Pallid Sturgeon Biology in the Platte River and Its Tributaries

2022 summary

Platte River Recovery Implementation Program

SCHOOL OF NATURAL RESOURCES

NEBRASKA GAME PARKS

Pallid Sturgeon Biology in the Platte River and Its Tributaries

OBJECTIVES

1. Identify relations among environmental conditions (i.e., river discharge and temperature) with the timing and extent of Pallid Sturgeon movement into and within the lower Platte River.

2. Identify Pallid Sturgeon spawning habitat in the lower Platte River and its tributaries.

3. Verify successful spawning by Pallid Sturgeon in the Platte River and/or its tributaries.

4. Provide Pallid Sturgeon genetic samples for further population and hybridization assessment (in collaboration with Dr. Heist's parallel project).

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2022 focus on catching fish, implanting transmitters, and getting telemetry network set up.

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Fish collection

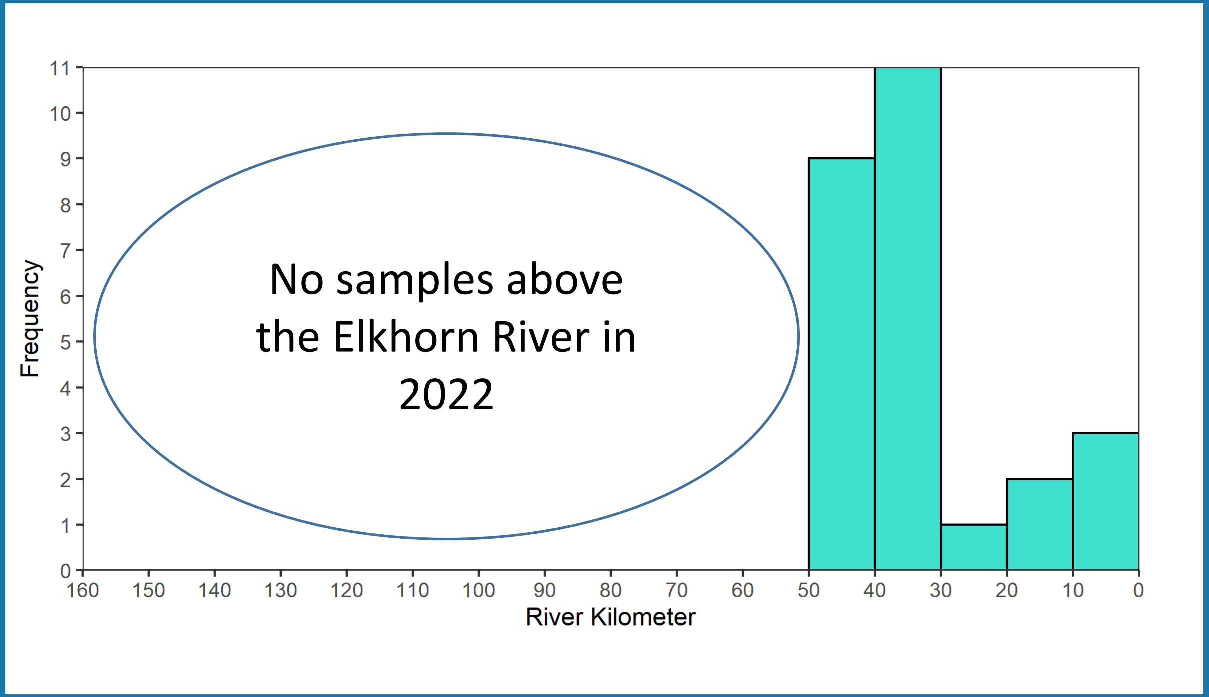
- Platte River
  - 164 trotlines set
  - 26 Pallid Sturgeon caught
    - 16 new acoustic transmitters implanted
    - 1 radio tag in existing acoustic fish
    - 10 too small for transmitters
  - Origins (all genetically confirmed)
    - Wild – 1 (adult male)
    - Hatchery – 15 (from many cohorts)
    - 1 F1-hybrid (no transmitter installed)

Species	Length (mm)	Weight (g)	Date Implanted	Acoustic Tag Number
PDSG	878	2416	3/17/2022	A69-1602-62088
PDSG	524	468	3/17/2022	A69-1602-62089
PDSG	885	1926	3/17/2022	A69-9001-58904
PDSG	796	1750	3/17/2022	A69-9001-58905
PDSG	809	2106	3/19/2022	A69-9001-58907
PDSG	607	748	3/25/2022	A69-1602-62100
PDSG	**889**	**2268**	**3/29/2022**	**A69-1602-62101**
PDSG	980	3308	4/10/2022	A69-9001-58908
PDSG	947	2736	4/9/2022	A69-1602-59042*
PDSG	1080	4688	4/16/2022	A69-9001-58906
PDSG	677	940	4/16/2022	A69-1602-62092
PDSG	635	726	4/16/2022	A69-1602-62091
PDSG	571	552	10/25/2022	A69-1602-62090
PDSG	1100	5042	10/27/2022	A69-1602-62094
PDSG	832	1792	10/27/2022	A69-1602-62095
PDSG	650	896	11/1/2022	A69-1602-62099
PDSG	995	3520	11/1/2022	A69-1602-62097

- 3280 nightcrawlers
- 315 total fish caught

Objective 1: Movement in Platte River system.

Fish collection



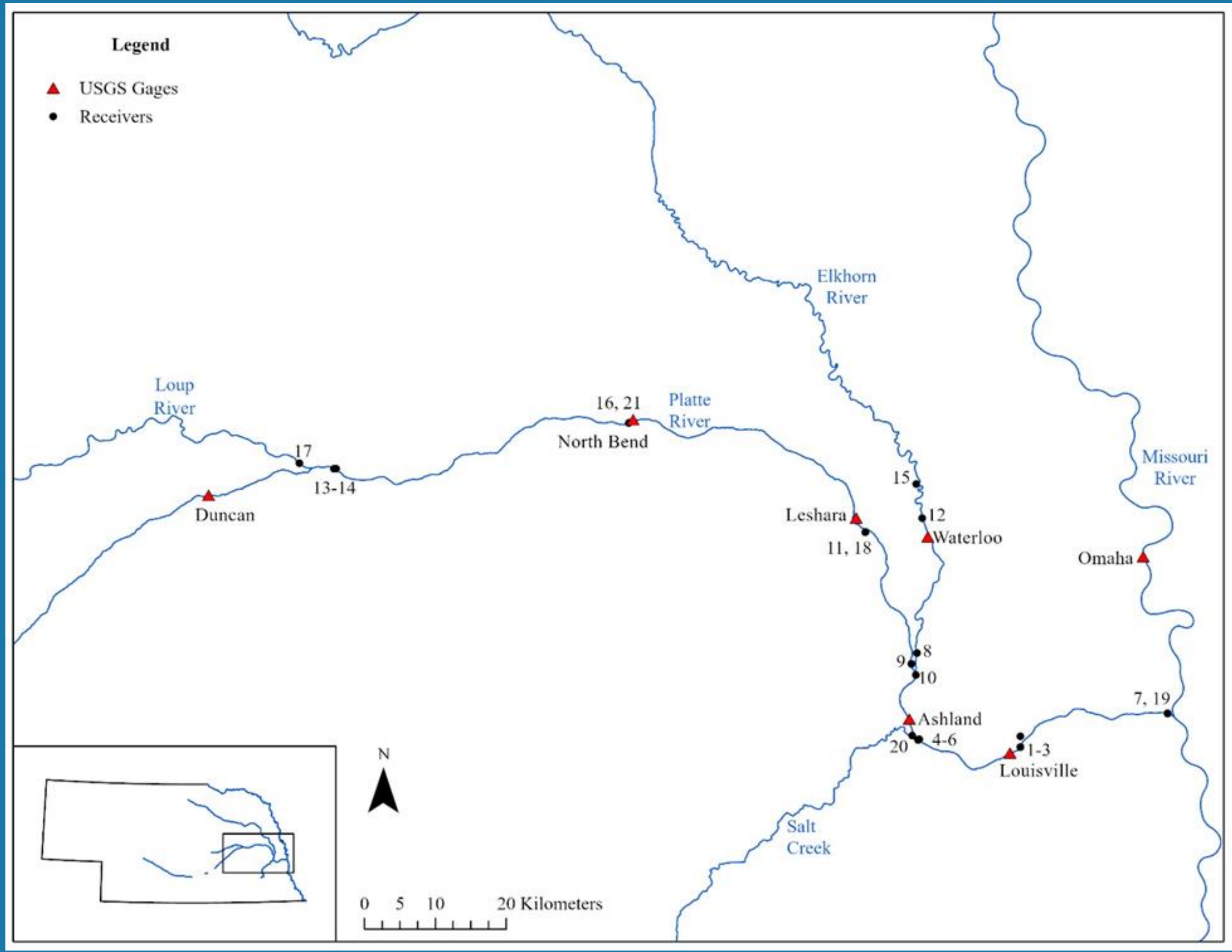
Objective 1: Movement in Platte River system.

Fish collection

Photo credit: Lincoln Journal Star

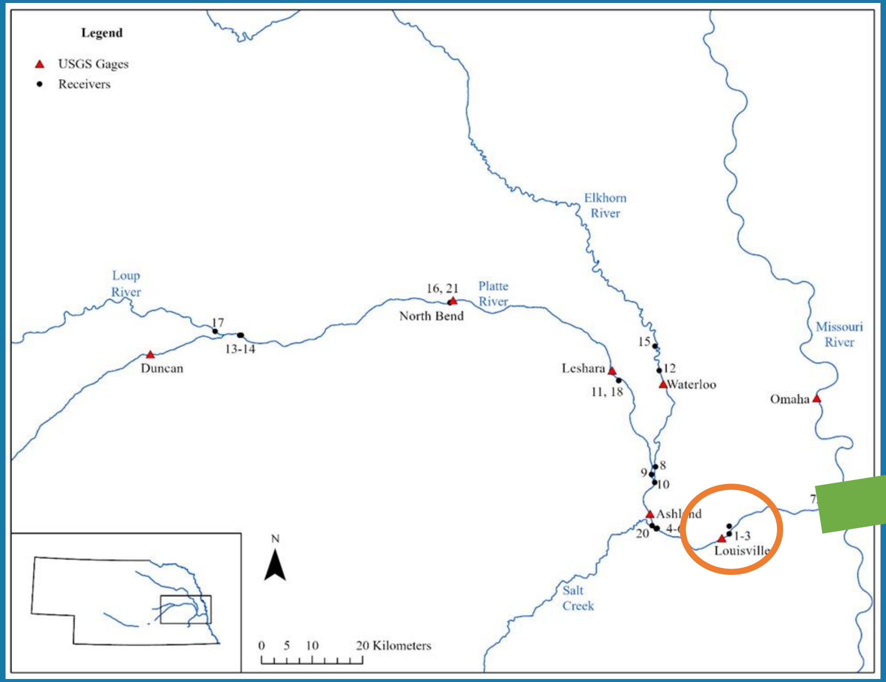
- Missouri River
  - 26 Pallid Sturgeon with transmitters made the turn into the Platte River.
    - 13 hatchery origin
    - 13 unknown origin (presumed wild?)

Passive receiver placements



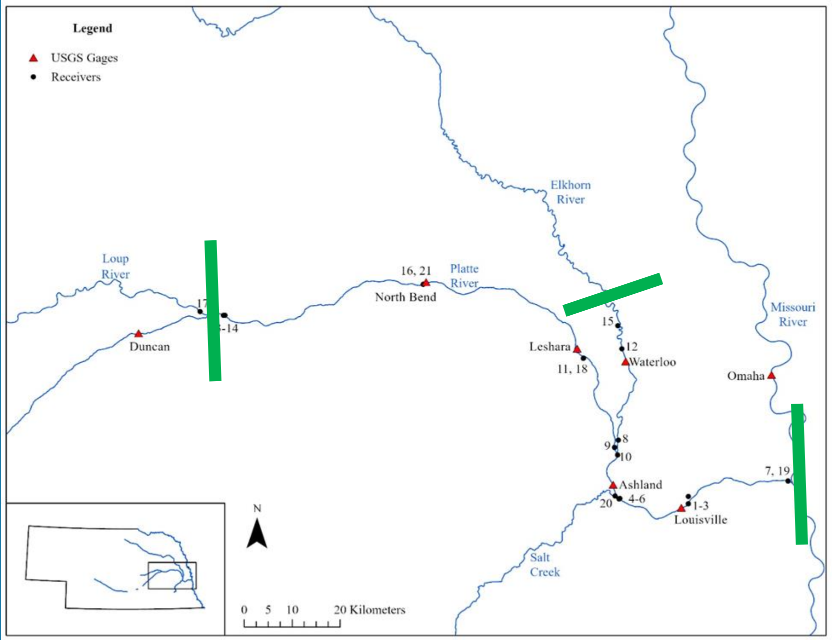
Objective 1: Movement in Platte River system.

Passive receiver placements



Objective 1: Movement in Platte River system.

