River, Loup River, and Loup River hydropower return. Ashland gage located just downstream of the Elkhorn River confluence. Louisville gage located downstream of the Salt Creek confluence.

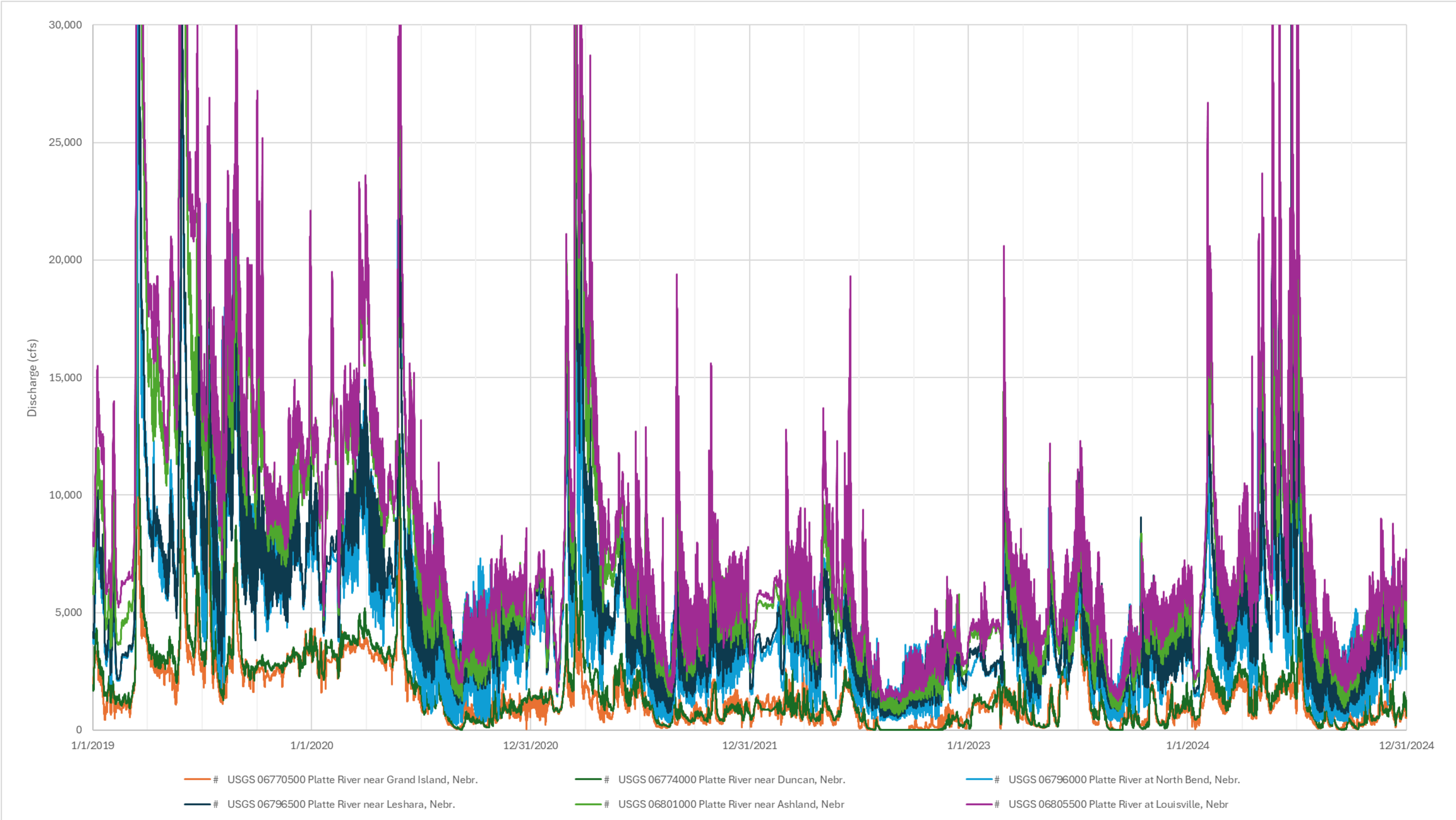


Figure 2. Real-time (15-minute interval) discharge measurements at gages of interest for the period of 2019-2024. High variability of sub-daily discharge in lower Platte gages due to hydrocycling in the Loup River system.

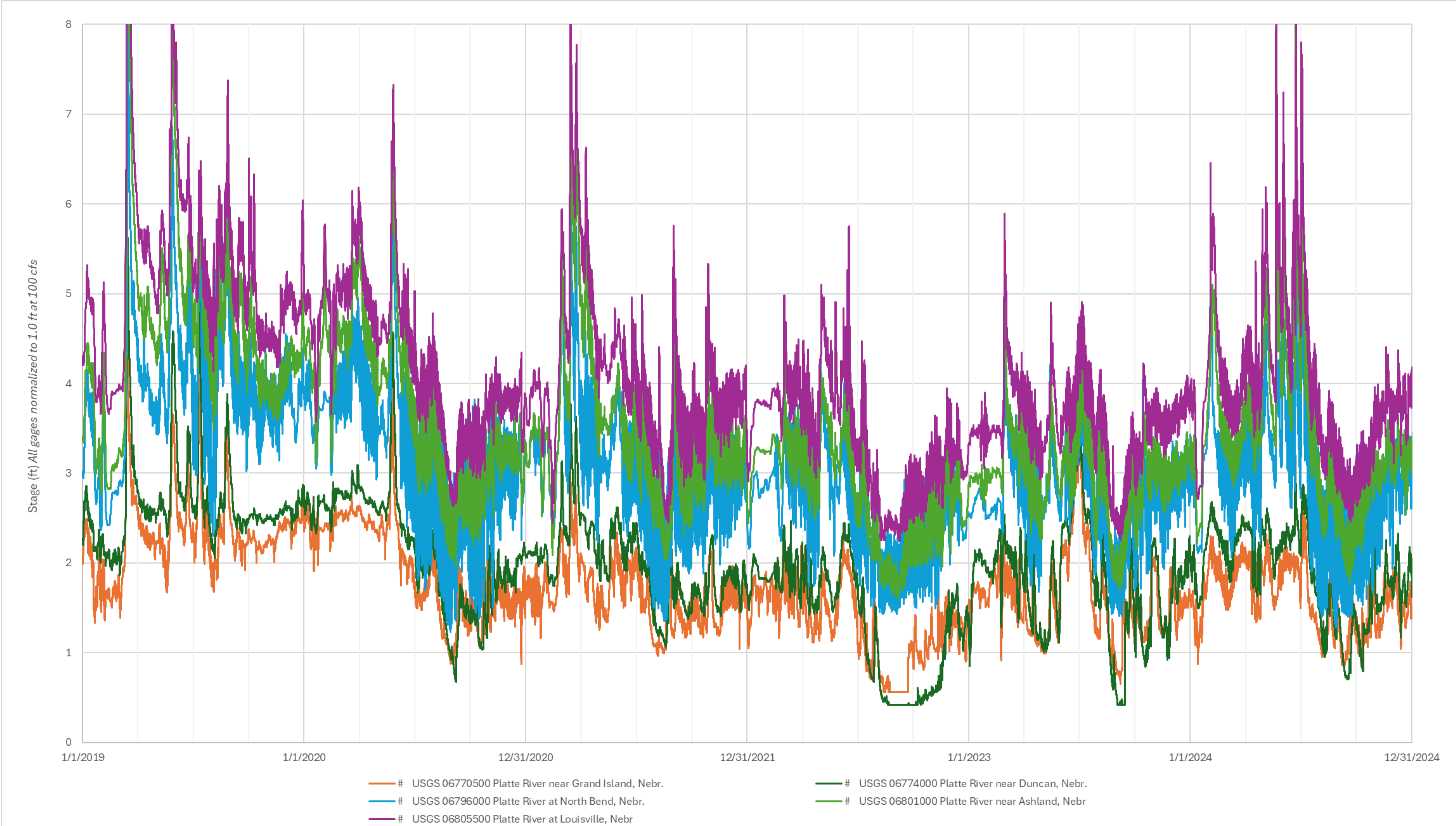


Figure 3. Real-time (15-minute interval) river stage measurements at gages of interest for the period of 2019-2024. All gages normalized to a stage of 1.0 ft at a discharge of 100 cfs to facilitate direct comparisons. High variability of sub-daily stage in lower Platte gages due to [hydrocycling in the Loup River system.]

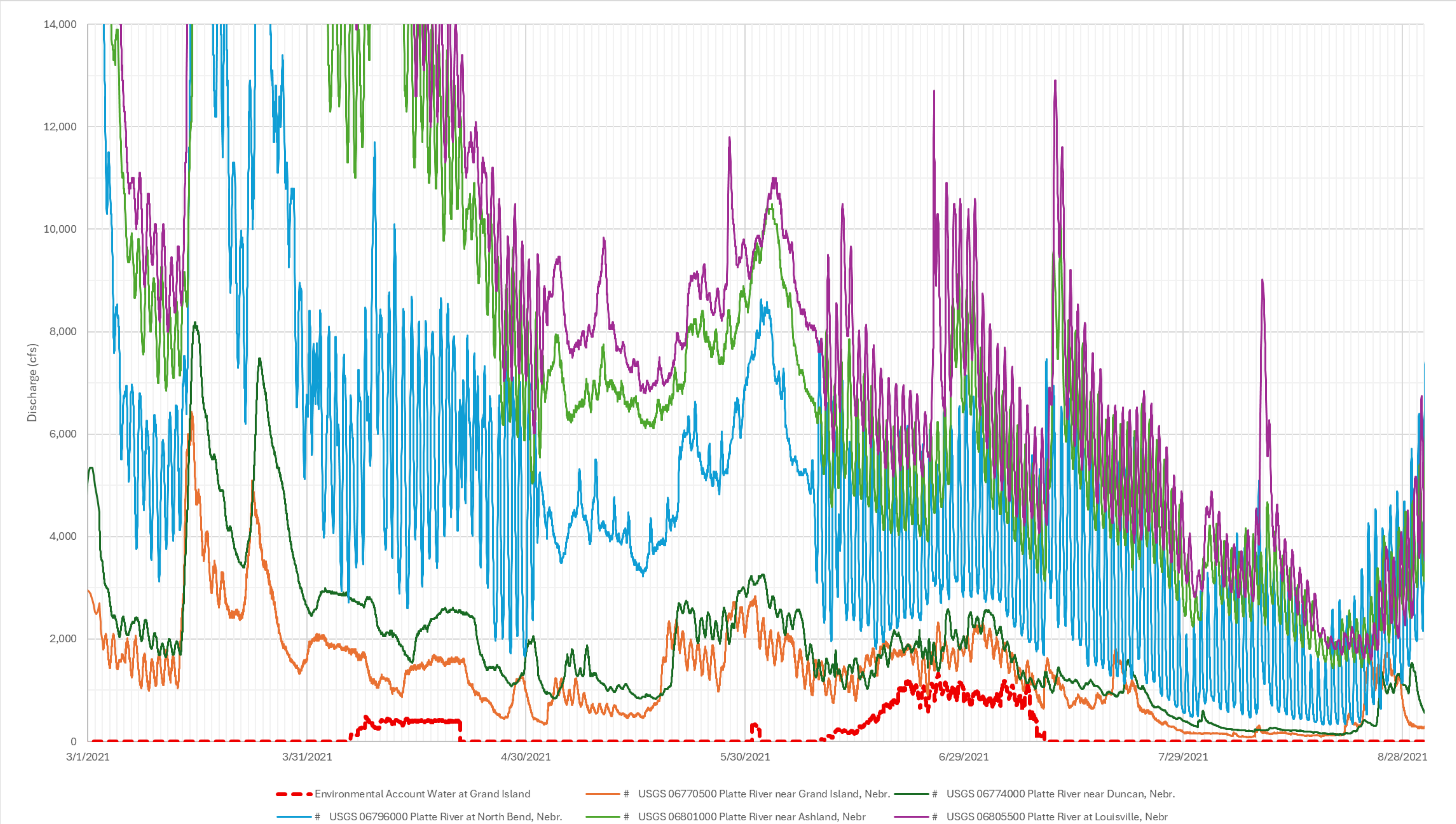


Figure 4. Real-time (15-minute interval) discharge measurements at a subset of gages for the period of March – August 2021. Figure indicates how much Environmental Account water was present at Grand Island gage during spring whooping crane habitat release (April) and germination suppression release (June-July). High variability of sub-daily discharge in lower Platte gages due to hydrocycling in the Loup River system.

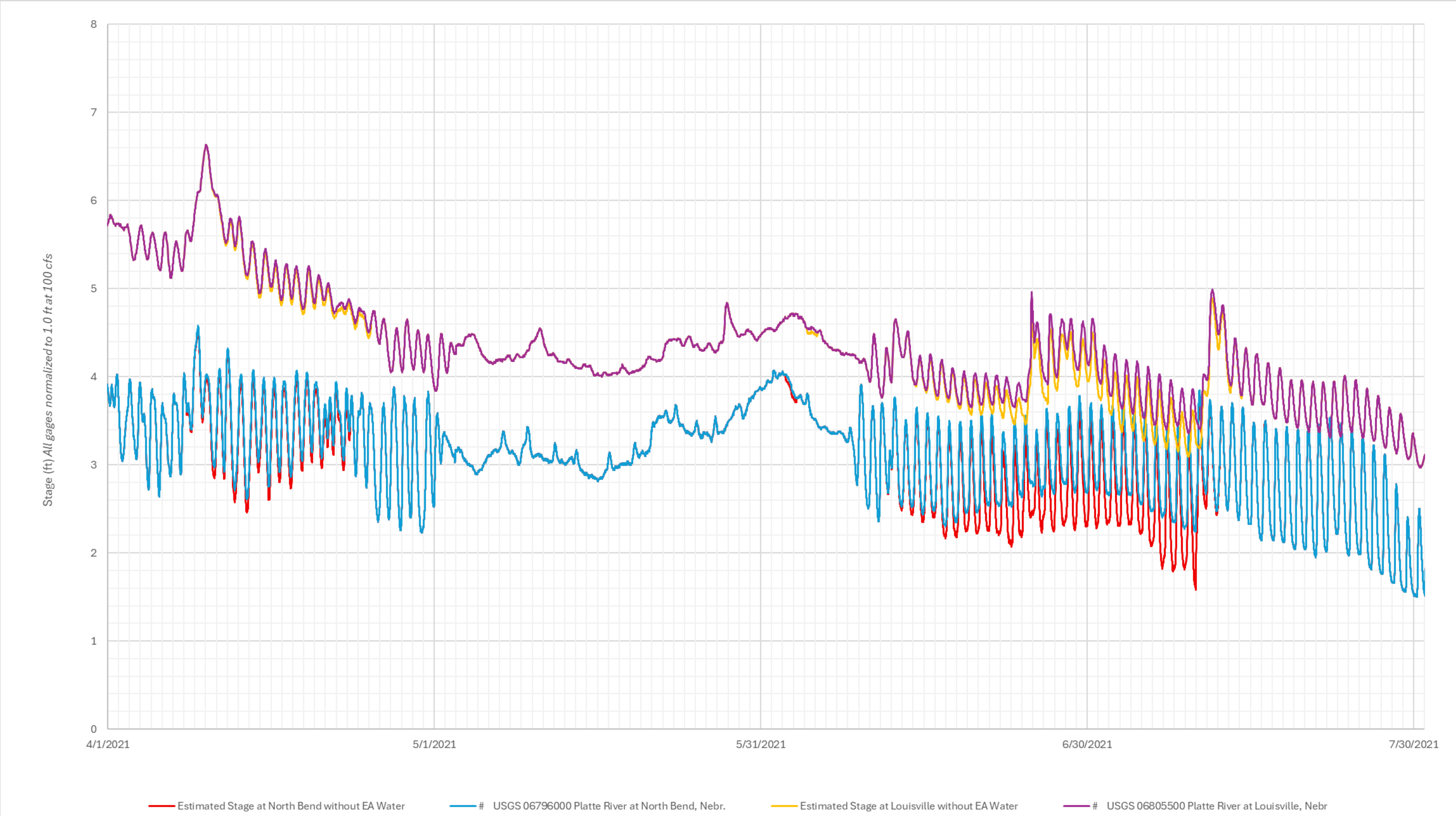


Figure 5. Real-time (15-minute interval) stage at North Bend and Louisville gages April – July 2021 along with estimated stage absent EA water. Blue line represents actual stage at the North Bend gage and purple line represents actual stage at Louisville. Red and yellow lines indicate estimated stages without EA water that was released in April for whooping crane habitat and in June – July for germination suppression. This figure is an example of the potential magnitude of discharge / stage benefits of flow management in the central Platte River to pallid sturgeon habitat in the lower Platte River at North Bend.

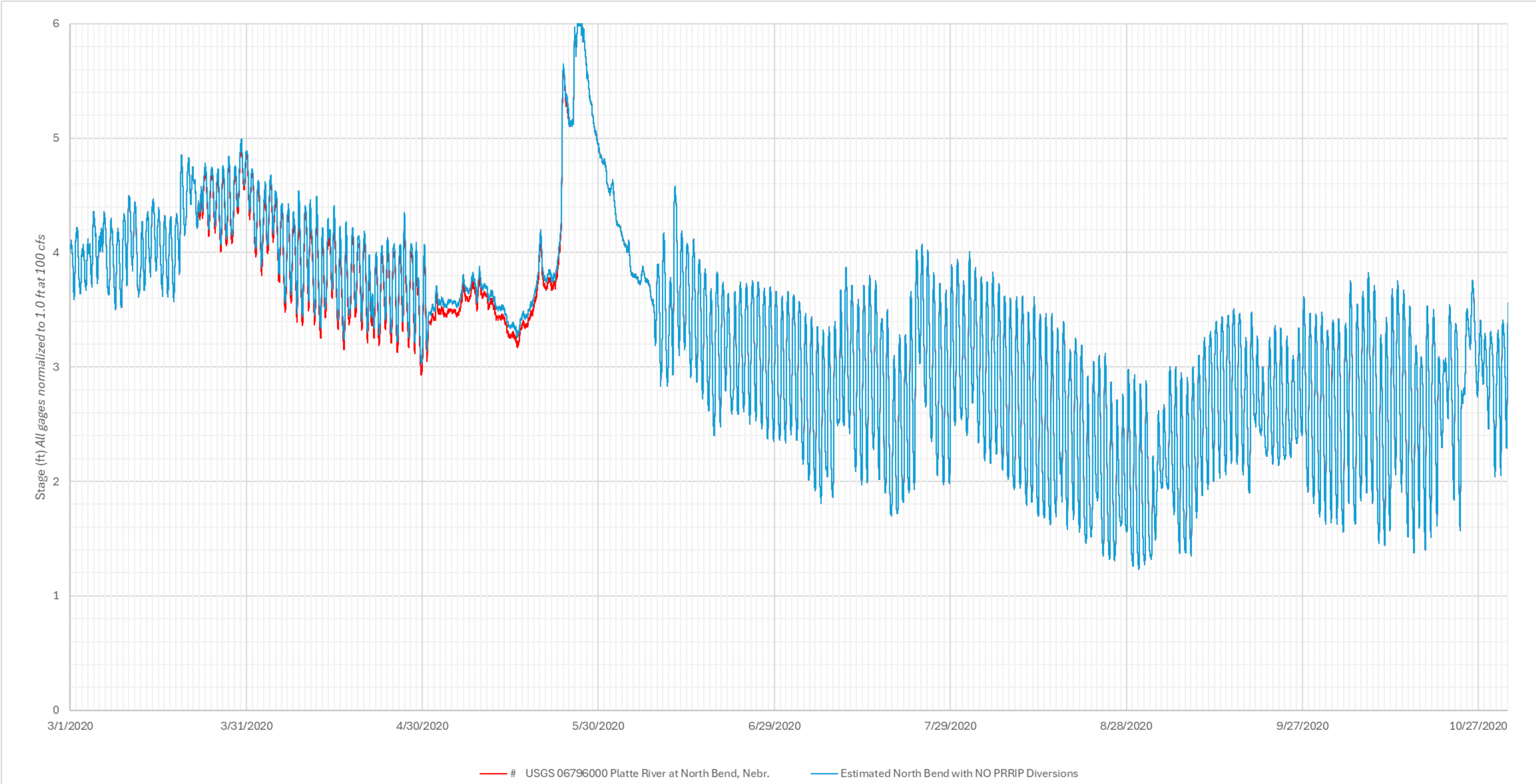


Figure 6. Real-time (15-minute interval) stage at North Bend gage March – October 2020 along with estimated stage without diversions of excess flow in the central Platte into Program recharge projects. Scenario presented demonstrates diversion of maximum recharge capacity of 350 cfs daily from March 20 – May 20 (typical period of excess flow availability). This simple conservative example assumes 350 cfs reduction in discharge at North Bend gage 4.7 days after diversion occurs near Overton. Red line represents actual stage at the North Bend gage. Blue line indicates estimated stage without water being diverted into Program recharge projects. This figure is an example of the potential magnitude of discharge / stage impacts of flow management in the central Platte River to pallid sturgeon habitat in the lower Platte River at North Bend.

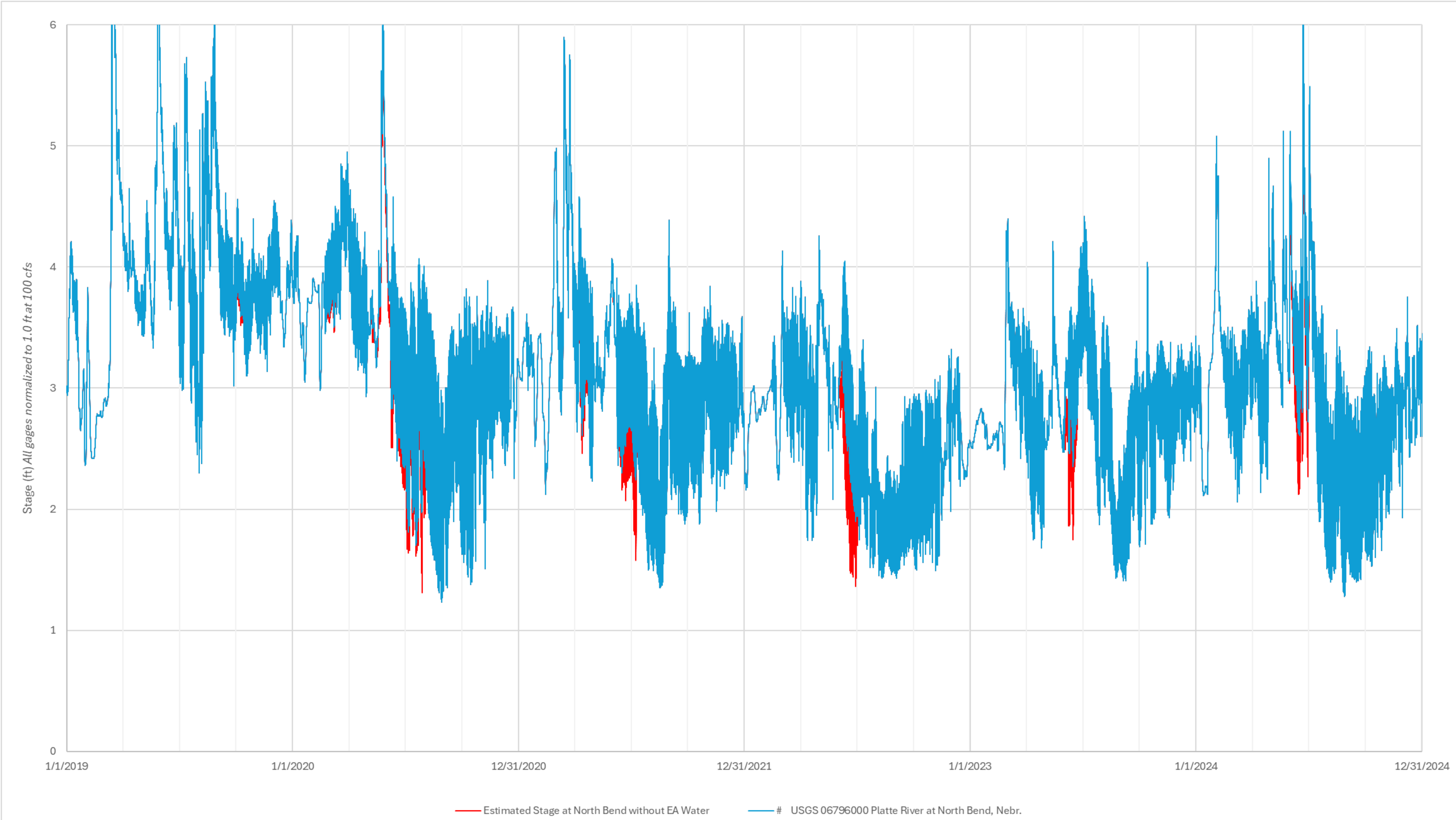


Figure 7. Real-time (15-minute interval) stage at North Bend gage 2019 - 2024 along with estimated stage absent EA water. Blue line represents actual stage at the North Bend gage. Red line indicates estimated stage without EA releases during this period. This figure is an example of the potential magnitude of discharge / stage benefits of flow management in the central Platte River to pallid sturgeon habitat in the lower Platte River at North Bend.

