Platte River Recovery Implementation Program (PRRIP or Program)

Extension Science Plan Big Question #4 (pg 51):

What factors influence WC decision to stop or fly over the AHR?

I. INTRODUCTION

A. Context

It has been hypothesized that whooping cranes respond to flow in the central Platte River by increasing or decreasing their use of the river during migration. To date, the Program has utilized systematic aerial surveys to document ground use locations and associated habitat characteristics, but has found no relationship between flow and riverine roost site selection (Baasch et al. 2019). In June of 2022 the Program's Governance Committee (GC) approved the First Increment Extension Science Plan (PRRIP 2022) including three specific questions asking what factors are associated with 1) whooping crane stopover decisions, 2) stopover lengths, and 3) differences in stopovers by season. The Program has specific management hypotheses focused on learning about how important river flow is for whooping crane stopover decisions, but also alternative hypotheses that ask about the role of channel widths unobstructed by dense vegetation, landcover, time of day, weather, previous stopover locations and stay lengths, and group composition.

B. Why cellular telemetry?

Cellular telemetry tracking data collected on individual whooping cranes from fall 2017 forward are uniquely suited to address these questions, providing locations at 15 min intervals. This fine temporal scale provides information on locations while the birds are still in the air approaching a potential stopover site, whether or not the bird actually stops. Additionally, these data are collected over the entire migratory corridor encompassing multiple stopover and stay length decisions for each telemetered individual over both spring and fall migratory seasons, allowing for more robust conclusions. The Program's Independent Scientific Advisory Committee (ISAC) has suggested that a wider look across a broader swath of the migratory corridor will not only provide a larger dataset for evaluating our three priority hypotheses, but also help us understand the potentially unique role of the Platte as stopover habitat.

II. OVERARCHING TIERED ANALYSIS PLAN

A. Research Questions and Hypotheses

Three research questions have been prioritized for learning during the Program's First Increment Extension to provide information needed to better manage whooping crane stopover habitat.

1) What factors influence whooping crane decision to stop or fly over the Program's Associated Habitat Reach along the central Platte River?

2) What factors influence whooping crane stopover length within the Program's Associated Habitat Reach along the central Platte River?
3) Why is spring whooping crane use greater than fall use of the Program's Associated Habitat Reach along the central Platte River?

Each of these research questions has ***management and physical process hypotheses*** that focus on learning about the importance of river flow and area of suitable wetted width and depth on whooping crane decision making. However, previous research done by the Program, Program partners, and other entities have provided support for ***alternative hypotheses*** that include factors that can be managed as well as those that may not be manageable. Included in this list are features of the landscape such as wide river channels unobstructed by dense vegetation; open, unforested landcover types; wetland landcovers; agricultural landcovers; and amount of development. Factors associated with a sequence of migratory decisions such as point in migration, time at last stopover, distance since last stopover, and time of day when stopover decisions are made have all been suggested as important. Additionally, weather conditions and season are also expected to be important for decision making as spring and fall migrations show different patterns that may be a function of life-history, group composition, associations with other migratory species, resource availability, and weather.

B. Tiered Analysis Plan

The current document outlines the broad strokes of a study plan to address Program research questions. In developing this study plan, we have taken into consideration the strong recommendation made by our ISAC to broaden our scale of analyses. We have also considered the value of limiting the scale of the analysis to include locational data over the spatial and/or temporal scales necessary to answer Platte-specific research questions. Thus, we have developed a two-tiered analysis plan to better understand the factors associated with stopovers along NE sand bed rivers, taking what we learn over the broader scale to help inform Platte-specific analyses.

III. TIER 1 – FACTORS INFLUENCING DECISIONS ALONG NEBRASKA SAND BED RIVERS

A. Research Questions and Hypotheses

We hypothesize that there are overarching factors that are important for decision-making that are consistent across the wider migratory corridor. Many of these overarching variables are largely unmanageable such as point in migration, previous stopover distance and stay length, time of day, and weather, but they exert an effect on decision making over the entire corridor. Learning about the effect size of these largely unmanageable variables in relation to those that may be managed (e.g. channel width) within the same analysis will help inform model selection to identify factors that play a role at a local level. Additionally, information on relative effect sizes of unmanageable versus manageable explanatory variables will reduce uncertainty and clarify expectations for whooping crane response to landscape features we can manage.

