



PLATTE RIVER RECOVERY IMPLEMENTATION PROGRAM (PRRIP -or- Program)

TO: Technical Advisory Committee (TAC)
FROM: Executive Director's Office (EDO)
SUBJECT: Landcover Classification and On-Channel Variables for Whooping Crane Stopover vs. Flyover Analysis
DATE: April 18, 2025

Background

In December 2024, the whooping crane working group finalized a stepwise analysis process to address EBQ #4, beginning with non-habitat, unmanageable variables and gradually incorporating on-channel and off-channel variables to better understand the factors associated with whooping crane stopover and flyover patterns. This [data analysis plan](#) was presented to the TAC in February, 2025. At that meeting, the EDO also presented a preliminary analysis that included non-habitat, unmanageable variables in Step 1 of the analysis process. This initial analysis established a framework for evaluating variables and set criteria to determine which ones warranted further investigation.

Following the stepwise plan, the EDO then began working on methods for quantifying on-channel habitat metrics to be added to the analysis framework for Step 1. Classification of land cover across all three river systems (Niobrara, Loup, and Platte) is essential for quantifying on-channel variables that the Program can manage, that have been shown to be important in prior analyses, and that can be linked back to river flow.

- **Unforested channel width**
- **Unobstructed channel width**
- **Wetted channel width**

The EDO has been refining methods to measure these variables consistently across migration seasons and river systems using landcover classifications derived from satellite imagery.

Landcover Classification Methods (see Steps section for visual example)

What imagery do we need, and why?

To capture wetted width of the river channel accurately, we require imagery representing both **low** and **high flow** conditions within each migration season on each river system (Niobrara, Loup, and Platte rivers). These conditions approximate the range of flows that birds may encounter and how they translate to wetted width on each river system. At the individual level, the ability to estimate wetted width at any flow during a migration season allows us to match what a telemetry bird experiences at a temporally relevant scale.



What imagery did we acquire?

- **Source:** Sentinel-2, 4-band satellite imagery ([LINK TO IMAGERY](#))
- **Coverage:** Multiple images were required for some areas, such as three images for the Loup River due to satellite path overlap
- **Challenges affecting what imagery we can utilize:**
 - Sentinel-2 revisits every 4–6 days
 - Image quality and availability was variable due to cloud cover (required < 30% cloud cover) and other factors.
 - Flows needed to be representative of seasonal low and high flows
 - Example – Niobrara Imagery for spring 2018
 - High Discharge occurred on 3/26/2018 (2,460 cfs; Figure 1)
 - Low discharge occurred on 4/6/2018 (1,470 cfs; Figure 1)

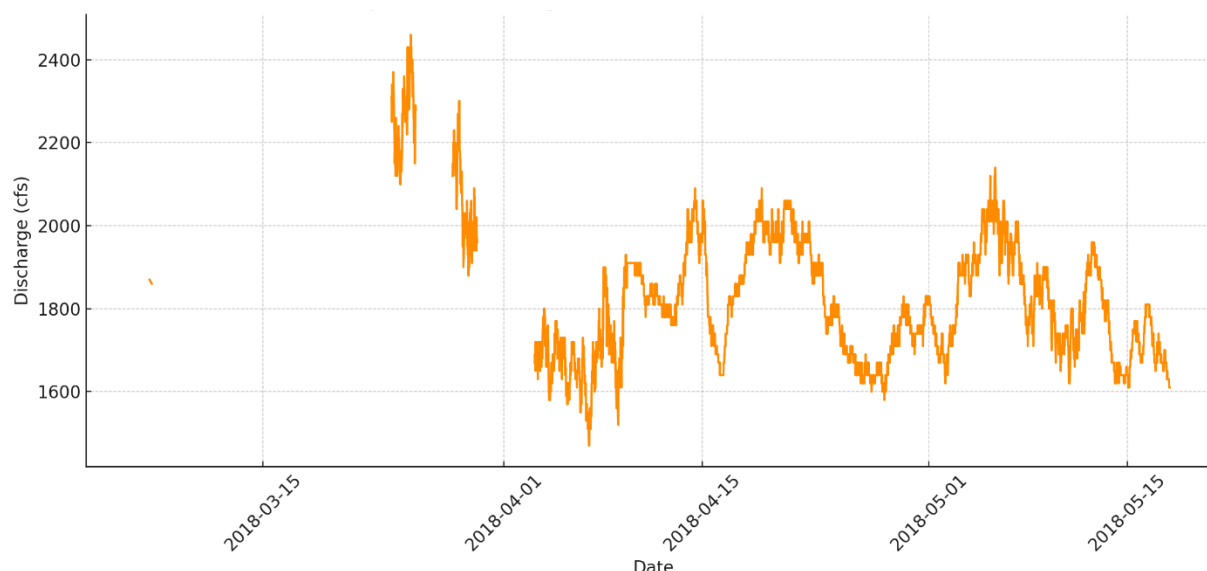


Figure 1. Discharge at Mariaville River Gage on the Niobrara River in spring 2018 from 3/6/2018 – 5/18/2018 (Figure 1).