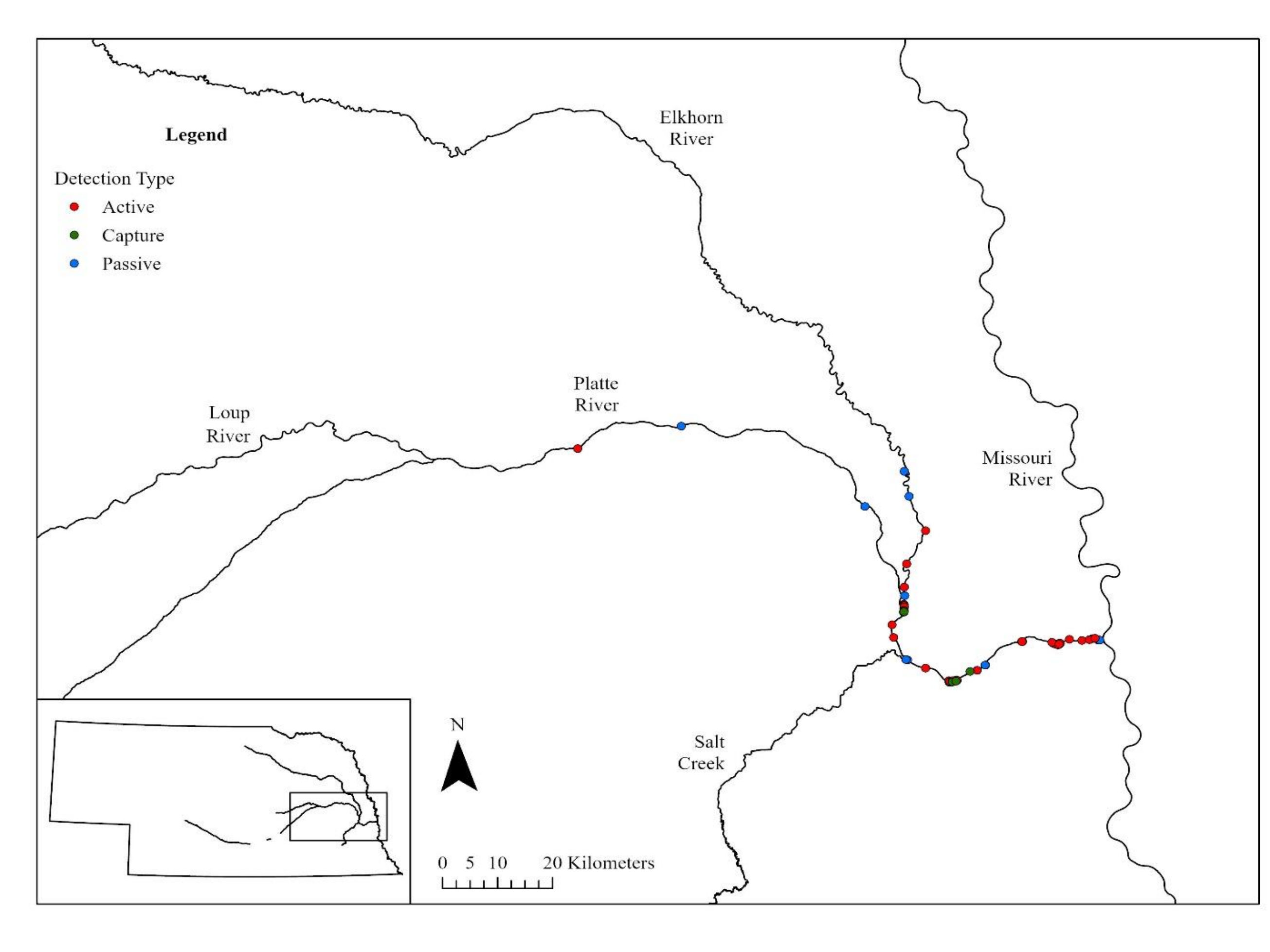
Active tracking



- Monthly river sweeps:
  - April – 190 rkm
  - May – 190 rkm
  - June – 190 rkm
  - July – 190 rkm
  - August – 190 rkm
  - September – 190 rkm
  - October – 190 rkm
  - November – 190 rkm

- Total – at least 1330 rkm searched.

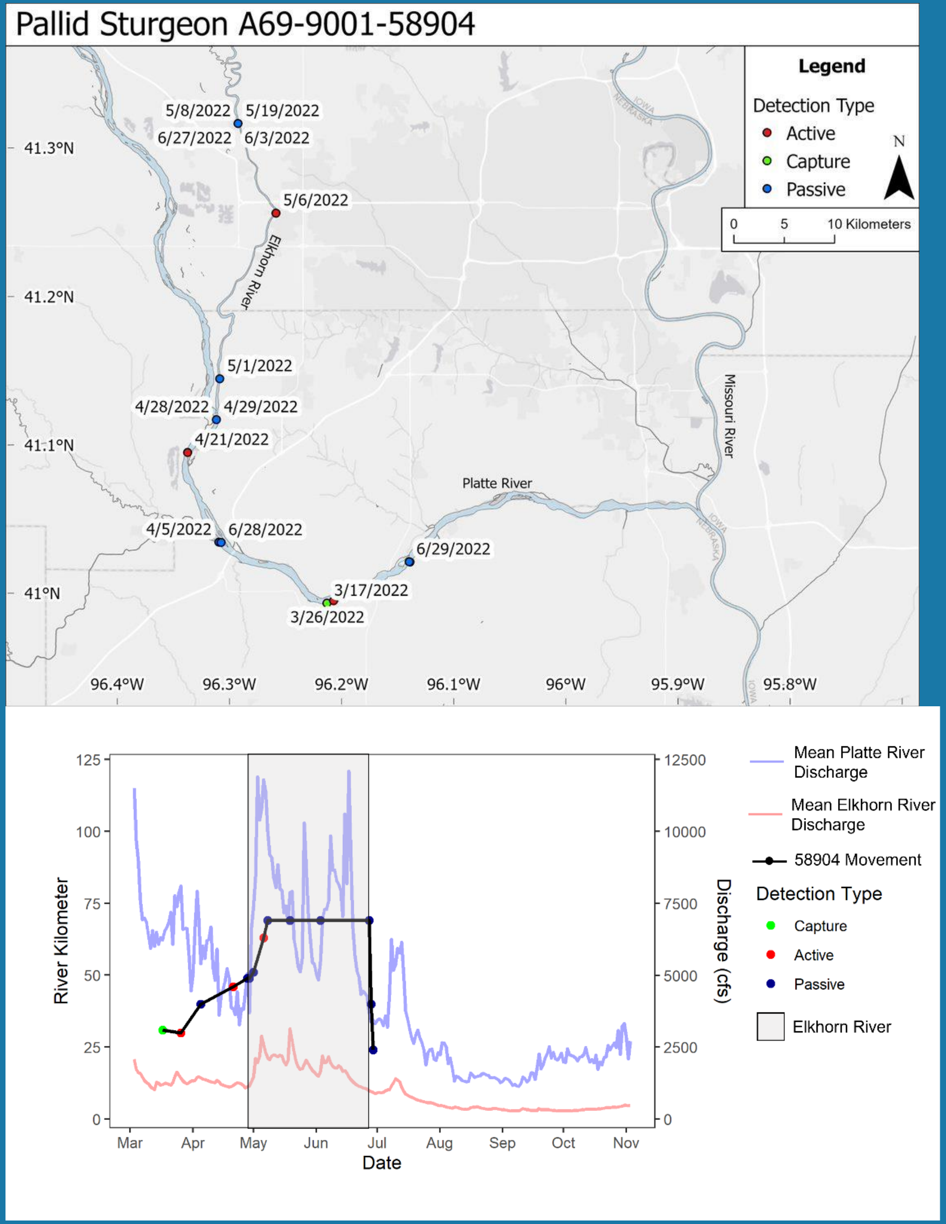
All Pallid Sturgeon encounters

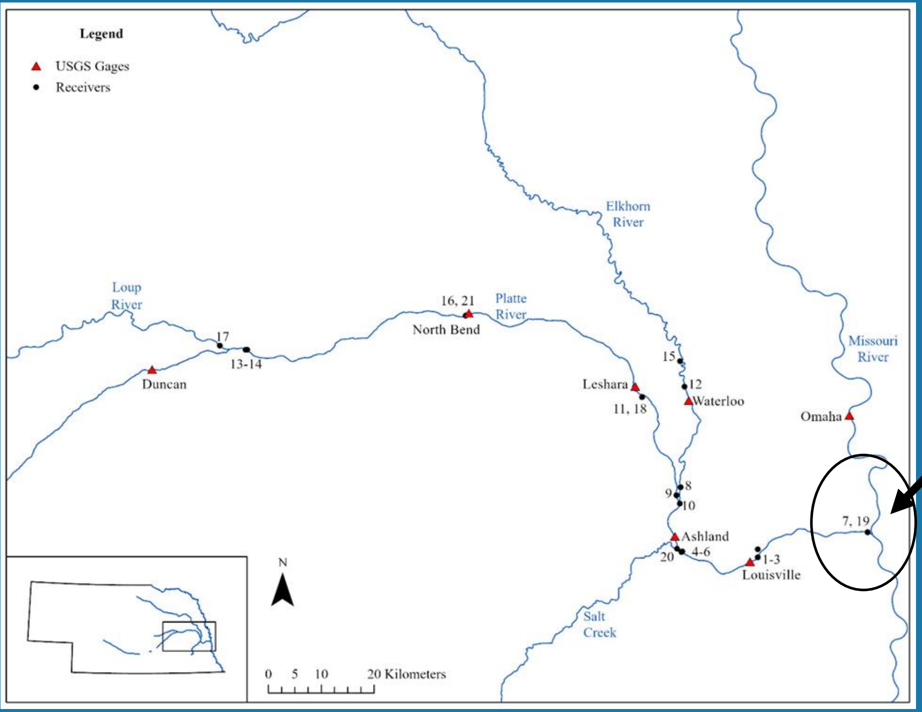


Raw counts

- Passive detections – 36,549
  - Many repeated detections
  - Includes all species encountered
    - 37 Pallid Sturgeon
    - 8 Silver Carp
    - 1 Blue Sucker
- Active detections – 54 total detections
  - 40 Pallid Sturgeon
    - Outside of suspected spawning time/location
  - 2 Silver Carp

Example movements

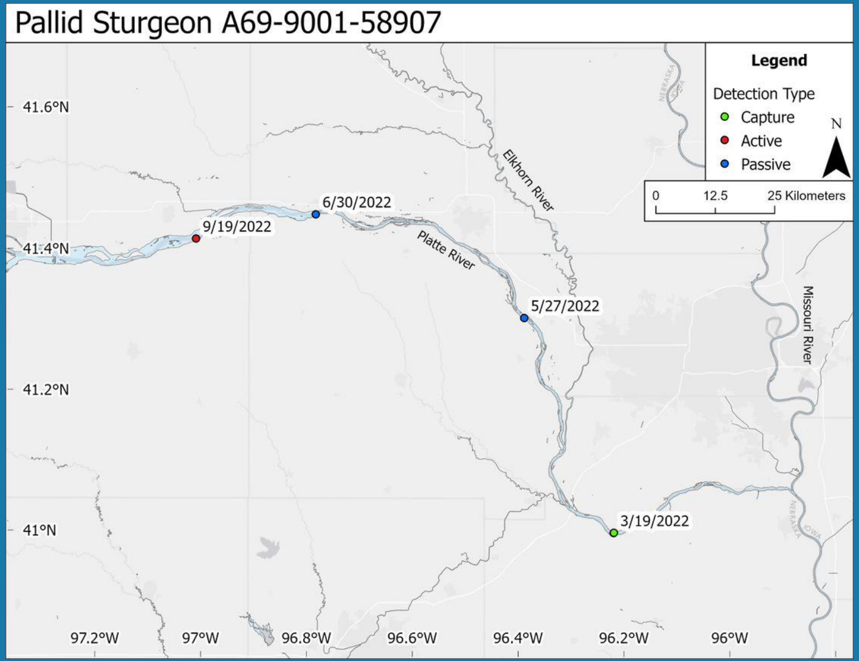


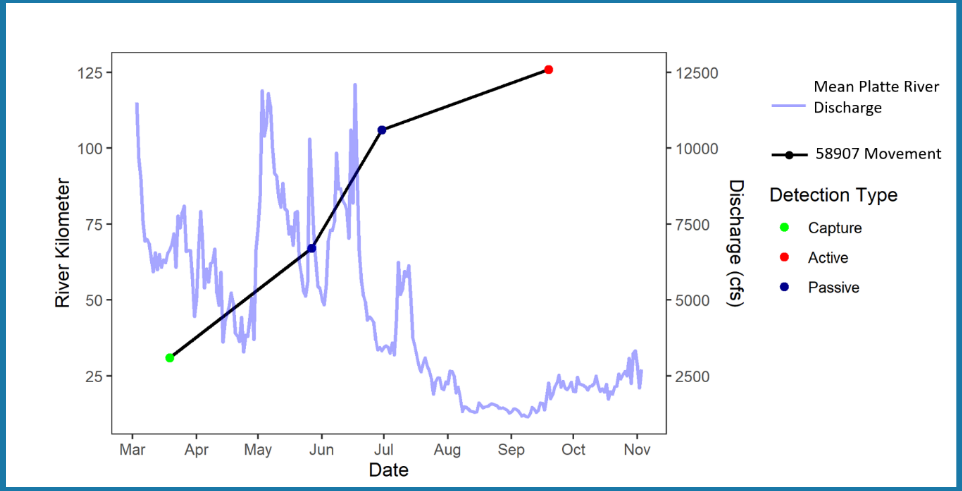


Fork Length = 885 mm
Sex = Unknown

Objective 1: Movement in Platte River system.

