Platte River

Recovery Implementation Program:

IMPLEMENTATION OF THE WHOOPING CRANE MONITORING PROTOCOL

SPRING 2023 REPORT

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PRRIP Technical Advisory and Governance Committees
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Table of Abbreviations

Abbreviation	Definition
AHR	Associated Habitat Reach
AMP	Adaptive Management Plan
AWB	Aransas-Wood Buffalo
cfs	Cubic feet per second
CI	Confidence interval
CSRT	Chapman secondary return transect
EBQ	Extension Big Question
EDO	Executive Director's Office
ESRT	Elm Creek secondary return transect
Fig.	Figure
ft	Feet or foot
GC	Governance Committee
GPS	Global positioning system
ID	Identification number or code
ISAC	Independent Scientific Advisory Committee
km	Kilometer
m	Meters
mph	Miles per hour
MUCW	Maximum width unobstructed by dense vegetation
MUOCW	Maximum unobstructed channel width
NE	Nebraska
NF	Nearest forest
Opp	Opportunistic
PRRIP or Program	Platte River Recovery Implementation Program
PWRTE	Primary wetland return transect east
PWRTW	Primary wetland return transect west
QA/QC	Quality assurance/quality control
SE	Standard error
SP	Spring
Sys	Systematic
TAC	Technical Advisory Committee
TUCW	Total unvegetated channel width
UFCW	Unforested corridor width
UOCW	Unobstructed channel width
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UTM	Universal Traverse Mercator
WC	Whooping crane, *Grus americana*
WSRT	Wood River secondary return transect
0SE	East river transect
0SW	West river transect

Executive Summary

The Executive Director's Office (EDO) of the Platte River Recovery Implementation Program ("Program" or "PRRIP") enumerated and monitored whooping cranes (*Grus americana*) during the spring 2023 migration using daily systematic aerial surveys along PRRIP's Associated Habitat Reach (AHR) on the central Platte River from Lexington to Chapman, Nebraska. During the 55-day monitoring period that extended from March 6 to April 29, 2023, PRRIP's EDO completed 77 of 110 (70%) scheduled flight transects with each day's survey including two transects to survey the entire AHR. Surveyors enumerated 57 individual whooping cranes consisting of 52 adults and five juveniles in 17 unique groups during systematic aerial surveys and from one opportunistic ground observation. Surveyors observed the first and last whooping crane groups on March 8 and April 13, respectively.

The 57 individual whooping cranes represented 0.106 (95% confidence interval [CI] = 0.089, 0.129) of the Aransas-Wood Buffalo (AWB) migratory population based on the U.S. Fish and Wildlife Service's 2022–2023 estimate of 536 whooping cranes (95% CI = 444, 644) on wintering grounds along the Texas coast of the Gulf of Mexico. With 20 whooping cranes having multiple day stopovers on the AHR, PRRIP's EDO estimated 210 total crane use days for spring 2023. When considering whooping cranes observed only between March 10 and April 17, which represented the 5th and 95th percentiles of dates of whooping crane group observations in Nebraska from the U.S. Fish and Wildlife Service public sightings database during 2013–2022, PRRIP's EDO enumerated 57 whooping cranes and 208 adjusted crane use days.

Flow in the Platte River as measured at four gaging stations along the AHR between Overton and Grand Island, Nebraska ranged from 42.9 to 2,370 cubic feet per second (cfs) during the monitoring period. Instantaneous discharge at the gaging station closest to each of 50 whooping crane groups observed in the river channel ranged from 283 to 1,970 cfs (mean = 784; standard error [SE] = 61). The majority (94%) of the 50 whooping crane groups observed in the river channel were closest to the Grand Island, Nebraska gage. At 50 whooping crane group use locations in the river channel, mean unobstructed channel width was 645 ft (range = 129 to 1,470 ft; SE = 43) and mean distance to the nearest forest was 373 ft (range = 47 to 1,011 ft; SE = 31).

We calculated 5th and 95th percentiles of dates of whooping crane group observations in Nebraska in 10-year periods between 1998 and 2022 and retrospectively calculated the adjusted proportion of the AWB population stopping on the AHR and adjusted number of crane use days from PRRIP spring surveys dating back to 2007. Use of 5th and 95th percentiles of dates to determine whooping crane stopover metrics resulted in adjustments being made to metrics in spring 2018, spring 2021, and spring 2022. We found PRRIP spring surveys during 2007 through 2013 did not include the 5th percentile date for the corresponding period. Therefore, it is likely the proportion of population and number of crane use days reported for 2007 through 2013 underestimate whooping crane stopover metrics during spring of those years. When evaluating adjusted metrics from 2014 through 2023, the adjusted spring proportion of the population that stopped on the AHR ranged from 0.011 to 0.200 (mean = 0.068; SE = 0.014) and the adjusted number of crane use days during spring varied between 13 and 464 days (mean = 108; SE = 26). We found no correlation between either the adjusted proportion of population stopping on the AHR and year, or the adjusted number of crane use days and year during 2014–2023 using a Spearman rank correlation. The number of

whooping cranes, proportion of population stopping on the AHR, and number of crane use days as determined through PRRIP spring surveys have increased over the past two years from recent lows in these metrics observed during 2019 through 2021. However, values of the metrics for spring 2023 remained within the ranges of annual variability of the metrics since 2007. The information collected from PRRIP's long-term systematic monitoring of whooping cranes along the central Platte River is being used to assess success of the Program's management objective of contributing to the survival of whooping cranes during migration and evaluate the biological response of whooping cranes to the Program's water and land management.

Introduction

The Platte River Recovery Implementation Program ("Program" or "PRRIP") is responsible for implementing certain aspects of the recovery plan for endangered whooping cranes (*Grus americana*). In 2007, the Program began its 13-year First Increment and implementation of an Adaptive Management Plan (AMP) to learn more about the physical processes of the central Platte River in Nebraska and the response of whooping cranes from the migratory Aransas-Wood Buffalo (AWB) population to Program management of land and water along the river. In 2020, the Program began a 13-year Extension of the First Increment to continue the work and gather additional information to inform decisions for management of whooping crane habitat along the Program's 90-mile Associated Habitat Reach (AHR) from Lexington to Chapman, Nebraska. The Program's original AMP was updated in 2022 as an Extension Science Plan (PRRIP 2022) to provide guidance for Program science priorities during the Extension.

The Program's management objective for whooping cranes is to contribute to their survival during migration (PRRIP 2021a). Quantifiable metrics to help evaluate the success of this objective include the: (1) availability and area of suitable roosting and foraging habitat; (2) number of days whooping cranes were observed along the AHR (i.e., crane use days); and (3) proportion of the AWB population that stops along the AHR during spring and fall migration. Additionally, several critical scientific and technical uncertainties about physical processes and the response of whooping cranes to management actions are the focus of applying rigorous adaptive management in the First Increment Extension through implementation of the Program's Extension Science Plan. These uncertainties are stated as broad hypotheses in the Extension Science Plan (PRRIP 2022) and, as a means of better linking science learning to Program decision-making, those uncertainties comprise a set of "Extension Big Questions" (EBQs) to link specific hypotheses and metrics to management objectives and overall Program goals (see PRRIP 2017a, PRRIP 2020). Three EBQs directly relate to measuring whooping crane response to Program management (Appendix A):

- *EBQ #4* – What factors influence whooping crane decisions to stop or fly over the AHR?
- *EBQ #5* – What factors influence whooping crane stopover length within the AHR?
- *EBQ #6* – Why is spring use of the AHR greater than fall use by whooping cranes?

To gather information to reduce remaining uncertainties about whooping cranes during the Extension, several finer-scale priority management hypotheses were developed by Program participants to focus on the influence of river discharge for whooping crane decision-making (Appendix A). Underlying physical process hypotheses were developed in support of the management hypotheses to explain how discharge interacts with channel morphology to provide suitable whooping crane roosting habitat (Appendix A). Broader scope alternatives were also posed for investigation as potential factors affecting whooping crane behavior (Appendix A). Implementation of the whooping crane monitoring protocol is intended to provide the systematically-collected whooping crane use and habitat (i.e., landscape level attributes at roost sites and diurnal use sites) data necessary to test these whooping crane hypotheses, evaluate learning related to the whooping crane EBQs, and ultimately assess progress toward meeting the whooping crane management objective (PRRIP 2017a, PRRIP 2020).

The Program's whooping crane monitoring protocol includes two major components (PRRIP 2017b):

1) Detect and confirm whooping crane stopovers through systematic aerial surveys of river channel and palustrine wetland habitat within the 90-mile AHR. Stopover data is used to comparatively evaluate changes in the frequency and distribution of stopovers within the study area over time.
2) Collect landscape-level habitat data at use locations. Habitat data is used for resource selection analyses and other analyses intended to inform Program habitat creation and maintenance activities.

In an effort to align survey dates with the period when most (90%) whooping cranes were sighted in Nebraska, the Program established spring and fall monitoring periods to encompass the 5th through 95th percentiles of initial sighting dates for all recorded sightings of whooping crane groups in Nebraska from the U.S. Fish and Wildlife Service's (USFWS) public sighting database for 1975–1999 (PRRIP 2021b). Since then, the 5th and 95th percentile window of observations has served as a guideline to adjust monitoring dates to accommodate for temporal shifts in whooping crane arrival in Nebraska. The most recent change to the spring monitoring period occurred in 2014, when a 55-day survey period was adopted that lasted from March 6 through April 29.

In this report, we summarize PRRIP's spring 2023 whooping crane monitoring efforts and results and place them in the context of PRRIP's long-term monitoring. Specifically, we report on the number of individual whooping cranes enumerated, proportion of the AWB population observed stopping on AHR, number of crane use days, and use locations and associated habitat and flow metrics. We provide maps of whooping crane locations and photographs of observations. We summarize systematic and opportunistic survey efforts and resulting observations. We report on the detectability of whooping crane decoys during aerial surveys. Finally, we provide an assessment of how the 5th and 95th percentiles of dates of whooping crane group observations in Nebraska from the USFWS public sighting database have changed over time and how these changes may affect interpretation of whooping crane stopover metrics.

Methods

Study area

The study area encompassed the Program's AHR along the central Platte River (Figs. 1, 2) that extends from the Highway 283 Platte River bridge near Lexington, Nebraska (40˚44'08.15" N; 99˚44'37.31" W) to the Platte River bridge near Chapman, Nebraska (40˚59'07.06" N; 98˚08'40.40" W). The monitoring area spanned a total of approximately 90 linear miles of river and included Platte River channels and adjacent palustrine wetlands and ponds within 3.5 miles of the river channel(s).

Systematic aerial surveys

The PRRIP EDO conducted spring whooping crane monitoring in accordance with the *Platte River Recovery Implementation Program – Whooping Crane Monitoring Protocol – Migrational Habitat Use in the Central Platte River Valley rev. June 2017* (PRRIP 2017b) during March 6 through April 29, 2023. We used two Cessna 172 aircraft, each crewed by a pilot and two observers, to make aerial observations along predetermined systematic flight transects (Figs. 1, 2). The pilot utilized a GPS unit to follow defined transects and track miles flown. We flew systematic aerial transects daily, weather and visibility permitting, at an air speed of approximately 100 mph and an altitude of approximately 750 ft unless conditions demanded higher altitudes. Two flights were initiated each morning with one departing from Grand Island, Nebraska (east route; shown in red on Figs. 1, 2) and one from Kearney, Nebraska (west route; shown in green on Figs. 1, 2). Planes were required to be at transect starting points one-half hour before sunrise. Flights were typically completed in less than two hours. In the event of adverse weather, crews were able to wait up to two hours after sunrise for conditions to improve before cancelling the flight. Pilots were also able to cancel flights the night before or morning of a flight if they judged weather to be unsuitable for flying.