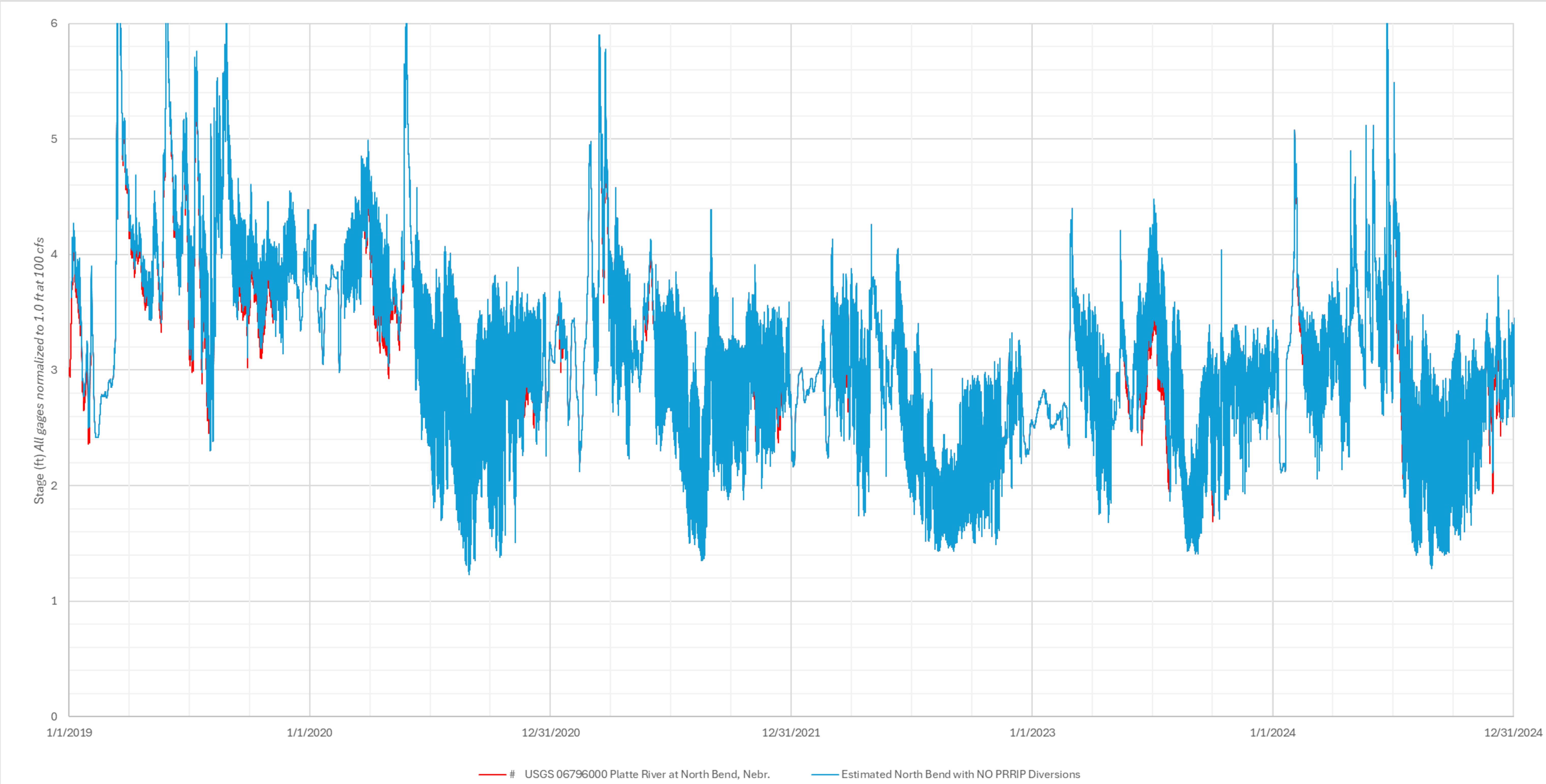


Figure 8. Real-time (15-minute interval) stage at North Bend gage 2019 - 2024 along with estimated stage absent Program diversions into recharge projects. Red line represents actual stage at the North Bend gage. Blue line indicates estimated stage without EA releases during this period. This figure is an example of the potential magnitude of discharge / stage impacts of flow management in the central Platte River to pallid sturgeon habitat in the lower Platte River at North Bend.

II: CENTRAL AND LOWER PLATTE WATER TEMPERATURE

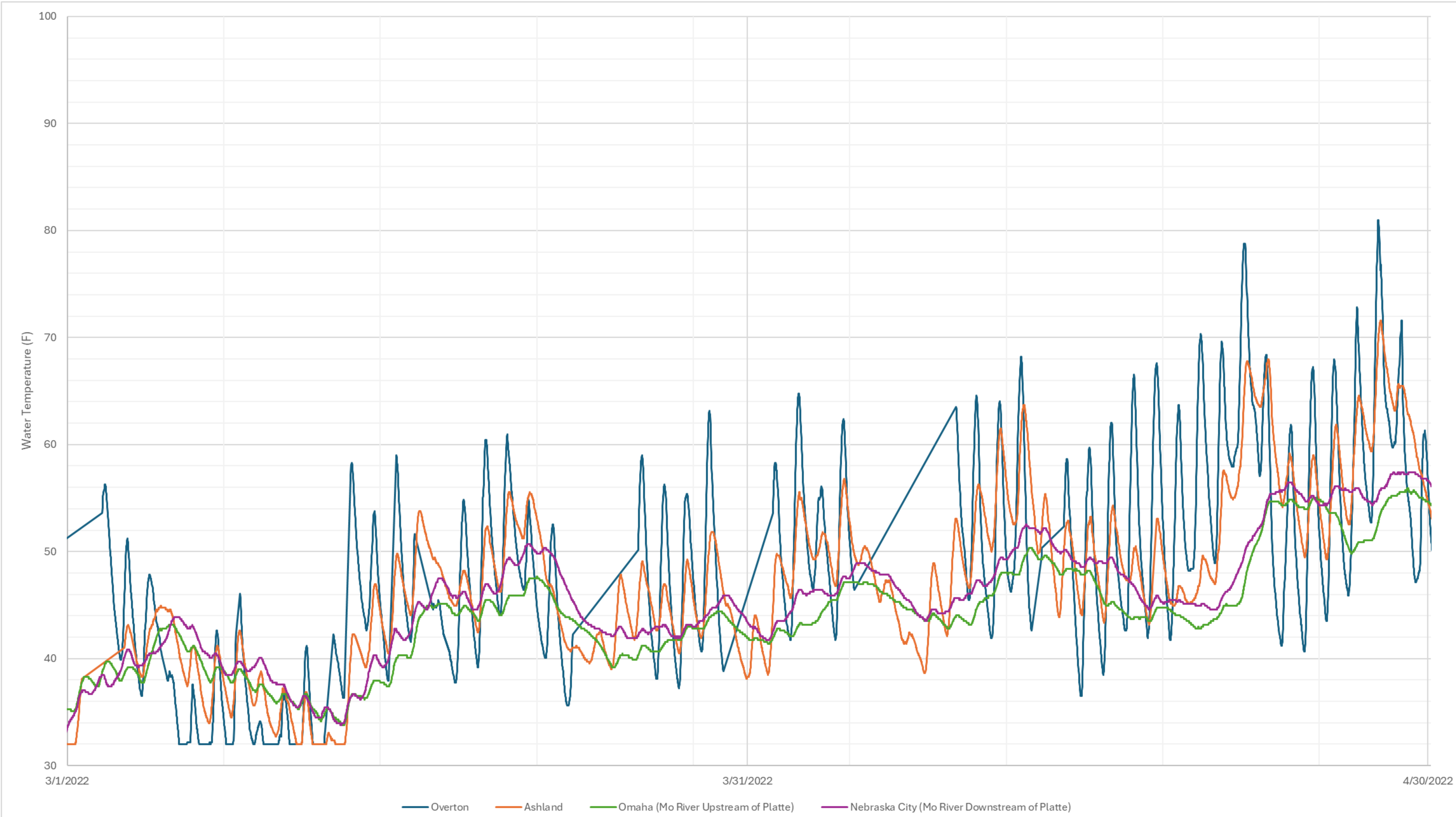


Figure 9. Real-time (15-minute interval) water temperature (F) at the Overton gage on the central Platte, Ashland gage in the lower Platte, Omaha gage on the Missouri River upstream of the Platte Confluence and Nebraska City gage downstream of the Platte confluence. Figure shows differences in water temperature patterns and variation between Platte and Missouri Rivers during the pallid sturgeon spawning window.

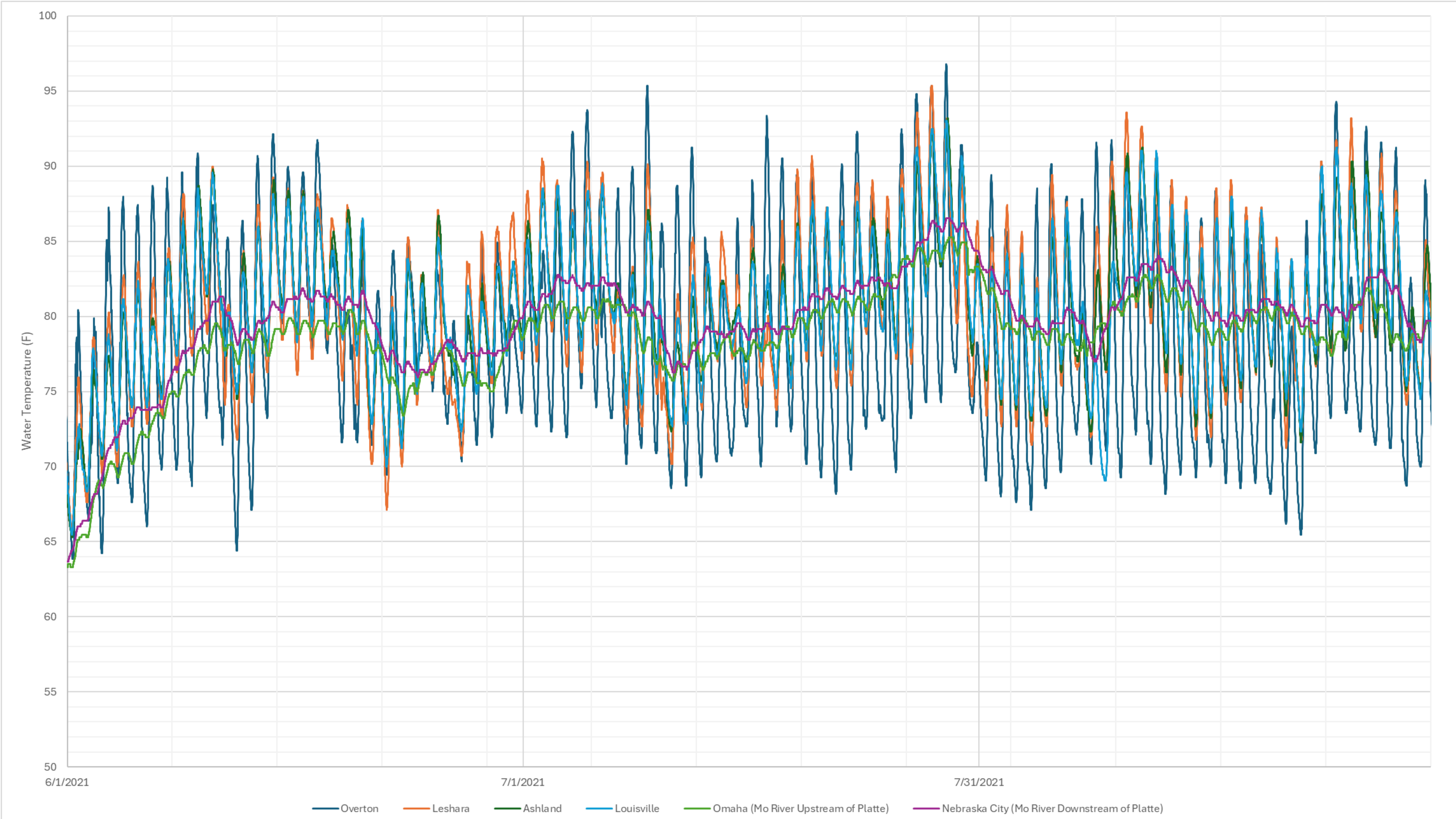


Figure 10. Real-time (15-minute interval) water temperature (F) at the Overton gage on the central Platte, Leshara and Ashland gages in the lower Platte, Omaha gage on the Missouri River upstream of the Platte Confluence and Nebraska City gage downstream of the Platte confluence. Figure shows differences in water temperature patterns and variation between Platte and Missouri Rivers during summer months.

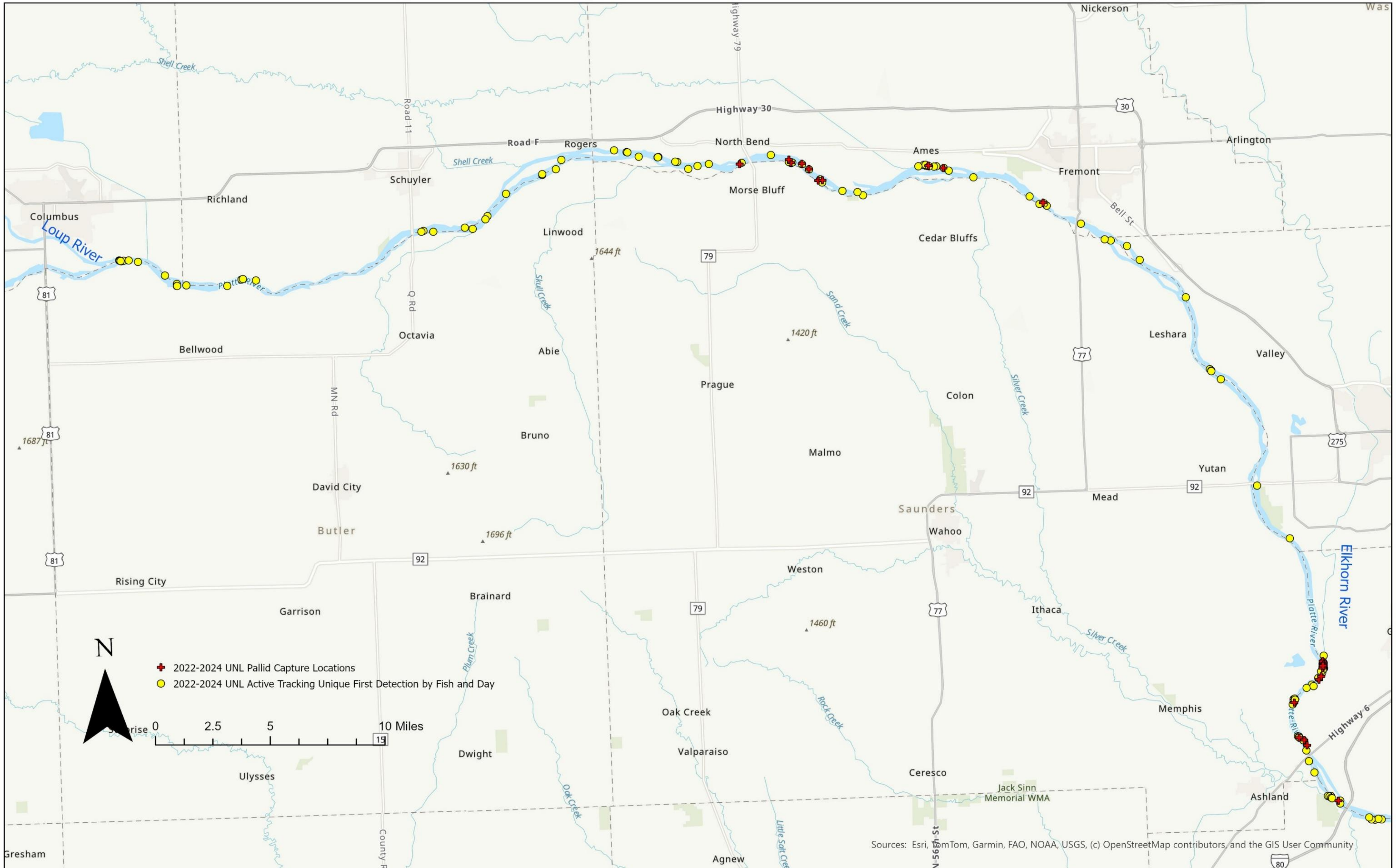


Figure 11. 2022-2024 pallid sturgeon capture locations and active tracking unique first location by day and fish from the Loup River confluence to the Elkhorn River confluence.

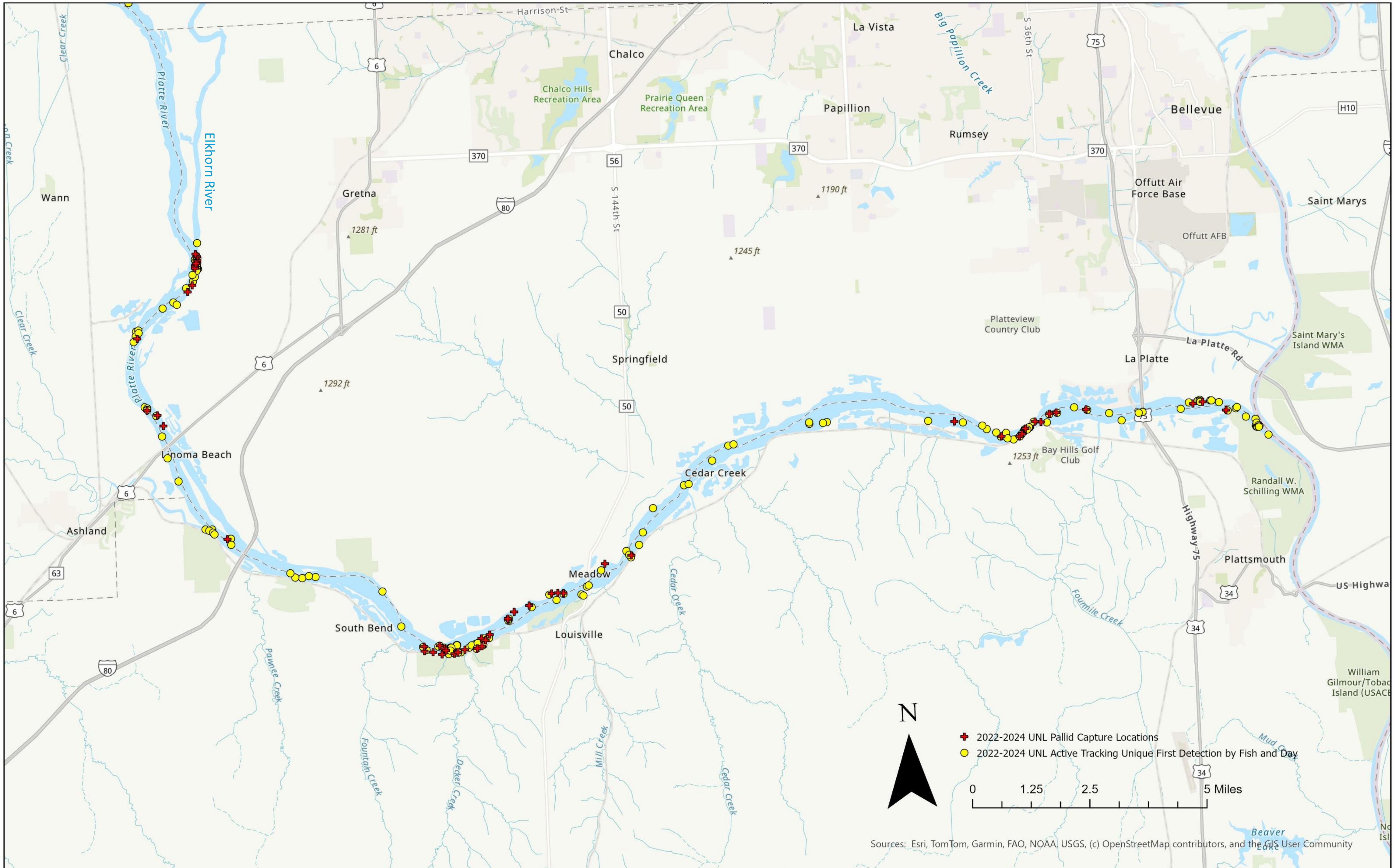


Figure 12. 2022-2024 pallid sturgeon capture locations and active tracking unique first location by day and fish below the Elkhorn River.