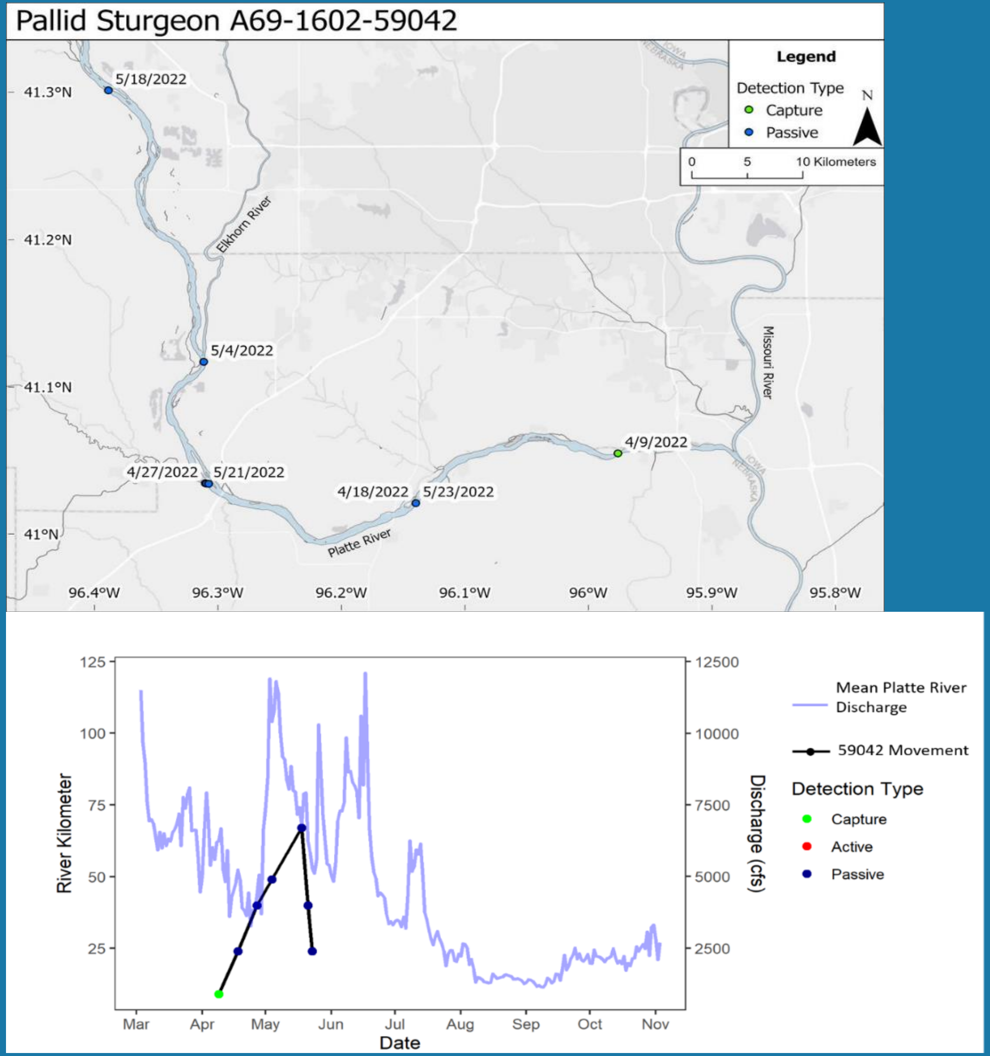
Example movements





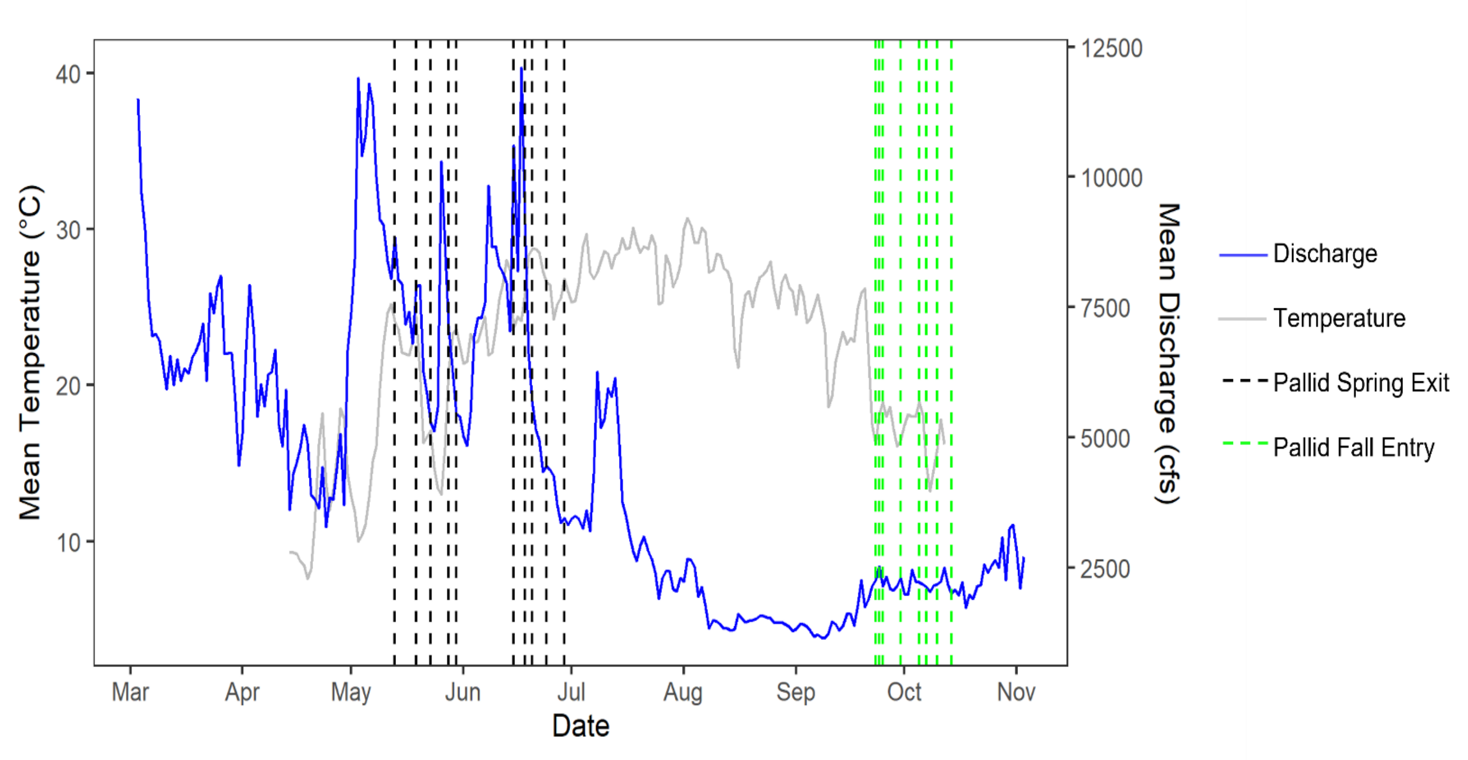
Fork Length = 809 mm
Sex = Unknown

Example movements



Fork Length = 947 mm
Sex = Female (USFWS tagged)

Pallid Sturgeon entries and departures



Detailed analyses on entry/exit timing and variables that may influence such behavior coming in the future.

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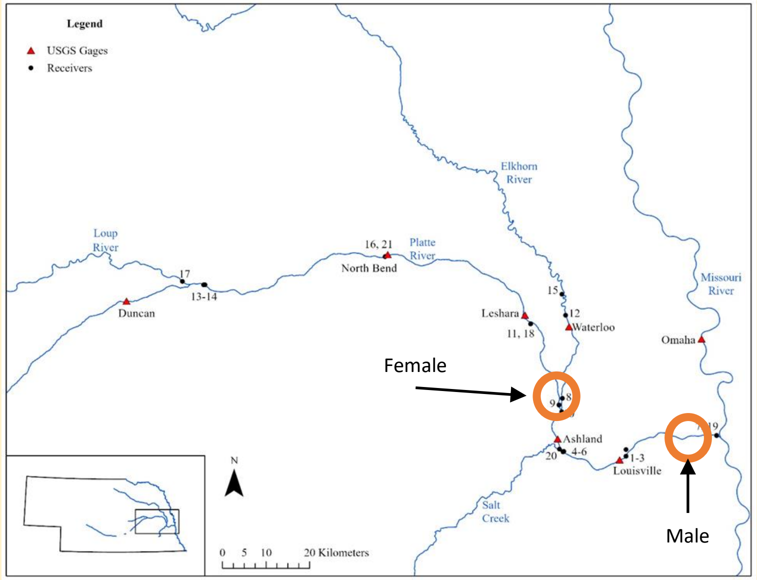
Potential spawning areas

(inferred from behavior*)

Intensive tracking

- Spawning temperature window (~15- 20 ^{o}C)
- Locate known reproductive individuals
- Monitor movements hourly - daily



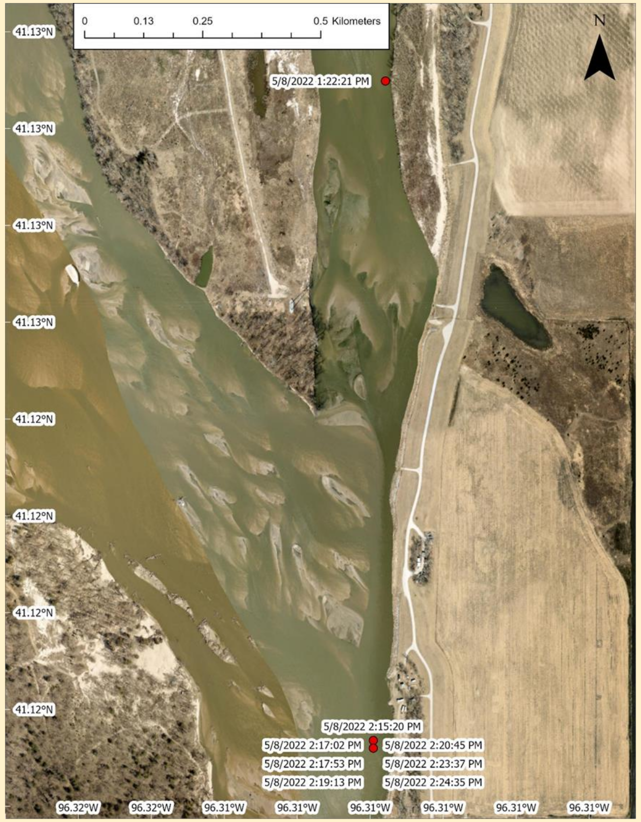
*Spawning behavior as identified in Missouri River

- Apex movement
- Females – repeated upstream/downstream movement in localized apex area.
- Males – remain in general apex area extended periods of time during window.

Objective 2: Identify spawning habitat.

Potential spawning areas

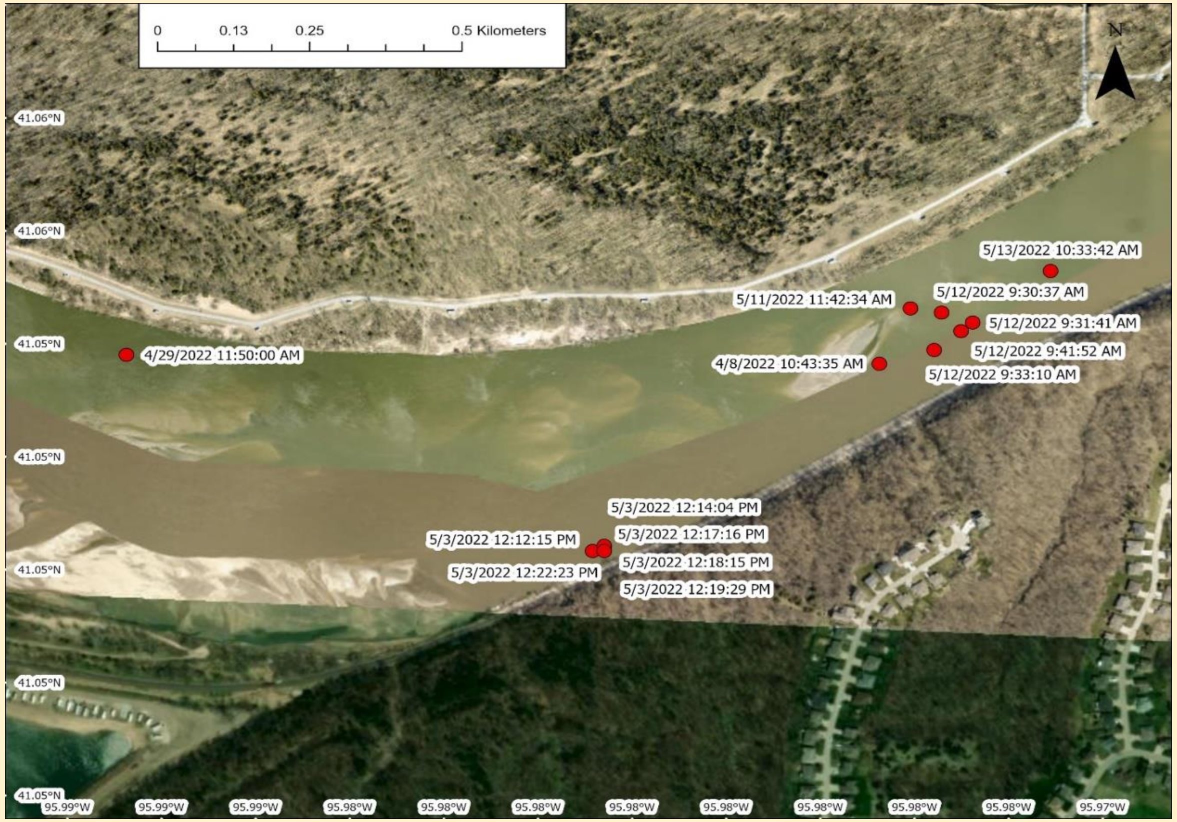
(inferred from behavior)



Fork Length = 1082 mm

Sex = Female (NGPC tagged)

Unknown origin - Reproductive (?)