Two types of transects were flown on each route to ensure coverage of both on-channel riverine and off-channel wetland habitat. On-channel river transects (shown in blue on Figs. 1, 2) were flown east to west with the plane located south of the southern-most river channel to reduce the effect of sun glare. Starting points along riverine transects were alternated daily between two flight routes to allow different sections of the study area to be observed as early as possible in the flight times. Off-channel transects (shown in red and green on Figs. 1, 2) were designed to survey existing off-channel habitat within 3.5 mi of the river and serve as functional routes for planes to return to starting airports.

Route 1. The first pilot flew the transect covering the west half of the AHR from the Minden, Nebraska bridge west to the Lexington, Nebraska bridge (0SW; Fig. 1). The first pilot then flew the primary wetland return transect (PWRTW) from west to east (Fig. 1). The second pilot simultaneously flew the transect covering the east half of the AHR from the Chapman, Nebraska bridge west to the Minden bridge (0SE), followed by the primary wetland return transect (PWRTE) from west to east (Fig. 1). The second pilot flew a secondary transect (CSRT) to return to the airport (Fig. 1).

Route 2. The first pilot flew the transect covering the west half of the AHR beginning at the midpoint of the 0SW river channel transect at the Odessa, Nebraska bridge west to the Lexington bridge (Fig. 2). The first pilot then flew the primary wetland return transect (PWRTW) east to the Minden bridge, followed by the 0SW river channel transect back to the Odessa bridge (Fig. 2). The first pilot flew a secondary return transect (ESRT) from Hwy 183 at Elm Creek, Nebraska east to return to the Kearney airport (Fig. 2). The second pilot simultaneously flew the transect covering the east half of the AHR from the midpoint of the 0SE river channel transect at the Wood River, Nebraska bridge west to the Minden bridge (Fig. 2). The second pilot then flew the primary wetland return transect (PWRTE) east to the Chapman bridge, followed by the remainder of the east half of the 0SE transect back to the Wood River bridge (Fig. 2). The second pilot flew a secondary return transect east (WSRT) to return to the Grand Island airport (Fig. 2).

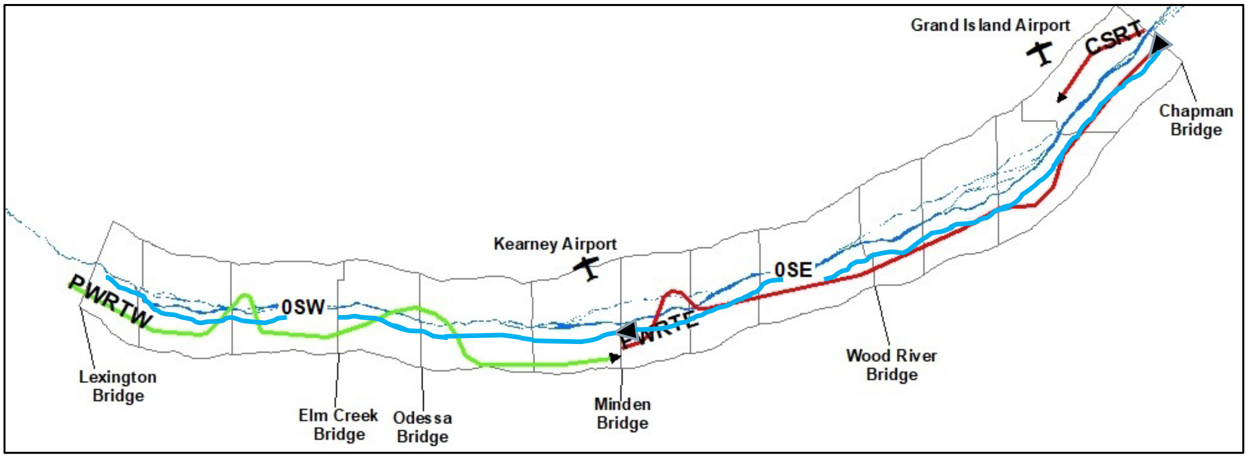


Figure 1. East and west flight transects for Route 1 of whooping crane aerial surveys between Lexington, and Chapman, Nebraska. Black and grey triangles indicate starting points of flights. River channel transects (0SW; 0SE) are shown in blue. The west primary wetland return transect (PWRTW) is shown as a green line. The east primary wetland return (PWRTE) and secondary return transects (CRST) are shown in red.

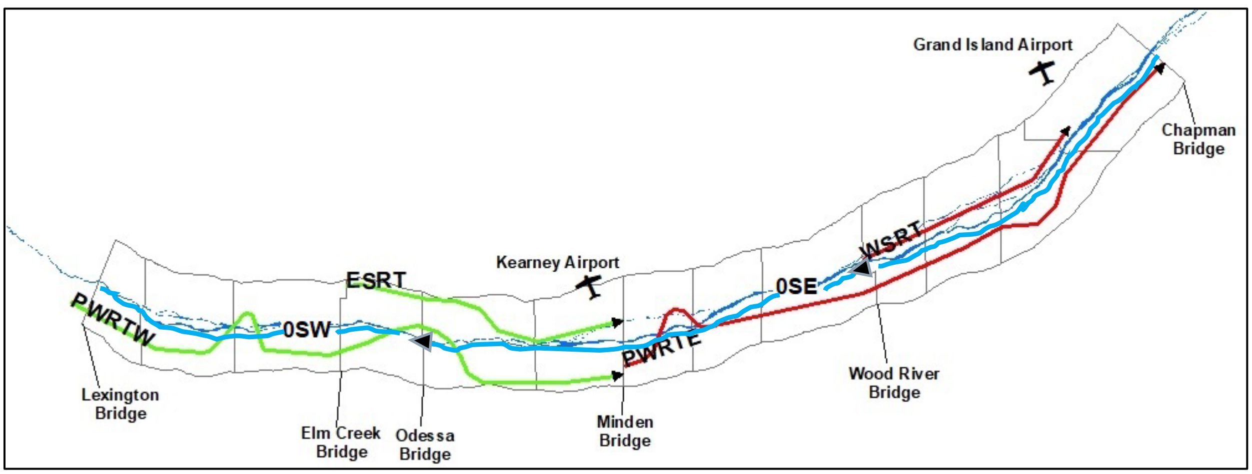


Figure 2. East and west flight transects for Route 2 of whooping crane aerial surveys between Lexington, Nebraska and Chapman, Nebraska. Black and grey triangles indicate starting points of flights. River channel transects (0SW; 0SE) are shown in blue. The west primary wetland return transect (PWRTW) and secondary return transect (ESRT) are shown as green lines. The east primary wetland return (PWRTE) and secondary return transects (WRST) are shown as red lines.

Observations and data collection

In addition to survey crews in airplanes, the EDO simultaneously deployed two ground crews on west and east survey routes to verify locations and identities of possible whooping cranes observed by aerial surveyors. Aerial survey crews relayed their position to ground survey crews via mobile phone at the beginning of each transect and at turn around points. Aerial surveyors used binoculars for sighting and a Canon Rebel T6s 760D camera for photo documentation of possible whooping cranes. If an aerial surveyor spotted potential whooping crane(s), then he or she took aerial photographs of the birds and the surrounding area to later confirm the identity and location. If additional observations for species identification were needed, then aerial surveyors contacted the nearest ground observer who positioned herself or himself to make a positive identification of the whooping crane(s) without disturbance. Aerial and ground survey crews also confirmed and recorded opportunistic whooping crane sightings that occurred in addition to those observed during aerial systematic surveys. Immediately after receiving a report, a plane was deployed to search the area and/or ground personnel surveyed the area until the whooping crane(s) were located and confirmed, or sufficient search time had been allotted to confirm the whooping cranes had left or were not present in the area. Ground searches concluded when the whooping crane group was located, a bird species other than whooping cranes were located and identified at the general location where possible whooping cranes were reported, or a reasonable amount of search effort had been put forth with no whooping crane location or species identity. We notified USFWS biologists of survey results and opportunistic sightings daily following the completion of both morning flights and any ground search efforts. We coordinated with USFWS to determine whether whooping crane groups had been observed on previous mornings or whether they were new to the AHR.

Throughout the spring monitoring period, EDO staff placed a total of 20 whooping crane decoy sets consisting of 42 decoys (one to three decoys per set) in 20 unique locations along the aerial transects to evaluate the ability of aerial surveyors to detect whooping cranes. We placed ten decoy sets at randomly selected locations within the river channel and ten decoy sets at randomly selected locations along off-channel conservation lands within 500 ft of the channel.

Aerial and ground surveyors documented their observations of whooping crane groups with photographs and recorded the number of whooping cranes observed, age category of individuals as adults or juveniles, location, land cover type, time, and date of observation. Surveyors defined a whooping crane group as one or more whooping cranes observed at one location. Surveyors gave each whooping crane group a unique identification (ID) code (e.g., 2023SP01) combining the year, season (SP for spring), and PRRIP group number at sighting. If the same confirmed group was observed the following day, then surveyors gave the group a new group ID (e.g., 2023SP02). We used aerial flight logs and ground search data sheets to document time and mileage devoted to searching for and identifying whooping cranes. During ground search surveys, mileage was calculated based on the driving distance from the location of the last reported sighting or known location to the conclusion of the search effort.

We recorded locations of each whooping crane group in Universal Transverse Mercator (UTM) coordinates within UTM Zone 14N using satellite imagery in ArcGIS Pro 3.1.1 (ESRI 2023) in conjunction with observation photographs and location descriptions provided by surveyors. We assigned use sites a number based on the date and time of sighting if the whooping crane group was observed in riverine, lacustrine, or palustrine land cover types. Whooping crane groups sighted outside of these land cover types were not assigned a use site number, but surveyors recorded the location's land cover classification. If the group was sighted while in flight, then surveyors recorded the location's land cover as "AIR." After entering data into the PRRIP species database, we conducted Quality Assurance/Quality Control (QA/QC) checks to ensure accuracy.

We used whooping crane group locations to evaluate river flow and habitat metrics at or near the use location. Four U.S. Geological Survey (USGS) flow gages were located on the Platte River throughout the AHR from west to east during spring 2023 monitoring: Overton (USGS 2023a); Cottonwood Ranch (USGS 2023b); Kearney (USGS 2023c); and Grand Island (USGS 2023d).

We used data from the gage closest to the whooping crane group location to the nearest 15 min of the group observation to assign a discharge in cubic feet per second (cfs) to each location. The width of the Platte River channel unobstructed by dense vegetation (i.e., unobstructed channel width) and the distance to the nearest riparian forest (i.e., distance to nearest forest) have both been found to be important predictors of whooping crane use of the Platte River (Baasch et al. 2019). We used fall 2022 LiDAR imagery of the Platte River channel and surrounding habitat and ArcGIS (ESRI 2023) to estimate the unobstructed channel width and distance to nearest forest for each of the whooping crane group locations located in the Platte River channel.