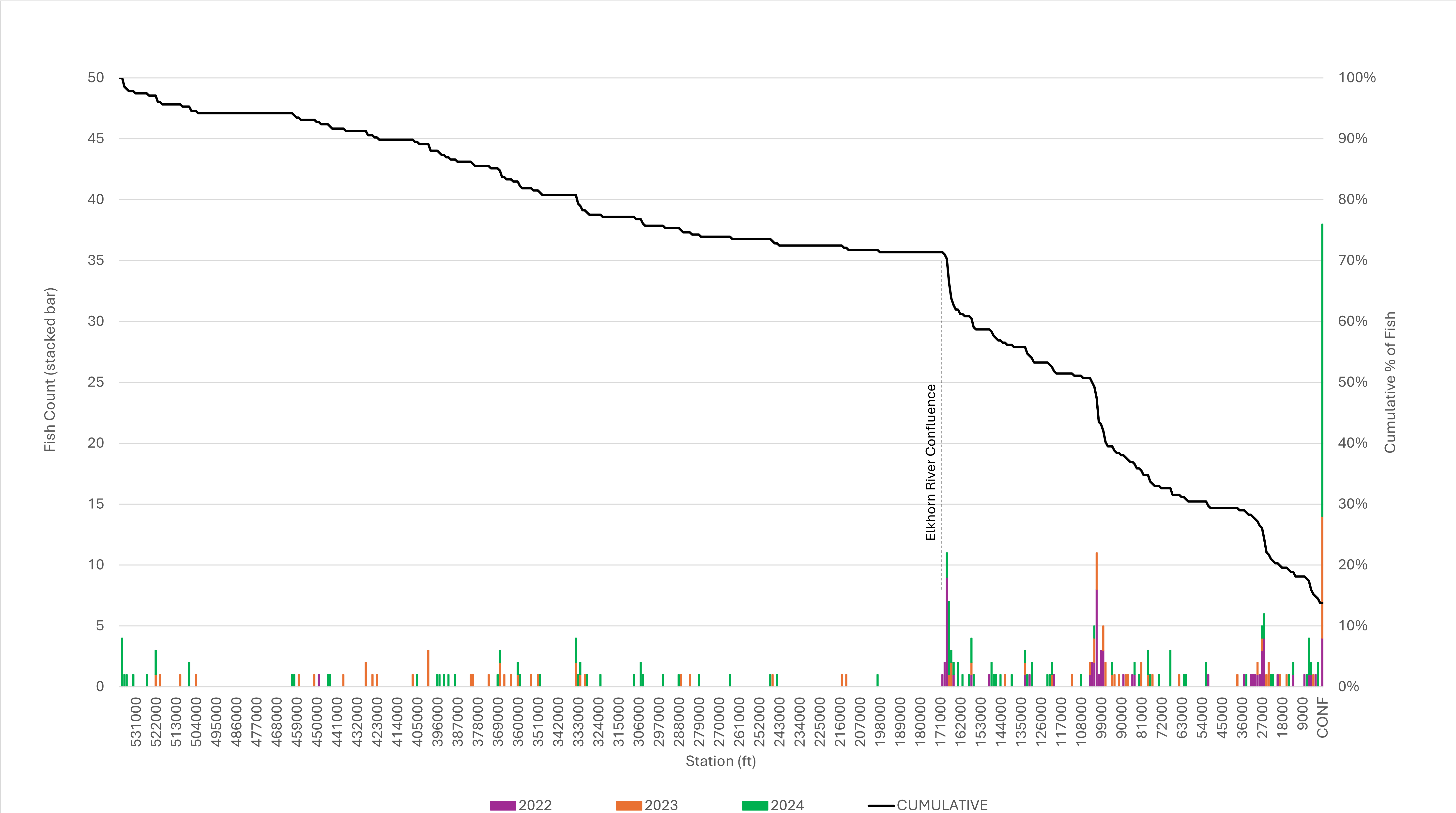
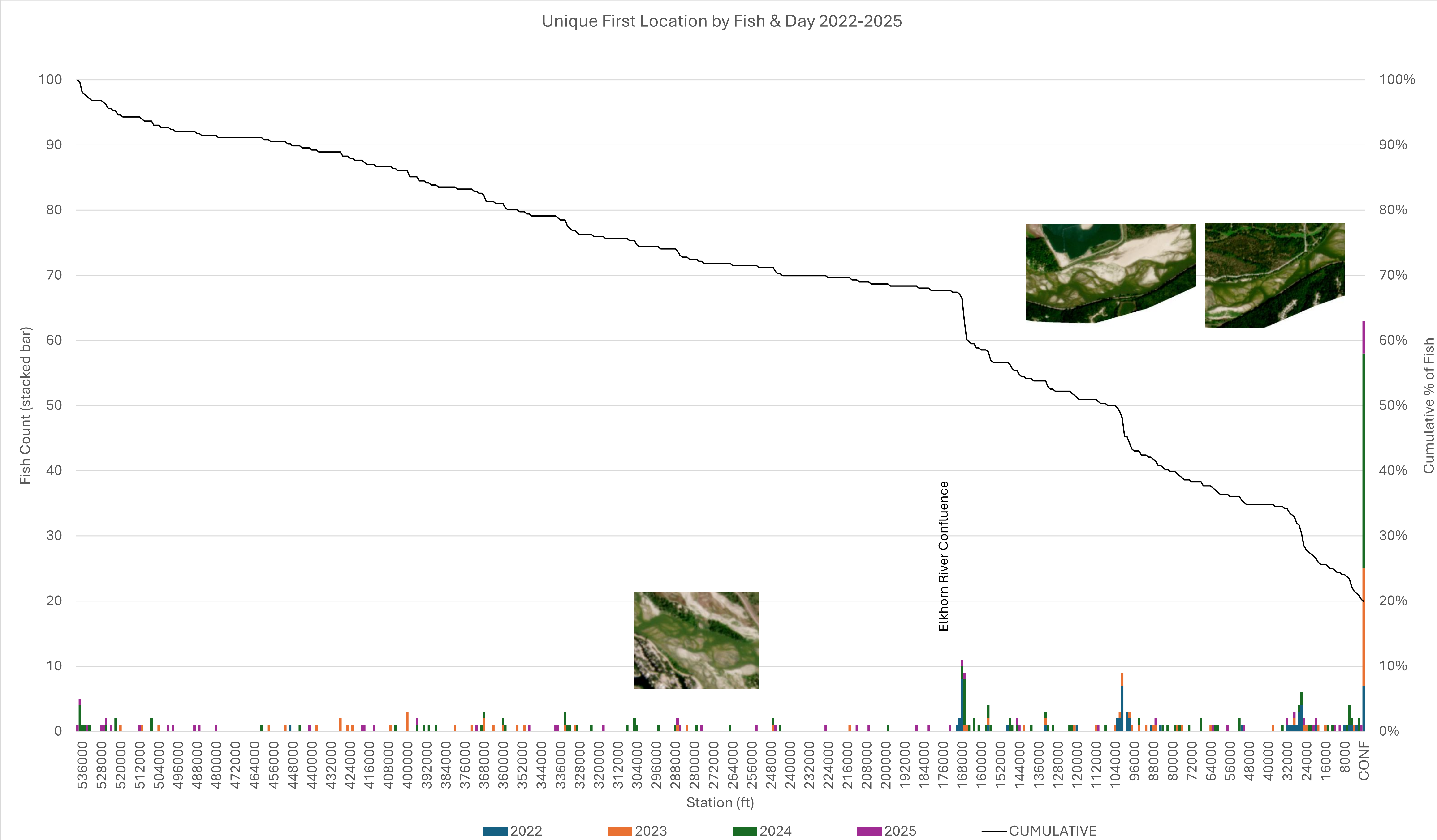


Figure 13. Active tracking unique first locations by fish and day during period of 2022 – 2024 for the lower Platte River extending upstream from the Missouri River confluence to the confluence of the central Platte and Loup Rivers. Confluence with Missouri River at right of figure. Confluence with the Loup River at left.


Unique First Location by Fish & Day 2022-2025
Fish Count (stacked bar)
100
90
80
70
60
50
40
30
20
10
0
Cumulative % of Fish
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Elkhorn River Confluence
536000 528000 520000 512000 504000 496000 488000 480000 472000 464000 456000 448000 440000 432000 424000 416000 408000 400000 392000 384000 376000 368000 360000 352000 344000 336000 328000 320000 312000 304000 296000 288000 280000 272000 264000 256000 248000 240000 232000 224000 216000 208000 200000 192000 184000 176000 168000 160000 152000 144000 136000 128000 120000 112000 104000 96000 88000 80000 72000 64000 56000 48000 40000 32000 24000 16000 8000 CONF
Station (ft)
2022
2023
2024
2025
CUMULATIVE

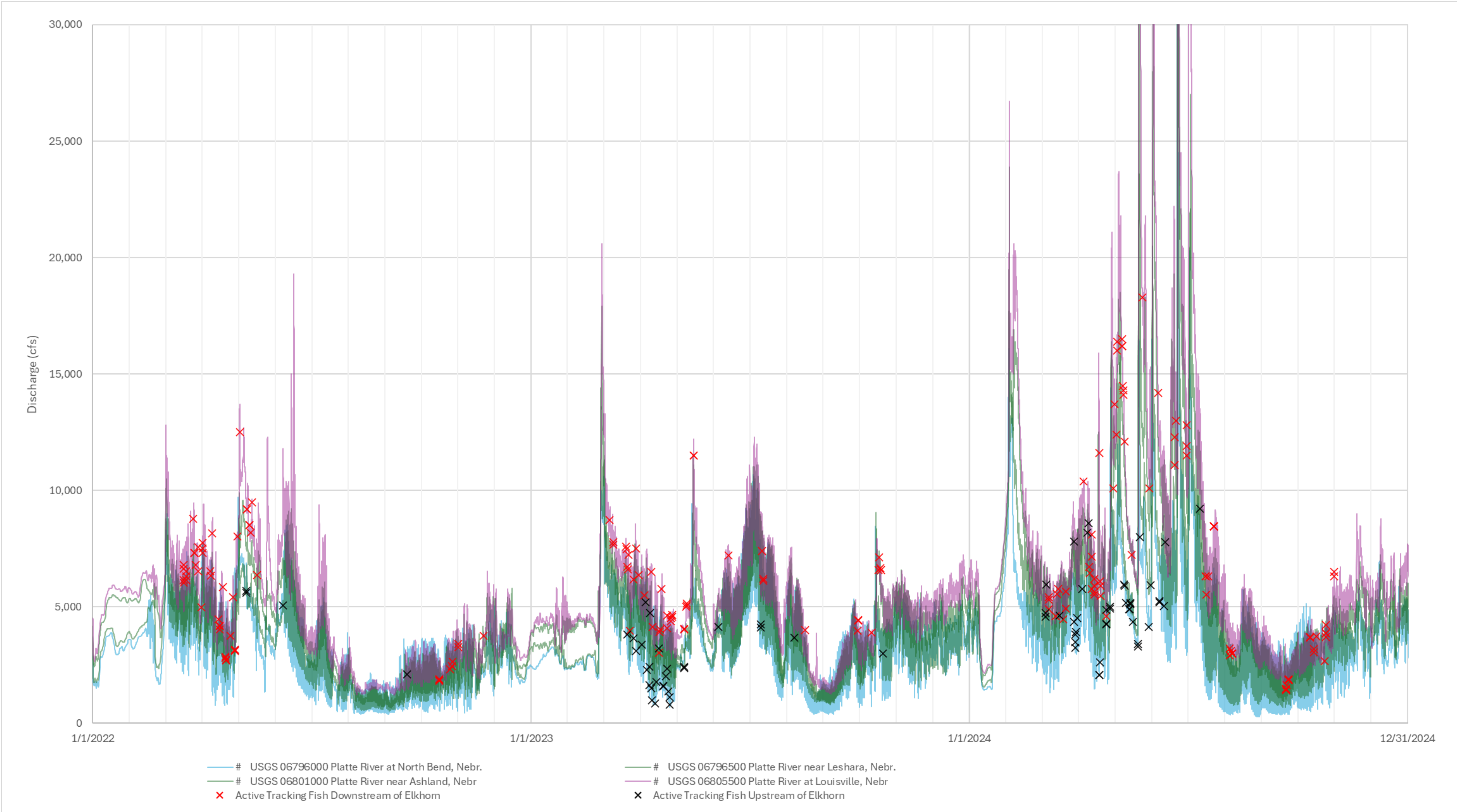


Figure 14. Active tracking unique first locations by fish and day during period of 2022 – 2024 in relation to real-time discharge in the lower Platte. Discharge for each active tracking location (split above/below Elkhorn) derived from the instantaneous discharge at the nearest stream gage at the time the fish was located (no interpolation of flow from gage to fish location).

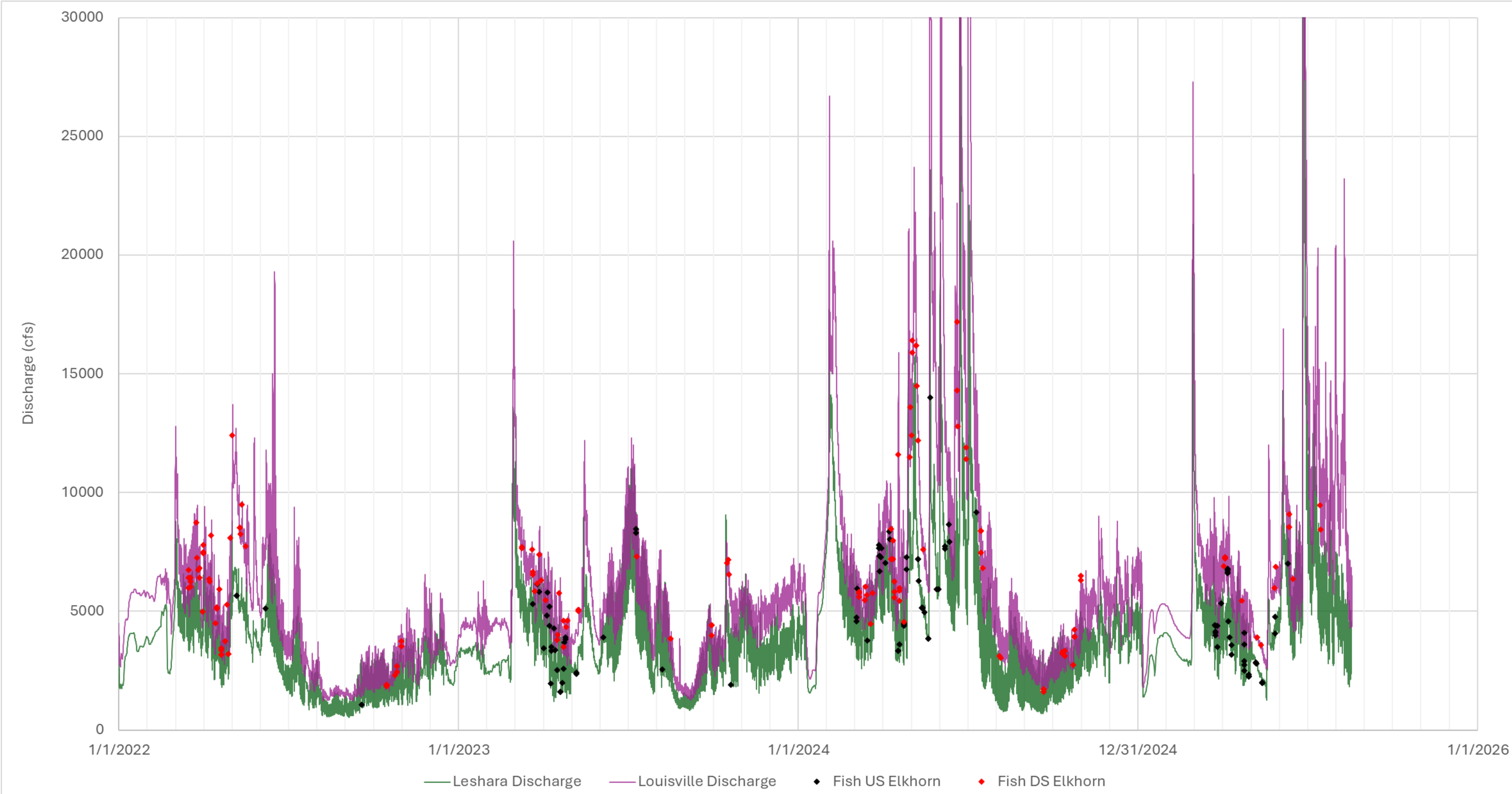


Figure X. Active tracking unique first locations by fish and day during period of 2022 – 2025 in relation to real-time discharge in the lower Platte. Discharge for each active tracking location (split above/below Elkhorn) derived from the instantaneous discharge at Leshara and Louisville gages at the time the fish was located (no interpolation of flow from gage to fish location). *NOTE: Removed fish at Missouri River confluence.*

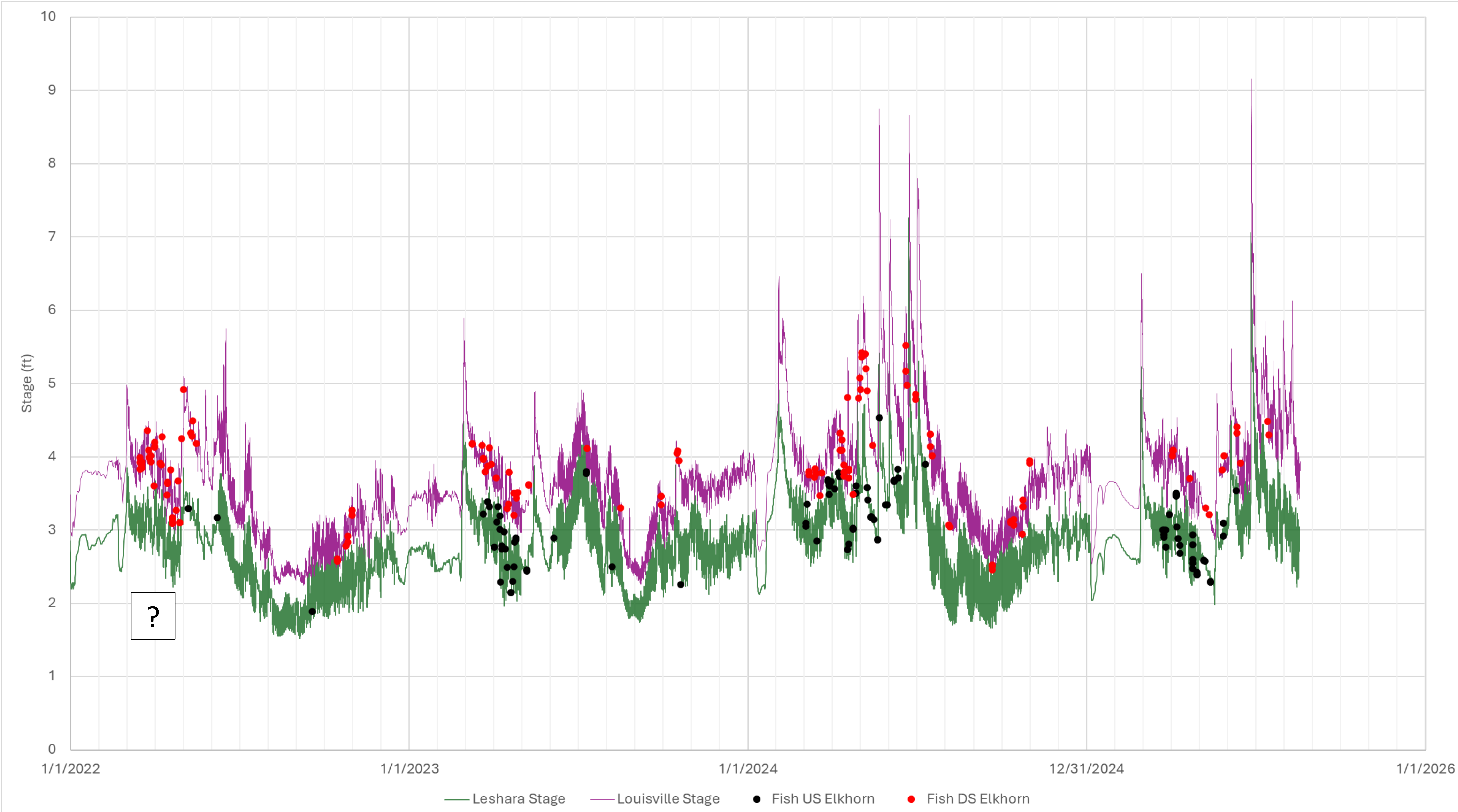


Figure X. Active tracking unique first locations by fish and day during period of 2022 – 2025 in relation to real-time stage in the lower Platte. Discharge for each active tracking location (split above/below Elkhorn) derived from the instantaneous stage at Leshara and Louisville gages at the time the fish was located (no interpolation of stage from gage to fish location). *NOTE: Removed fish at Missouri River confluence.*

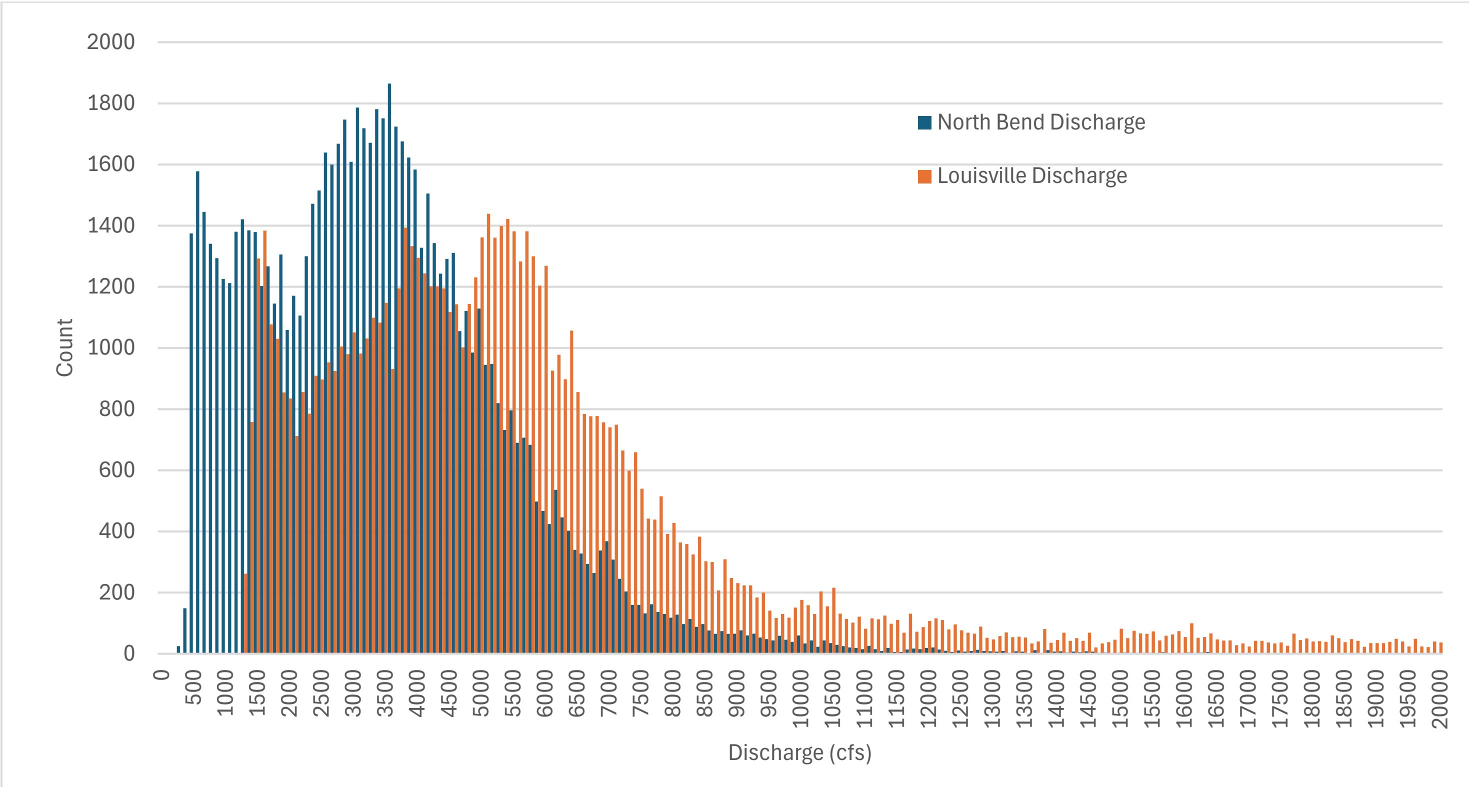


Figure 15. Histograms of real-time (15 minute) discharge at the North Bend and Louisville stream gages during 2022-2024.

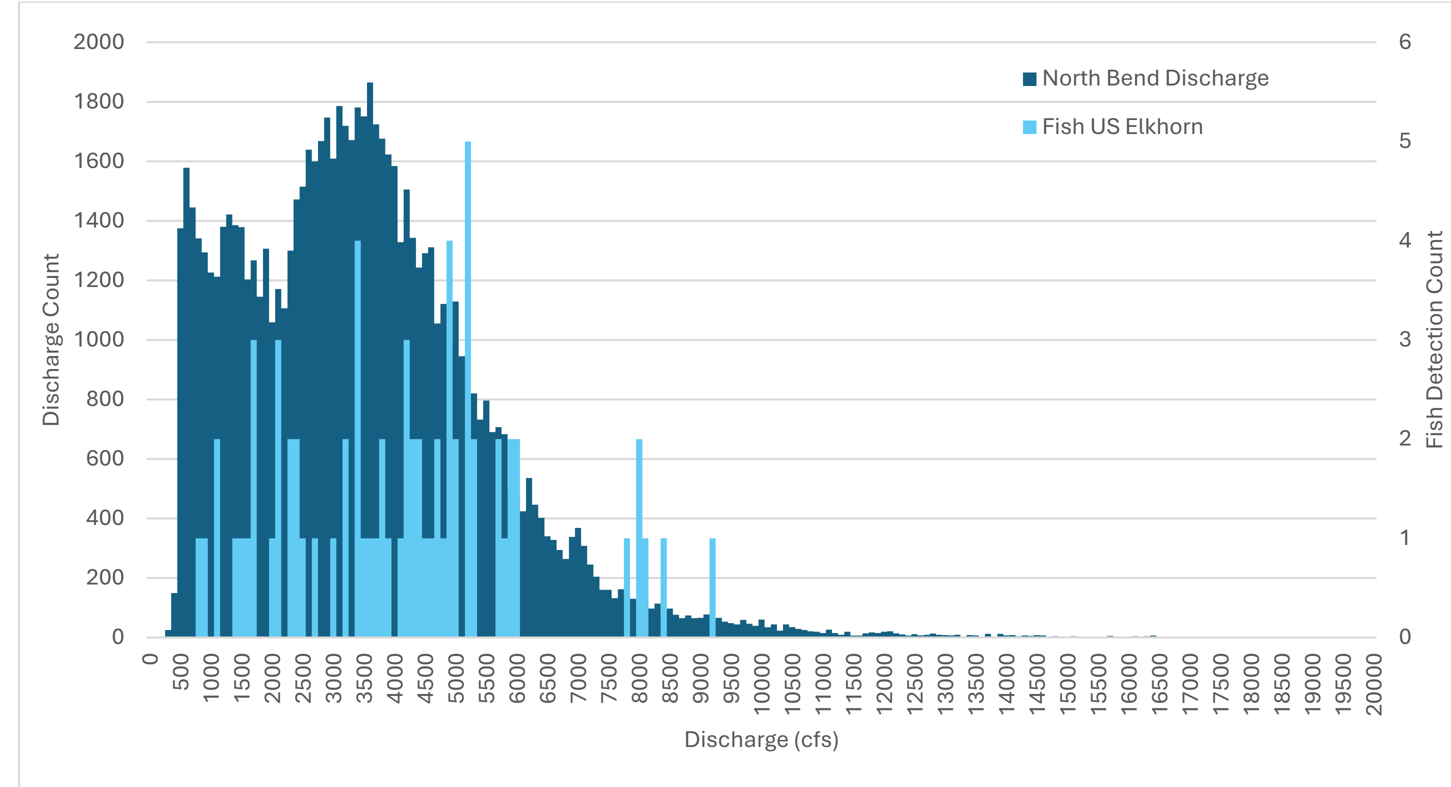


Figure 17. Histograms of real-time discharge at the North Bend gage and active tracking unique fish detections upstream of the Elkhorn during 2022-2024.