Fork Length = 889 mm

Sex = Male (UNL tagged)

Wild - Reproductive (?)

Objective 2: Identify spawning habitat.

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NEBRASKA GAME PARKS

Verify spawning - egg and larvae sampling

Sampling:

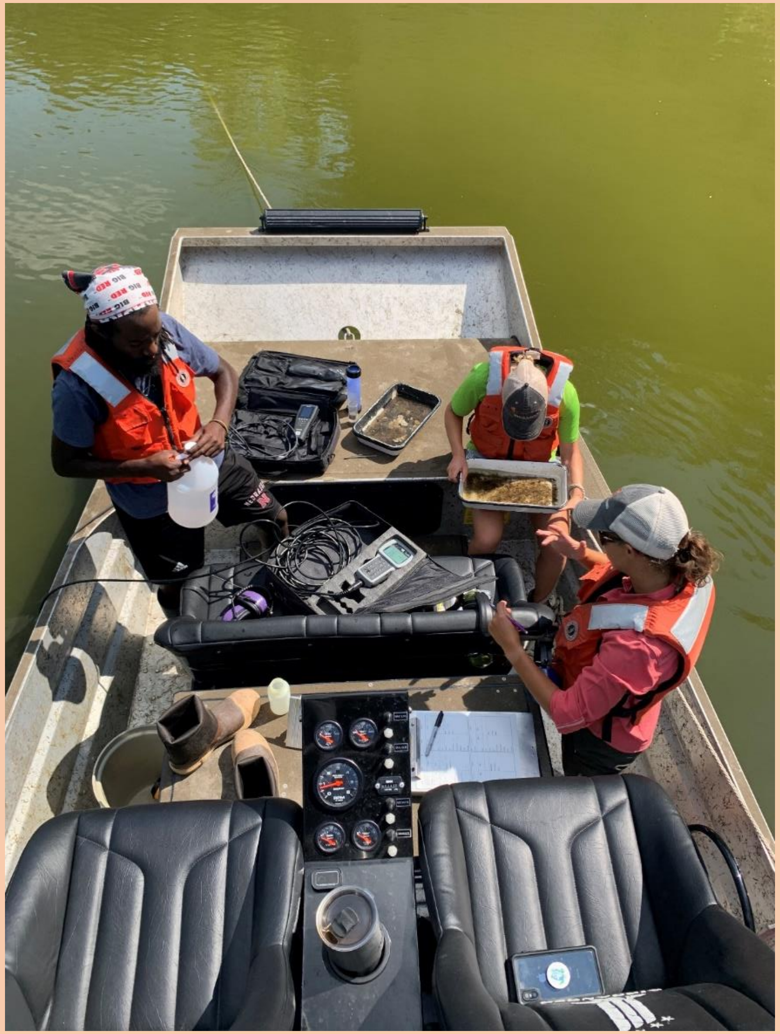
- At least 3 locations sampled per site
- Paired nets set simultaneously (subsamples)
- Targeted 5-min sets
- Catch immediately checked for Acipenseridae

Routine samples (Weekly)

- Platte-Missouri confluence
- Elkhorn-Platte confluence

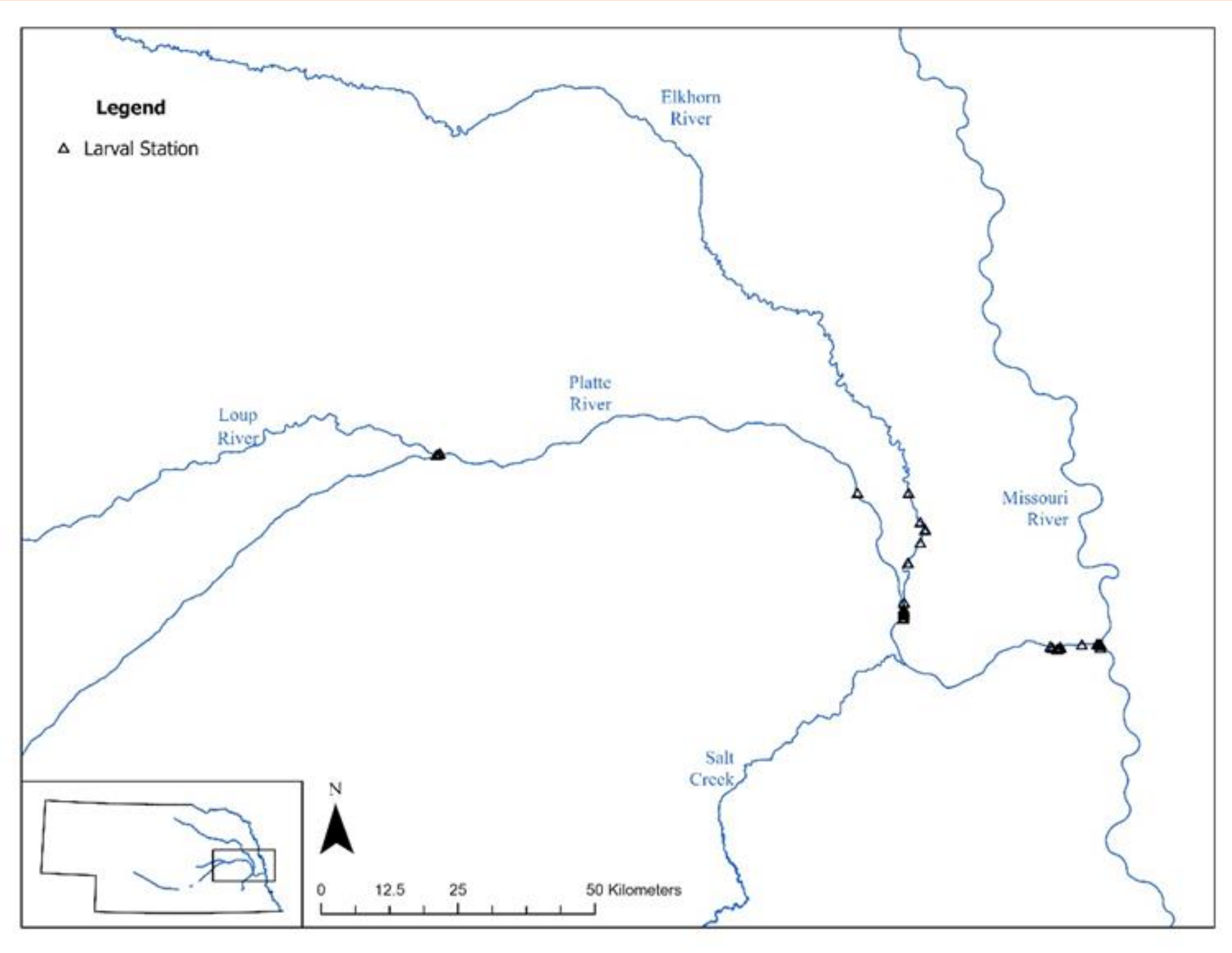
Targeted sampling:

- Suspected spawning areas from telemetry
- Similar concentrations of sturgeons elsewhere



Objective 3: Spawning verification – eggs/larvae.

Verify spawning - egg and larvae sampling



Summary

- 178 total net sets (540,000+ m^3 sampled)
  - ~216 Olympic-sized swimming pools
- 454 eggs collected
- 84 larval fish collected
- No Pallid Sturgeon collected

Objective 3: Spawning verification – eggs/larvae.

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NEBRASKA GAME PARKS

Pallid Sturgeon genetic samples

Samples sent:

- 27 fin clips
  - 1 confirmed wild individual
  - 24 hatchery (1 individual had 2 clips)
  - 1 confirmed F1 hybrid

- 2 eggs
  - *Scaphirhynchus* spp.

- 1 larva (collected during sampling for a concurrent project)
  - Confirmed Shovelnose Sturgeon

Objective 4: Genetic samples.

Take homes so far

- Captures and telemetry locations were typically in the deepest water available – consistent with previous works across their distribution.

- A lot more Pallid Sturgeon originally tagged in the Missouri River entered the Platte River and its tributaries than anticipated.
  - 215 Pallid Sturgeon implanted with Vemco transmitters in Lower Missouri River in spring 2022
  - 26 (12%) of those were located in the Platte River and its tributaries in 2022

- Works in progress
  - Improve habitat measures through direct and remote sampling
    - LiDAR and ADCP to better characterize habitat characteristics across larger spatial scales
  - Data sharing with Missouri River effort – sorting through agreements and availability logistics

Logistical challenges (2022) and future plans (2023+)

- 2022 (year of the airboat motor)
  - Logistics (the usual suspects)
    - Personnel shortages (strange, new world of hiring people)
    - Boat motor break downs/repairs/etc.
    - Sampling and data collection
      - Trotline sampling
      - Receiver placement
      - Receiver recovery

- 2023 and beyond (work in-progress)
  - Logistics
    - Personnel – sorted, hopefully
    - 2 new airboat motors (fingers crossed!)
    - Sampling and data collection
      - Targeted trotline sampling in upper reaches
      - More receivers placed above Elkhorn River
      - Receiver deployment designs are work in progress
      - Increase number of habitat samples to assist ADCP and LiDAR data.

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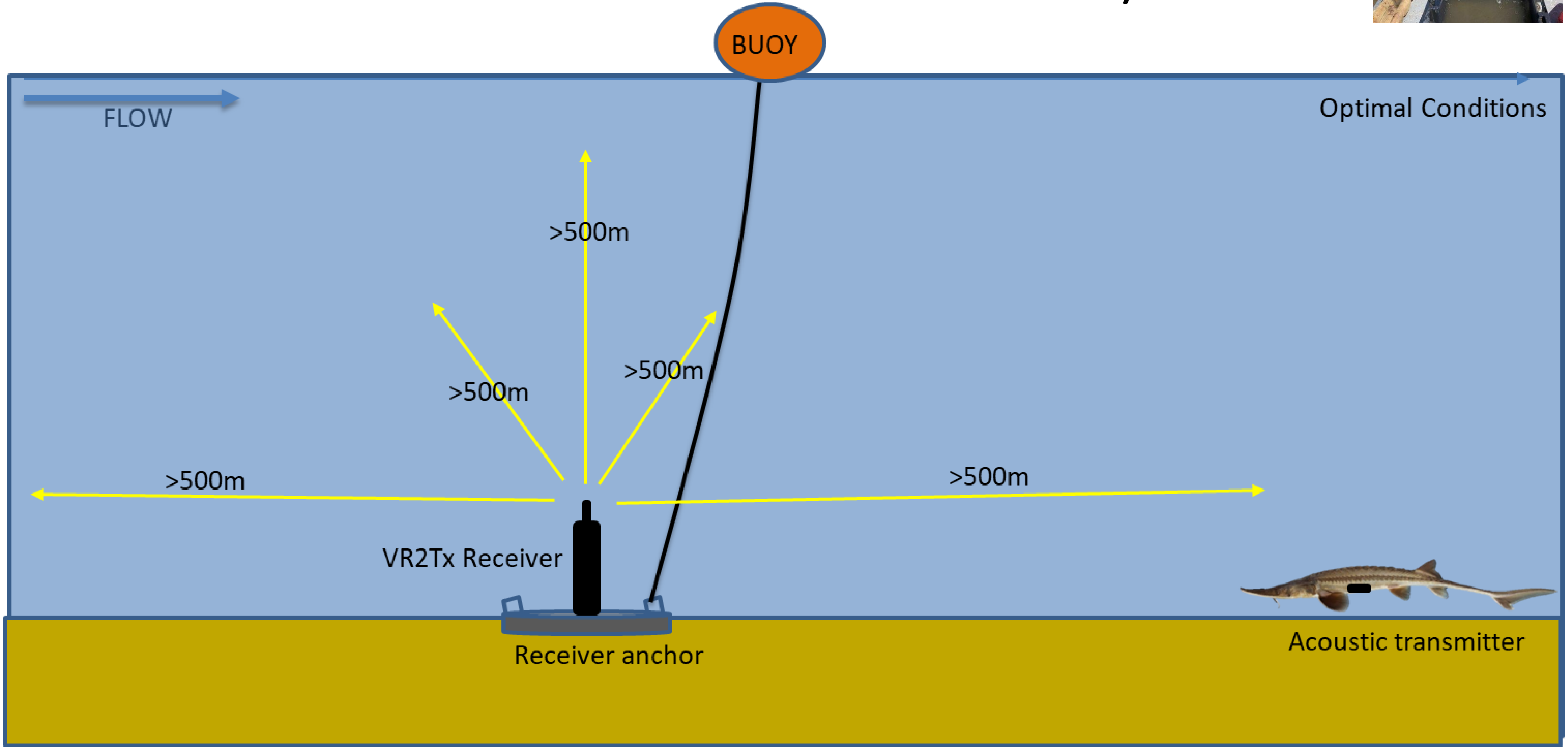
Student updates