Calculation of whooping crane stopover metrics and 5th and 95th percentiles of dates of observations

Proportion of population stopping on the AHR. We determined the total number of unique individual whooping cranes observed by PRRIP's EDO during both systematic and opportunistic monitoring efforts throughout the AHR between March 6 and April 29, 2023. Unique individuals and groups were typically identifiable by their arrival date, location, and group composition. We divided the total number of unique individual whooping cranes observed by the estimated size of the AWB population from winter 2022–2023 surveys (USFWS 2023) to estimate the proportion of the AWB population that stopped on the AHR during the spring 2023 migration.

Number of crane use days. We calculated the number of crane use days for each whooping crane group observed by multiplying the number of individual cranes in each group by the number of days the group was present, and adding one day per whooping crane observed. We added one day per whooping crane observed because we assumed the birds were present and roosting on or near the river the evening prior to the morning of the observation. PRRIP crane use days includes observations made within the designated systematic survey period and any extensions of that survey period due to continued observed crane presence on the AHR per the Program's monitoring protocol. PRRIP crane use days includes days when crane groups are not observed by PRRIP if dates of no observations are between consecutive PRRIP observations of that group. This assumes the group did not leave and return and that it is the same group. Unique groups are typically individually identifiable by their arrival date, location, and group composition. We calculated the total number of crane use days for spring 2023 by summing the number of crane use days across all whooping crane groups observed.

5th and 95th percentiles and adjusted whooping crane metrics. We used the USFWS whooping crane public sighting database for Nebraska (USFWS *unpublished data*) to determine the initial date of whooping crane group observations during 1998–2022. We divided the data into 16 10-year rolling periods with the first and last periods spanning 1998–2007 and 2013–2022, respectively. We used R version 4.2.2 (R Core Team 2022) to calculate the 5th and 95th percentiles of initial dates of group observations for each 10-year period.

For each year of PRRIP systematic surveys dating back to 2007, we calculated adjusted metrics as the total number of individual whooping cranes observed and total number of crane use days within the dates corresponding to the 5th and 95th percentiles of initial dates of group observations for each 10-year period. For example, for PRRIP surveys conducted during 2007, we used percentiles calculated from USFWS data from 1998–2007. For PRRIP surveys conducted during 2022, we used percentiles calculated from USFWS data from 2013–2022. Because USFWS data for 2023 were not complete at the time of our analyses, we used percentiles calculated from USFWS data from 2013–2022 for the spring 2023 adjusted metrics. We used a non-parametric Spearman's rank correlation (Neter et al. 1996) to calculate the Spearman's correlation coefficient (ρ) and assess whether significant relationships at $\alpha = 0.05$ existed between the adjusted proportion of population and year, and adjusted number of crane use days and year during 2014–2023. Surveys before 2014 began later in the spring and start dates were not included in 5th percentiles (see Results for details); therefore, we did not analyze data for 2007–2023 together. We also used package *nlme* in R (Pinheiro and Bates 2000, R Core Team 2022, Pinheiro et al. 2023) to develop a mixed-effects model to assess whether a relationship existed between the number of individual whooping cranes observed during PRRIP spring surveys and the estimated size of the AWB population during 2016–2023. We used 2016–2023 as a range for this analysis because there was a change in survey dates and methodology for USFWS surveys on the winter range between winter 2014–2015 and winter 2015–2016 (USFWS 2023).

Results

Whooping crane observations and monitoring effort

Aerial and ground surveyors enumerated 57 individual whooping cranes consisting of 52 adults and five juveniles in 17 unique groups during spring 2023 monitoring (Fig. 3; Appendix B, Appendix C). The locations and distribution of historical spring observations of whooping crane groups by PRRIP during 2001–2023 are provided online at https://arcg.is/01uW1v. Overall, PRRIP surveyors observed 62 whooping crane groups based on repeated observations of the same groups during the 55-day monitoring period (Appendix B, Appendix C). These 62 groups consisted of a total of 123 adults and eight juveniles (Appendix B, Appendix C). Surveyors observed the first whooping crane group on March 8, 2023, and the final group on April 13, 2023. The mean and median initial dates of whooping crane group observations were March 29 and April 3, respectively (standard error [SE] = 2.6 days, n = 17). The mean and median dates of all 62 group observations were March 26 and March 28, respectively (SE = 1.1 days).

Systematic aerial surveys. During systematic aerial monitoring, surveyors observed a total of 100 whooping cranes (95 adults; five juveniles) in 47 groups consisting of 56 individual whooping cranes (51 adults; five juveniles) in 16 unique groups (Table 1; Fig. 3; Appendix B, Appendix C). The majority (91.5%) of whooping crane groups observed during systematic aerial surveys were located along on-channel transects (Table 1). Pilots completed 77 of 110 (70%) regularly scheduled flights (Table 2). Thirty-three flights were either cancelled or not completed due to low visibility or poor weather (Table 2). Among all 302 scheduled systematic transects encompassing river channel and off-channel primary/secondary return transects, 211 (69.9%) were completed (Table 1). There were four transects initiated but not completed when weather conditions deteriorated mid-survey (Table 2). Transects not initiated prior to ending the survey were recorded as cancelled along with all transects scheduled when the plane did not depart the airport. In total, 87 transects were cancelled (Table 2).

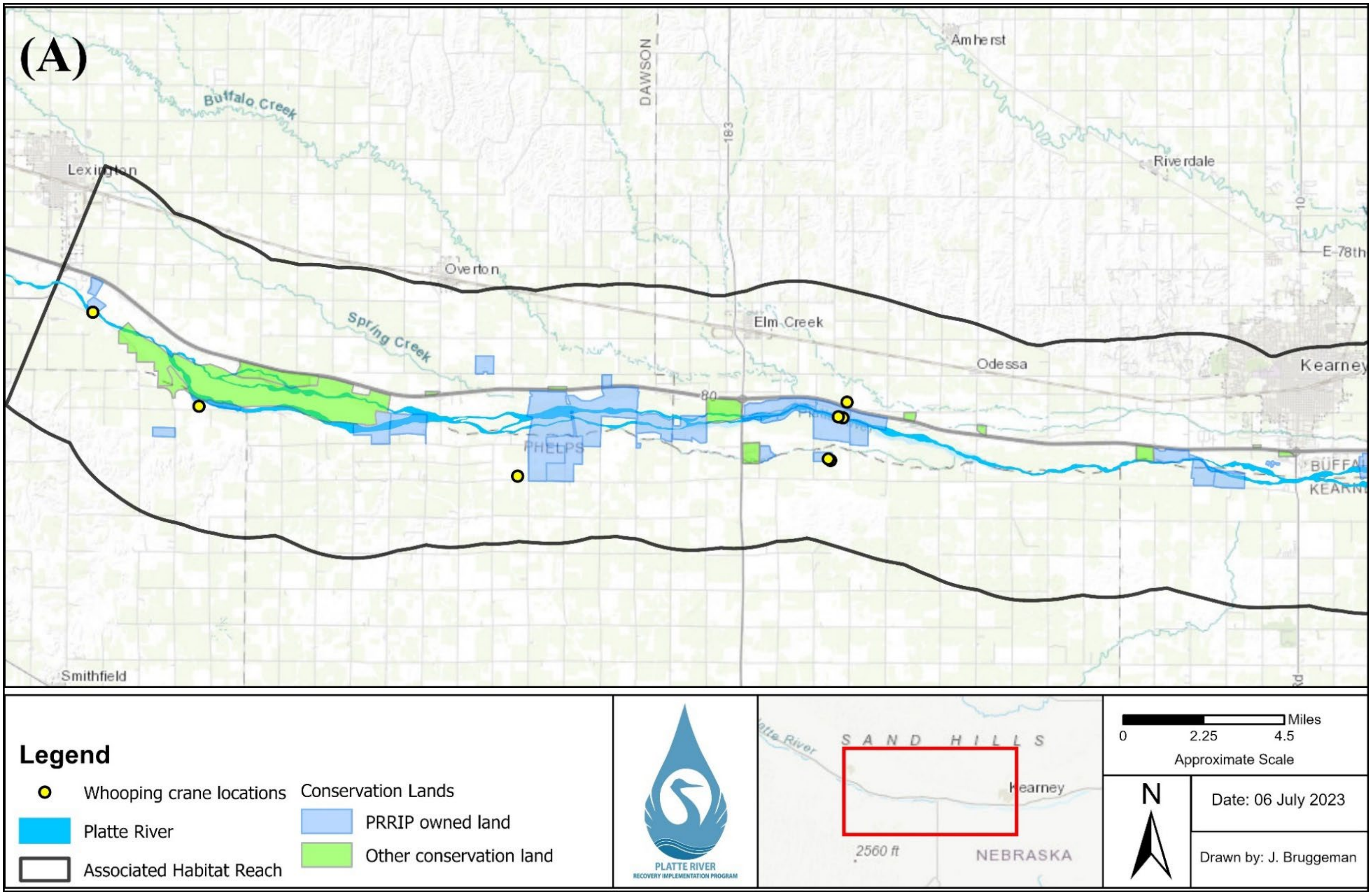


Figure 3. Locations of whooping crane groups observed during spring 2023 PRRIP systematic aerial surveys and ground surveys along the Associated Habitat Reach of the central Platte River between **(a)** Lexington and Kearney, Nebraska. Enlarged and detailed location maps with group identification numbers are provided in Appendix C. The locations and distribution of historical spring observations of whooping crane groups by PRRIP during 2001–2023 are provided online at https://arcg.is/01uW1v.