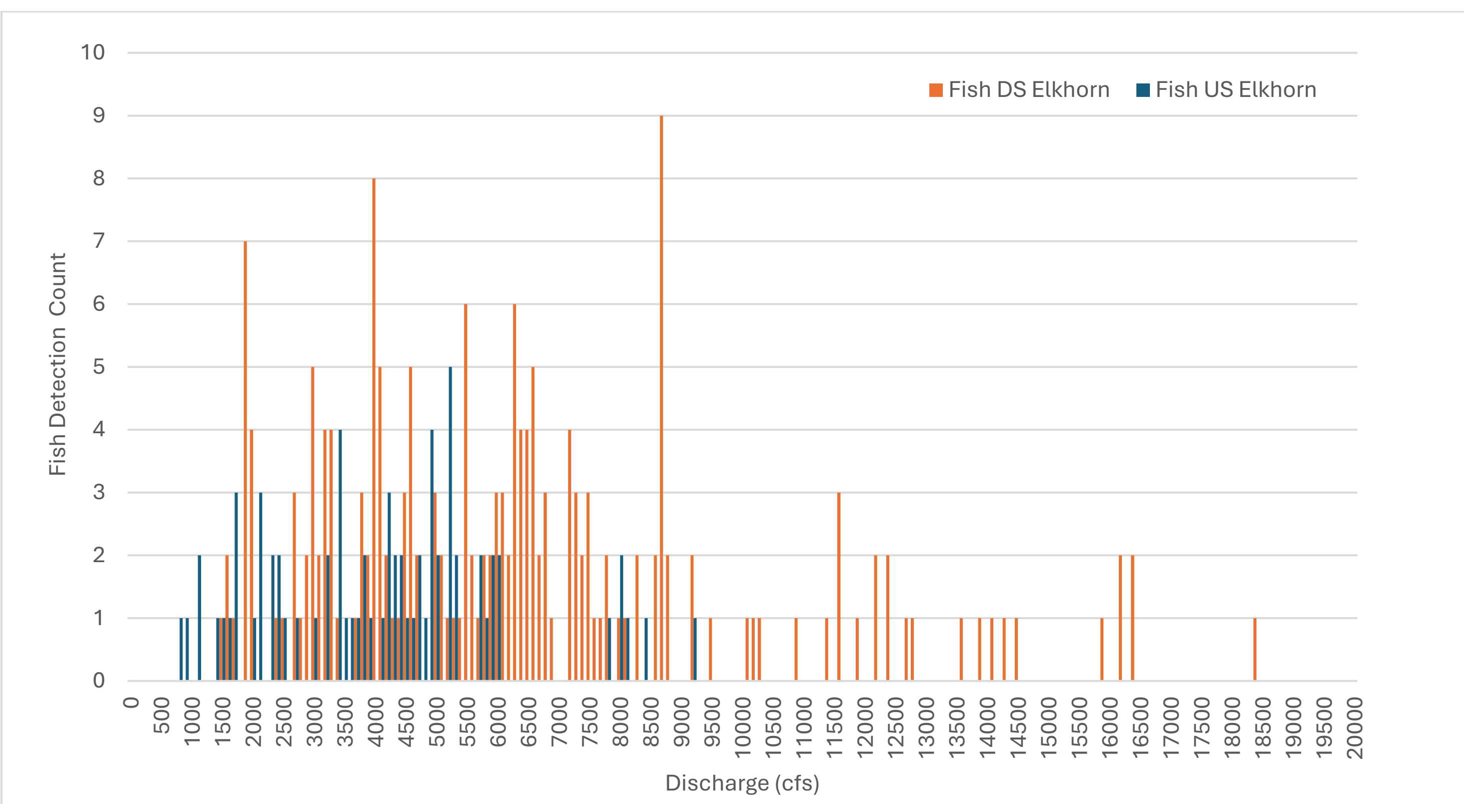


Figure 16. Histograms of active tracking unique detections by fish and day upstream and downstream of the Elkhorn River during 2022-2024.

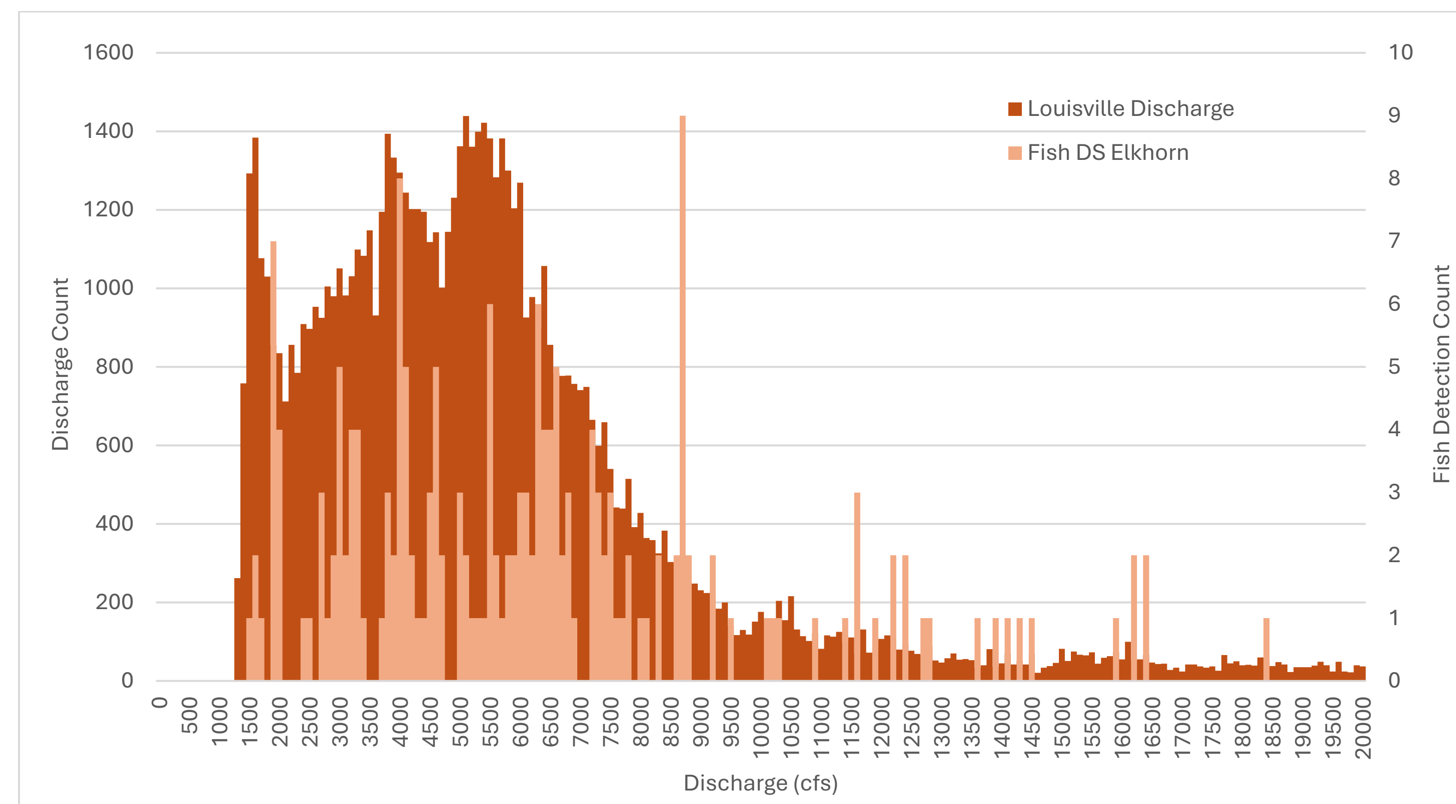


Figure 18. Histograms of real-time (15 minute) discharge at the Louisville stream gage and active tracking unique fish detections downstream of the Elkhorn during 2022-2024.

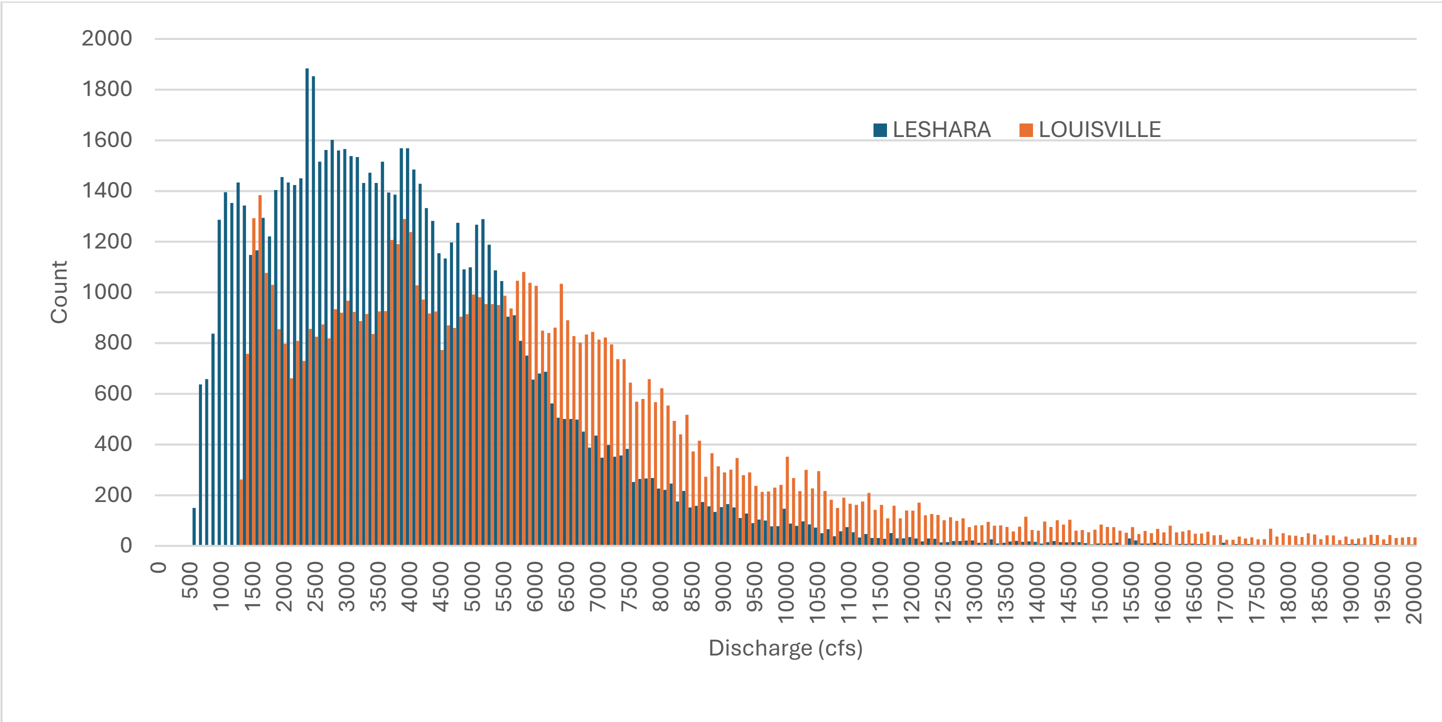


Figure X. Histograms of real-time (15 minute) discharge at the Leshara and Louisville stream gages during 2022-2025 (March through October).

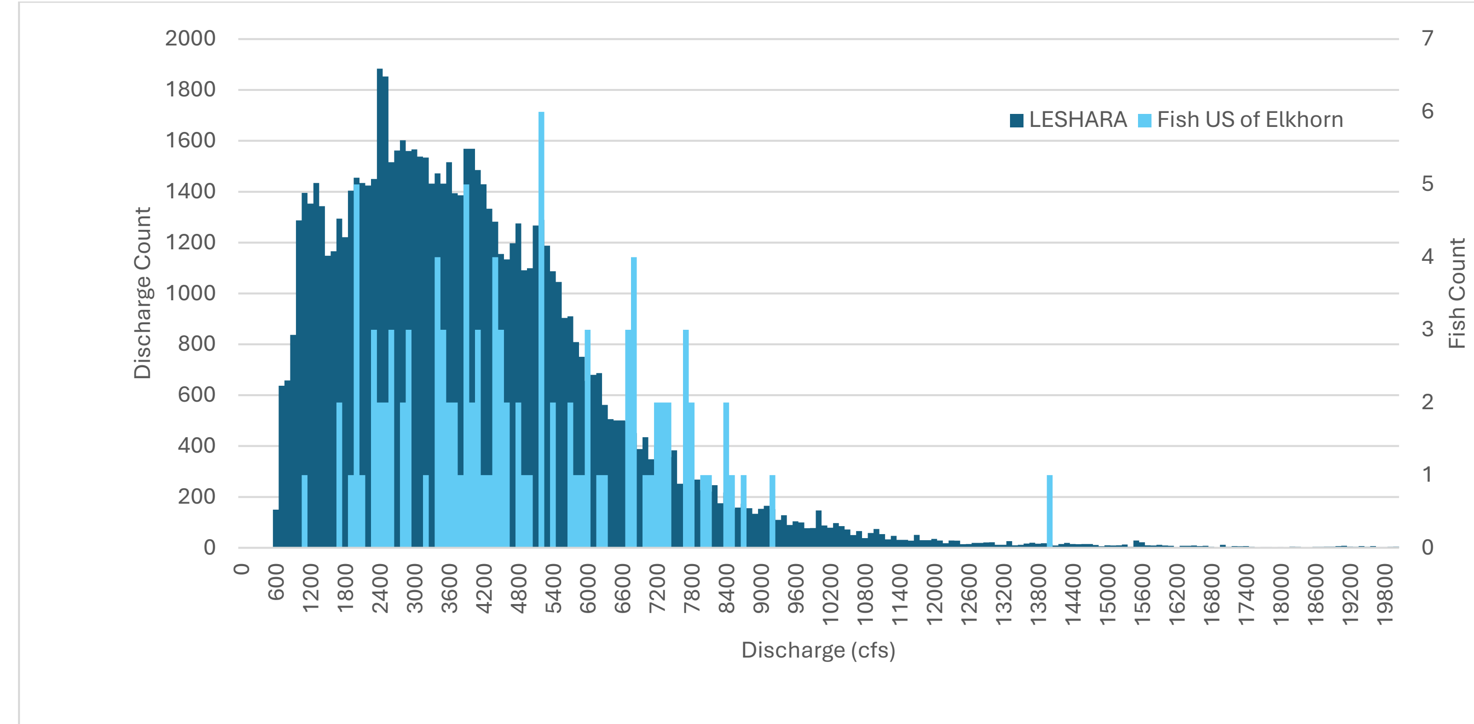


Figure X. Histograms of real-time discharge at the Leshara gage and active tracking unique fish detections upstream of the Elkhorn during 2022-2025.

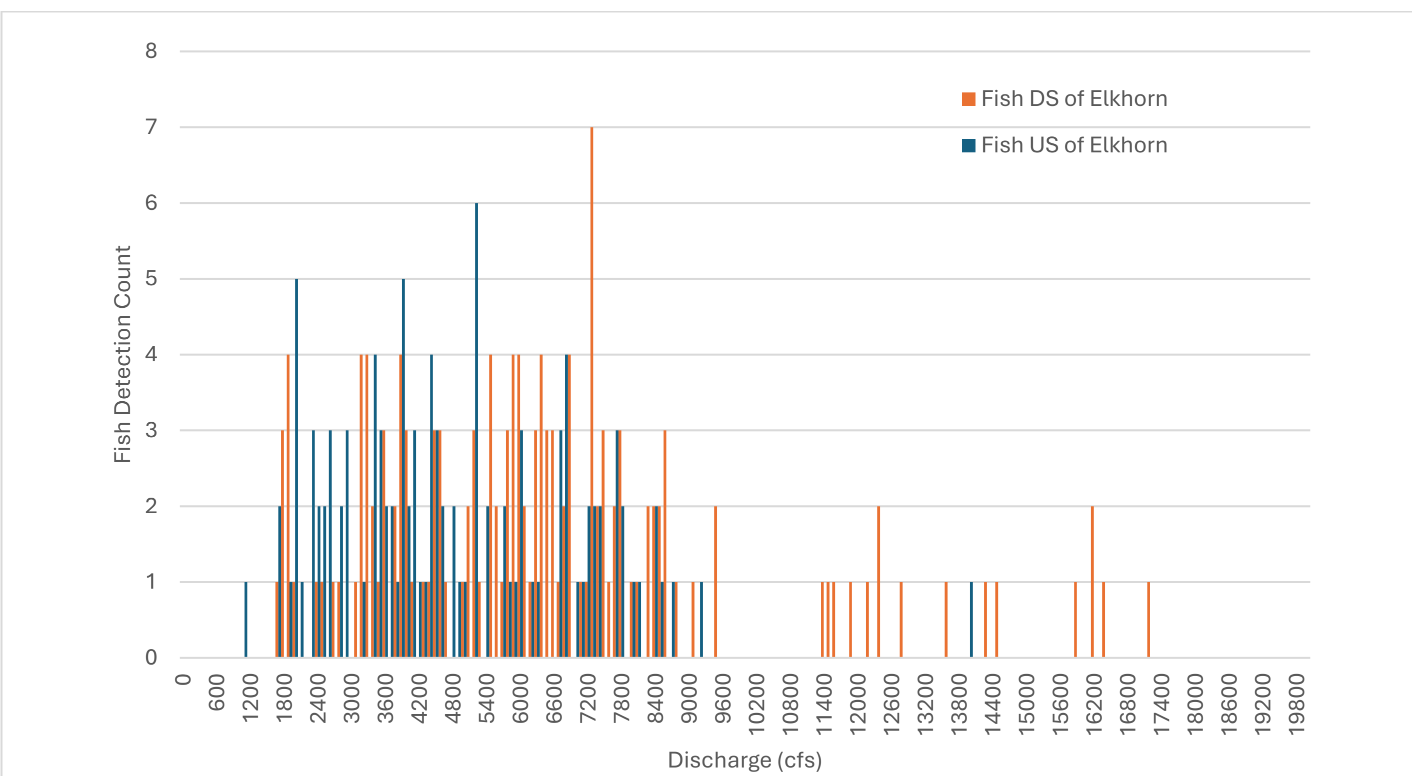


Figure X. Histograms of active tracking unique detections by fish and day upstream and downstream of the Elkhorn River during 2022-2025 excluding fish detected in/at mouth of Missouri River.

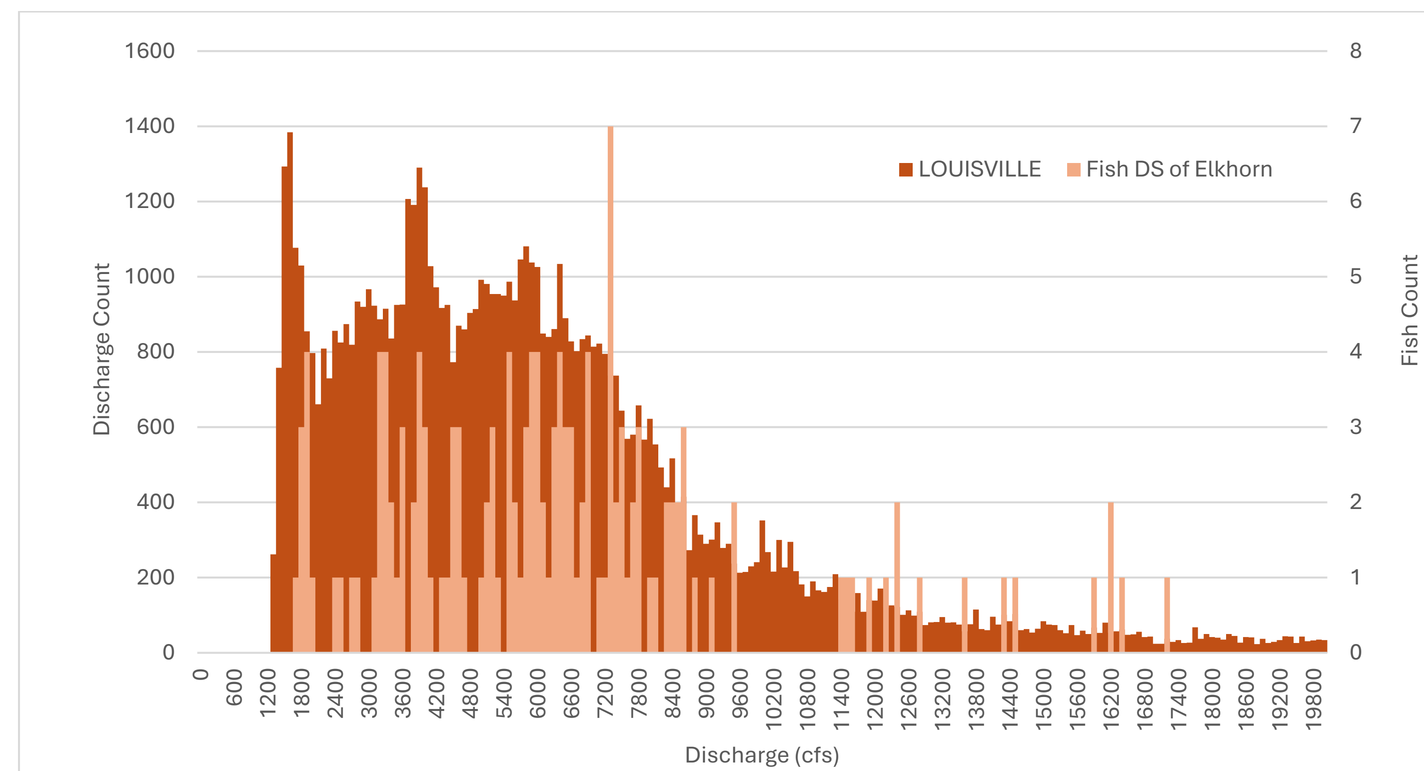


Figure 18. Histograms of real-time (15 minute) discharge at the Louisville stream gage and active tracking unique fish detections downstream of the Elkhorn during 2022-2025.