Chris Pullano – MS student

Jenna Ruoss – PhD student

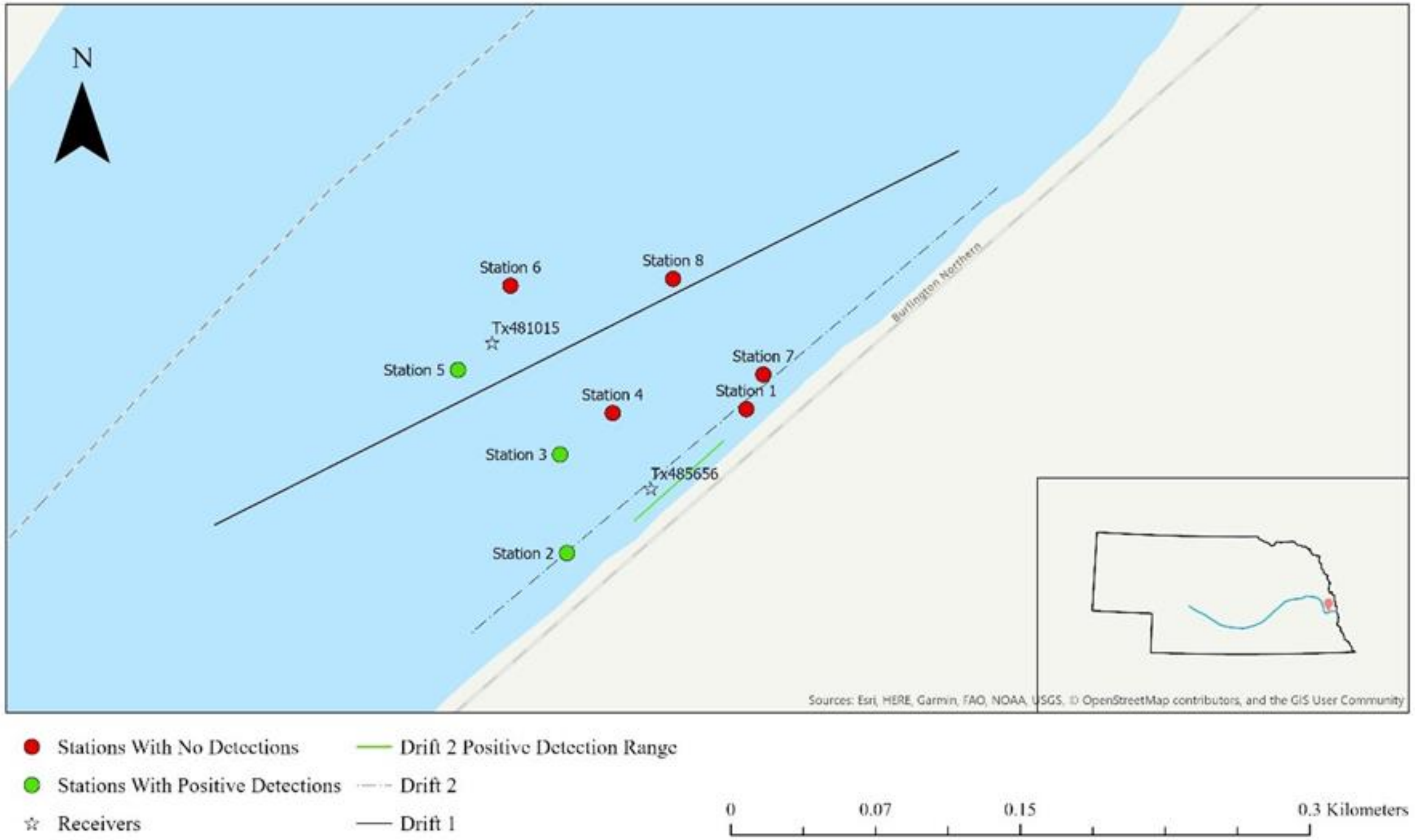
Performance of Acoustic Telemetry

Performance of Acoustic Telemetry

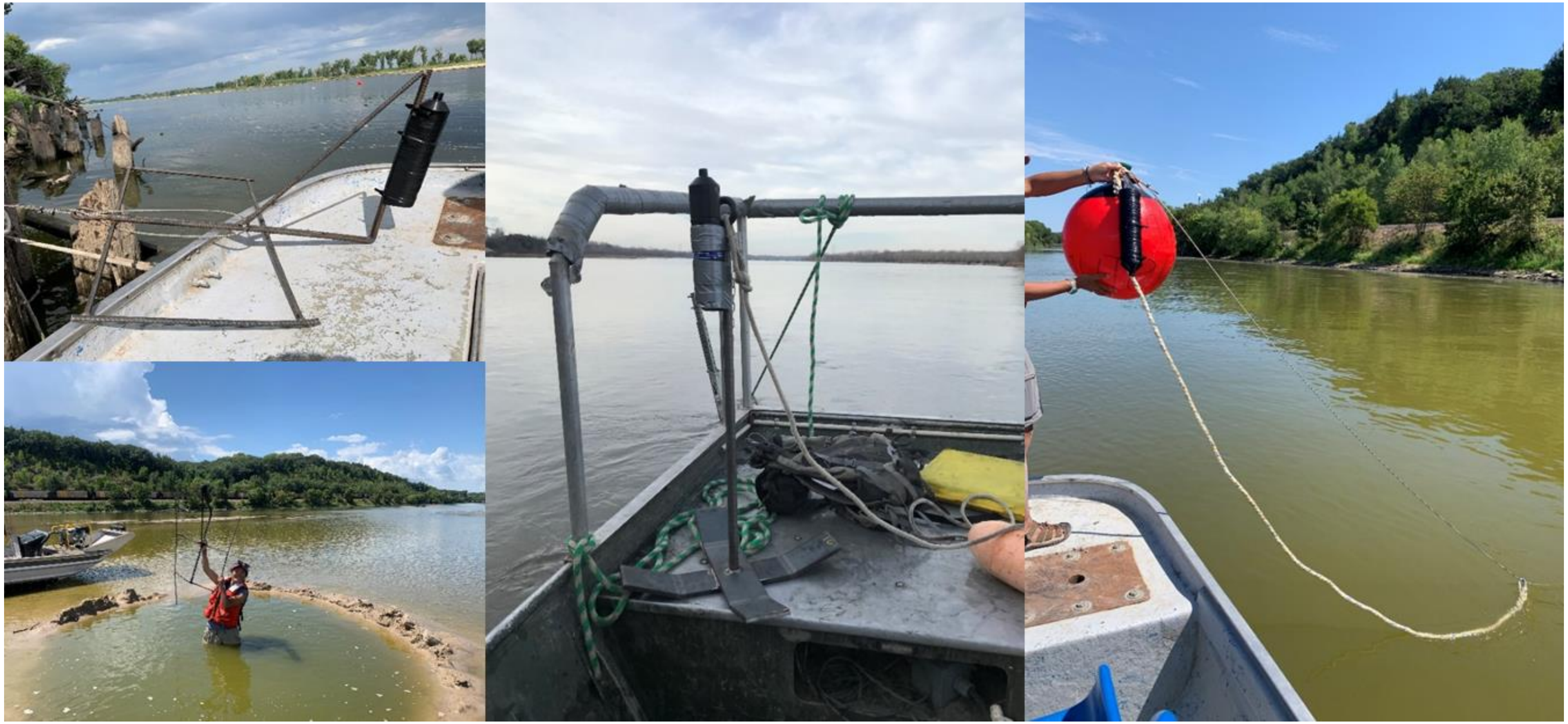


Performance of Acoustic Telemetry

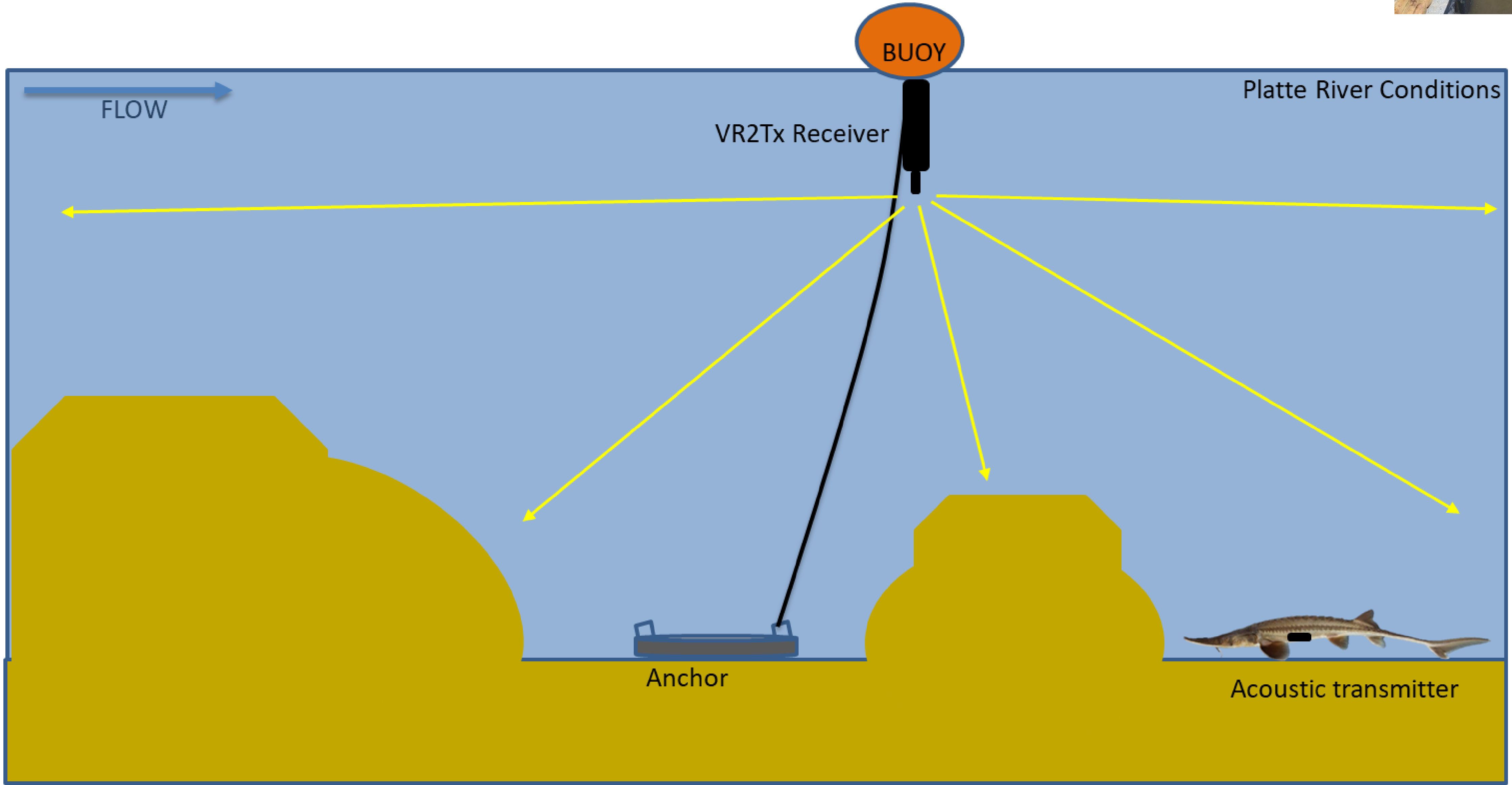
Performance of Acoustic Telemetry



Performance of Acoustic Telemetry



Performance of Acoustic Telemetry

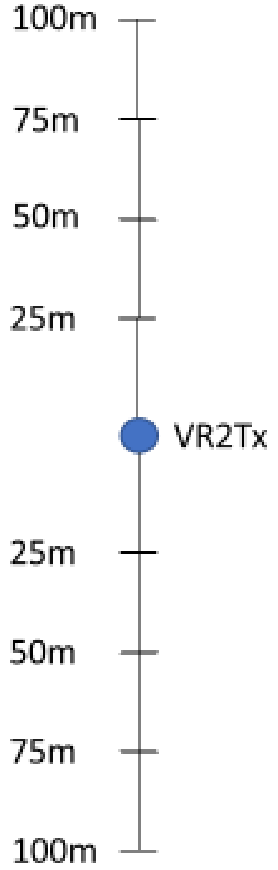


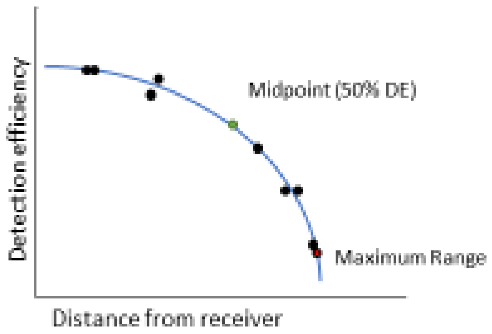
Performance of Acoustic Telemetry

1. Determine the influence of environmental conditions on the performance of acoustic telemetry in the lower Platte River, NE
    - Perform stationary range tests at three sentinel receivers using two sizes of acoustic transmitters
        - Elkhorn River (Waterloo), Platte River (North Bend), Platte River (Louisville)
        - Once per season: Spring, Summer, Fall, Winter (if possible)

- How does depth, discharge, turbidity, wind, and transmitter type influence detection range & efficiency?