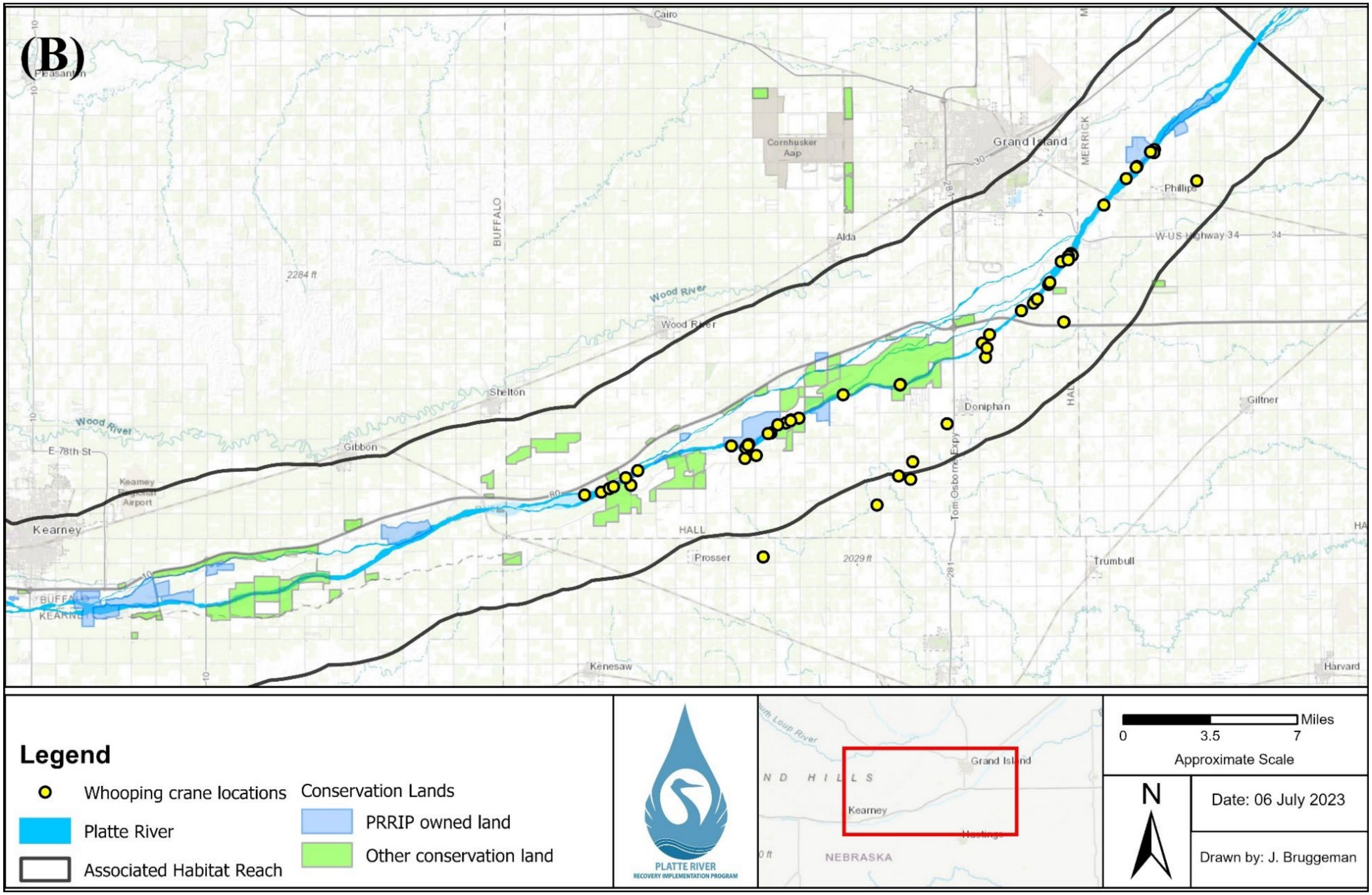


Figure 3. Locations of whooping crane groups observed during spring 2023 PRRIP systematic aerial surveys and ground surveys along the Associated Habitat Reach of the central Platte River between **(b)** Kearney and Chapman, Nebraska. Enlarged and detailed location maps with group identification numbers are provided in Appendix C. The locations and distribution of historical spring observations of whooping crane groups by PRRIP during 2001–2023 are provided online at https://arcg.is/01uW1v.

Table 1. Number of whooping crane groups observed during systematic aerial surveys and opportunistic aerial and ground surveys during spring 2023 along the Associated Habitat Reach of the central Platte River between Lexington and Chapman, Nebraska. Included for each type of survey effort are the: number of whooping crane groups observed; number of transects completed, incomplete, cancelled, and scheduled; duration of survey effort; and number of miles flown or driven during surveys.

Survey type		Flight transects	No. whooping crane groups observed[a]	No. transects completed	No. transects incomplete	No. transects cancelled	Total no. transects scheduled	Duration of survey effort[b]	Miles flown or driven
Systematic aerial surveys	On channel	0SE, 0SW[c]	43	77	3	30	110	42:31	8,566
	Off channel	PWRTE, PWRTW[d]	4	77	1	32	110	35:39	
		WSRT, CSRT, ESRT[e]	0	57	0	25	82	9:31	
Opportunistic surveys	Flight[f]	na[h]	1	na	na	na	na	na	na
	Ground[g]	na	14[i]	na	na	na	na	40:39	835
Total			62	211	4	87	302	128:20	9,401

[a] see Appendix B for whooping crane group observation details.
[b] duration of survey effort is denoted in hours:minutes
[c] primary transect (riverine): East – 0SE; West – 0SW (Figs. 1, 2)
[d] primary return transect: East – PWRTE; West – PWRTW (Figs. 1, 2)
[e] secondary return transect: East – WSRT; CSRT; West – ESRT (Figs. 1, 2)
[f] opportunistic flight: includes aerial observations made while in route to systematic transects or deviations from the systematic transects
[g] opportunistic ground: includes efforts made by motorized vehicle outside of systematic flight transects to confirm or deny unconfirmed crane groups or to independently search for previous day groups when flights were cancelled
[h] "na" denotes the entry was not applicable
[i] A total of 25 observations of whooping crane groups were made during opportunistic ground surveys totaling 835 miles of driving search effort, but 11 of these locations were secondary locations of the same group.

Opportunistic ground and aerial monitoring. We considered all ground monitoring observations and all aerial observations made when not surveying defined transects to be opportunistic. Surveyors observed a total of 31 whooping cranes (28 adults; three juveniles) in 15 groups during ground monitoring and through opportunistic aerial observations (Tables 1, 3; Fig. 3; Appendix B, Appendix C). Of the 15 whooping crane groups, one group was unique from groups observed during systematic monitoring and consisted of one adult (PRRIP ID 2023SP07; USFWS ID 23A-07; Appendix B). Of the 15 opportunistic group observations, surveyors made one (2023SP59B) aerial observation when not surveying the systematic transect (Appendix B). This observation was combined with opportunistic ground observation 2023SP59 to add information about the three adults and one juvenile in the group (Table 3). Ground survey crews drove a total of 835 mi to search for potential whooping cranes (Table 3).

Table 2. Number of systematic aerial surveys completed, cancelled or incomplete, and scheduled during spring 2023 whooping crane monitoring for east and west flight routes along the Associated Habitat Reach of the central Platte River between Lexington and Chapman, Nebraska.

Systematic surveys	East route	West route	Total
No. completed	38	39	77
No. cancelled/incomplete	17	16	33
No. scheduled	55	55	110
Percent completed	**69.1%**	**70.9%**	**70.0%**

Table 3. Summary of ground search efforts for whooping cranes during spring 2023 monitoring along the Associated Habitat Reach of the central Platte River between Lexington and Chapman, Nebraska. The date of the search; information source that prompted the search (aerial sighting by plane [plane]; previous known location [known]; no information [none]); miles driven during the search; and type of effort (aerial and ground surveyors working together [both]; ground observation only [ground]) are provided for each ground search effort entry. For confirmed whooping crane observations, the number of adults and juveniles enumerated are provided along with the corresponding USFWS and PRRIP group IDs. Color-coded unique group icons correspond to group symbols on Figures 6–9 and locations on maps in Appendix C.

Unique group icon	USFWS group ID	PRRIP group ID	Date	Source	No. of confirmed whooping cranes (adults:juveniles)	Miles driven	Type of effort
	23A-03	2023SP01	8-Mar	Known	1:0	36	Ground
	23A-03	2023SP01	8-Mar	Known	1:0	20	Ground
	23A-03	2023SP02	9-Mar	Known	1:0	1	Ground
	23A-03	2023SP02	9-Mar	Known	1:0	6	Ground
na	na	na	10-Mar	Known	None	44	Ground
	23A-03	2023SP03	10-Mar	Known	1:0	64	Ground
na	na	na	11-Mar	Known	None	42	Ground
	23A-03	2023SP05	13-Mar	Known	1:0	5	Ground
	23A-07	2023SP07	15-Mar	None	1:0	1	Ground
	23A-03	2023SP08	15-Mar	Plane	1:0	3	Both

Table 3 continued

Unique group icon	USFWS group ID	PRRIP group ID	Date	Source	No. of confirmed whooping cranes (adults:juveniles)	Miles driven	Type of effort
	23A-06	2023SP09	15-Mar	Plane	1:0	7	Both
	23A-06	2023SP11	16-Mar	Known	1:0	1	Ground
na	na	na	16-Mar	Known	None	49	Ground
	23A-03	2023SP10	16-Mar	Known	1:0	6	Ground
na	na	na	16-Mar	Known	None	36	Ground
na	na	na	18-Mar	Known	None	12	Ground
na	na	na	21-Mar	Plane	None	8	Both
na	na	na	21-Mar	Known	None	34	Ground
na	na	na	22-Mar	Plane	None	22	Both
na	na	na	27-Mar	Plane	None	38	Both
na	na	na	27-Mar	Plane	None	45	Both
	23A-03	2023SP31	28-Mar	Known	1:0	1	Ground
	23A-17	2023SP30	28-Mar	Plane	7:0	18	Both
na	na	na	29-Mar	Known	None	22	Ground
	23A-03	2023SP32	29-Mar	Plane	1:0	1	Both
na	na	na	30-Mar	Known	None	19	Ground
	23A-17	2023SP42	31-Mar	Known	7:0	63	Ground
	23A-03	2023SP39	31-Mar	Known	1:0	1	Ground
	23A-23	2023SP41	31-Mar	Known	1:0	5	Ground
	23A-23	2023SP41	31-Mar	Known	1:0	35	Ground
	23A-06	2023SP40	31-Mar	Known	1:0	41	Ground
	23A-27	2023SP48	3-Apr	Plane	6:0	1	Both
	23A-31	2023SP53	5-Apr	Known	4:1	24	Ground
na	na	na	5-Apr	Known	None	90	Ground
na	na	na	6-Apr	Known	None	2	Ground
	23A-37	2023SP54	6-Apr	Plane	10:1	3	Both
	23A-37	2023SP59	7-Apr	Known	3:1	2	Ground
	23A-37	2023SP60	8-Apr	Known	3:1	2	Both
na	na	na	9-Apr	Known	None	24	Ground
	23A-47	2023SP61	13-Apr	Plane	2:1	1	Both
Total					**59:5**	**835**	

Whooping crane stopover metrics

Proportion of population stopping on the AHR. The USFWS estimated the AWB migratory whooping crane population to be 536 birds (95% confidence interval [CI] = 443.5, 644.1) based on winter 2022–2023 survey efforts within the primary survey area along the Texas coast of the Gulf of Mexico, USA wintering range (USFWS 2023; Appendix D). Based on the 57 individual whooping cranes enumerated during PRRIP surveys, we estimated that 0.106 (95% CI = 0.089, 0.129) of the AWB whooping crane population was observed on the AHR along the central Platte River during the spring migration (Fig. 4a). The proportion of the AWB population using the AHR along the central Platte River during the spring migration has varied between 0.011 and 0.234 during 2007–2023 (mean = 0.070; median = 0.061; SE = 0.015; Fig. 4a).

Number of crane use days. The 17 unique whooping crane groups remained in the study area between one and 25 days (mean = 4.4; SE = 1.8). Based on these lengths of stay and the number of whooping cranes enumerated in each group, we calculated a total of 210 crane use days for the spring 2023 monitoring period between March 6 and April 29 (Fig. 4a). Between 2007 and 2023, the number of crane use days during the spring migration has varied between 13 and 501 days (mean = 111; median = 71; SE = 28; Fig. 4a).