The Program's priority hypothesis is to learn more about the relative importance of river flow to

whooping crane stopover decisions. To address this management hypothesis, we would like to examine patterns across Nebraska sand bed river systems. The Loup River, Niobrara River and Platte River are all west to east flowing sand bed rivers that are close in proximity (alternative stopover locations within the same flight day) and are similar in terms of both on- and off-channel habitat. Here we will be looking at general patterns that persist across these river systems and comparing explanatory variables included in top models and effect sizes across three Nebraska sand bed river systems. Model differences may help us understand how selection for the Platte River may differ from other river systems that whooping cranes have to choose from within the same regional context.

B. Whooping Crane Locational Dataset

For this tier of analysis, we will focus on Nebraska sand bed river stopover locations and compare them to in-flight locations associated with flyovers of these rivers. The WCTP has provided flight and stopover locations for all whooping cranes that stop or cross over the Loup, Niobrara, and Platte Rivers in Nebraska. Though this tier is focused on a smaller regional scale, we will be evaluating all locations (i.e., flight and stopover locations) from one stopover prior to through one stopover following an individual stopping or flying over the Loup, Niobrara, and Platte Rivers. This will provide the data to test alternative hypotheses on factors such as weather, time of day, distance since last stopover, time at last stopover etc., that may affect the stopover of interest. A stopover for this purpose can be defined as spending at least one night at a location. Tier 1 adds information from the Loup River and Niobrara River that are close in proximity and similar to the Platte in both on- and off-channel habitat to increase sample sizes and widen applicability of conclusions.

C. Explanatory Variables

Table 1 provides an example of explanatory variables of interest for inclusion in analyses. We expect explanatory variables for this scale of analysis to be broad-scale metrics available across the region in comparable form, such as landcover types available from the National Land Cover Database and National Wetlands Inventory. We also anticipate using broader riverine metrics such as channel width and wetted width to broadly represent how flow is distributed over channels that differ in width. Results from broader-scale tiers of analyses will help inform model selection for Platte-specific analyses.

D. Potential Analyses

At this broader scale of analysis we hope to gain a better understanding of how important unmanageable, non-habitat variables are to stopover decisions in relation to broader landcover and riverine metrics. To examine factors important for making stopover decisions at a broad scale we may take an approach similar to a use vs. available resource selection model (Pearse et al. 2021). To examine factors important for making stopover decisions along Nebraska sand bed rivers we will compare the factors associated with stopovers along the Platte, Loup, and Niobrara rivers to the factors associated with encounters with those rivers that result in flyovers. The scale for the

choice set of flyover locations to compare with stopover locations will be defined by the geomorphological characteristics of the river. The buffer area around each point location used to quantify area-based habitat metrics will be informed by flight patterns derived from the telemetry dataset.

Another potential analysis to test for factors associated with stopovers and duration of stay uses a general linear mixed model regression approach. A multivariable complementary log-log regression model is also an option to test for associations between potential explanatory variables and stopovers. Correlation of explanatory variables will be examined, and results used to reduce the number of variables included in models for testing. Collinearity among multi-variable landcover models will also be examined. *A priori* hypotheses derived from Program science and published literature will drive model selection. We will compare models to identify best explanatory variable combinations using Akaike Information Criterion adjusted for small sample size (AICc) and calculated area under the precision-recall curve (AUC-PR) to evaluate model performance (Sofaer et al. 2019). As we are interested in how stopover decision contexts may differ across years and seasons, we will examine these as fixed effects in our models while also controlling for individual bird ID as a random effect if our dataset includes multiple stopovers or flyovers of individual telemetered birds. We will also account for differences across rivers by including river as a random variable. Separate analyses for each river system may be informative if there are sufficient stopovers along each river. If seasonal effects are important for predicting stopovers and stay, we will perform the prior analyses described above separately for spring and fall to compare model results.