Performance of Acoustic Telemetry

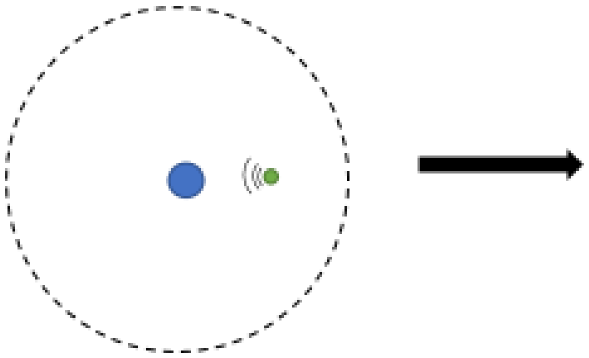


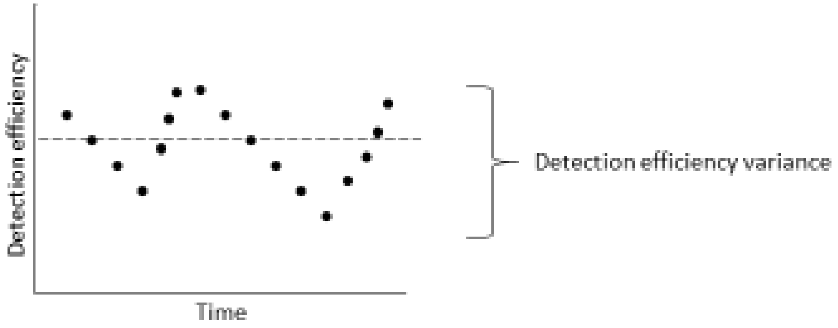


$$DEv_{r,t} = DE_{r,t} - \mu_r \quad (1)$$

$$DE_{r,t} - \mu_r < 0 \Leftrightarrow DEvc_{r,t} = \frac{DE_{r,t} - \mu_r}{\mu_r} \times 50$$
$$DE_{r,t} - \mu_r \geq 0 \Leftrightarrow DEvc_{r,t} = \frac{DE_{r,t} - \mu_r}{(100 - \mu_r)} \times 50 \quad (2)$$

$$DRc_{r,t} = MR_r + MR_r \times \frac{DEv_{r,t}}{100} \quad (3)$$



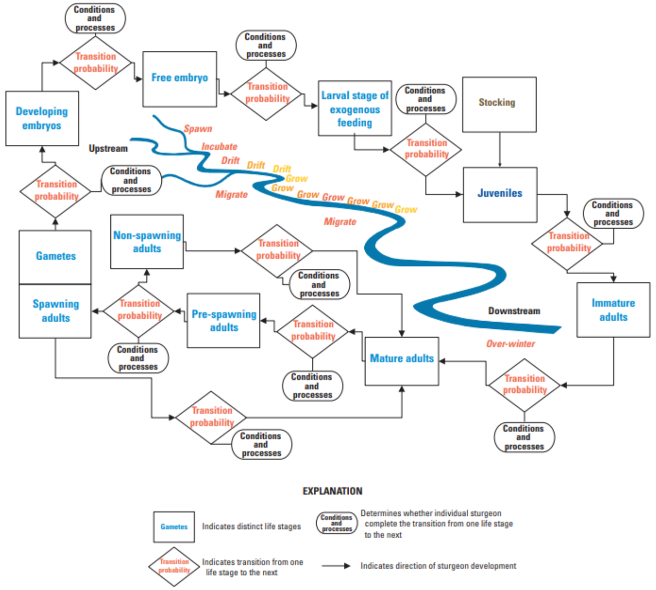


Movement Patterns of Pallid Sturgeon

- Few studies provide insight on movements of Pallid Sturgeon within tributary habitats
- Pallid Sturgeon display phenotypic plasticity with differential reproductive and life history traits among populations
- Do different demographic groups display differential movement patterns?

Trait	Upper Basin	Lower Basin
Female weight (kg)	21.6 ± 0.7 kg	3.1 ± 0.2 kg
Eggs/kg of body weight	6,146 ± 437	4,936 ± 404
Eggs extracted	112,175 ± 10,932	14,531 ± 1,484
Age at first maturity	17 female; 10–17 male	10 female; 7–10 male
Spawning cycle	2–3 years	1–3 years
Maximum age	100 years (95% CI 83–120 years)	39 years (95% CI 34–49 years)
L^{∞}	1,841 mm (95% CI 1618–2062 mm)	1,219 mm (95% CI,1,151–1,287 mm)
Annual survival	96% (95% CI 95–97%)	89% (95% CI 87–91%)
Mean life expectancy	56.4 years (95% CI 45–76 years)	19.8 years (95% CI 17–24 years)

Hamel et al. 2020

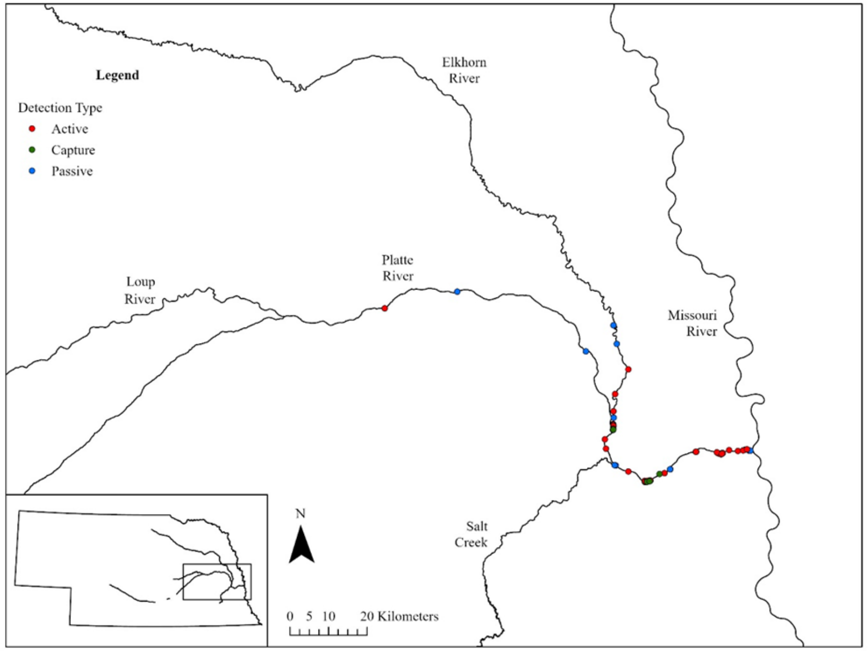


Wildhaber et al. 2007

Movement Patterns of Pallid Sturgeon

2. Determine the differences in movement patterns among demographic groups

- Use active & passive telemetry detections to determine differences in yearly displacement among demographic groups (sex, year class, length, reproductive stage, origin)



Implications of Research

1. Better inform placement and design of acoustic telemetry methods to monitor Pallid Sturgeon in the lower Platte River, NE
   - Provide index of system performance for comparisons across systems
   - Provide more accurate estimates of movement patterns

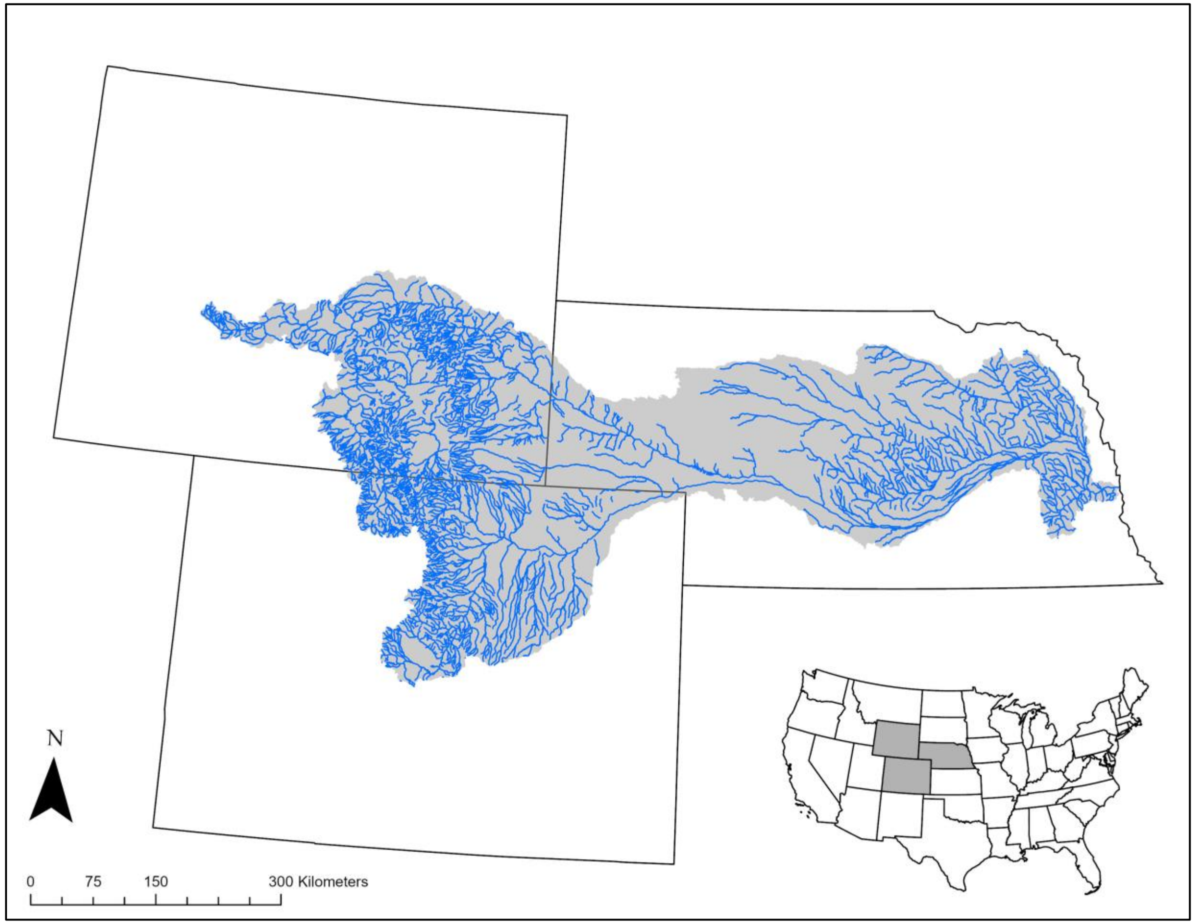
2. Increase our understanding of Pallid Sturgeon range within the Platte River and movement patterns displayed by various demographic groups

Objectives

1. Model flows of the Platte River Basin using a Soil and Water Assessment Tool (SWAT) model to determine differences between the historic flow regime with present-day.

SWAT Model

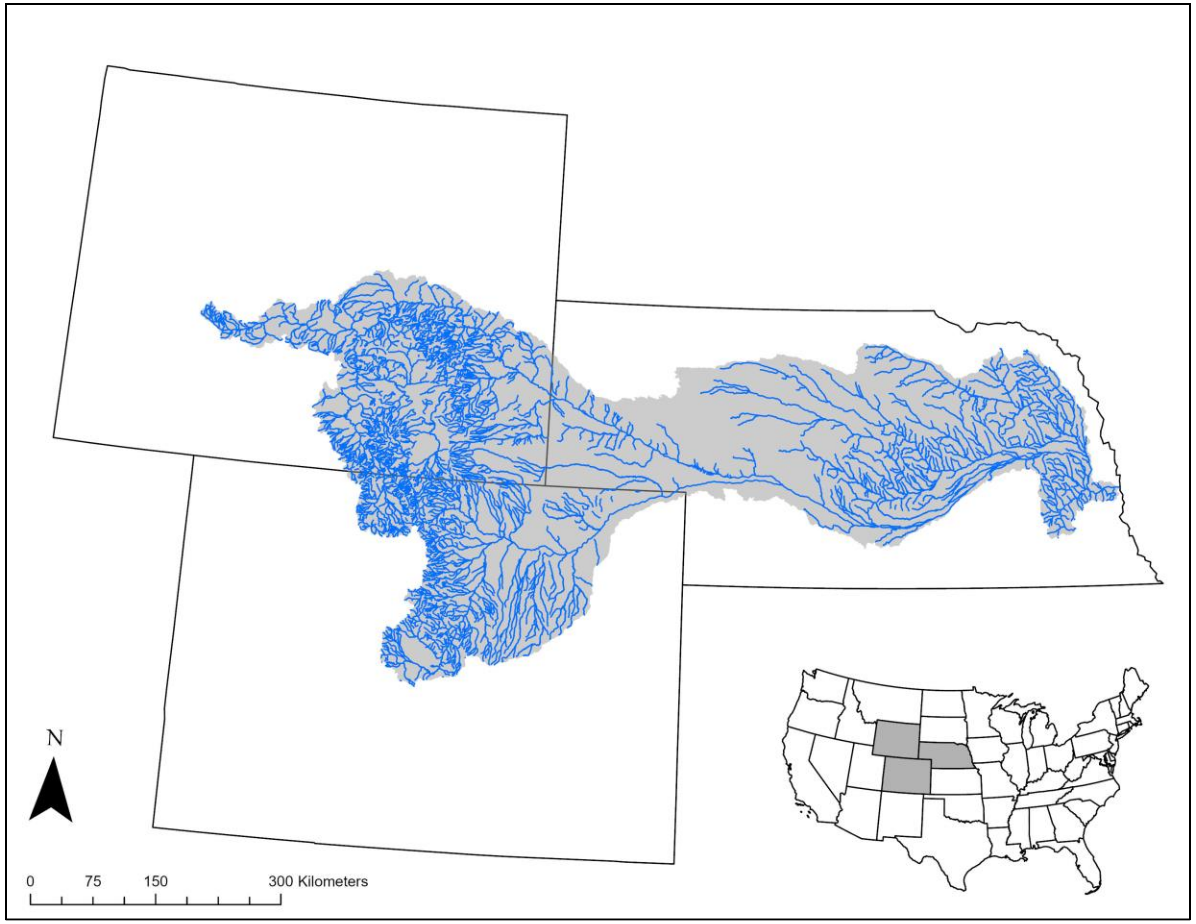
- Apply to model historic flows.



SWAT Model

- Apply to model historic flows.

- Major components: 90 m DEM, National Land Cover Data, soil layer, daily values of precipitation, and min/max air temperatures.