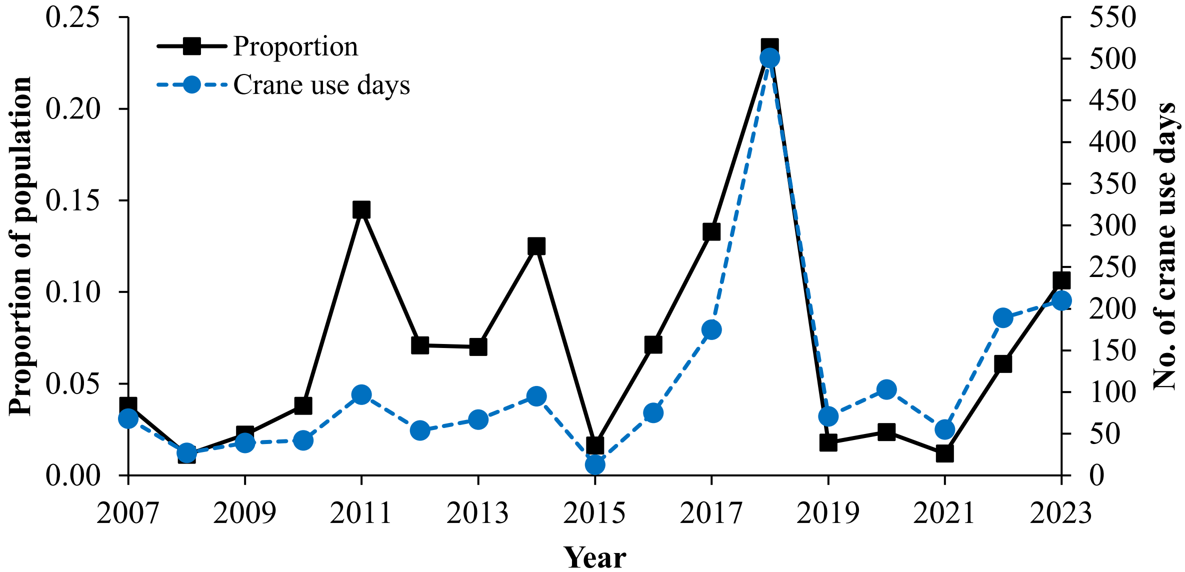
5th and 95th percentile dates of whooping crane group observations and adjusted whooping crane stopover metrics

Fifth percentile dates of initial whooping crane group observations in Nebraska from the USFWS public sighting database ranged from March 7 to March 15 (mean = March 8; SE = 0.69 days) over the 16 10-year periods (Table 4). Ninety-fifth percentile dates ranged from April 17 to May 4 (mean = April 20; SE = 1.2 days; Table 4). The smallest range of days between the 5th and 95th percentile dates was 38 days between March 10 to April 17 during the 2013–2022 period (Table 4). The largest range of days between the 5th and 95th percentile dates occurred during the 2000–2009 period, which spanned 55 days between March 10 to May 4 (Table 4).

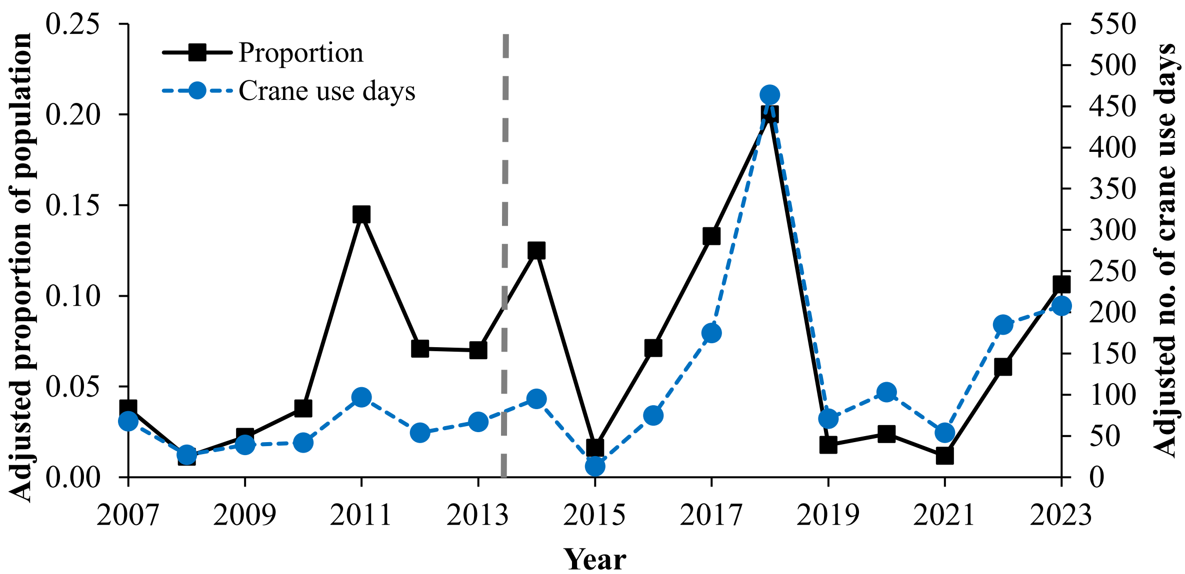
Surveys during 2007 through 2013 did not include the 5th percentile date for the corresponding period (Table 4). Surveys during 2007 through 2011 began on March 21 or March 22. Surveys in 2012 and 2013 began on March 9 and March 11, respectively. Surveys in 2009 ended on April 28 and did not include the 95th percentile date for the corresponding period (Table 4). Therefore, we could not assess the extent whooping crane metrics would have been adjusted during those years.

Table 4. The 5th and 95th percentiles of initial dates of whooping crane group observations in Nebraska for 16 10-year periods ranging from 1998–2007 to 2013–2022. Percentiles were calculated using the USFWS whooping crane public sighting database for Nebraska during 1998–2022. For each period, the applicable survey year(s) for which the percentiles were used to adjust whooping crane metrics is provided. The start and end dates for PRRIP monitoring during each survey year are also provided.

Period	Applicable survey year(s)	5th percentile	95th percentile	Survey start date	Survey end date
1998–2007	2007	March 8	April 20	March 22	April 29
1999–2008	2008	March 10	April 22	March 21	April 29
2000–2009	2009	March 10	May 4	March 22	April 28
2001–2010	2010	March 15	April 29	March 21	April 29
2002–2011	2011	March 14	April 24	March 21	April 29
2003–2012	2012	March 7	April 24	March 9	April 29
2004–2013	2013	March 7	April 19	March 11	April 29
2005–2014	2014	March 7	April 19	March 6	April 29
2006–2015	2015	March 7	April 18	March 6	April 29
2007–2016	2016	March 7	April 18	March 6	April 29
2008–2017	2017	March 7	April 17	March 6	April 29
2009–2018	2018	March 7	April 18	March 6	April 29
2010–2019	2019	March 8	April 17	March 6	April 29
2011–2020	2020	March 7	April 17	March 6	April 29
2012–2021	2021	March 7	April 17	March 6	April 29
2013–2022	2022, 2023	March 10	April 17	March 6	April 29



(a)



(b)

Figure 4. Annual variability in the proportion of the Aransas-Wood Buffalo (AWB) migratory whooping crane population that stopped on the Associated Habitat Reach (AHR) of the central Platte River and the associated number of crane use days between 2007 and 2023 during the spring migration. Panel **(a)** depicts the proportion of the population and number of crane use days for the entire spring survey period, whereas **(b)** illustrates the proportion of the population and number of crane use days calculated only for dates constrained by the 5th and 95th percentiles of dates of spring whooping crane group observations in Nebraska (see text for details). Whooping cranes were enumerated using PRRIP's systematic aerial surveys and opportunistic aerial and ground sightings during spring of each year across the AHR between Lexington and Chapman, Nebraska. For the 2021 proportion calculation, the estimated AWB population from winter 2019–2020 was used because no winter survey was completed during 2020–2021. The vertical dashed line in **(b)** denotes surveys before 2014 did not include the 5th percentile date of group observations and adjusted metrics from 2007–2013 are not directly comparable to those from 2014–2023.

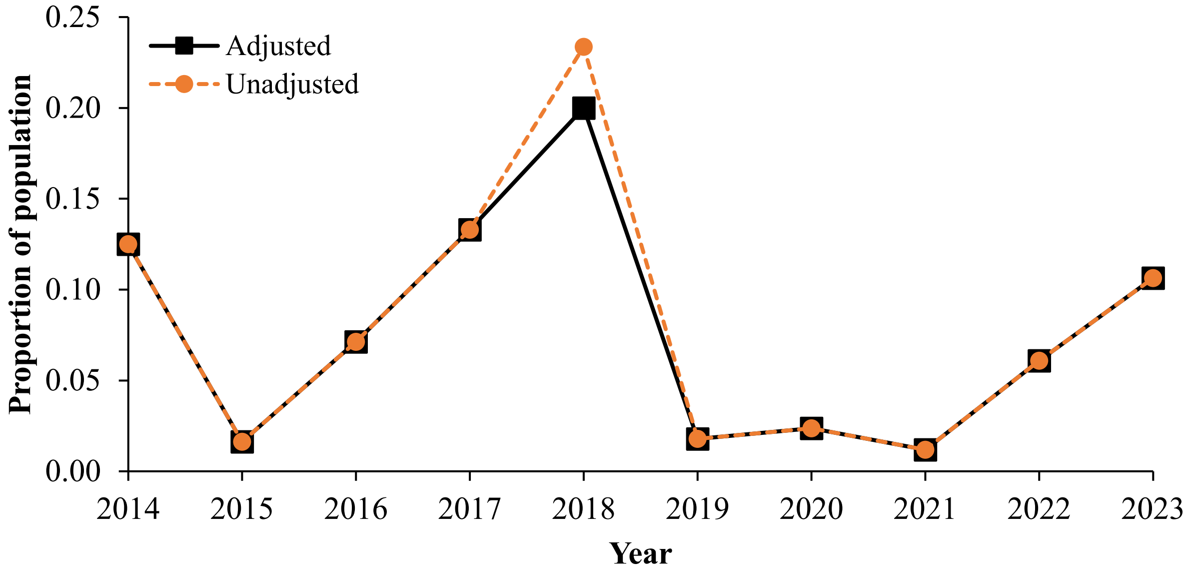
Use of 5th and 95th percentiles of dates to calculate whooping crane metrics resulted in adjustments being made to metrics in 2018, 2021, 2022, and 2023, but not other years (Figs. 4, 5). In 2018, the number of individual whooping cranes observed, proportion of population that stopped on the AHR, and number of crane use days decreased from 118 to 101 birds, 0.234 to 0.200, and 501 to 464 crane use days, respectively, when accounting for whooping cranes observed only during the 5th through 95th percentiles of dates from the 2009–2018 period (Figs. 4, 5). In 2021, 2022, and 2023, the number of individual whooping cranes observed and proportion of population that stopped on the AHR did not change between unadjusted and adjusted metrics (Figs. 4, 5a). However, the number of crane use days decreased from 55 to 54 in 2021, 189 to 185 in 2022, and 210 to 208 in 2023 when accounting for whooping cranes observed only during the 5th through 95th percentiles of dates from the 2012–2021 and 2013–2022 periods (Figs. 4, 5b).