IV. TIER 2 – FACTORS INFLUENCING DECISIONS ALONG THE CENTRAL PLATTE RIVER

A. Research Questions and Hypotheses

The Program is primarily interested in learning about the factors that affect whooping crane decisions to stop, how long they stay, and the potential seasonal differences in this decision context along the central Platte River. However, sample sizes limit the power of statistical analyses and confidence in conclusions. A preliminary Platte-specific analysis using cellular telemetry locations of 49 individual birds within 100 km of the central Platte River from fall 2017 - fall 2020 provided only 9 stopovers to compare with 108 flyovers, with 5 of those stopovers occurring within a single season. That preliminary analysis indicated that time of day was a better predictor of stopovers along the Platte than either unobstructed channel width or river flow. However, with such few data points, confidence in the wider applicability of results was low. Tier 1 adds information from the Loup River and Niobrara River that are close in proximity and similar to the Platte in both on- and off-channel habitat to increase sample sizes and widen applicability of conclusions. If stopover locations along the Platte River alone provide an adequate sample size with stopovers distributed across years and seasons, we would also perform a Platte-specific analysis of the factors important for stopover and stay length decisions.

This Platte-specific tier of analysis would focus on river flow as the management hypothesis to be

tested but would also include detailed landcover and riverine metrics available only for the Platte River. Additionally, we will incorporate unmanageable variables in the analysis to examine effect size in comparison to those items the Program can manage. Information provided by this tier of analyses is expected to provide specific information to inform Program water and land management along the central Platte River.

B. Whooping Crane Locational Dataset

For this tier of analyses, we will focus on central Platte River stopover locations within the 90-mile Associated Habitat Reach of the Program from Lexington to Chapman, Nebraska. However, to test alternative hypotheses on factors such as weather, time of day, distance since last stopover, point in migration, etc., that may affect these stopovers, we will need the datasets requested for previous tiers.

C. Explanatory Variables

Tier 2 analyses will include the explanatory variables from previous analyses but at a more refined scale, informed with more robust landcover and riverine specific datasets. For the Program's Associated Habitat Reach we have more detailed and annually updated landcover data layers for both the flood plain surrounding the active river channel and within the active channel itself. In addition, annual LIDAR flights provide detailed information on channel geomorphology to inform 2D hydraulic modelling that allows us to estimate metrics like wetted widths at a given flow.

D. Potential Analyses

We will use a similar analysis to that described in Tier 1 above to compare the factors associated with stopovers along the central Platte River to the factors associated with encounters with the central Platte that result in flyovers. Another option for understanding the context for whooping crane stopover decision-making specific to the central Platte River would be to compare the set of factors associated with whooping crane flyovers upon encountering the central Platte River to the factors associated with the stopover location ultimately selected just past the Platte River.

VI. ANTICIPATED PRODUCTS

The Program typically produces programmatic documents distributed via the Program's secure website to inform stakeholders of results, synthesizing information to help inform habitat and river flow management activities on the central Platte River. We also anticipate publishing and presenting results. The research is designed to provide information for a structured decision-making process and Program Second Increment negotiations beginning in 2028.

VII. POSSIBLE IMPLICATIONS

Program stakeholders will develop implications of the proposed research that are applicable over over regional riverine systems. Program stakeholders will also develop implications specifically

for the central Platte River. Direct implications for the Program include developing a better understanding of the relationship between flow and whooping crane use and stopover length. Those relationships will be used by Program decision-makers to weigh the costs and benefits of flow releases during migration against other flow management actions such as inundating releases to suppress seedling establishment and maintain unvegetated channel width.

VIII. TIMELINE

We would like to continue receiving the data requested until the end of the tracking project. We anticipate at a minimum incorporating new cellular telemetry data into the analysis framework developed under this collaboration on an annual basis, producing an annual summary to be shared at our Science Plan Reporting Session in February of each year. Multi-year evaluations and syntheses are planned for 2024 and again in 2027.