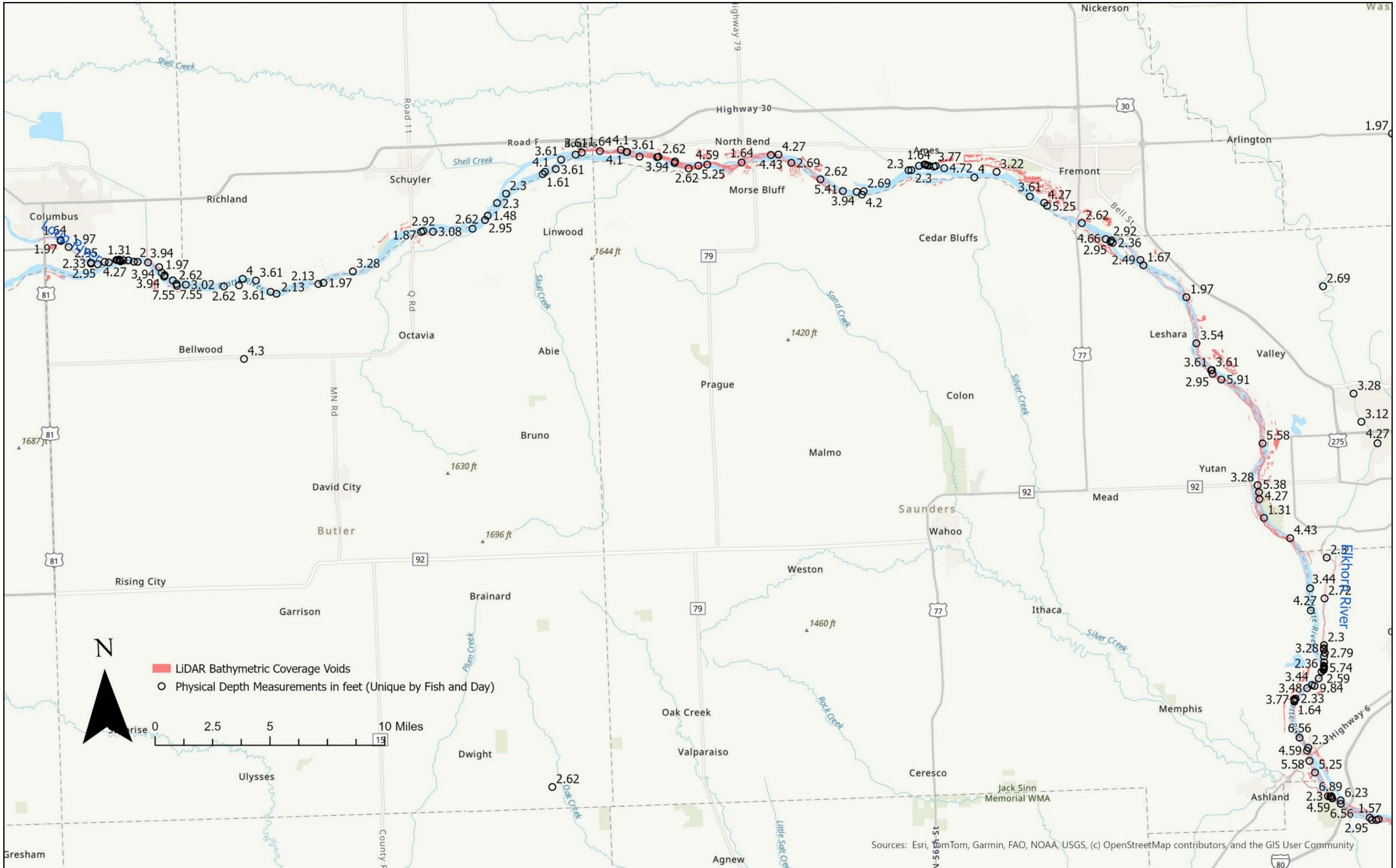


Figure 19. Unique (by fish and day) physical depth measurements collected during active tracking in 2022 - 2025 above the Elkhorn River.

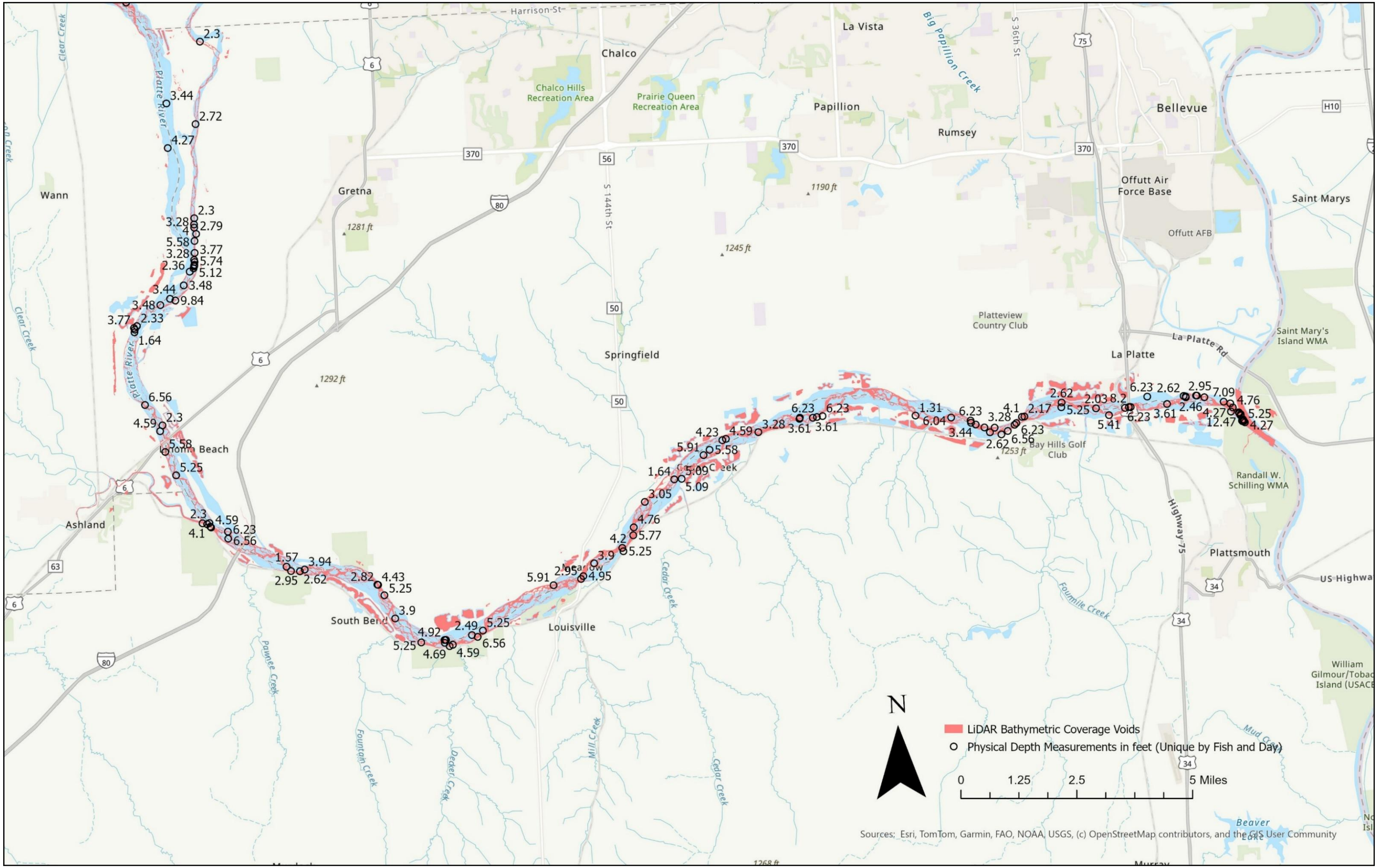


Figure 20. Unique (by fish and day) physical depth measurements collected during active tracking in 2022 - 2025 below the Elkhorn River.

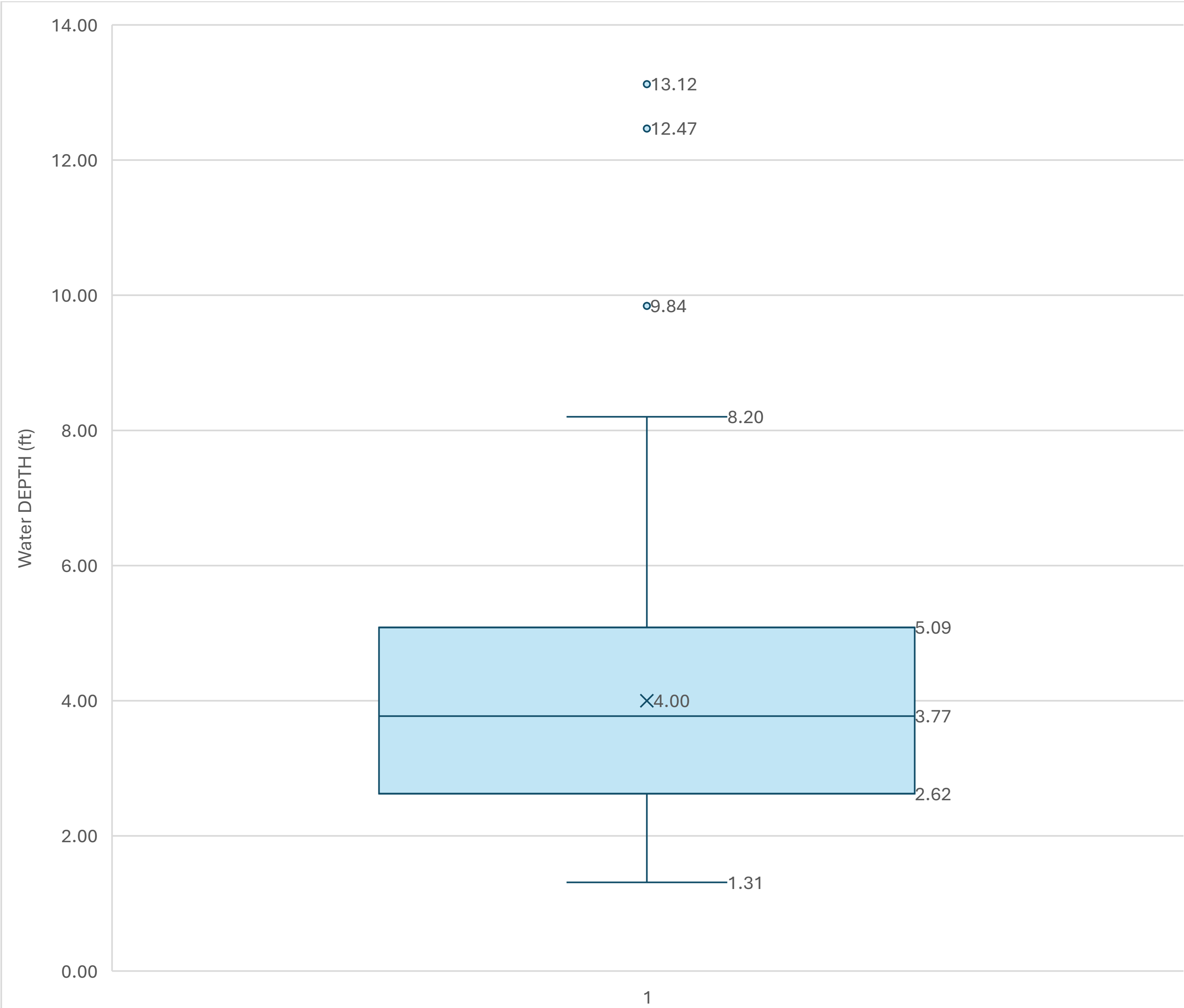


Figure 21. Histogram of measured water depth at active tracking locations (unique by fish and day) in 2022 - 2025. Highest depth values at or very near the Missouri River confluence.

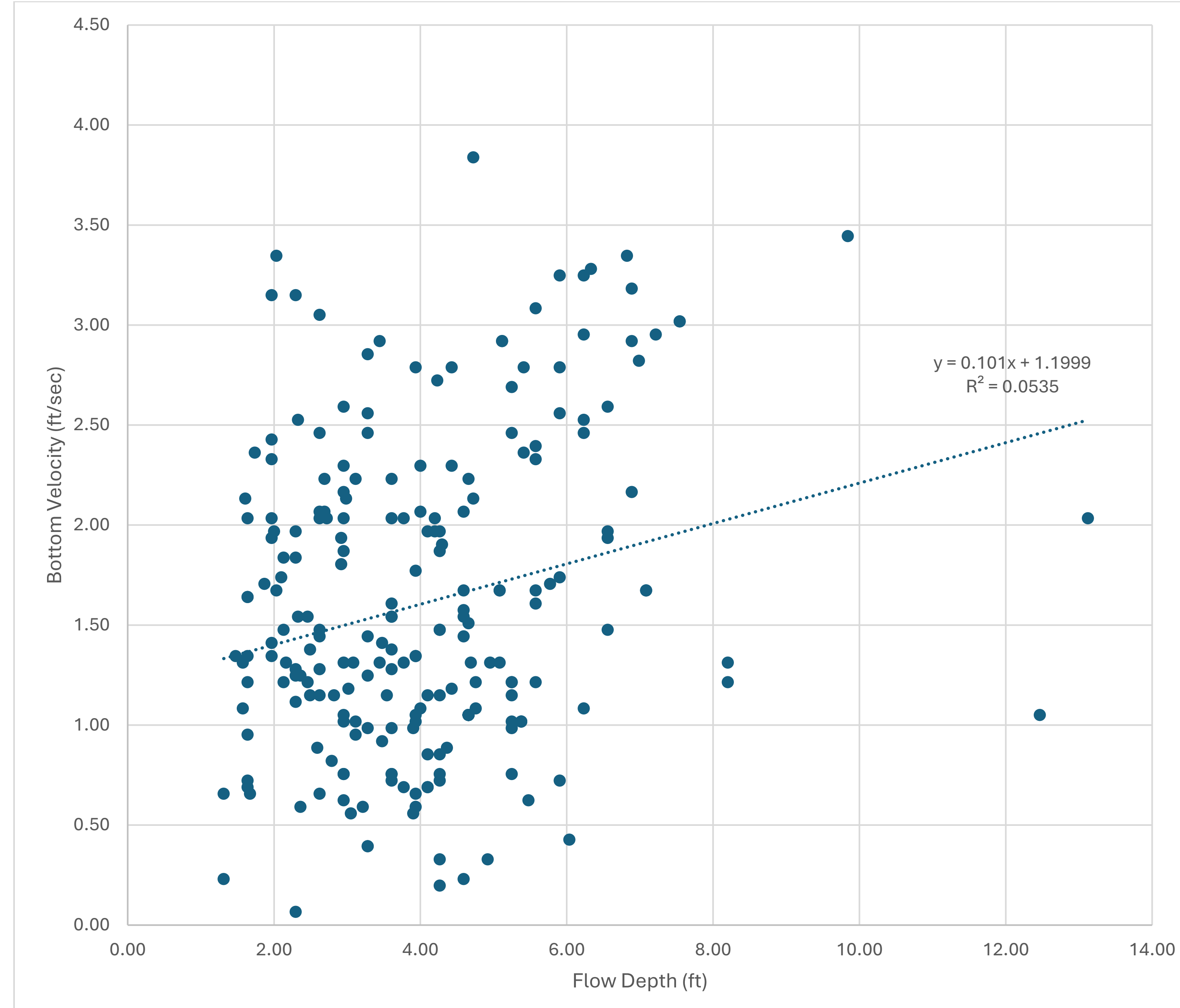


Figure 22. Relationship between water depth and bottom velocity at active tracking locations (unique by fish and day) in 2022 - 2025.

IV: 2D HEC-RAS MODEL OVERVIEW

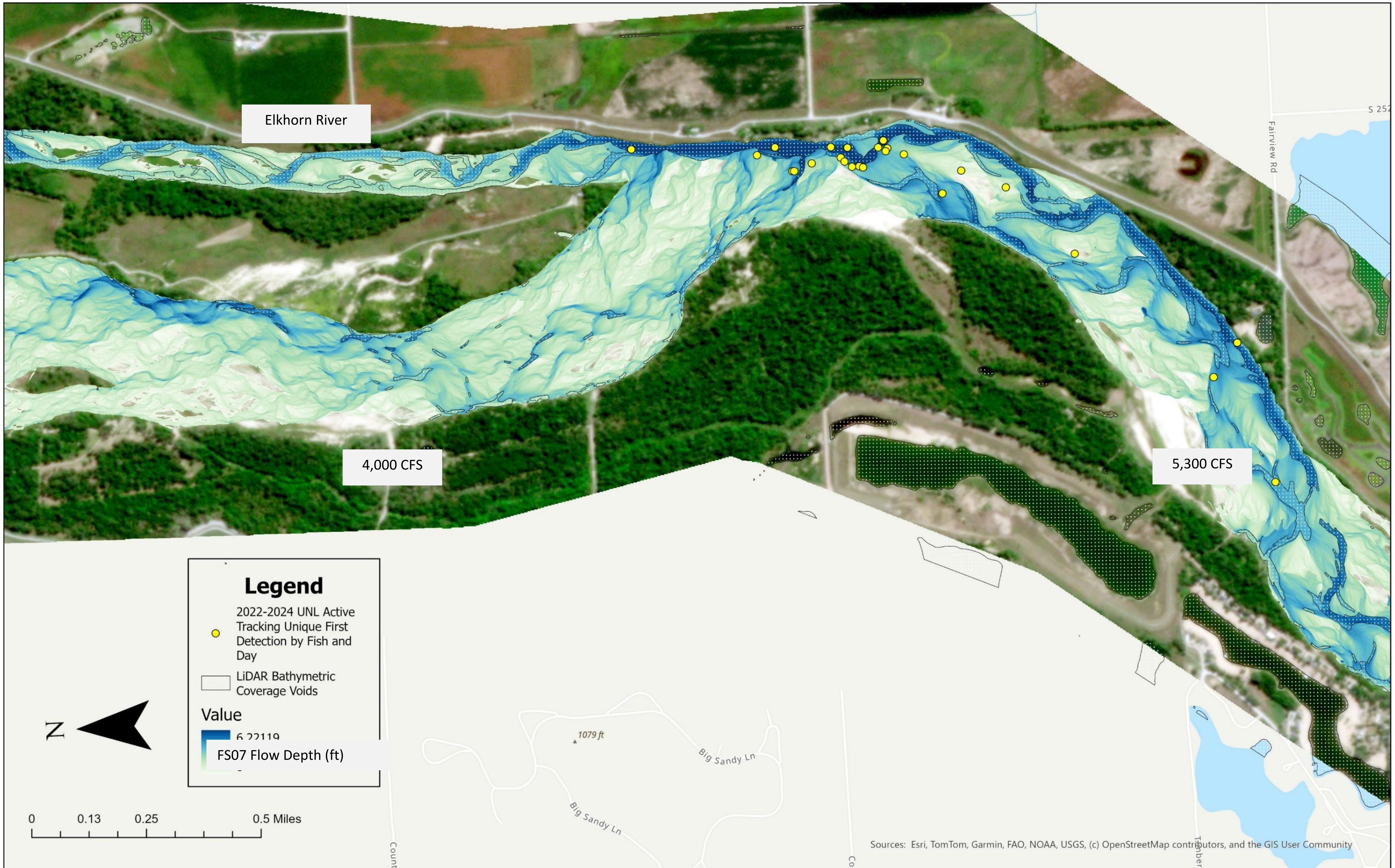


Figure 23. Example of HEC-RAS 2D model output (flow depth in ft) for Flow Scenario 7 (FS 07) at the Elkhorn River confluence. In this flow scenario, discharge above the confluence is 4,000 cfs and 5,300 cfs below the confluence. Unique first active tracking detections (by fish and day) are also plotted as well as areas where LiDAR voids required development of synthetic topography.

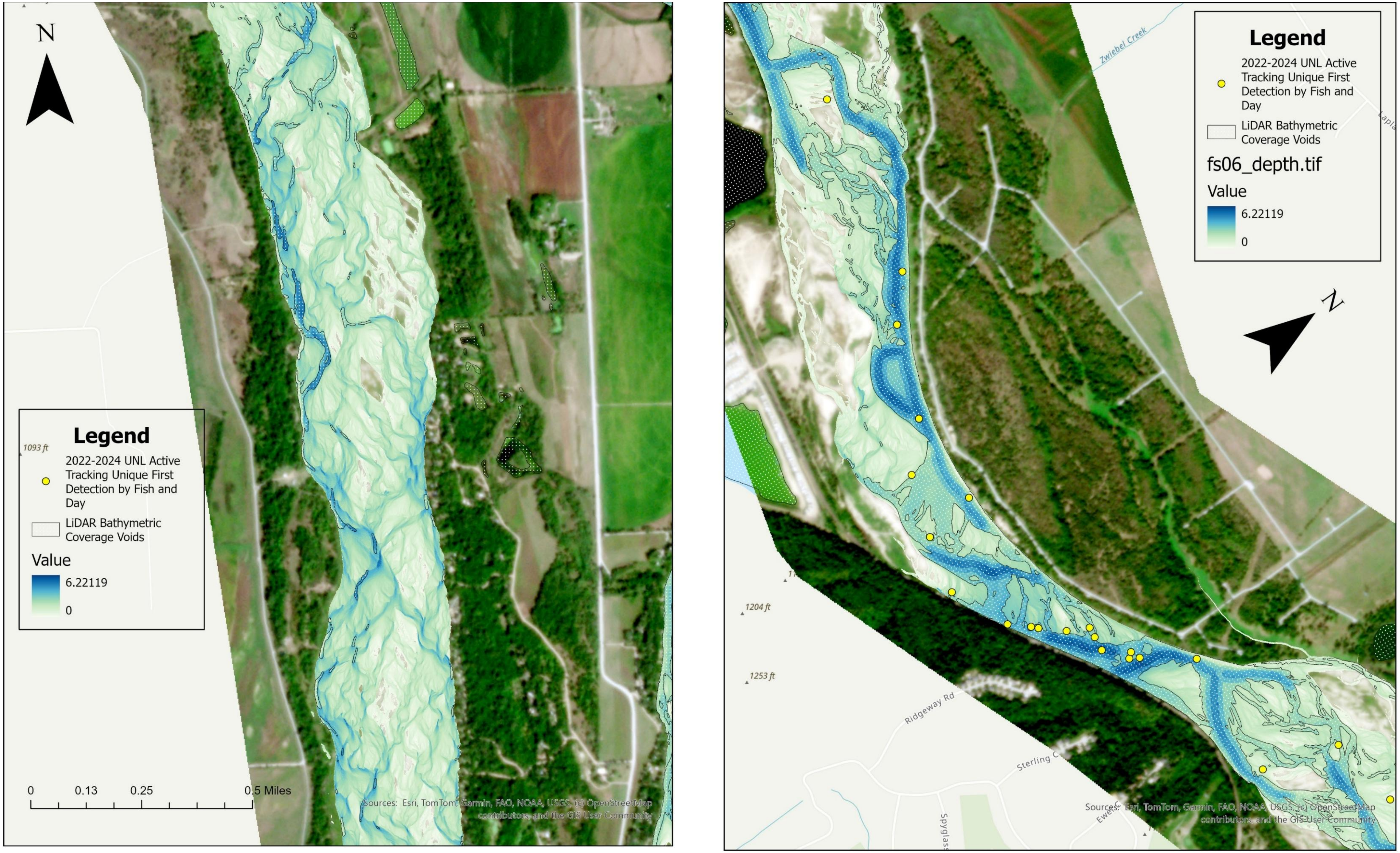


Figure 24. Comparison of 2D HEC-RAS modeled water depths at a discharge of 4,000 cfs upstream of the Elkhorn River (left) and downstream of Louisville near the confluence with the Missouri River (right).