When evaluating adjusted metrics from 2014 through 2023, the proportion of the population that stopped on the AHR ranged from 0.011 to 0.200 (mean = 0.068; median = 0.061; SE = 0.014; Fig. 4b, 5) and the number of crane use days varied between 13 and 464 days (mean = 108; median = 71; SE = 26; Fig. 4b, 5). We found no correlation between either the adjusted proportion of population stopping on the AHR and year ($\rho = -0.212$; $p = 0.560$), or the adjusted number of crane use days and year during 2014–2023 ($\rho = 0.394$; $p = 0.263$). We also found no relationship between the number of whooping cranes enumerated during PRRIP spring surveys and the estimated AWB population size during 2016–2023 ($p = 0.393$; Fig. D2, Appendix D).

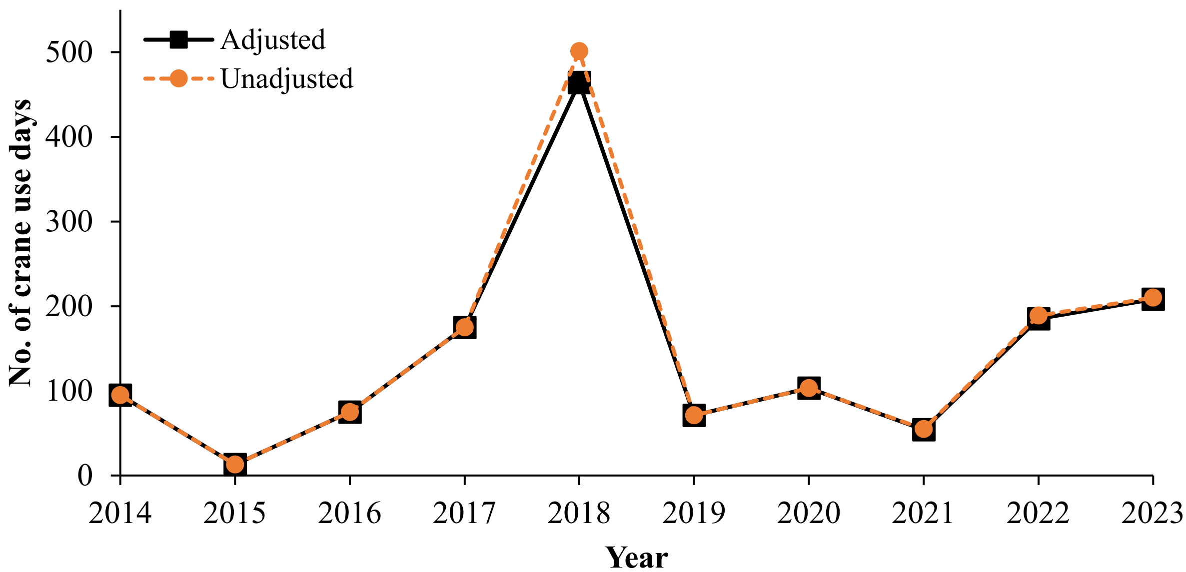
Whooping crane observations in relation to Platte River discharge and habitat metrics

During the March 6 through April 29 spring 2023 whooping crane migration monitoring period, Platte River discharge in the AHR ranged from a low of 42.9 cfs at Kearney on April 29 (USGS 2023c) to a high of 2,370 cfs at Overton on March 23 and 24 (USGS 2023a). Platte River discharge at the Overton gage (USGS 2023a) ranged from 136 to 2,370 cfs (mean = 711; SE = 9.7; $n = 5{,}271$) with low and high flows recorded on April 29 and March 23–24, respectively (Fig. 6). Discharge at the Cottonwood Ranch gage (USGS 2023b) ranged from 120 to 1,370 cfs (mean = 559; SE = 6.5; $n = 3{,}972$) with low flow recorded on April 29 and high flows recorded on March 24, April 1, and April 2 (Fig. 7). At the Kearney gage (USGS 2023c), discharge reached a low of 42.9 cfs on April 29 and a high of 2,280 cfs on March 24 and 25 (mean = 757; SE = 8.4; $n = 5{,}265$; Fig. 8). The Grand Island gage (USGS 2023d) recorded a low discharge of 137 cfs on April 29 and peak discharge of 2,250 on March 26 (mean = 760; SE = 7.4; $n = 5{,}270$; Fig. 9).

Instantaneous discharge at the gaging station closest to the whooping crane group location ranged from 283 to 1,970 cfs (mean = 784; median = 690; SE = 61; $n = 50$; Table 5; Fig. 10). These discharge measurements were recorded to the nearest 15 min of the time the whooping crane group was observed. The majority of the 50 whooping crane groups observed in the river channel were closest to the Grand Island gage (Table 5; Fig. 8). No whooping crane groups were observed closest to the Kearney gage (Table 5; Fig. 7). Unobstructed channel widths at the 50 whooping crane riverine use sites ranged from 129–1,470 ft (mean = 645; SE = 43; Table 6). Distance to the nearest forest ranged from 47–1,011 ft (mean = 373; SE = 31; Table 6).



(a)



(b)

Figure 5. Annual variability between 2014 and 2023 during the spring migration in **(a)** the proportion of the Aransas-Wood Buffalo migratory whooping crane population that stopped on the Associated Habitat Reach (AHR) of the central Platte River, and **(b)** the associated number of crane use days. Each panel illustrates the whooping crane metric for the entire spring survey period (unadjusted; orange circles and dashed line) and only for dates constrained by the 5th and 95th percentiles of dates of spring whooping crane group observations in Nebraska (adjusted; black squares and solid line; see text for details). Whooping cranes were enumerated using PRRIP's systematic aerial surveys and opportunistic aerial and ground sightings during spring of each year across the AHR between Lexington and Chapman, Nebraska. Data from 2007–2013 are not shown because surveys during these years did not include the 5th percentile date for the corresponding period (Table 4) and adjusted metrics could not be calculated. For the 2021 proportion calculations, the estimated AWB population from winter 2019–2020 was used because no winter survey was completed during 2020–2021.

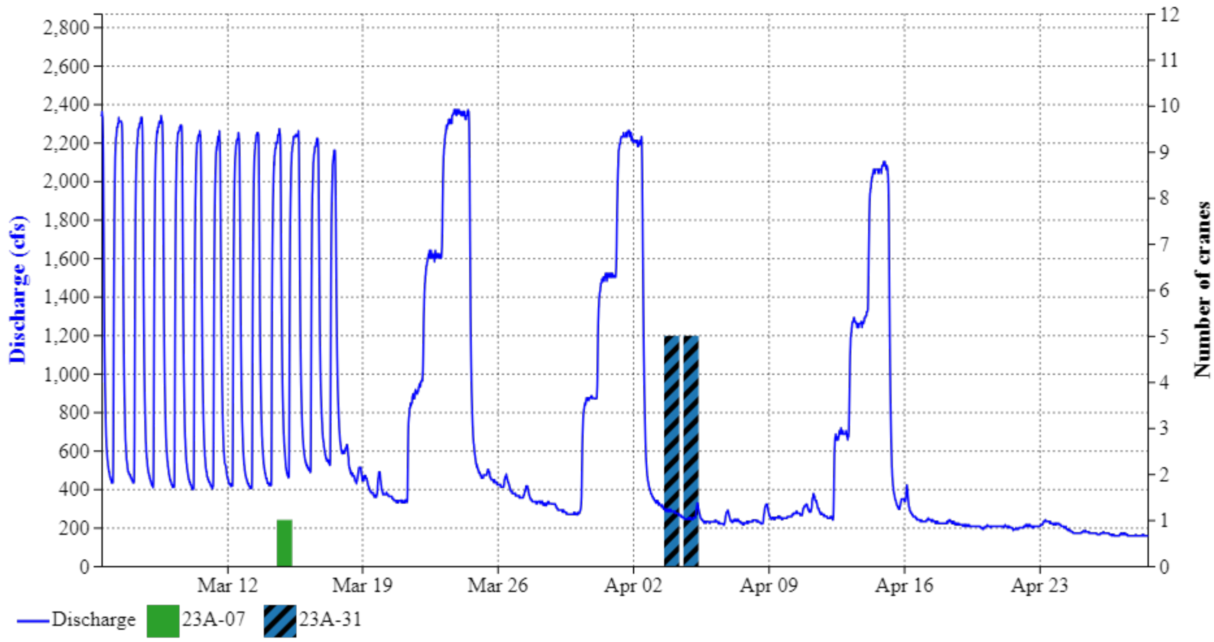


Figure 6. Platte River discharge in cubic feet per second (cfs; blue line) at the Overton, Nebraska gage during March 6 through April 29, 2023 (USGS 2023a) and the corresponding numbers of whooping cranes from each group (USFWS groups 23A-07; 23A-31 in color-coded bars) observed on the indicated dates either on- or off-channel at locations for which Overton was the nearest gaging station.

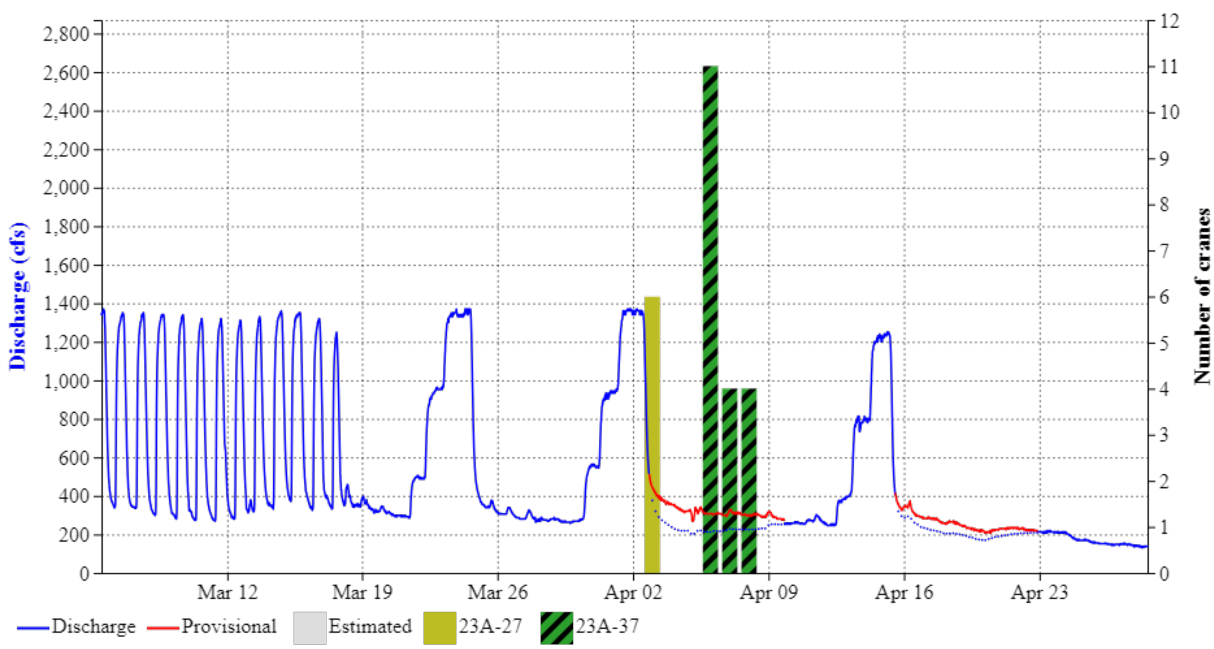


Figure 7. Platte River discharge in cubic feet per second (cfs; blue line; blue dots [estimated data]; red line [provisional data]) at the Cottonwood Ranch, Nebraska gage during March 6 through April 29, 2023 (USGS 2023b) and the corresponding numbers of whooping cranes from each group (USFWS groups 23A-27; 23A-37 in color-coded bars) observed on the indicated dates either on- or off-channel at locations for which Cottonwood Ranch was the nearest gaging station.