- **Imagery Results**
 - Imagery typically acquired within **30 days** of the target dates to get flows within 20% of low or high flows within the migration seasons (Table 1).
 - Some imagery from outside of migration season due to imagery availability with appropriate flows.
 - Flows were typically within 20% of the low or high flow from the migration season.



Table 1. Comparison of target dates and flows to when imagery was available for the 2018 spring and fall migration seasons on the Niobrara River.

River	Year	Season	Flow	Target date	Target Flow (cfs)	Imagery Dates	Imagery Flow Min (cfs)	Imagery Flow Max (cfs)
Niobrara	2018	spring	min	4/7/2018	1470	June 2nd, June 3rd, June 5th, June 8th	1200	1600
Niobrara	2018	spring	max	3/25/2018	2460	March 22nd, March 27th, June 22nd	2000	2200
Niobrara	2018	fall	min	11/2/2018	1400	August 24th, August 26th	1100	1100
Niobrara	2018	fall	max	10/10/2018	1750	October 3rd, October 5th	1600	1650

Once Imagery was acquired, how did we classify imagery into landcover classes?

- Explored *supervised classification methods* including Random Forest, K nearest neighbor and XG Boost.
 - However, developing training data for each river within each migration season would be impractical at our spatial and temporal scale.
- Instead, we tested **Gaussian mixed model** and **K means clustering** *unsupervised classification methods* against 119 validation points with known landcover types.
 - Gaussian Mixed Model predicted the vegetated class correctly 80% of the time.
 - Results were like those obtained from supervised classifications.
- Final classifications used Gaussian Mixed Model to identify eight land cover classes along river channels.



Where and when have we applied classification methods and measured on-channel variables?

- Unvegetated channel width (sand and water) and wetted channel width (water) have been measured for the entire **Niobrara River** in fall 2018 and spring 2018 and a section of the **North Loup River** in spring 2018.
- Unobstructed channel width was simplified to **unvegetated channel width** due to our inability to assess vegetation height without LiDAR.

How did we validate accuracy of on-channel variables?

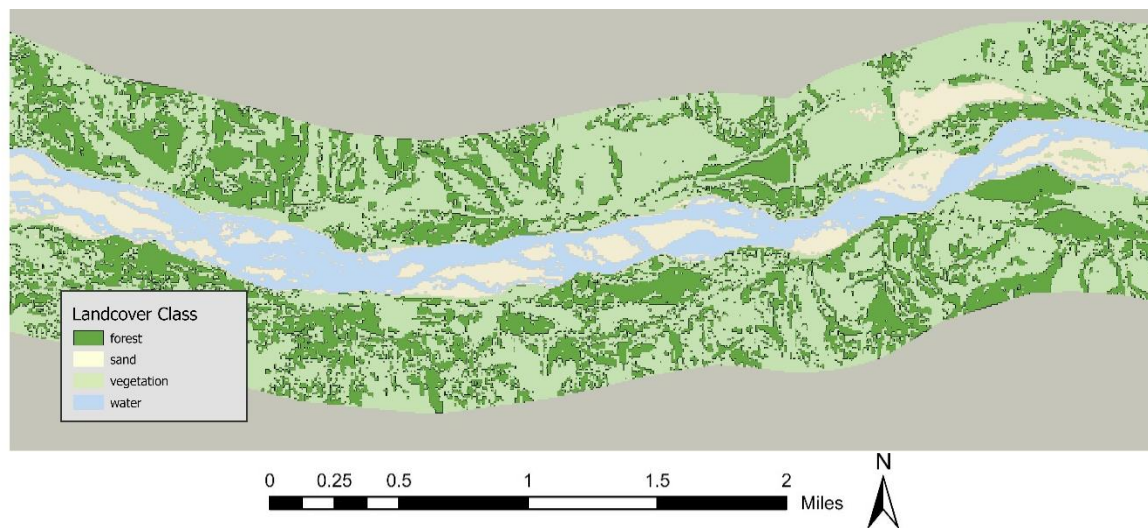
- Compared wetted widths and unvegetated channel widths derived from classified imagery (**auto-generated**) with **photo-interpreted** measurements at transects spaced every 5000 ft (125 transects on the Niobrara) for spring 2018.
- Have not tested unforested channel width yet.
- **Results**
 - Unable to accurately estimate wetted width through photo-interpretation due to image clarity in the river channel.
 - Automated classification was better able to distinguish shallow water from dry sand in the river channel than photo interpretation likely due to the near-infrared band.
 - Unvegetated widths similar for auto generated and photo generated methods.
 - Example Spring 2018
 - At Minimum flows – 6% difference on average
 - At Maximum flows – 2% difference on average