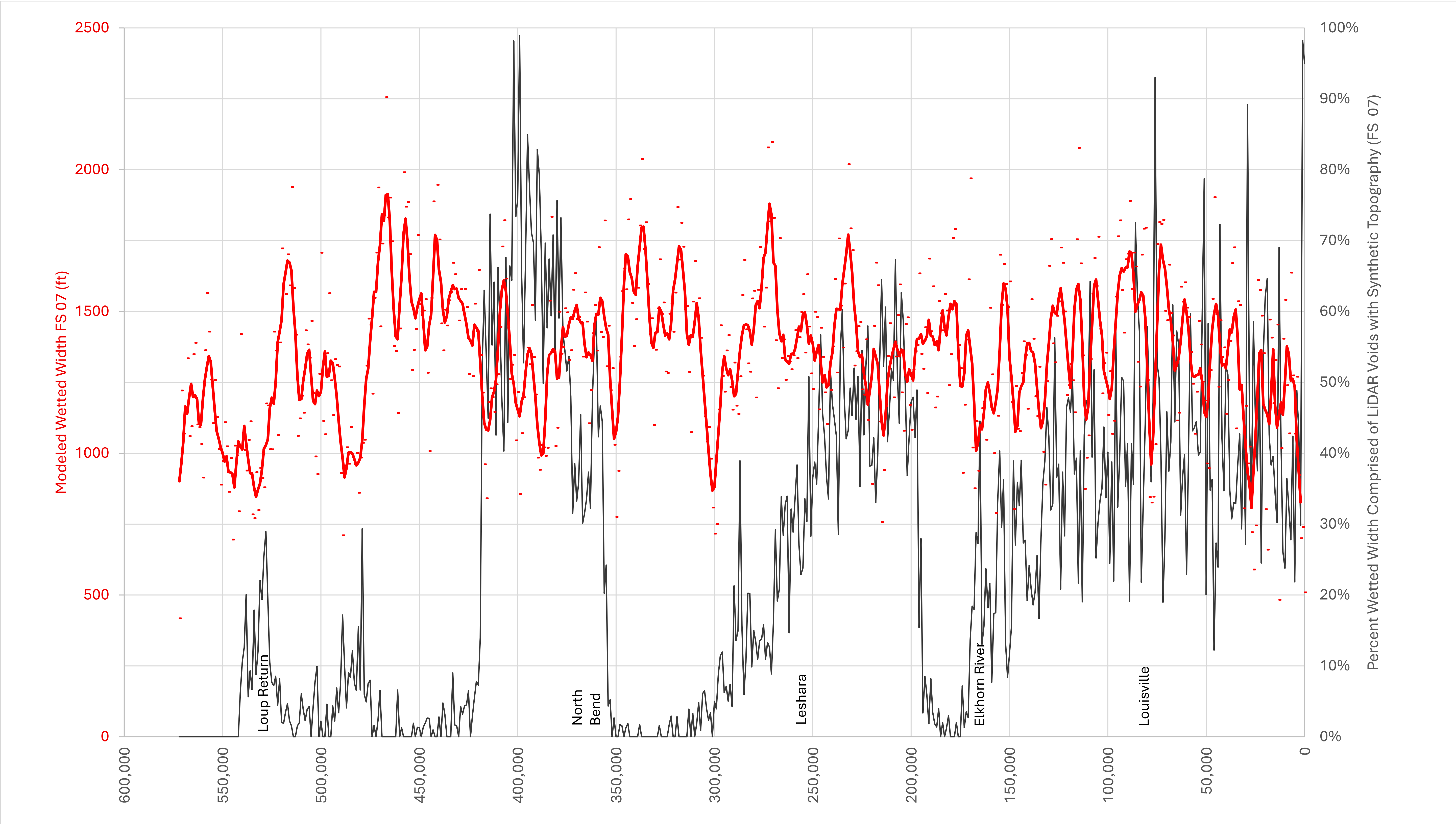


Figure25. HEC-RAS 2D modeled wetted widths for Flow Scenario 7 (FS 07) in relation to the percent of wetted width that is comprised of synthetic topography in LiDAR void areas. Flow scenario includes 1,400 cfs upstream of the Loup, 4,000 cfs at North Bend (downstream of Loup) & 6,500 cfs at Louisville downstream of the Elkhorn River and Salt Creek.

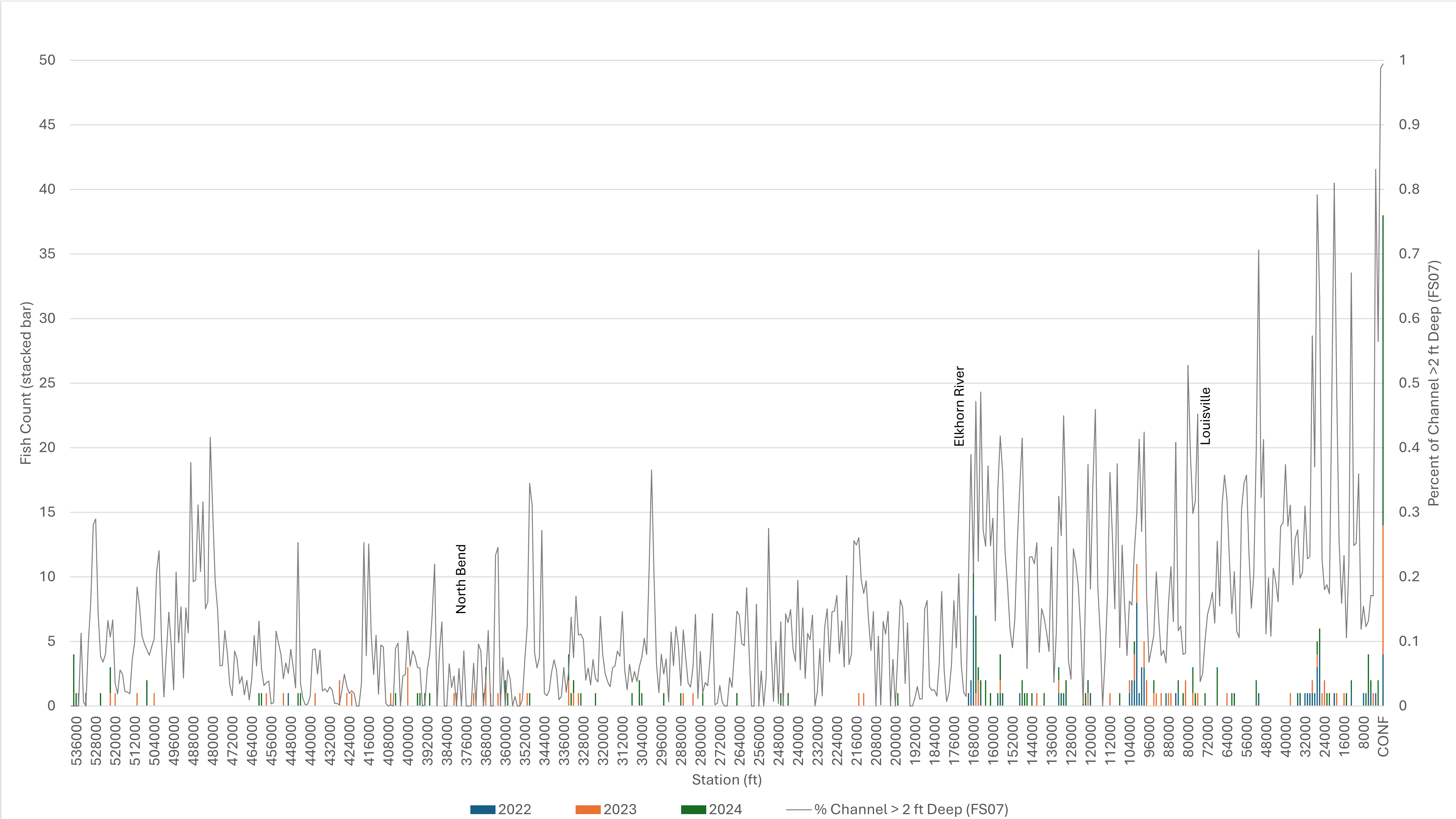


Figure 26. HEC-RAS 2D modeled proportion of the channel with flow depth >2 ft for FS 07 in relation to active tracking unique first locations by fish and day during period of 2022 – 2024. Water depth exceeded 2 ft in approximately 90% of active tracking locations (2022, 2023 and 2025). FS 07 includes 1,400 cfs upstream of the Loup, 4,000 cfs at North Bend (downstream of Loup) & 6,500 cfs at Louisville (downstream of Elkhorn River and Salt Creek).

V: OTHER INFORMATION OF RELEVANCE

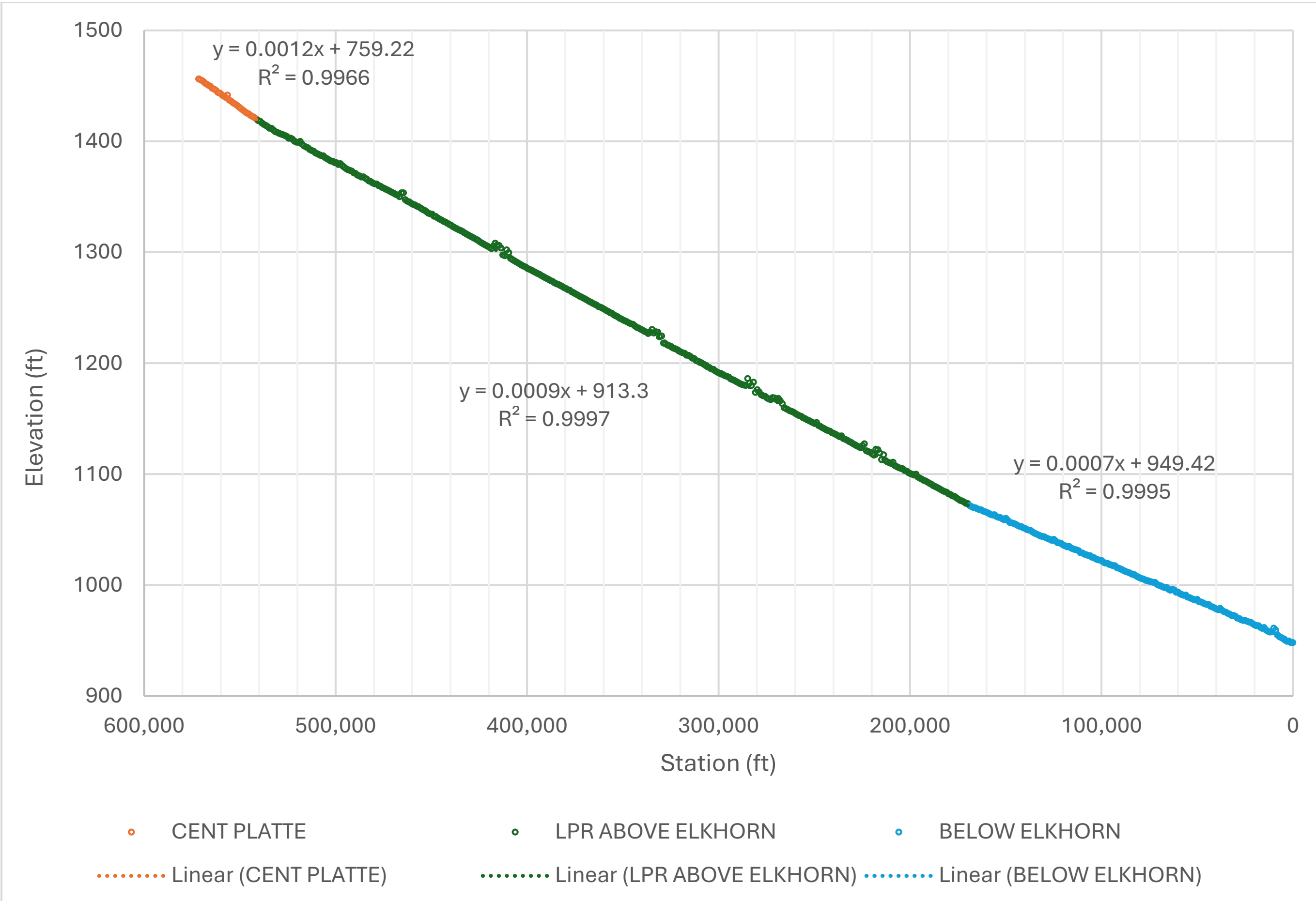
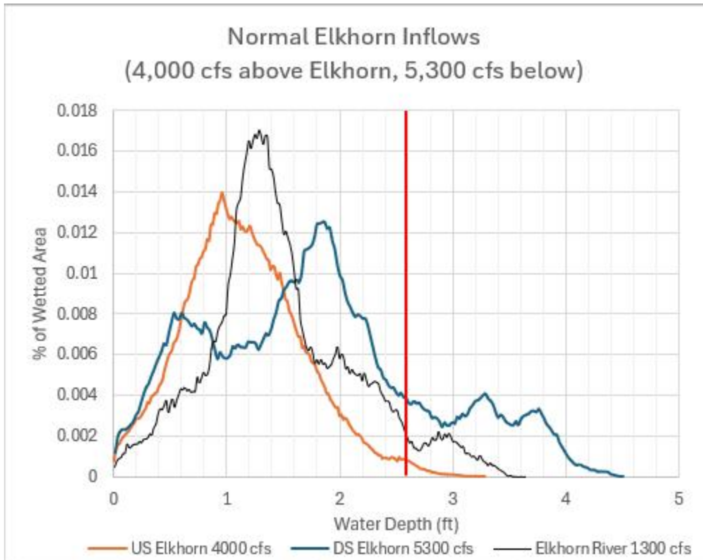
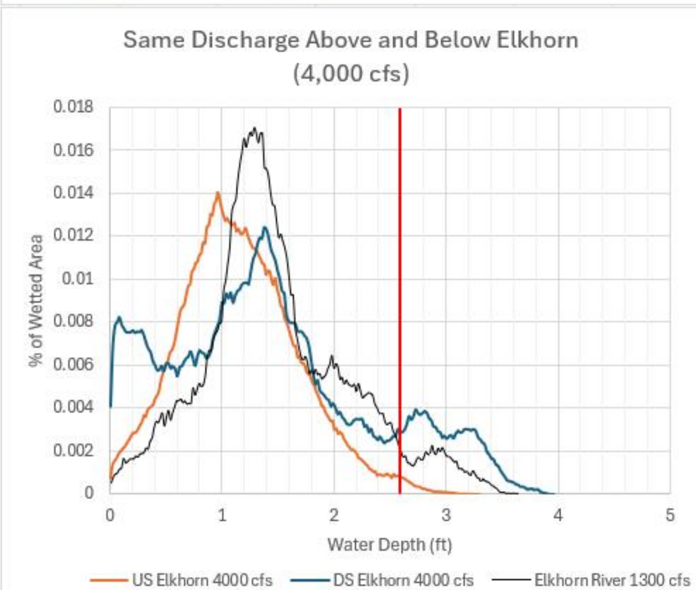


Figure 27. Slope of the Platte River from upstream of the Loup River Confluence to the Missouri River confluence. Slope of the central Platte upstream of the Loup River is approximately 0.0012. Slope of the lower Platte from the Loup River to the Elkhorn River confluence is approximately 0.0009. Below the Elkhorn, slope is approximately 0.0007.


Normal Elkhorn Inflows
(4,000 cfs above Elkhorn, 5,300 cfs below)
% of Wetted Area
Water Depth (ft)
US Elkhorn 4000 cfs
DS Elkhorn 5300 cfs
Elkhorn River 1300 cfs


Same Discharge Above and Below Elkhorn
(4,000 cfs)
% of Wetted Area
Water Depth (ft)
US Elkhorn 4000 cfs
DS Elkhorn 4000 cfs
Elkhorn River 1300 cfs


US Elkhorn
DS Elkhorn
500 ft
1500 ft
2500 ft
3500 ft
4500 ft

LINK TO LOWER PLATTE HYDRAULIC MODEL WEBMAP: [Platte River]

Hydrology, hydraulics, and limited pallid sturgeon information for September meeting of the ISAC

The following bullet points provide a brief description and summary of a series of figures the EDO developed to inform ISAC, UNL, and Program stakeholder conversations about the status and future direction of pallid sturgeon research.

Part I. Baseline hydrology and channel hydraulics

- Figure 1 provides an overview of the location of central and lower Platte Untied States Geological Survey (USGS) stream gages. The Overton gage is located just downstream of the J2 Return where releases from the Lake McConaughy Environmental Account (EA) are delivered (or returned) to the river from Central Nebraska Public Power and Irrigation District's (CNPPID) system. The Grand Island gage is located near the downstream end of the Program's Associated Habitat Reach (AHR) and is the official gage for accounting of Program water. Moving downstream, the Duncan gage is located just upstream of the Loup River confluence. The North Bend gage reflects central Platte flow along with flow from the Loup River system which is divided between Loup River flow and hydropower returns from Loup Power District. There are no major tributaries between the North Bend and Leshara gages. The Ashland gage is located downstream of the Elkhorn River confluence and the Louisville gage is located downstream of Salt Creek. The Program's lower Platte Associated Habitats extends from the Elkhorn River downstream to the Missouri River confluence.
- Figure 2 provides a six year series of real-time (15-minute interval) discharges starting at Grand Island and moving downstream through the lower Platte. This series spans a range of hydrologic conditions from very wet in 2019 to dry in 2022 and 2023.
- Figure 3 provides the same real-time data converted from discharge to river stage using the current (June 2025) discharge-stage rating tables for each gage. Please note that we normalized all relationships to a common datum of 1.0 ft at a flow of 100 cfs to allow for easier comparison of stage between gages.
- Figure 4 provides an example of actual central Platte flow releases in 2021 relative to lower Platte flows during the same period.
- Figure 5 is an attempt to provide an example of the magnitude of stage increase in the lower Platte due to the 2021 EA releases to benefit target species in the central Platte. *This is a good representation of the maximum degree to which whooping crane and/or germination suppression flow releases may increase stage (benefit to pallids) in the lower Platte above and below the Elkhorn River.* This should be viewed as conservatively optimistic scenario for magnitude of benefit as we selected a dry year and we simply translated EA water downstream from Grand Island and did not account for losses or attenuation.
- Figure 6 attempts to provide a similar example for the potential magnitude of impacts to stage in the lower Platte due to the diversion of excess flows in the central Platte into Program recharge projects. This should be viewed as a conservatively pessimistic scenario (maximized impacts) as we assumed that the Program's full 350 cfs diversion capacity would be realized at

the North Bend gage 4.7 days after "diversion" occurred at Overton. True impacts would likely be much harder to identify due to central Platte water operations. When recharge operations are occurring the central Platte, return flows at Overton are not reduced by 350 cfs. Instead, the duration of daily hydrocyling releases are shorted by the amount of time equal to the volume of water delivered to Program recharge projects. IE, the duration of daily hydrocycling release of 1,600 cfs would be shorted by 5 hours.

- Figure 7 reflects applications of the method above to estimate the magnitude of benefits of actual Program flow releases during the period of 2019-2024.
- Figure 8 reflects the estimated magnitude of potential impacts of Program excess flow diversions during the same period based on times when excess flows were available.
- Figure 9 provides series of real-time water temperature data in the central Platte, lower Platte, and Missouri River during the spring pallid sturgeon spawning window. *Note: The USGS stopped collecting (or at least reporting) lower Platte temperature data near the beginning of the pallid sturgeon research project.*
- Figure 10 provides a series of real-time water temperature data during the summer months. Note that sub daily water temperatures in the central Platte fluctuate more than the lower Platte. In any given day the maximum temperature of the central Platte is greater than the lower Platte and the minimum temperature is lower than that of the lower Platte. As such, benefits (or impacts) of flow management in the central Platte would primarily be a function of increased or decreased thermal inertia in the lower Platte due to increased or decreased flow volume. *IE, the central Platte is not a potential source of warmer/cooler water that would be expected to directly raise or lower water temperature at the Loup River confluence.*

Part II. Context setting – fish and flow

- Figures 11 and 12 provide an overview of the location of pallid captures and unique (by fish and day) active tracking locations for 2022-2024. These data provide a sense of the distribution of pallids in the lower Platte relative to the Elkhorn River confluence. Note that active tracking locations, especially downstream of the Elkhorn appear to be nonrandomly distributed – they are clustered near confluences, outer bends, and other locations likely to have disproportionately (for this system) deeper water.
- Figure 13 provides the distribution of unique (active tracking) fish locations throughout the reach in 2022-2024. The highest fish count occurred at the Missouri River confluence. Overall, approximately 30% of active tracking detections occurred upstream of the Elkhorn.
- Figure 14 attempts to place the active tracking detections into the context of flow conditions near the time of detection. We did not evaluate active tracking effort in relation to detections so cannot comment on whether the generally reduced number of detections in summer months was a function of absence of fish or lower effort.
- Figures 15 – 18 are a series of flow and fish (active tracking unique) histograms above and below the Elkhorn River 2022-2024. During these years, fish were observed across much of the range of discharges in both segments.

- Figures 19 and 20 provide unique (by fish and day) physical depth measurements at active tracking locations for 2022- spring 2025. Depth measurement locations are plotted along with void areas in 2022 lower Platte LiDAR collection. Pallid observations/depth measurements disproportionately occurred in areas where hydraulic model topography had to be synthesized because of voids in LiDAR.
- Figures 21 and 22 summarize physical depth and velocity measurements at unique (fish and day) active tracking locations 2022-spring 2025.
- Figure 23 provides a HEC-RAS 2D depth raster (FS 07) at the Elkhorn River confluence. The figure also includes LiDAR void areas and 2022-2024 unique active tracking observations. This flow scenario represents average flow conditions in the lower Platte during the study period. Note the difference in channel morphology below the confluence where more flow is consolidated into the thalweg. *Thought question: Assume discharge above the Elkhorn River confluence was 5,300 cfs. Would you expect the same pallid occurrence as when the segment downstream of the Elkhorn is 5,300 cfs? If not, why and how does this "why" affect how data is analyzed?*
- Figure 24 shows the difference in modeled flow depths at 4,000 cfs above the Elkhorn River confluence and in a high use area near the Missouri River confluence.
- Figure 25 provides HEC-RAS 2D modeled wetted widths for FS 07 and percent of wetted width comprised of synthetic topography in areas of LiDAR voids. Above the Elkhorn there are segments with almost complete LiDAR coverage that would be useful as references reaches in that segment.
- Figure 26 provides a comparison of modeled flow depths for FS 07 in relation to unique active tracking detections in 2022-2024. The difference in model flow depths above/below the Elkhorn is a function of both flow magnitude and channel morphology.
- Figure 27 is a simple linear regression of channel slope in the lower portion of the central Platte and two segments of the lower Platte derived from 2022 LiDAR topography. This figure indicates one driver of channel morphology above and below the Elkhorn. Another is an increase in valley confinement below the Elkhorn leading to channel segments that are much narrower than the rest of the reach.
- It is difficult to visualize hydraulic model results for the entire lower Platte. As such, the EDO developed a web map of hydraulic model results for FS 07, which represents average flow conditions in the lower Platte during the study period. The link is located at the beginning of this document.

Excerpts from EDO-ISAC Emails About Pallid Sturgeon in August 2025

Contents

Loup River Hydrocycling

From: **David Marmorek** <dmarmorek@essa.com>
Date: Sun, Aug 10, 2025 at 5:30 PM

As Gary commented, the effects of Loup River hydrocycling are very noticeable at the North Bend and other gages below the Loup River confluence. I noticed that there are a few periods when the Loup River hydrocycling was suspended, e.g.,

- January and February 2020
- April and first part of May 2020
- January and February 2021
- May and first part of June 2021
- January and February 2023
- January and part of February 2024

Can pauses in hydrocycling after the UNL work started in 2022 provide some off / on contrasts to elucidate the effects of hydrocycling on pallid sturgeon movement? I realize that it's not a perfect experiment because the "off" periods are generally in winter since 2022, and not distributed throughout the year. In a related matter, I recall that the CV of flow was an important covariate in the migration analyses, so I'm wondering if that covariate is reflecting hydrocycling in the Loup River, and seasonal contrasts in that variation. Do pallid sturgeon do something different when Loup River hydrocycling is on or off?

Jason's response (Aug. 11):

See link to Loup Power PDF below (PDF page 10 and 11). There are a number of FERC operations requirements that dictate the extent of hydropeaking. For Example:

> 40. To facilitate pallid sturgeon migration in the lower Platte River, the license requires Loup Power District to operate the project in an instantaneous run-of-canal mode from May 1 through June 7 by maintaining a constant water surface elevation in Lake North and Lake Babcock such that at any point in time, outflow from the lakes approximates the sum of inflow to the lakes.

https://loup.com/wp-content/uploads/Relicensing/html/documents/P1256%20--%20Loup%20License%20Order_20170522-3032%2832176928%29.pdf

The lack of hydropeaking during Jan and Feb (as far as I remember) is a function managing ice both in the Loup and the lower Platte, which is susceptible to developing major ice jams.