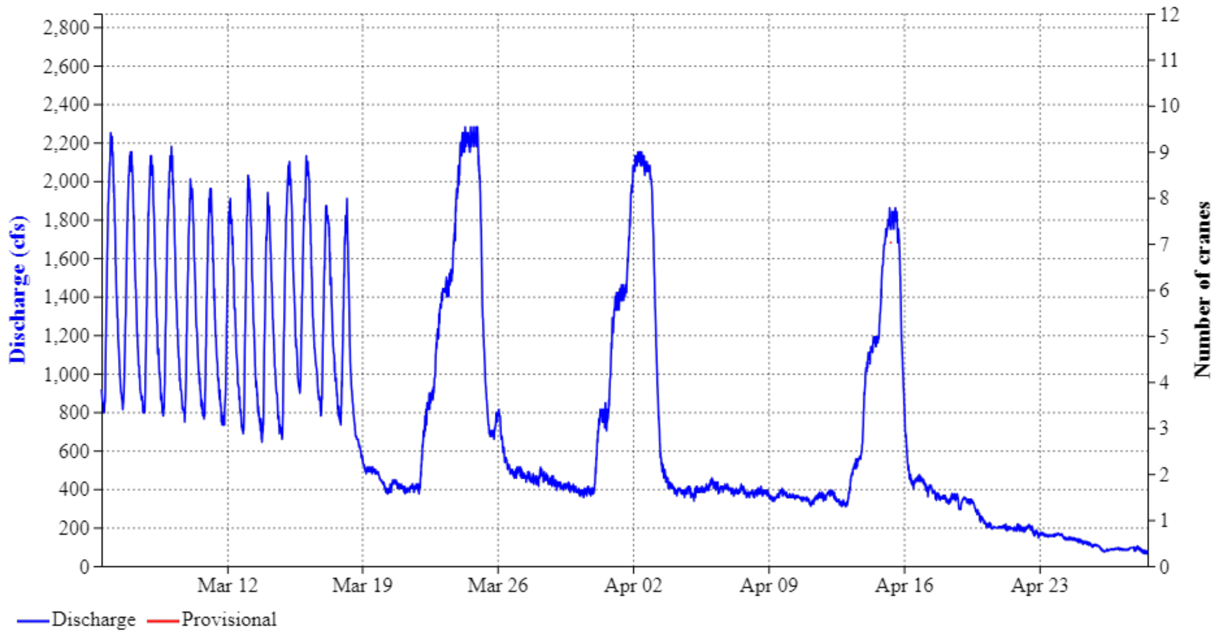


Figure 8. Platte River discharge in cubic feet per second (cfs; blue line) at the Kearney, Nebraska gage during March 6 through April 29, 2023 ([USGS 2023c]()). No whooping cranes were observed along the central Platte River for which Kearney was the nearest gaging station.

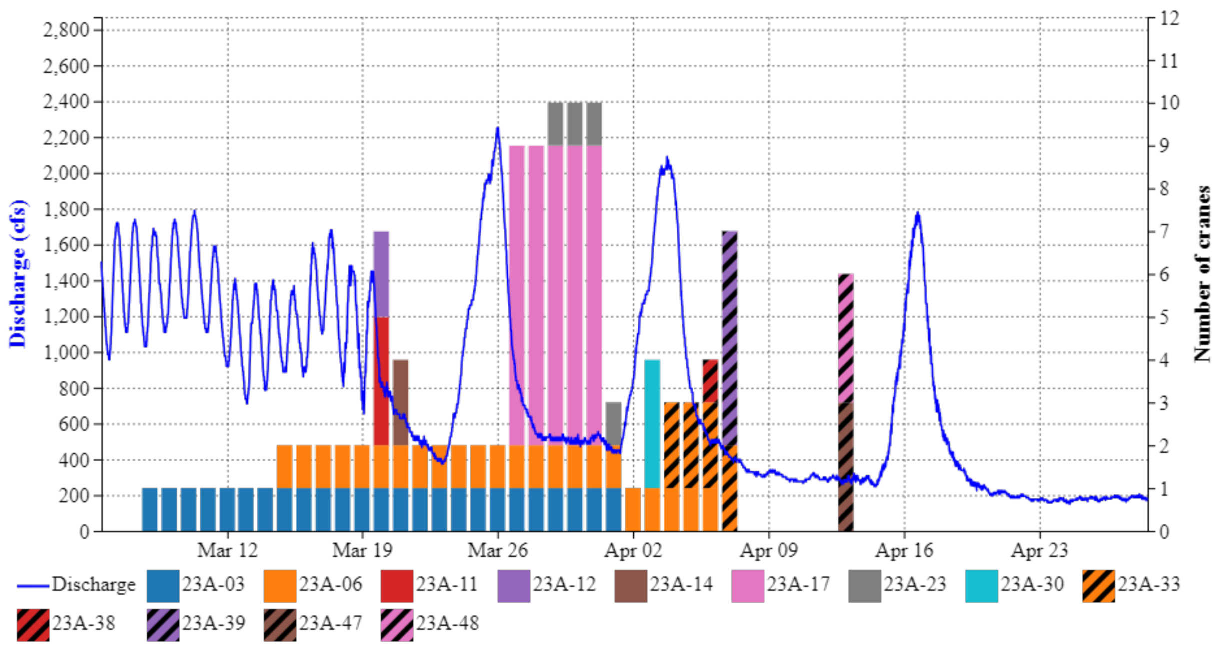


Figure 9. Platte River discharge in cubic feet per second (cfs; blue line) at the Grand Island, Nebraska gage during March 6 through April 29, 2023 ([USGS 2023d]()) and the corresponding numbers of whooping cranes from each group (USFWS groups 23A-03; 23A-06; 23A-11; 23A-12; 23A-14; 23A-17; 23A-23; 23A-30; 23A-33; 23A-38; 23A-39; 23A-47; 23A-48 in color-coded bars) observed on the indicated dates either on- or off-channel at locations for which Grand Island was the nearest gaging station.

Table 5. Whooping crane groups observed in the Platte River channel within the Associated Habitat Reach between Lexington and Chapman, Nebraska, and the associated river discharge (cubic feet per second [cfs]) at the gaging station nearest to the group location during spring 2023 monitoring. Discharge data from the gaging station was used based on the time of group observation to the nearest 15 minutes. Color-coded unique group icons correspond to group symbols on Figures 6–9 and locations on maps in Appendix C.

Unique group icon	USFWS Group ID	PRRIP Group ID	No. of whooping cranes (adults: juveniles)	Use site no.	Date	Gaging station[a]	Discharge (cfs)
	23A-03	2023SP02	1:0	1	3/9	Grand Island	1,380
	23A-03	2023SP04	1:0	2	3/12	Grand Island	920
	23A-03	2023SP06	1:0	3	3/14	Grand Island	864
	23A-03	2023SP08	1:0	4	3/15	Grand Island	1,050
	23A-06	2023SP09	1:0	5	3/15	Grand Island	1,030
	23A-03	2023SP12	1:0	6	3/17	Grand Island	1,340
	23A-06	2023SP13	1:0	7	3/17	Grand Island	1,340
	23A-06	2023SP14	1:0	7	3/18	Grand Island	885
	23A-06	2023SP15	1:0	7	3/19	Grand Island	727
	23A-03	2023SP16	1:0	6	3/19	Grand Island	805
	23A-12	2023SP17	2:0	8	3/20	Grand Island	804
	23A-11	2023SP18	3:0	9	3/20	Grand Island	804
	23A-06	2023SP19	1:0	10	3/20	Grand Island	804
	23A-03	2023SP20	1:0	11	3/20	Grand Island	804
	23A-03	2023SP21	1:0	12	3/21	Grand Island	652
	23A-14	2023SP22	2:0	13	3/21	Grand Island	628
	23A-03	2023SP23	1:0	12	3/22	Grand Island	505
	23A-06	2023SP24	1:0	14	3/24	Grand Island	842
	23A-03	2023SP25	1:0	15	3/24	Grand Island	868
	23A-06	2023SP26	1:0	16	3/25	Grand Island	1,720
	23A-17	2023SP27	7:0	17	3/27	Grand Island	793
	23A-06	2023SP28	1:0	18	3/27	Grand Island	793
	23A-03	2023SP29	1:0	19	3/27	Grand Island	793
	23A-17	2023SP30	7:0	20	3/28	Grand Island	541
	23A-03	2023SP31	1:0	21	3/28	Grand Island	523
	23A-03	2023SP32	1:0	22	3/29	Grand Island	522

Table 5—Continued

Unique group icon	USFWS Group ID	PRRIP Group ID	No. of whooping cranes (adults: juveniles)	Use site no.	Date	Gaging station[a]	Discharge (cfs)
	23A-06	2023SP33	1:0	23	3/29	Grand Island	522
	23A-23	2023SP34	1:0	24	3/29	Grand Island	505
	23A-23	2023SP35	1:0	25	3/30	Grand Island	487
	23A-17	2023SP36	7:0	26	3/30	Grand Island	503
	23A-06	2023SP37	1:0	27	3/30	Grand Island	503
	23A-03	2023SP38	1:0	28	3/30	Grand Island	503
	23A-03	2023SP39	1:0	29	3/31	Grand Island	519
	23A-03	2023SP43	1:0	30	4/1	Grand Island	451
	23A-06	2023SP44	1:0	32	4/1	Grand Island	451
	23A-23	2023SP52	1:0	31	4/1	Grand Island	451
	23A-06	2023SP45	1:0	33	4/2	Grand Island	942
	23A-06	2023SP46	1:0	34	4/3	Grand Island	1,650
	23A-30	2023SP47	2:1	35	4/3	Grand Island	1,650
	23A-27	2023SP48	6:0	36	4/3	Cottonwood	431
	23A-31	2023SP49	4:1	37	4/4	Overton	283
	23A-06	2023SP50	1:0	38	4/4	Grand Island	1,970
	23A-33	2023SP51	2:0	39	4/4	Grand Island	1,970
	23A-37	2023SP54	10:1	40	4/6	Cottonwood	307
	23A-38	2023SP55	1:0	42	4/6	Grand Island	492
	23A-06	2023SP56	1:0	41	4/6	Grand Island	492
	23A-33	2023SP57	2:0	43	4/7	Grand Island	412
	23A-39	2023SP58	4:1	44	4/7	Grand Island	398
	23A-47	2023SP61	2:1	45	4/13	Grand Island	285
	23A-48	2023SP62	3:0	46	4/13	Grand Island	285

[a] Gaging Stations: Overton, Nebraska (USGS 2023a); Cottonwood Ranch, Nebraska (USGS 2023b); Grand Island, Nebraska (USGS 2023d).