IX. REFERENCES

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Table 1. Example of unmanageable, on-channel, and landcover explanatory variables of interest.

Tier	Explanatory Variable	Description
Unmanageable Non-Habitat Variables		
1,2	Time of Day	Number of hours before dark (daily sunset plus 30 mins) for the last location recorded before a stopover and for the flyover locations.
1,2	Point in Migration	Proportion of days into a migration season for each stopover or flyover location. OR Proportion of total distance traveled during a migration season for each stopover or flyover location.
1,2	Latitude	Latitude associated with a point location.
1,2	Longitude	Longitude associated with a point location.
1,2	Distance since Last Stopover	Distance traveled since previous stopover location.
1,2	Length of Stay at Last Stopover	Days spent at previous stopover location.
1,2	Weather	Includes a suite of variables such as wind speed and direction, precipitation, temperature, barometric pressure, etc. associated with a stopover or flyover location. Cumulative exposure to weather conditions leading up to a stopover/flyover.
2	*Group Composition**	Number, age category, reproductive status of telemetered individuals and group they with which they are associated. Associations with sandhill cranes are also of interest. **This information is available for Platte River only*.
On-Channel Habitat Variables		
1,2	Unobstructed Channel Width	Width of active channel unobstructed by tall vegetation or wooded islands measured perpendicular to midline of the channel at use or available location.
1,2	Nearest Forest	Distance to nearest riparian forest measured from use location or available point in any direction.

Tier	Explanatory Variable	Description
1,2	Wetted width	Width of the channel that is inundated at a specified discharge.
2	Instantaneous river flow (cfs)	River discharge extrapolated from nearest gage within 15 mins of time stamp on point location.
2	*Point-based river flow (cfs)**	River discharge at whooping crane locations and available locations obtained from 2D hydrodynamic model with input from nearest gage within 15 mins prior to locational data. **This information is available for Platte River only*.
Landcover Habitat Variables		
1	Landcover	Predominant landcover type within buffer area
1,2	Wetland	Proportion of buffer area covered by wetland or water surface extent.
1,2	Wetland Shoreline	Total linear distance around perimeter of wetlands (shoreline) within buffer area.
1,2	Wetland Distribution	Size, distribution, proximity of wetlands to one another withing the buffer area.
2	*Distance to Ground Water** *Distance above/below River Elevation**	Distance to ground water. OR Distance above or below river elevation. **This information is available for Platte River only*.
2	Sand and Water	Proportion of buffer area covered by unvegetated sand and water.
1,2	Grassland	Proportion of buffer area covered by grassland.
2	Prairie	Proportion of buffer area covered by upland grassland.
2	Meadow Marsh	Lowland grassland + Wetland Footprint (Natl. Wetlands Inventory) + Flooding Frequency (USDA NRCS) (Baasch et al. 2022)
1,2	Forest	Proportion of buffer area covered by forest.

Tier	Explanatory Variable	Description
1,2	Agriculture	Proportion of buffer area covered by agriculture of any type.
2	Corn	Proportion of buffer area covered by corn.
2	Soybeans	Proportion of buffer area covered by soybeans.
2	Alfalfa	Proportion of buffer area covered by alfalfa.
2	Other	Proportion of buffer area covered by other agricultural crops.
2	Agricultural Wetland	Proportion of buffer area covered by agriculture + wetland footprint + Flooding Frequency (USDA NRCS) (Baasch et al. 2022).
1,2	Developed	Proportion of buffer area covered by anthropogenic development (roads, parking lots, buildings, infrastructure, etc.).
2	Distance to Development	Distance to nearest developed landcover type (see above definition) measured from use or available location in any direction.
2	Distance to Transmission Lines	Distance to nearest transmission lines measured from use or available location in any direction.
2	Length of Transmission Lines	Total length of transmission lines within buffer area.