Dave's response (Aug 11) – why didn't hydrocycling stop in 2021 when temperatures were > 93°F?

Thanks Jason for those helpful clarifications. Attached is the FERC relicensing doc for which Jason sent a link. I've highlighted bits on pages 11, 15 and 16 that pertain to pallid sturgeon. The 2016 USFWS Biological Opinion cited in the FERC document (page 16) mandates that hydrocycling stop when water temperatures reach 93°F (33.9°C) at Louisville, which is a higher threshold than recommended by others (e.g., < ~25°C is considered optimal for various sturgeon species in references cited by Blevin 2011, also attached). Figure 10 in the WORD file of graphs sent by Jason shows that water temperatures at Louisville exceeded 93°F at Louisville briefly in late July and August 2021, but hydrocycling continued (red circles below). I think that water temperatures in the LPR are going to become more and more important as climate change continues. I've saved the two attached docs to our shared folder of pallid sturgeon documents.

Dave

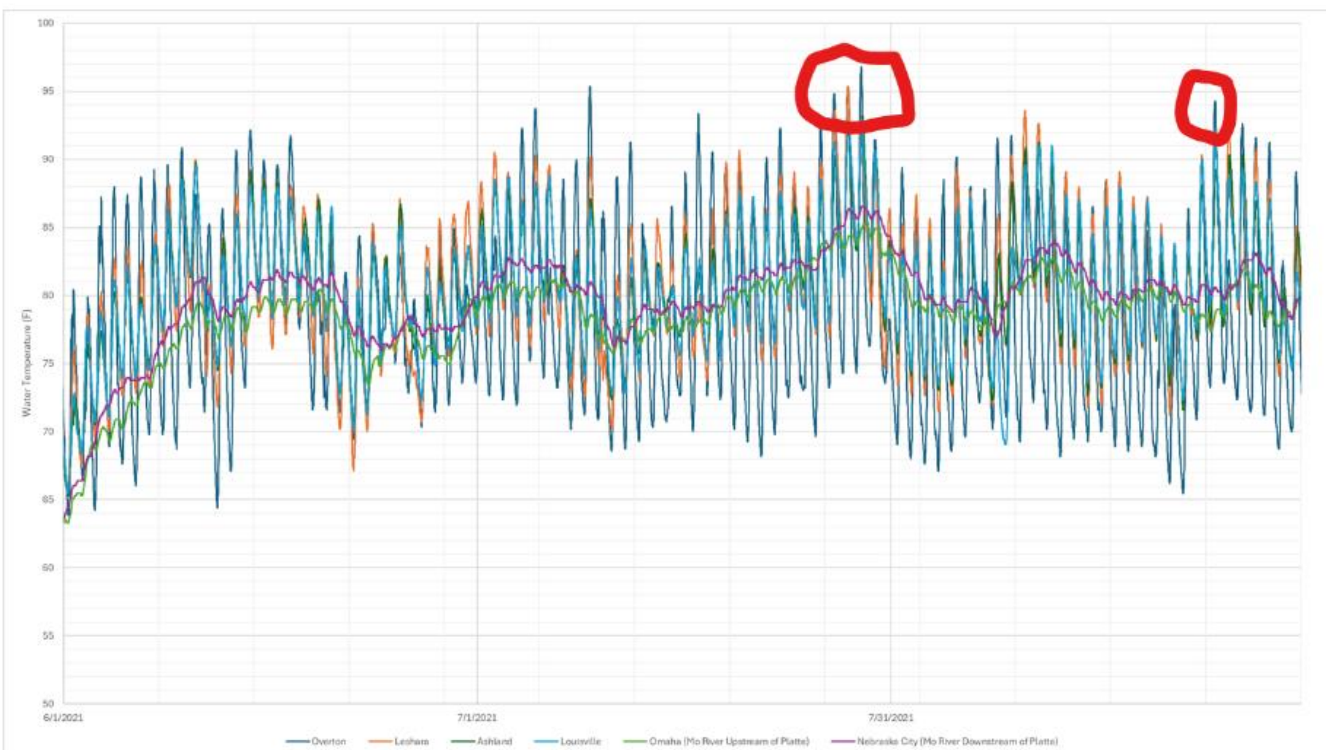


Figure 10. Real-time (15-minute interval) water temperature (F) at the Overton gage on the central Platte, Leshara and Ashland gages in the lower Platte, Omaha gage on the Missouri River upstream of the Platte Confluence and Nebraska City gage downstream of the Platte confluence. Figure shows differences in water temperature patterns and variation between Platte and Missouri Rivers during summer months.

Gary's Comment (Aug. 11)

Indeed, those water temps are pretty ghastly and drier, hotter future conditions will only exacerbate.

Jason's Response (Aug. 11) explaining that FERC issued a variance on that license requirement
See link below for reason Loup Power didn't cease hydrocycling when temp exceeded license limits in

2021. FERC issued a variance on that license requirement after the first implementation of the new license requirement in 2017 caused a massive fish kill in their system.

https://foxnebraska.com/news/local/loup-power-district-works-to-change-regulations-following-fish-kill

Dave's Response (Aug 11) – why stop diverting water to Loup Canal instead of just stopping hydropeaking?

Thanks Jason for that news article from 2017. It seems like they stopped diverting water to the Loup River canal back in July 2017, which killed a bunch of fish. However, the 2016 Biological Opinion (BO; pasted below) just required that they stop operating in a peaking mode, not that they stop diverting water[1]. Was there an additional federal order to stop diverting water beyond the BO requirement to stop peaking?

As for our September meeting, I think it would be great to understand how PRRIP flow management actions might affect LPR temperatures, which I suspect is negligible given how small the flow effects are. I realize that the HDR model does not include temperature, but perhaps some empirical relationships between flow, air temperatures and water temperatures could help to connect these dots.

Jason's Explanation (Aug 11)

As for 2017 – If I remember correctly when Loup flow is below some threshold they can only hydropeak because of turbine limitations. IE, you can only run turbines at 1,000 cfs so any inflow below that requires storage and hydropeaking. As such, only option was to not divert. (I don't think I am making this up but 2017 seems like a lifetime ago!).

[1] Dave/me missed Section 65 of the FERC license (pasted above), which says that there will be no diversion of water in the power canal when temperatures exceed 93ºF. USFWS clearly did not anticipate the consequences of this rule.

E. Pallid Sturgeon

64. The BO requires the project to cease operating in a peaking mode once real-time water temperatures have met or exceeded 93° F (33.9° Celsius), as reported by the USGS gage (No. 06805500), located at Louisville, Nebraska. This measure was not analyzed in the final EA.

65. Under this requirement, there will be no diversion of water into the power canal and cessation of project peaking operation will continue until the daily maximum water temperature at the Louisville stream gage falls below 93° F for 72 consecutive hours following the initial 93° F reading. The BO's requirement does not affect Article 405, which requires the project to operate in a run-of-canal mode from May 1 through June 7 each year to facilitate pallid sturgeon migration within the lower Platte River.

66. Project peaking effects are detected as far downstream in the lower Platte River as Louisville, Nebraska. The BO's requirement to cease peaking operation when water temperatures reach 93° F at Louisville will eliminate the fluctuation of water elevations in the river caused by project operation during periods of high water temperatures, thereby providing more depth and volume of water in the streambed, increasing potential habitat for the pallid sturgeon, and reducing the potential for the water to become too warm, which makes pallid sturgeon more susceptible to fish kills. The annual project operating cost of this requirement is $85,300.

Can pauses in hydrocycling after the UNL work started in 2022 provide some off / on contrasts to elucidate the effects of hydrocycling on pallid sturgeon movement?

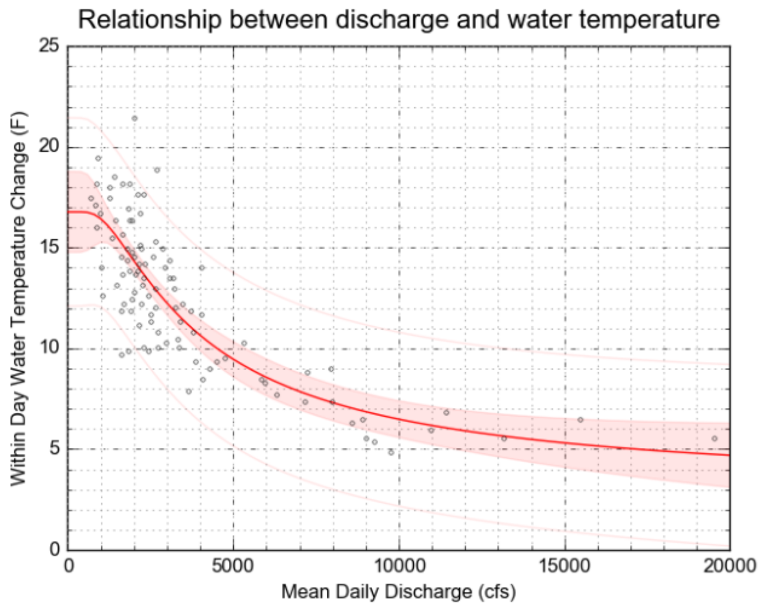
MDH: Looks like we do have periods when hydrocycling was off while UNL was collecting movement data, generally May through early June of 2022-2025 for comparison. What gets complicated is that because of the consistent timing of off periods, Mar-April upstream spawning window and late June to early July downstream movements and exit of system both occur during hydrocycling with higher CV's. Whether this CV is important as a cue pallids are using, or simply coincidental with the natural history and timing of pallid spawning behavior and movement remains to be determined.

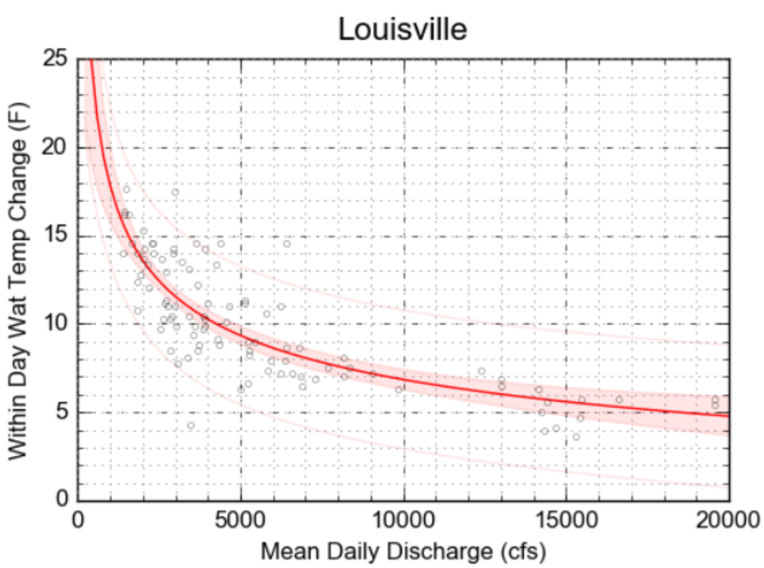
UNL uses daily CV of discharge as an explanatory variable. UNL's results to date found increasing CV as an important predictor of immigration into the Platte system, but not of emigration out of the system.

Water Temperature vs Discharge

From: **Jason Farnsworth** <farnsworthj@headwaterscorp.com>
Date: Tue, Aug 12, 2025 at 6:58 AM

Good morning! Here are two quick and dirty graphs that may be helpful. They are the modeled relationships between mean discharge and within-day water temperature change (Leshara top Louisville bottom) for days in July and August when maximum air temperatures in Valley (nearest NWS station) exceeded 90 degrees. Red band is 95% confidence interval, red lines are 95% prediction interval. Think of this as a proxy for the relationship between discharge and thermal inertia. Ignore both relationships below 1,000 cfs. I didn't have time to figure out how to chop function plots in this curve fitting software.





Relationship between air temperature, discharge, and water temperature.

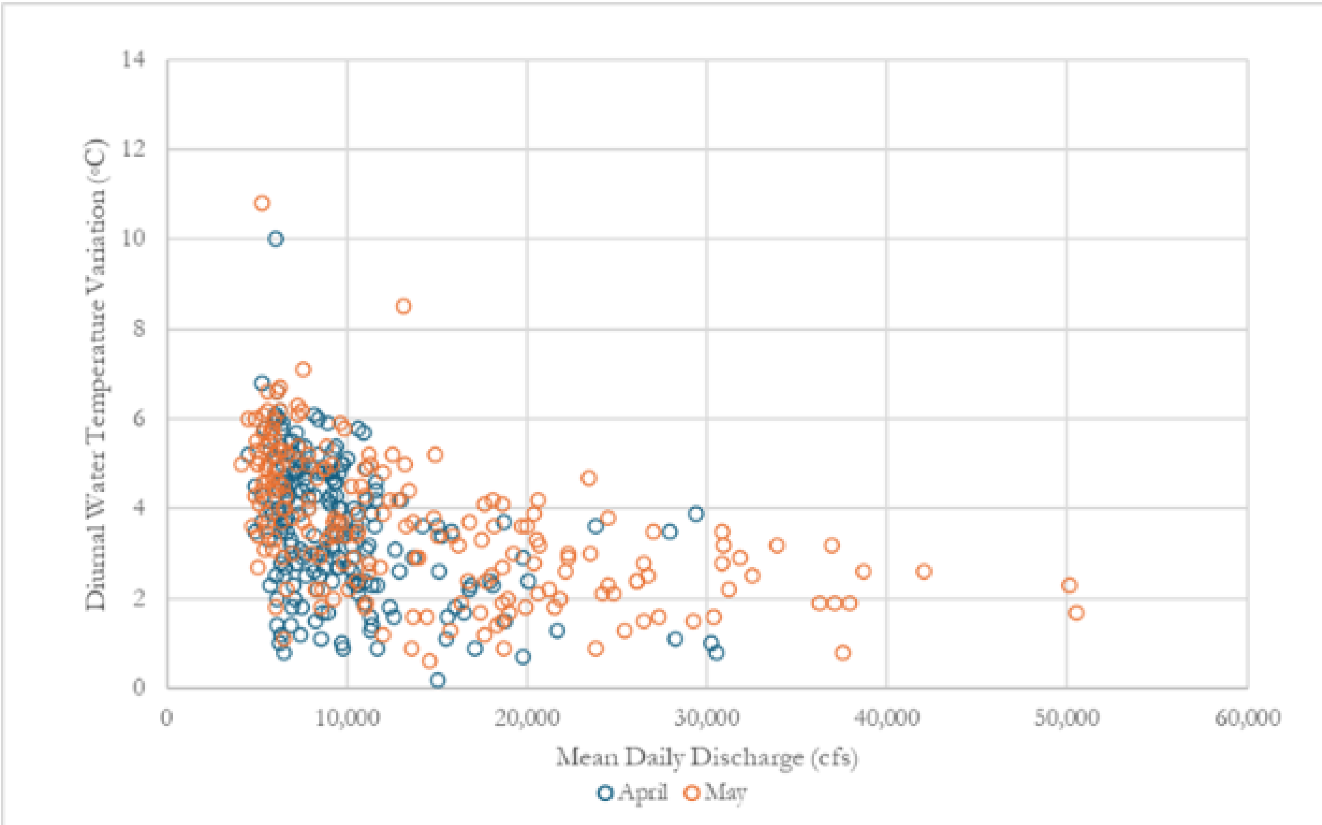
PRRIP produced a white paper in 2018 that addressed this question. Included below are those figures from the data available at the time. Though the data are not current, they do demonstrate how, in the wide and shallow Platte River, water temperatures are highly dependent upon air temperature.

Figure 4. Relationship between April and May maximum daily air temperature near Ashland and maximum daily water temperature at the Louisville gage (2011–2017).

Important point:

There is a strong correlation between air and water temperatures during the months of April and May.

Figure 5. Relationship between April and May discharge and diurnal water temperature variation at the Louisville gage (2011–2017).

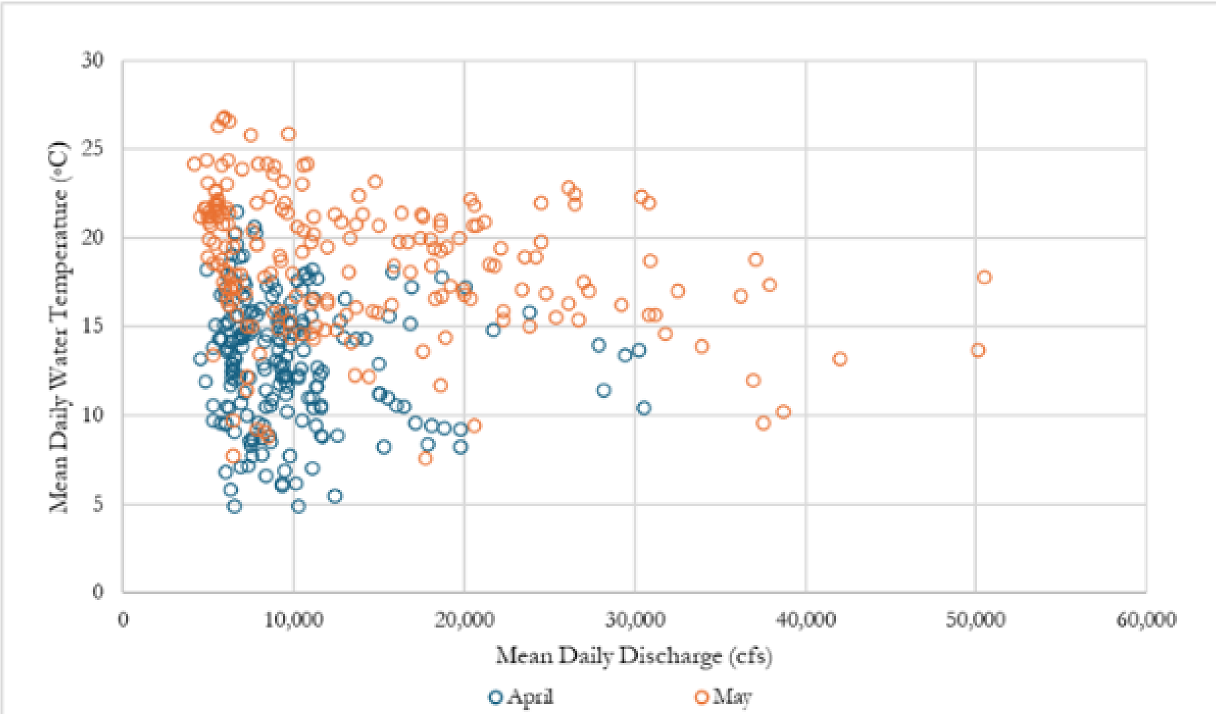


Important points:

During the months of April and May, there appears to be a relationship between discharge and diurnal water temperature variation with larger within-day water temperature swings at lower discharges.

This is likely a function of the reduced heat storage capacity of the river at lower discharges.

Figure 7. Relationship between April and May mean daily discharge and water temperature at the Louisville gage (2011–2017).



Important points:

- There is not a strong correlation between discharge and water temperature at the Louisville gage during the months of April and May.
- In May, water temperature may decrease slightly with increasing discharge, but the relationship appears to be highly uncertain.

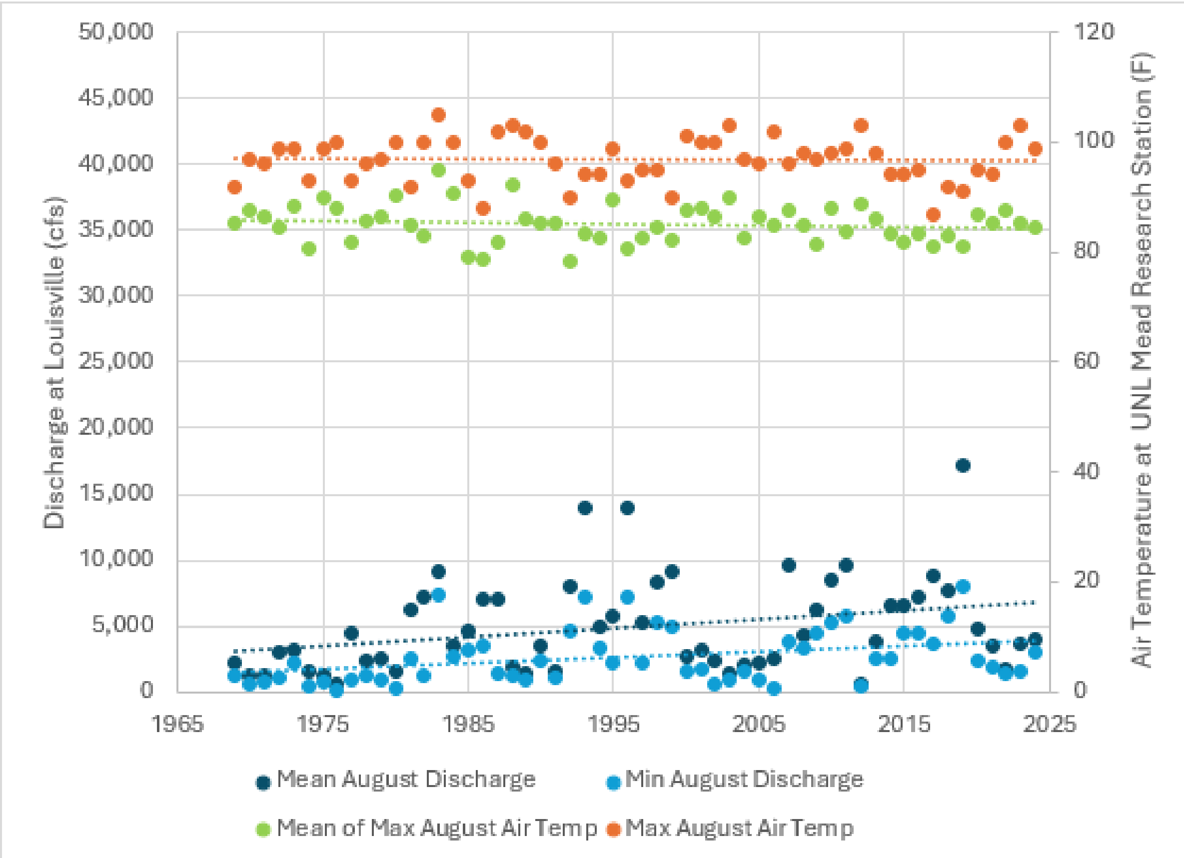
Trends in Discharge and Air Temperature, 1965 to 2025 & Possible Climate Change Effects

---------- Forwarded message ---------

From: **Jason Farnsworth** <farnsworthj@headwaterscorp.com>

Date: Tue, Aug 12, 2025 at 9:15 AM

All – one final graph before I shift focus. I noticed several comments about the relationship between and water temp through time and into the future. I quickly grabbed that data back as far as I could for the closest weather station that isn't in the middle of an urban heat island (UNL Mead Ag Research Station).