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1. Model flows of the Platte River Basin using a Soil and Water Assessment Tool (SWAT) model to determine differences between the historic flow regime with present-day.
2. Determine the interconnectedness of habitats in the lower Platte River using data collections from fish location assessments, LiDAR, and acoustic doppler current profiling.

Patch Dynamics

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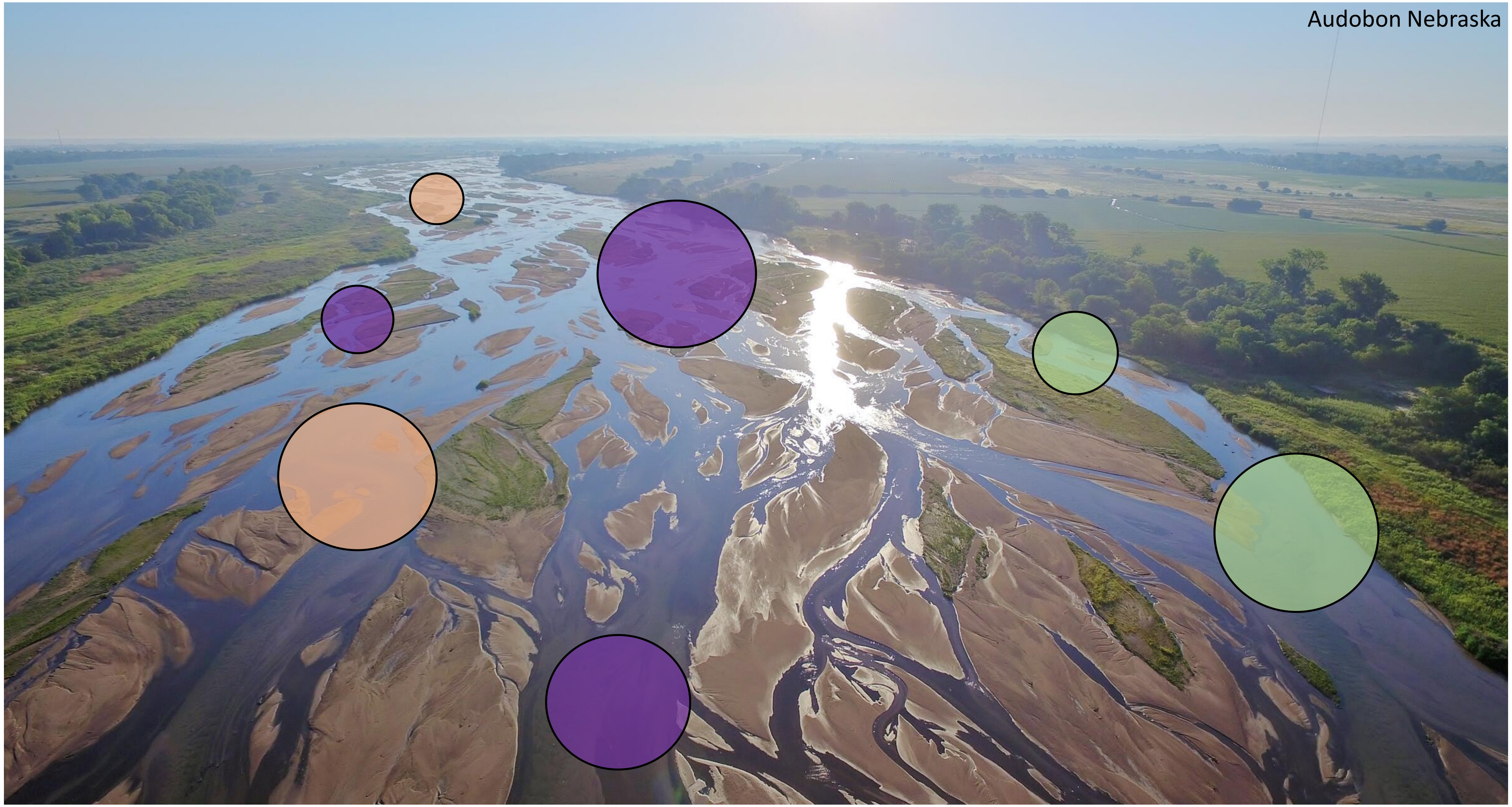
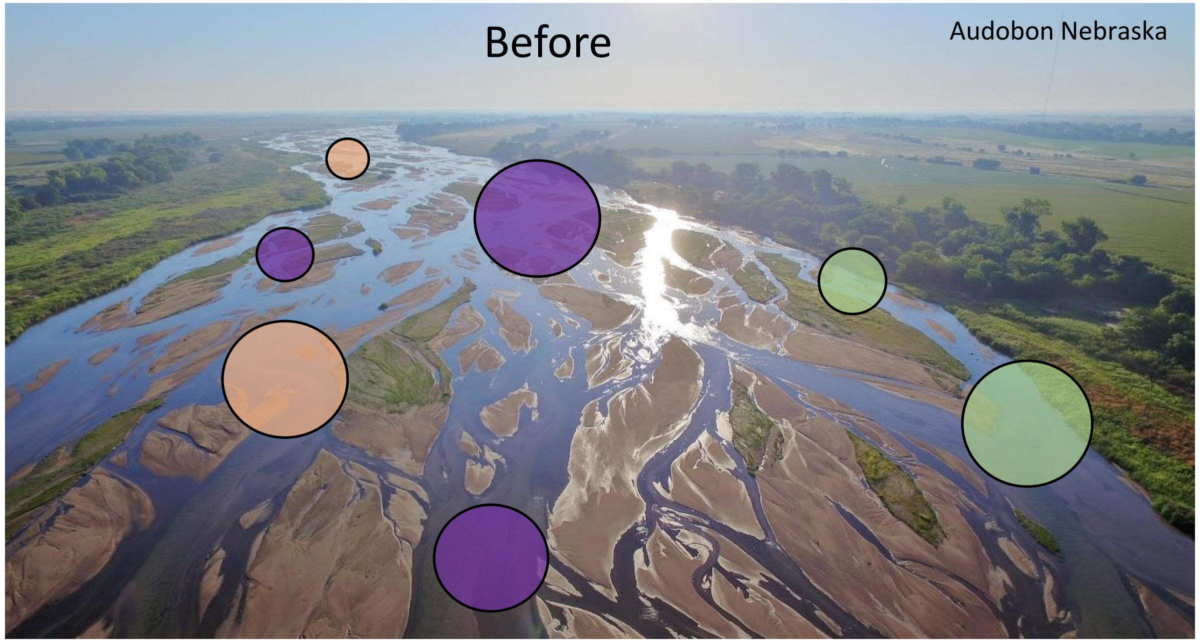
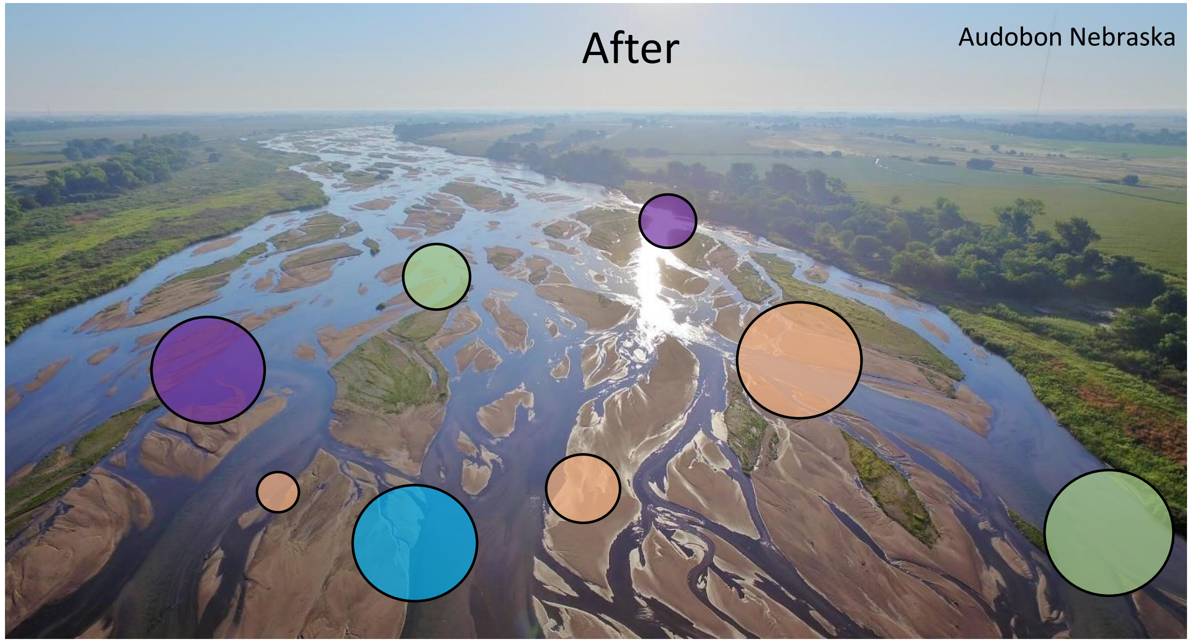


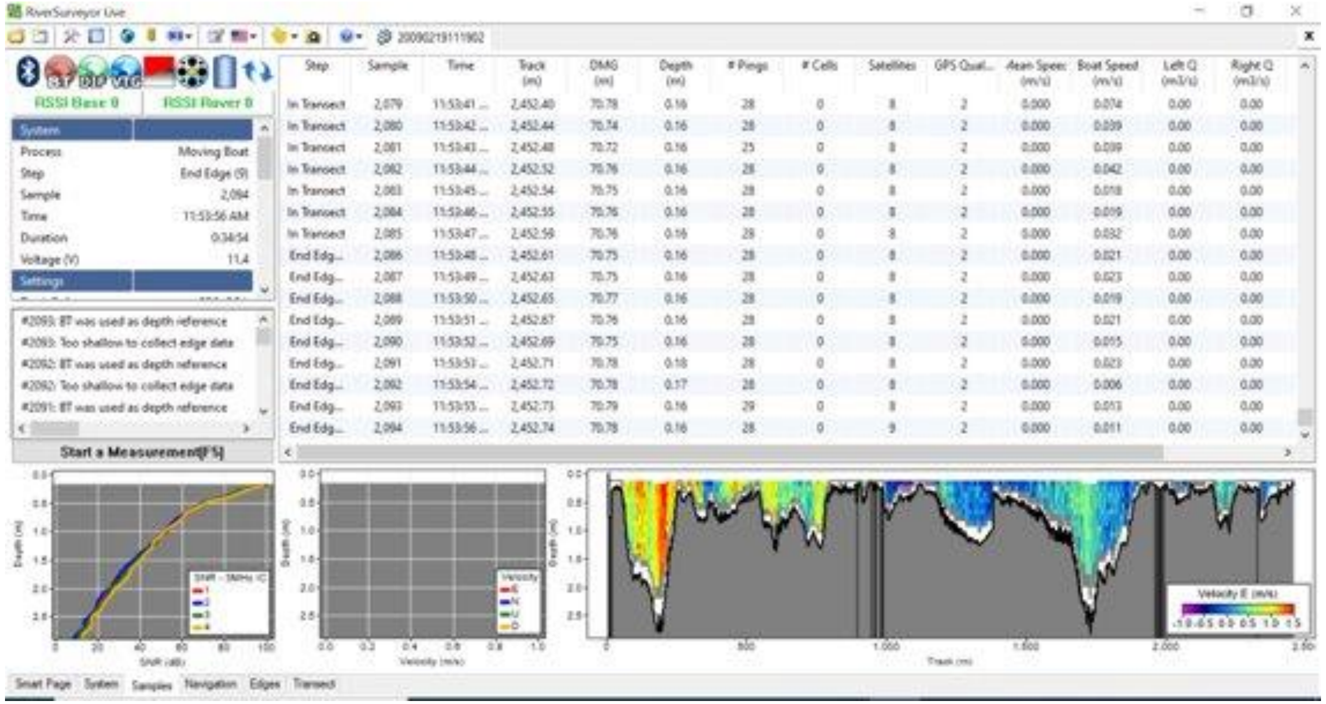
Patch Dynamics





Patch Dynamics

- Determine patches throughout the lower Platte River using LiDAR and acoustic doppler current profiler habitat mapping.
- Overlay patches with Pallid Sturgeon detections.
- Use for mapping suspected spawning areas where spawning behavior is thought to be observed.