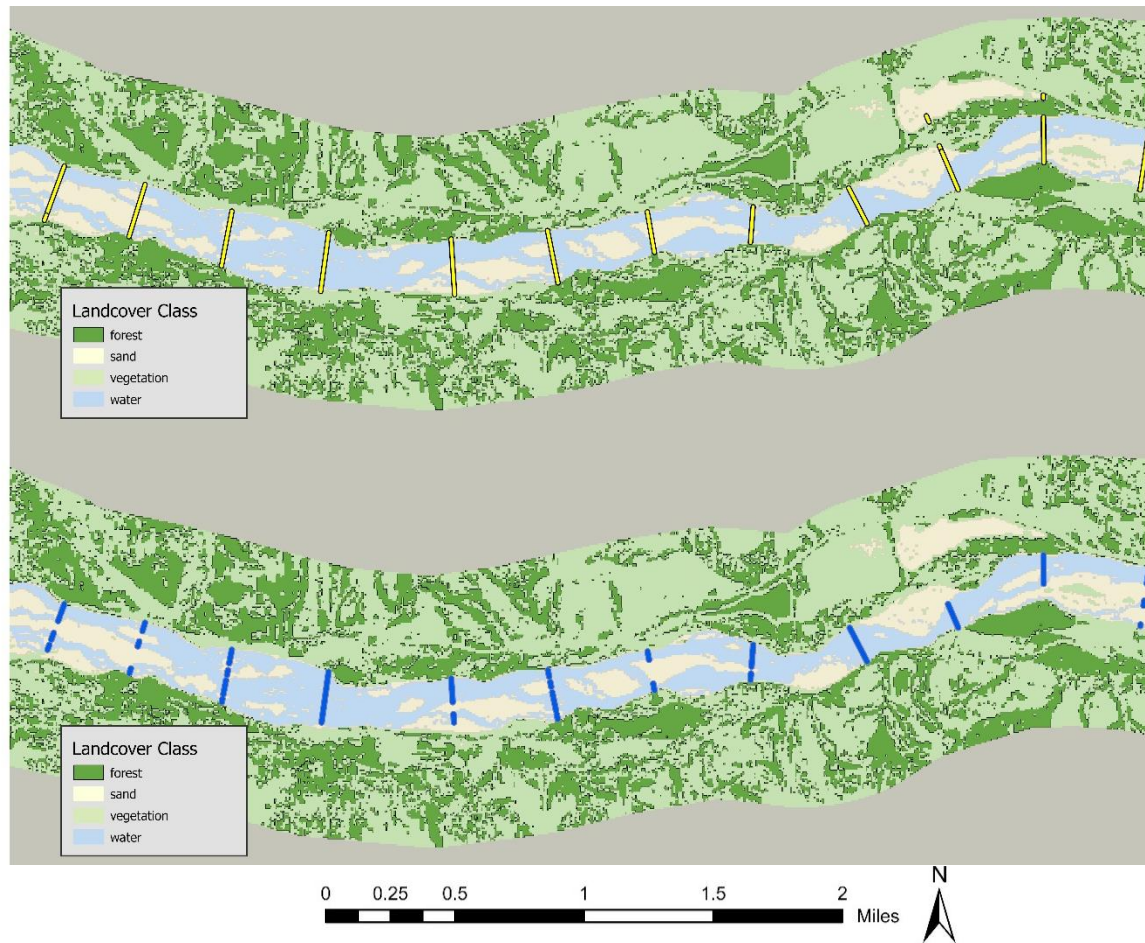
Steps for Landcover Classification and Measurement of On-Channel Variables - Niobrara River in spring 2018 for minimum flows



Step 1: Acquisition of imagery (June 2nd)



Step 2: Landcover classification



Step 3: Measurement of unvegetated channel widths (shown at 1,000 ft intervals)

Step 4: Measurement of wetted channel width (shown at 1,000 ft intervals)



Working group Conclusion about Landcover Classification Methods

On April 16th, the working group reviewed the methods and landcover classifications for sections of the Niobrara River. They also reviewed the methods for measuring on-channel variables using the landcover classifications and discussed the accuracy of the methods. The working group agreed that the data source and methods described above for landcover classification provide our best shot to represent on-channel conditions across Nebraska sandbed rivers in the stopover/flyover analysis. Because wetted width is the explanatory variable linked to flow across all three river systems, the working group discussed the tradeoffs between using imagery to match targeted flow versus targeted date to best reflect low and high flows during whooping crane migratory seasons (Table 1). The working group prioritized acquiring imagery closer to the targeted low and high flows during migration to obtain a better estimate of wetted width encountered by whooping cranes each season.

Next Steps: April–July 2025

The working group will reconvene in July, prior to the July TAC meeting, to evaluate the outcomes of an analysis adding on-channel variables as predictors of whooping crane stopovers vs. flyovers. The group will then consider whether off-channel variables should be integrated into the analysis process and, if so, further define the off-channel variables to be included.

To prepare for this July discussion, the following actions will be completed by the EDO:

- **Acquire imagery** representing both low and high flow conditions for each migration season from fall 2017 to fall 2023 across all targeted river systems (Niobrara River, Loup River system segments, Platte River).
- **Apply the landcover classification methods** described above to each image to quantify habitat features.
- **Generate on-channel variables** using a transect-based approach (spaced every 1,000 feet).
- **Measure on-channel variables** at appropriate spatial and temporal scales associated with each recorded stopover and flyover event.
- **Conduct an analysis** incorporating both non-habitat, unmanageable variables and the newly derived on-channel habitat variables.
- **Evaluate model performance** and determine the relative importance of each variable in predicting stopover and flyover events.