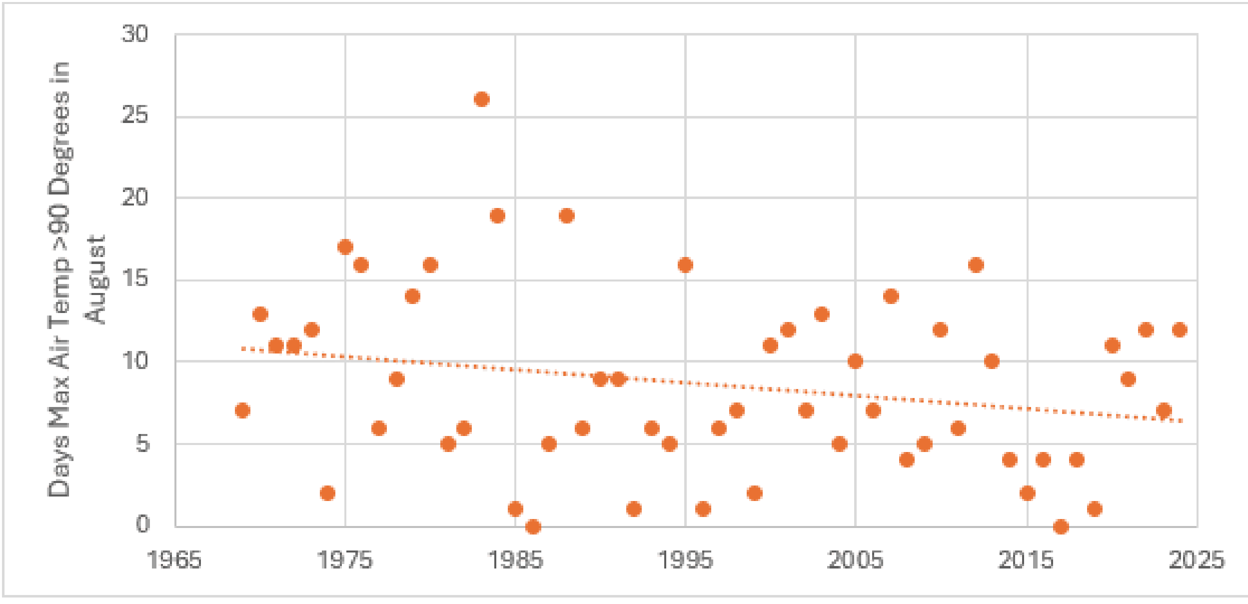


Gary Response

Thanks for the helpful plots! Just wondering, but for the latest one with the time series, water temperature is not plotted -- correct? It shows August discharge and air temp only, if I am interpreting it correctly.

Jason Response to Gary

Yeah – sorry about that. I should stop trying to do multiple things at once. The plots are air temp not water temp. There doesn't appear to be an increase in summer air temps or a decrease in summer low flows since the late 1960s (given normal cyclical patterns). Temps going up or flow going down would be negative indicators for the future. Both happening at once would be a big red flag. I also briefly looked for an increase in the number of days > 90 degrees in August. That plot below.



Dave Comment on PRRIP Flow Mgmt. and Temperature (Aug 12)

Thanks a lot Jason for these very helpful graphs. It seems like one of the interesting questions, which was raised in the stage change study, is the ability of the PRRIP to influence flow conditions and temperatures in the LPR during periods of extreme drought, low flows and very warm temperatures. The graphs that were distributed earlier in the WORD document make it apparent that current PRRIP water management has a negligible effect on LPR flows and presumably a negligible effect on temperatures, at least for recent years. In an extremely dry year, I suspect that there would not be enough water in the Environment Account to mitigate low flows and high temperatures in the LPR. That is just a hypothesis, but my recollection is that is what they found out in the stage change study (for flows).

In 2014, UNL did an excellent summary of climate change projections and impacts for Nebraska, which can be found here: https://snr.unl.edu/research/projects/climateimpacts/. One interesting insight is that irrigation in Nebraska has increased precipitation in recent decades. Unsurprisingly, much warmer air temperatures are predicted.

Thinking Like A Sturgeon (Aug 13)

From: **Jason Farnsworth** <farnsworthj@headwaterscorp.com>
Date: Wed, Aug 13, 2025 at 10:06 AM

I very much appreciate the hard work and thought the ISAC is putting into this task. While I am thinking about it – I wanted to sketch out an overarching issue/question about PS movement into and use of the lower Platte. The only way I can think to frame it up is from a PS point of view (flow-habitat focused) so please excuse the oddness of perspective:
Imagine being a PS that has overwintered in the Missouri. It's early spring and you are in the Missouri downstream of the Platte confluence. Water depth is > 10+ ft. When you navigate out of the Missouri channel into the Platte, you almost immediately transition to a depth of 3-4 ft. Missouri backwater effects extend about ¾ of a mile up the Platte from the confluence so there are minimal daily stage fluctuations due to hydrocycling and lower flow velocity than upstream.

Once you make it a mile upstream into the Platte, channel slope/velocity increases and you enter a 23-mile segment with no major tributary inflows. The thalweg is somewhat consolidated and meanders through a series of dramatic changes in channel width (600 – 2000 ft) with deeper chutes and rip-rapped banks along outer bends. If hydrocycling is happening, stage fluctuates on average about 0.5 ft a day. Many PS are congregated at deeper points (4-6 ft) along riprapped outer bends and channel chutes.

Around Mile 24, you encounter Salt Creek. Above the confluence, flow drops by about 20% and daily stage fluctuations increase by about the same amount. Channel conditions are not that different than the segment below Salt Creek although the thalweg is slightly less continuous and there are fewer deep pools.

At Mile 31, you encounter the Elkhorn River confluence. There are deep pools along the right bank, below the confluence that hold PS. Above this confluence turbidity decreases and flow drops by another 30%. Daily stage fluctuations double (~ 1 ft) and channel morphology immediately changes. Channel slope increases and the continuous thalweg disappears – the river is wider, shallower and is more strongly braided. Deeper water is mostly isolated to the pools immediately below the downstream faces of bars and in locations where the thalweg abuts the bank. This is the beginning of a 68-mile reach with similar morphology.

As you continue up the Platte from the Elkhorn confluence, daily fluctuations in stage continue to increase (up to <1.5 ft near the Loup River). Otherwise, channel morphology is somewhat stable.

Approximately 68 miles upstream of the Elkhorn and 100 miles upstream of the Missouri River confluence, you encounter the Loup Power Return and Loup River. Above the Loup River confluence, discharge drops by another 65%. Channel width doesn't change so water depth is much shallower. Daily stage fluctuations drop dramatically.

My point/question is this - as PS immigrate into the lower Platte and move upstream they all navigate these linear transitions from what would be considered (based on current and past analyses) more suitable to less suitable habitat. The farther they move upstream, the less suitable habitat becomes. This is especially apparent at Missouri and Elkhorn tributaries. These fish are not randomly encountering habitat and of varying depth, velocity and stage fluctuation - every movement upstream past a confluence is an immediate selection against flow-related suitability. IE, if more water and less stage fluctuation are truly driving immigration and movement in the lower Platte then PS should never progress upstream past Missouri River backwater because suitability is always higher in the rearview mirror.

Put another way, I am used to thinking about selection relative to whooping cranes. Each WC encounters the Platte and decides to stop or continue on based on habitat at the location their migration path crosses the river. What if, instead, every bird using the central Platte encountered the river at the location of the greatest unobstructed channel width near Grand Island and then (those that decide to stop) turned west and flew upstream some distance to roost at a spot that was narrower - the farther up the narrower the channel. Would we perform a use-availability analysis of widths at available locations throughout the central Platte relative to widths at use locations and conclude that habitat suitability increases with increasing width? Every foot they flew upstream is a selection against width - so there must be something else going on.

How do we/UNL appropriately deal with this issue from a modeling/analysis perspective (immigration and movement) since all of the flow metrics vary along the same high to low gradient through space and time.

Hopefully this makes sense?

Jason

Ps. I just remembered Loup is prohibited from cycling during the spring when pallids enter the Platte - any simple analysis that isn't temporally constrained will likely result in an increase in immigration with decreasing CV for that reason alone.

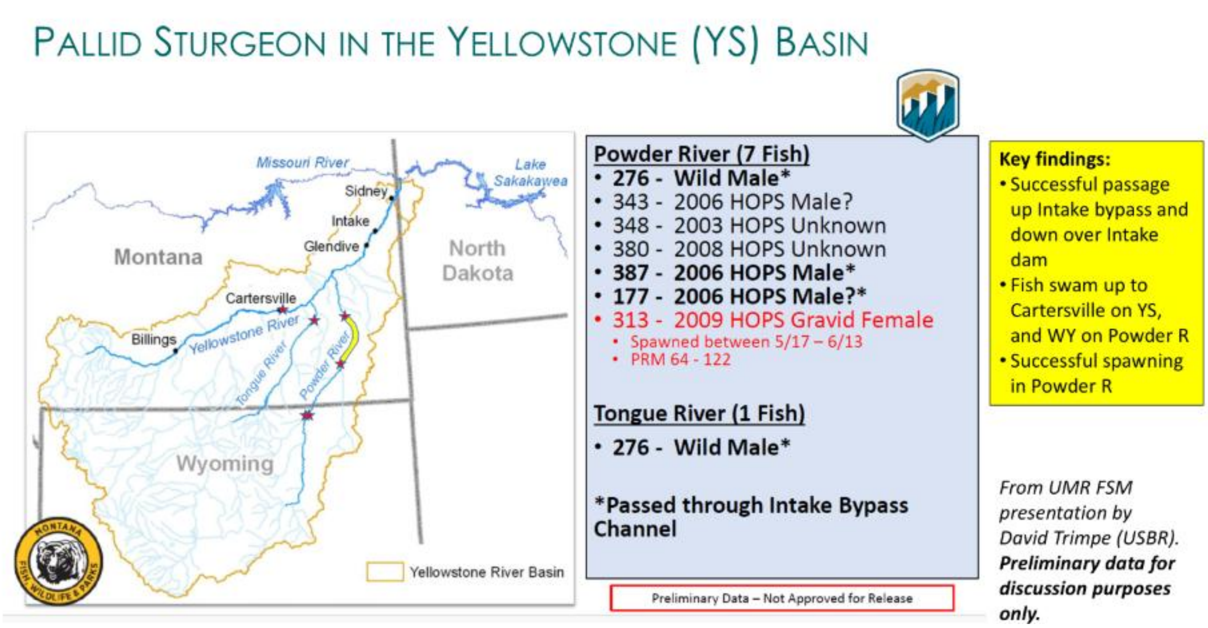
Dave's Response to Jason
Date: Wed, Aug 13, 2025 at 11:42 AM

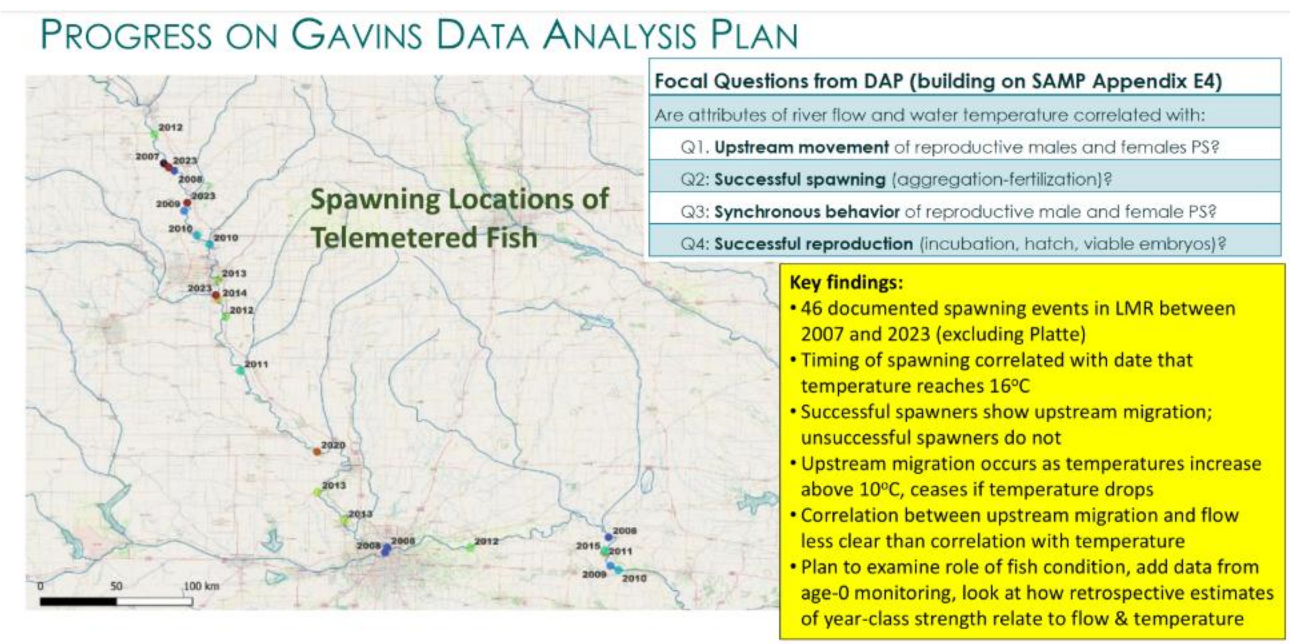
It's great to try to hypothesize what might influence a pallid sturgeon's decisions, and to then compare those hypotheses with the data. Your pallid sturgeon sounds to me like it might have also got a degree in geomorphology with a minor in PHABSIM, since it's thinking primarily about depths and velocities to determine habitat suitability. An alternative hypothesis is that female pallid sturgeon in rivers are a bit like salmon, and driven to migrate as far upstream as possible and then look for good spawning habitat (and males), thereby giving the maximum possible drift distance for their offspring. The recent creation of a fish bypass on the Yellowstone River around Intake Dam (a partial migration barrier) has resulted in pallid sturgeon migrating far up the Yellowstone and Powder Rivers, all the way into Wyoming (figure below, from the PS 101 deck I circulated on May 21). Prior to the creation of the bypass around Intake Dam, most fish spawned near Sydney in the lower Yellowstone.

Our imaginations are shaped (and limited) by our experience and training. So, **my** imaginary female pallid sturgeon got some post-grad training in SDM, and weighs the benefits of migrating as far upstream as possible against the quality of spawning habitat in those reaches, plus the suitability of temperatures for egg maturation and spawning, and the availability of males. Though spawning is distributed widely throughout the Lower Missouri River (second figure below, also from PS 101 deck), pallid sturgeon which show upstream migration are more successful in spawning than those which do not.

In the Trinity River, fall Chinook swim upstream past perfectly suitable spawning gravels to spawn just below the Lewiston Dam, often depositing their eggs on top of where other salmon have already spawned (or having another salmon do that to their eggs). It makes no biological sense to spawn there given the availability of less crowded and high quality spawning habitat downstream, unless you're absolutely driven to swim upstream as far as possible, which is what they did before the Trinity and Lewiston Dams were built in the early 1960's. Genes do drive behaviour.

Of course, a bit like Weird Al Yankovic in "Like A Surgeon", none of us really know how a sturgeon / surgeon operates. Maybe we could compose a parody of the parody, and call it "Like A Sturgeon".





From LMR FSM presentation by Ibrahim Alemeddine (ESSA).

Jason's Response to Dave

This is perfect - exactly the kind of thinking we need. Past analyses are all firmly situated in the first paradigm and never made a lot of sense to me because half the time (upstream movement) the fish are making decisions against the gradient of physical habitat suitability - you are describing the something else that is missing from past analyses.

UNL Concerns and Requests

The primary concern we have regarding analysis is largely centered on environmental conditions and measurements within the basin that are largely beyond our control. This situation will potentially limit inferences for some of the overall program hypotheses and questions. For example, water conditions have generally been on the median or lesser side of flows for the duration of the project. It is unclear how Pallid Sturgeon will respond to greater annual flow cycles when they occur beyond what has previously been reported in the literature.

Outstanding data limitations, issues, and needs

Continuity of environmental data measured by external sources. Hydrologic gages and water quality data are disjointed and can limit inference tied to specific behaviors. Turbidity is a prime example wherein there are substantial data gaps over the course of the study (see below for more information). Continuously monitored turbidity data are not available from USGS as originally anticipated. That is, there are numerous breaks in the data string that can overlap with when Pallid Sturgeon are moving into, out of, or within the Platte River system. These breaks range from 1-2 hours to multiple days (Figure 23). We will attempt to align turbidity observations with specific Pallid Sturgeon movement as best possible, but may be limited to daily mean or median values rather than using specific time an individual was detected. Further, the spatial coverage of gages that measure turbidity is coarse at best. This will likely limit inferences to localized turbidity conditions, especially at suspected transition points like the Platte River-Missouri River confluence.

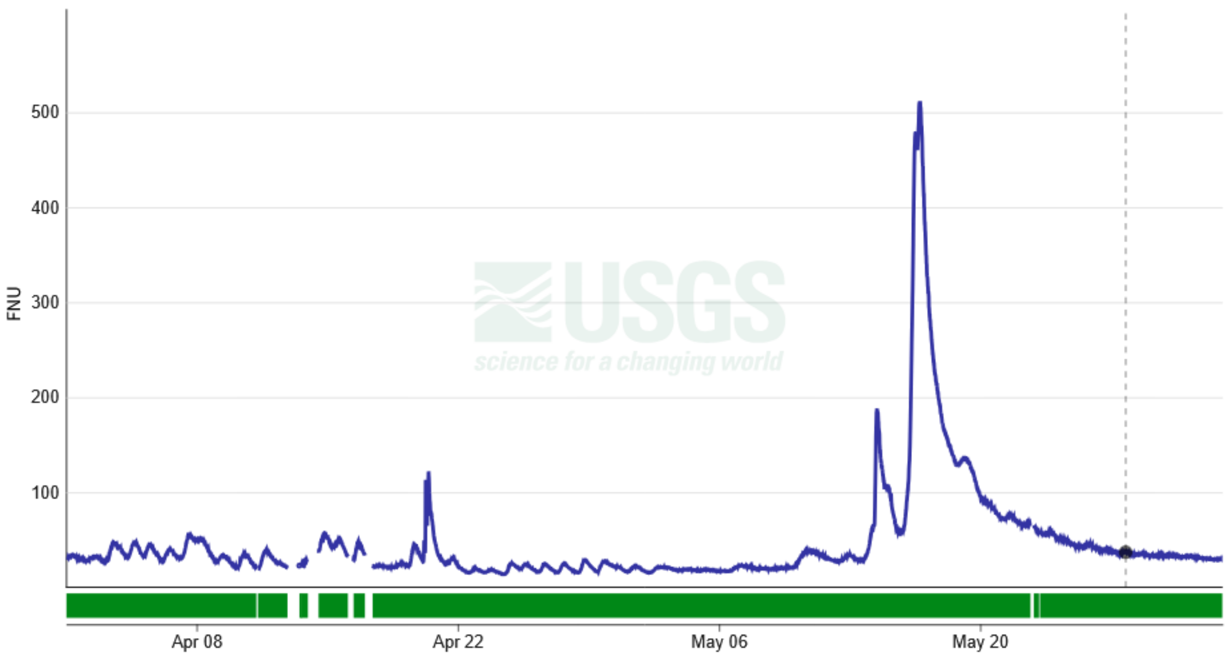


Figure 23. Example turbidity data from the USGS Louisville, NE gage (*06805500) during the 2023 spawning window. Breaks in the lines indicate missing data. Missing data can occur over a range of hours to days during the open water season. No measures are recorded during winter. Figure from USGS.*

ISAC Comments and Suggestions

Pallid Sturgeon

PRRIP is interested in determining how Program water management actions might affect pallid sturgeon in the LPR. The challenge is to find reliable predictive relationships which link flow metrics to biological responses.

Questions

1. For UNL and HDR - **Objective 1**: Water temperatures are strongly affected by air temperatures. Given the strong correlations of pallid sturgeon immigration and emigration with maximum water temperature, is it fair to conclude that air temperatures (driven by weather / climate change) will likely have a stronger effect on PS immigration / emigration than LPR flows, at least for the range of flows you observed during this study? Is it important for the PRRIP to have a model (e.g. 1D HEC-RAS temperature module) that can predict water temperatures in the LPR, to distinguish the relative importance of air temperatures and flow in affecting water temperatures? Or, to save money and time, can some simple empirical analyses show the relative importance of flow and air temperature in affecting maximum water temperature in the LPR?
    a. *Background:* In the Upper Missouri River, 1D HEC-RAS modeling by Craig Fischenich has shown that air temperatures have a very strong effect on water temperature once you move beyond the influence of Fort Peck Dam powerhouse releases (cold water from the bottom of Fort Peck reservoir). Craig has had to debug the HEC-RAS temperature module, so it may be better to start with simple empirical analyses.[From Dave]
2. For EDO: See question 2 above for UNL and HDR. Has HDR done any statistical analyses of how maximum water temperature in the LPR varies with flow and air temperature? [from Dave]
3. For EDO: From Tables 3 and 4 in the 2025 Progress Report, the flow metrics which showed the highest correlation with Pr (immigration) and Pr(emigration) were the daily CV of flow, the slope of flow, 1-day lagged flow and 7-day lagged flow, all measured at the Louisville gage. Can your hydrology model generate estimates of these metrics at the Louisville gage for alternative water years and PRRIP water management scenarios? If so, it should be possible for UNL to assess what changes in Pr (immigration) and Pr(emigration) might occur across a range of years and water management scenarios. That assessment would ideally include predicted temperatures at the Louisville gage. If temperatures are largely independent of flow (see question 1), then UNL could just use the temperatures associated with each water year [from Dave].
4. For EDO: The 20+ degree F daily fluctuations in river water temperatures (Figures 9 and 10) are rather stunning, as are temperatures that can exceed 90 degrees in mid-summer in the Platte. How are these related to discharge (see question 1 above also), hydroelectric flows, epilimnetic reservoir discharges, and other factors? [From Gary]

5. For EDO: From the LIDAR, is there evidence of gaining and losing reaches in the lower Platte (independent of tributary inputs) that could potentially provide thermal refugia during peak summer temperatures? [From Gary]
6. For EDO: it looks like the difference in Observed vs modeled WSE at Louisville is somewhere around 0.5 feet, or 6 inches. These WSE uncertainties are on par with the estimated WSE change that PRRIP releases can cause (see "7_30_25 Pallid Sturgeon - Flow - Stage - Tracking figures for September 2025 ISAC") – so to put this another way, do we have confidence that Program releases can actually affect WSE, if the magnitude of those impacts are within the uncertainty of the model itself? This isn't a commentary on the quality of the modeling effort or product, but rather I'm just wondering if, given its bounds of uncertainty, the model can meaningfully inform water depth impacts as they relate to PS? [From Alan]
7. For EDO: The model was run at 40 ft/40 ft resolution (12x12 m). Is this good enough to capture the heterogeneous nature of the Platte River and its hydraulics? Are fishing using features at that scale, or smaller scales? What are the computational costs of increasing the resolution? [From Alan]

Pallid Sturgeon/Flow/Stage Tracking figures created by EDO

"7_30_25 and 8_20_25 Pallid Sturgeon - Flow - Stage - Tracking figures for September 2025 ISAC"

Figure 5 – am I interpreting this right that without EA water, stage at North Bend would be about 6 inches lower at most (during late June/early July), and stage at Louisville would be about 3 inches lower at most (during late June/early July)? Are these big numbers or small numbers in terms of habitat? [From Alan] What level of stage change is *biologically meaningful* for pallid sturgeon habitat use in the Platte? [from Michal]

Figure 6 - As opposed to EA *releases* tangibly affecting stage at North Bend and Louisville, it looks like PRRIP *diversions* do basically nothing to stage. Is this interpretation in line with EDO findings? And if so, how does that square with FWS' position that "*Program water withdrawals will reduce lower Platte River flow and the inability to detect those water withdrawals does not equate to no PS impact."* [From Alan]

Fig 14: definitely need to account for active tracking effort. How are you doing that? [From: Jennifer]

Fig 19: Tell me more about the Lidar voids (missing data) on the Lower Platte Hydraulic Model webmap. Is the HDR modeling valid given all the voids? For example, Fig 19 caption says "Pallid observations/depth measurements disproportionately occurred in areas where hydraulic model topography had to be synthesized because of voids in LiDAR." (from the file 7_30_25 Pallid Sturgeon - Flow - Stage - Tracking figures for September 2025 ISAC.docx) [From Jennifer]

Figure 21 – I’m used to seeing histograms as bins on the x-axes and counts on the y-axis. Can you produce an actual histogram of depth vs. fish locations? These are helpful for interpreting, for instance, Whooping Crane use of various channel widths. [From Alan]

Figure 22 – The scattershot nature of this correlation isn’t too surprising, as depth should have relatively little correlation with bottom velocity; that’s because velocity goes to zero at near-bed elevations (“Law of the Wall”). Any way to get average water column velocity rather than bed velocity? [From Alan]

Figure 24 – do you think that the capture locations are biased toward deeper, faster, main channels? That is, aren’t these the places one would take a boat (and thus sample), instead of all the tiny and tough-to-navigate side channels? [From Alan]

Figure 27 – this isn’t technically a plot of slope, it’s a plot of elevation against distance. Suggest replacing with a true scatterplot of slope (i.e., where the y-axis has numbers like 0.00001, etc.)