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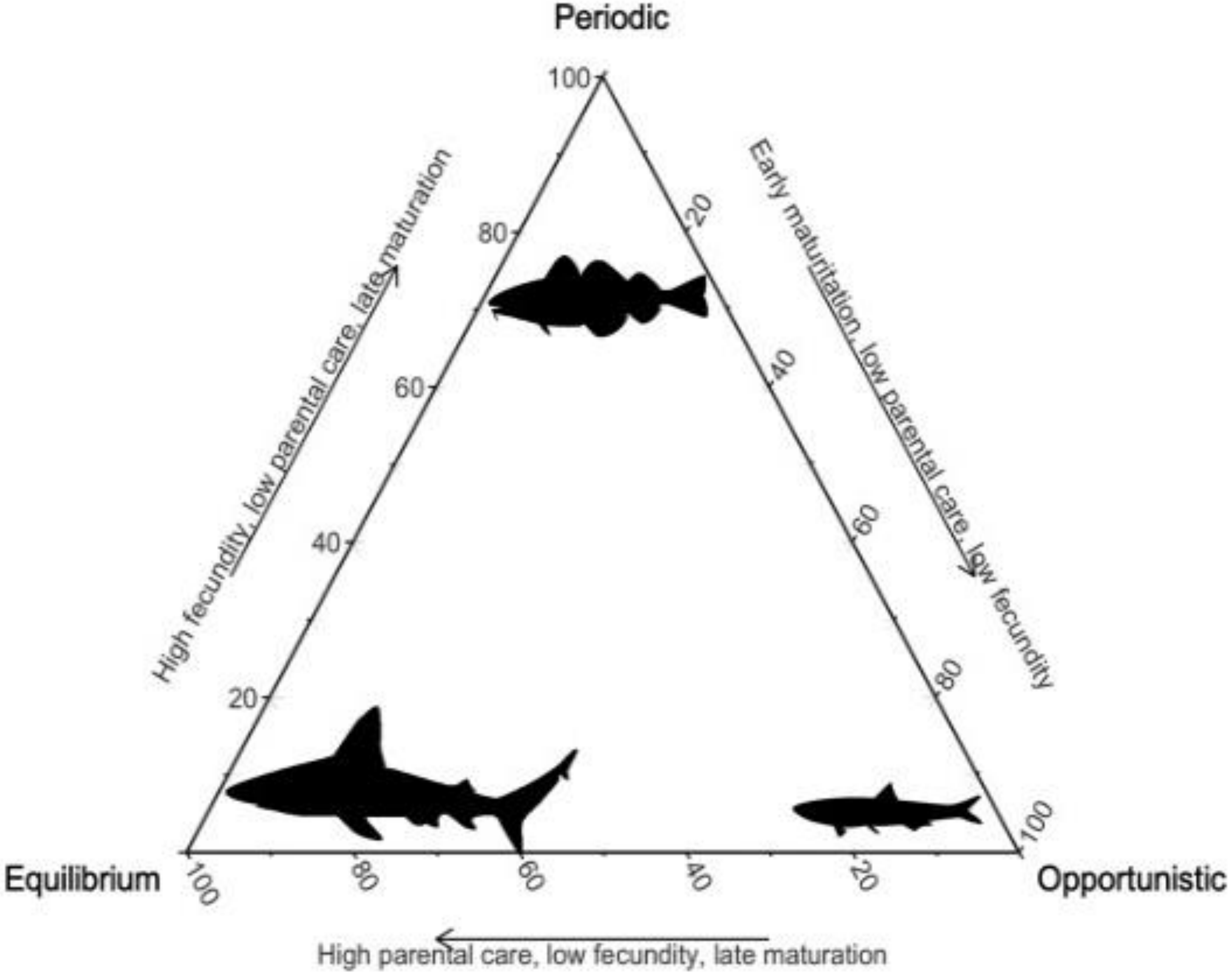
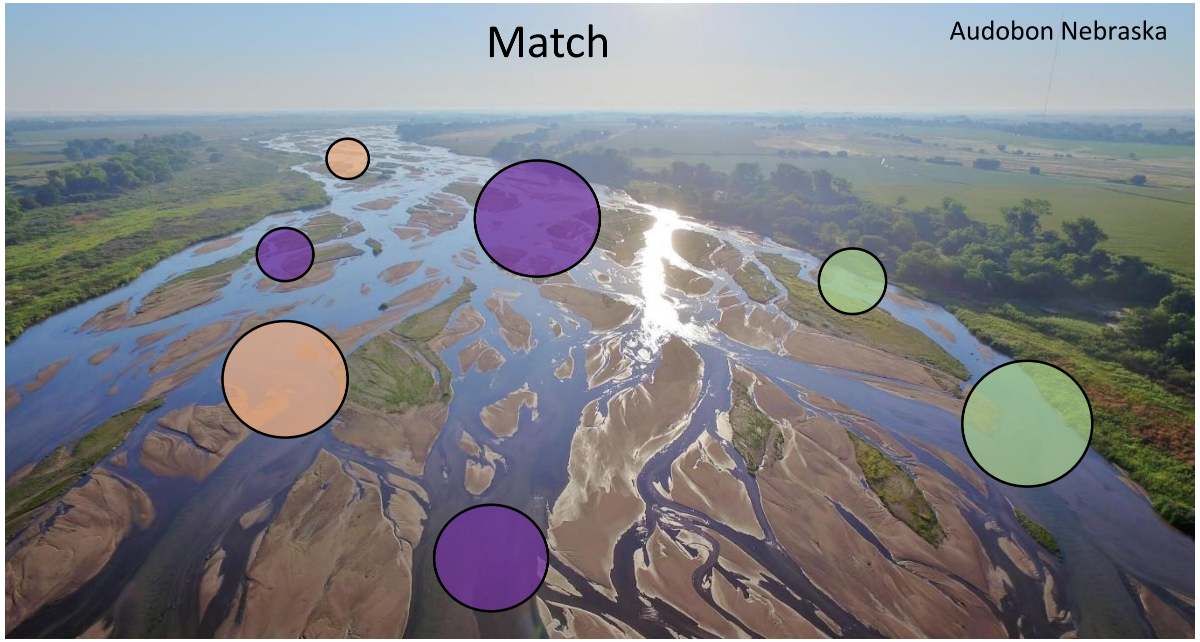
2. Determine the interconnectedness of habitats in the lower Platte River using data collections from fish location assessments, LiDAR, and acoustic doppler current profiling.
3. Determine how suitable the lower Platte River is for its current fish assemblages by using discharge records, fish surveys, and fish life history classifications.

Life History Theory



Source: Petrik (2019) derived from life histories described by Winemiller (2005).

Match-Mismatch Theory



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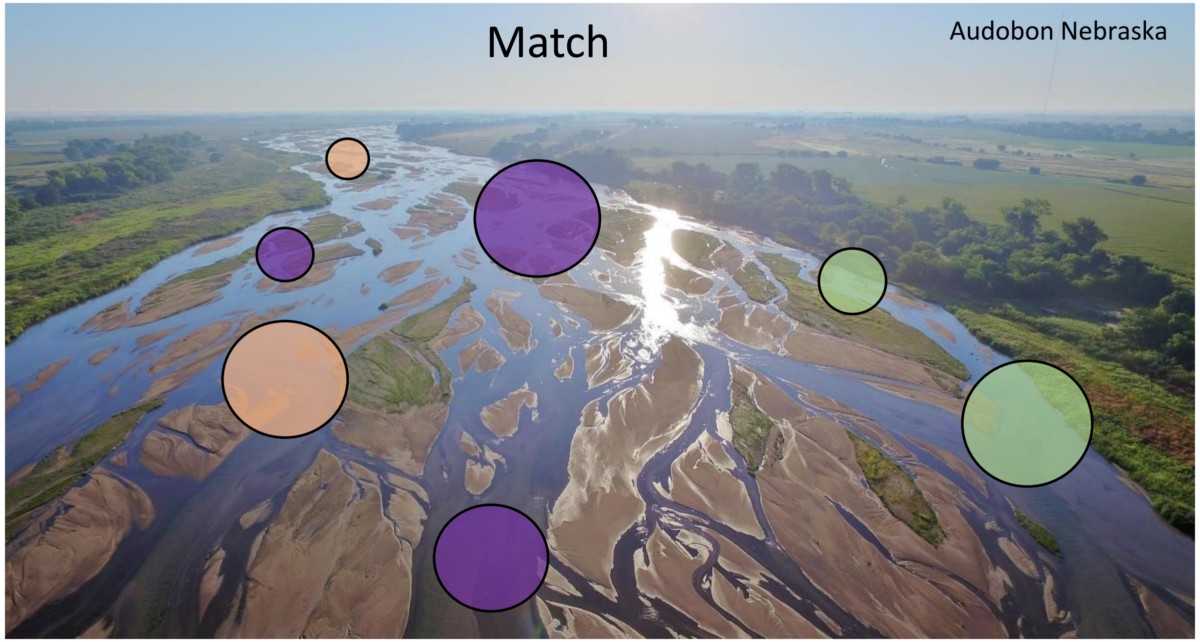
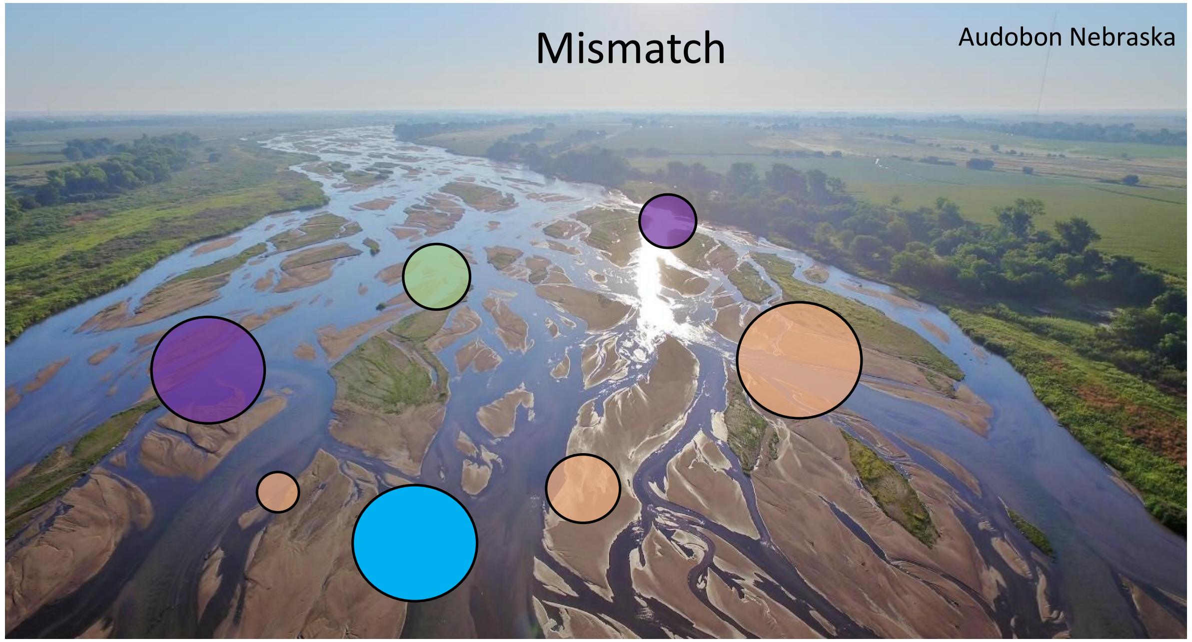
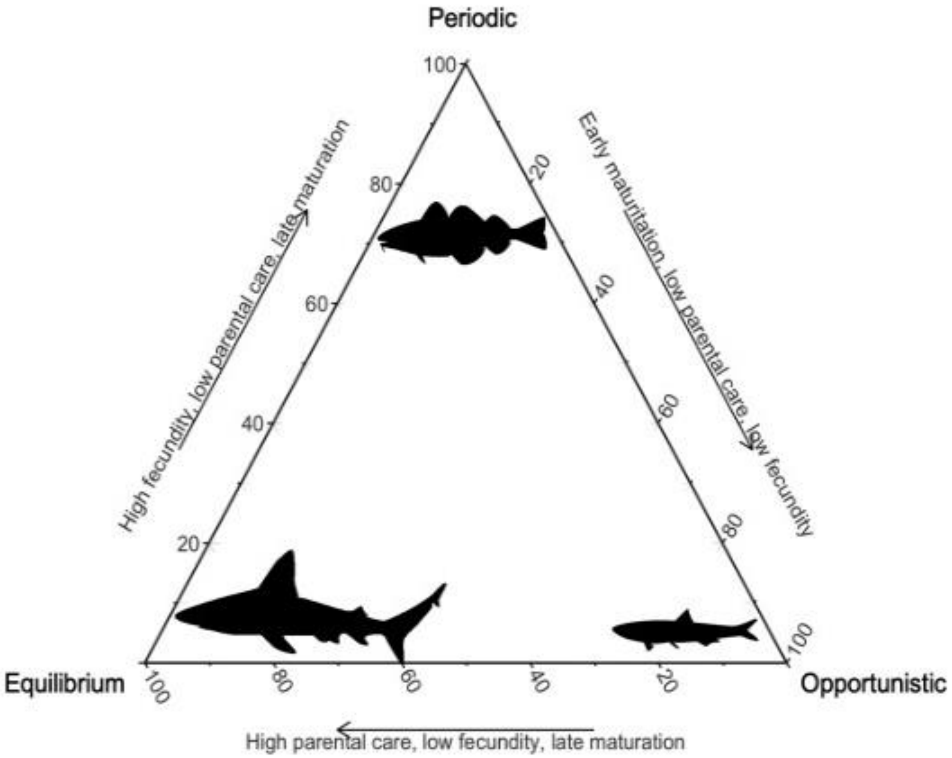




Match-Mismatch Theory

- Use fish survey data and classify fish into each life history category.

- Use methods described by Mims and Olden (2013) to determine the relationship between hydrologic variables (e.g., flow variability, predictability) and proportion of life history composition.



Source: Petrik (2019) derived from life histories described by Winemiller (2005).

Objectives and Implications

1. Model flows of the Platte River Basin using a Soil and Water Assessment Tool (SWAT) model to determine differences between the historic flow regime with present-day.
2. Determine the interconnectedness of habitats in the lower Platte River using data collections from fish location assessments, LiDAR, and acoustic doppler current profiling.
3. Determine how suitable the lower Platte River is for its current fish assemblages by using discharge records, fish surveys, and fish life history classifications.

Understand how current hydrological conditions are structuring fish communities in large, braided rivers. More specifically, understand how compatible life history strategies are for the present fish assemblage to current conditions as it relates to the timing of flows, access to habitat, etc. across space and time.