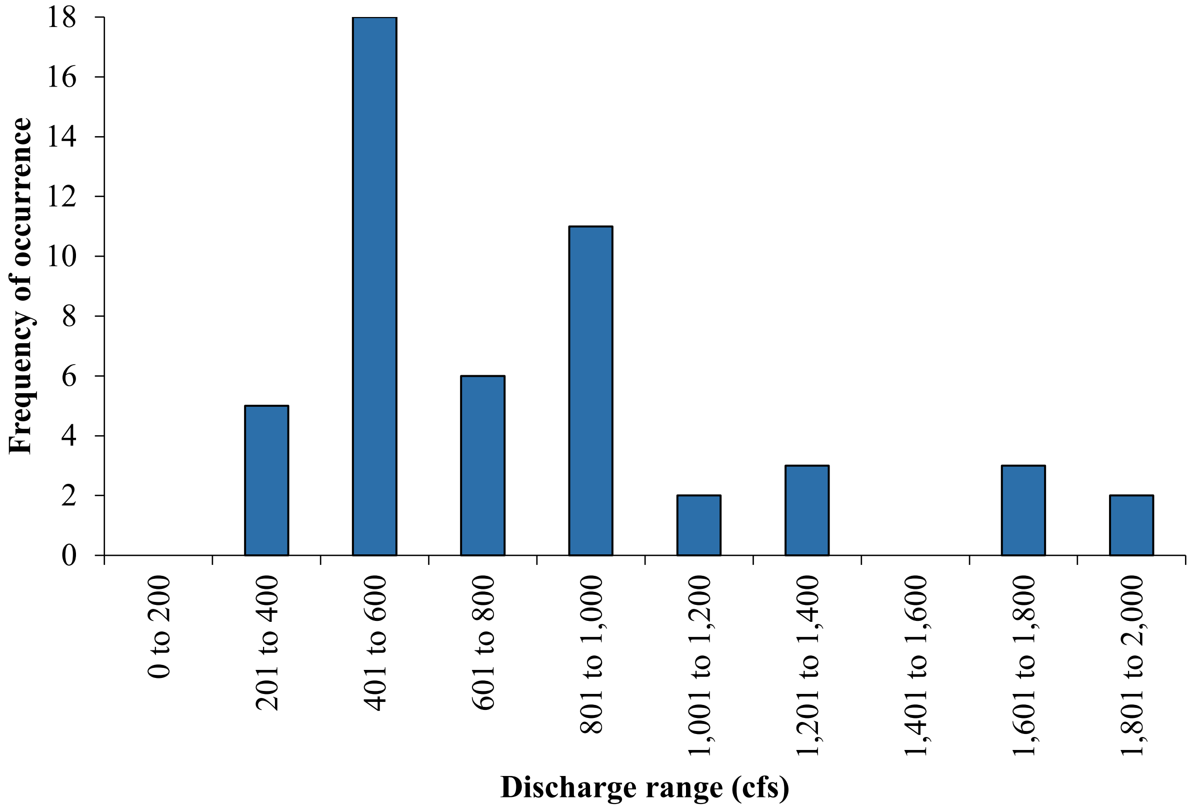


Figure 10. Distribution of Platte River discharge (cubic feet per second [cfs]) at the 50 total whooping crane group locations observed in the river channel during spring 2023 PRRIP monitoring. Discharge was determined from the gaging station nearest to the group location. Discharge data from the gaging station was used based on the time of group observation to the nearest 15 minutes.

Table 6. Whooping crane groups observed in the Platte River channel within the Associated Habitat Reach between Lexington and Chapman, Nebraska, and the associated unobstructed channel width and distance to the nearest forest (nearest forest) at the used location. Provided for each group are the USFWS and PRRIP group identification (ID) number; use site number; x and y UTM 14N coordinates. Color-coded unique group icons correspond to group symbols on Figures 6–9 and locations on maps in Appendix C.

Unique group icon	USFWS group ID	PRRIP group ID	Use site no.	UTM x	UTM y	Unobstructed channel width (ft)	Nearest forest (ft)
	23A-03	2023SP02	1	545281	4514666	932	613
	23A-03	2023SP04	2	548972	4515303	791	232
	23A-03	2023SP06	3	548986	4515330	799	138
	23A-03	2023SP08	4	538998	4511231	129	571
	23A-03	2023SP12	6	539195	4511471	482	409
	23A-03	2023SP16	6	539195	4511471	482	409
	23A-03	2023SP20	11	539132	4511431	460	344
	23A-03	2023SP21	12	539142	4511405	405	440
	23A-03	2023SP23	12	539142	4511405	405	440
	23A-03	2023SP25	15	540448	4512167	1,035	790
	23A-03	2023SP29	19	540615	4512208	1,051	1,011
	23A-03	2023SP31	21	541926	4513050	786	482
	23A-03	2023SP32	22	541893	4512990	746	512
	23A-03	2023SP38	28	541584	4512854	781	672
	23A-03	2023SP39	29	542426	4513159	690	254
	23A-03	2023SP43	30	541907	4513001	741	523
	23A-06	2023SP09	5	554294	4518005	662	108
	23A-06	2023SP13	7	554749	4518563	364	213
	23A-06	2023SP14	7	554749	4518563	364	213
	23A-06	2023SP15	7	554749	4518563	364	213
	23A-06	2023SP19	10	548970	4515328	794	178
	23A-06	2023SP24	14	559384	4523279	865	156
	23A-06	2023SP26	16	559849	4523613	995	530
	23A-06	2023SP28	18	560093	4523677	956	125

Table 6 continued

Unique group icon	USFWS group ID	PRRIP group ID	Use site no.	UTM x	UTM y	Unobstructed channel width (ft)	Nearest forest (ft)
	23A-06	2023SP33	23	557711	4520722	323	92
	23A-06	2023SP37	27	558576	4521801	332	239
	23A-06	2023SP44	32	558651	4521935	345	399
	23A-06	2023SP45	33	557708	4520735	331	116
	23A-06	2023SP46	34	557593	4520584	372	219
	23A-06	2023SP50	38	557835	4520859	152	59
	23A-06	2023SP56	41	559829	4523399	1,187	286
	23A-11	2023SP18	9	564279	4529418	813	346
	23A-12	2023SP17	8	563589	4528631	254	130
	23A-14	2023SP22	13	528590	4508196	553	713
	23A-17	2023SP27	17	530179	4508619	870	498
	23A-17	2023SP30	20	531236	4509317	405	477
	23A-17	2023SP36	26	532023	4509780	280	311
	23A-23	2023SP34	24	565411	4530522	929	368
	23A-23	2023SP35	25	565385	4530314	873	47
	23A-23	2023SP52	31	564235	4529370	485	224
	23A-27	2023SP48	36	472404	4503582	940	520
	23A-30	2023SP47	35	541073	4512730	1,470	905
	23A-31	2023SP49	37	438738	4508321	147	202
	23A-33	2023SP51	39	562146	4526922	941	366
	23A-33	2023SP57	43	565156	4530358	1,018	784
	23A-37	2023SP54	40	472194	4503627	848	414
	23A-38	2023SP55	42	556812	4520100	378	182
	23A-39	2023SP58	44	538061	4511368	495	338
	23A-47	2023SP61	45	560012	4523790	941	444
	23A-48	2023SP62	46	529665	4508378	467	411

Comparison between PRRIP and USFWS data

We provide a comparison between whooping crane observations collected during PRRIP monitoring with those from the USFWS whooping crane public sighting database (USFWS *unpublished data*) for spring 2023 in Table 7. PRRIP coordinates with the USFWS to determine unique whooping crane groups throughout the monitoring period. Unique groups are typically individually identifiable by their arrival date, location, and group composition. However, discrepancies among datasets occur when: (1) whooping crane groups arrive and are reported to USFWS later in the day after systematic transects have been flown; (2) whooping crane groups leave the river prior to the plane surveying that portion of the transect; (3) observers do not see the group; (4) or flights are cancelled due to poor visibility or weather.

The USFWS reported a whooping crane group that was not observed by PRRIP on three occasions during spring 2023 (Table 7). The USFWS reported group 23A-05 on March 8, which was a day that PRRIP flights were cancelled due to weather and ground surveyors did not detect any whooping cranes (Table 7). Additionally, groups 23A-18 on March 28 and 23A-19 on March 27 were not observed during PRRIP surveys (Table 7). There were four instances when the USFWS reported groups arriving earlier and/or staying longer than what PRRIP observed, resulting in additional crane use days to the USFWS total (Table 7). Overall, the USFWS database consisted of 72 whooping crane (67 adults; five juveniles) observations resulting in a total of 272 crane use days (Table 7). In comparison, PRRIP surveyors observed 57 whooping cranes (53 adults; four juveniles) days resulting in a total of 210 crane use days (Table 7).

Detectability of whooping crane decoys

EDO staff placed whooping crane decoy sets at 20 unique locations between March 7 and April 19, 2023 (Table 8). Four decoy sets consisted of one whooping crane decoy; 10 sets contained two decoys; and six sets consisted of three decoys (Table 8). EDO staff placed three of the four decoy sets comprised of one decoy, four of 10 sets consisting of two decoys, and three of six sets containing three decoys in the river channel (Table 8). Aerial surveyors spotted seven of ten decoy sets placed in the river channel (70%) and one of ten decoy sets placed at off-channel locations (10%; Table 8). Aerial surveyors detected two of the four sets consisting of one decoy; three of 10 sets consisting of two decoys; and three of six sets consisting of three decoys (Table 8).

Table 7. Comparison between whooping crane groups observed during PRRIP surveys with those from the USFWS public sighting database during spring 2023 monitoring along the central Platte River, Nebraska. Included for each unique group are a color-coded icon; group identification (ID) numbers assigned by PRRIP and USFWS; the date(s) the group was observed and number of days present; the number of adults and juveniles in the group; and number of crane use days. Color-coded unique group icons correspond to group symbols on Figures 6–9 and locations on maps in Appendix C.

	PRRIP					USFWS				
Unique group icon	PRRIP Group ID[a]	Dates present	Adults: juveniles	No. days present	Crane use days[c]	USFWS Group ID[b]	Dates present	Adults: juveniles	No. days present	Crane use days[d]
	2023SP01, 02, 03, 04, 05, 06, 08, 10, 12, 16, 20, 21, 23, 25, 29, 31, 32, 38, 39, 43	3/8 - 4/1	1:0	25	26	23A-03	3/6 - 4/1	1:0	27	28
na	na	na	na	na	na	23A-05	3/8	2:0	1	4
	2023SP09, 11, 13, 14, 15, 19, 24, 26, 28, 33, 37, 40, 44, 45, 46, 50, 56	3/15 - 4/6	1:0	23	24	23A-06	3/15 - 4/6	1:0	23	24
	2023SP07	3/15	1:0	1	2	23A-07	3/15	1:0	1	2
	2023SP18	3/20	3:0	1	6	23A-11	3/20	3:0	1	6
	2023SP17	3/20	2:0	1	4	23A-12	3/20	2:0	1	4
	2023SP22	3/21	2:0	1	4	23A-14	3/21	2:0	1	4
	2023SP27, 30, 36, 42	3/27 - 3/31	7:0	5	42	23A-17	3/27 - 3/31	7:0	5	42
na	na	na	na	na	na	23A-18	3/28	2:1	1	6
na	na	na	na	na	na	23A-19	3/27	10:0	1	20
	2023SP34, 35, 41, 52	3/29 - 4/1	1:0	4	5	23A-23	3/29 - 4/1	1:0	4	5

Table 7 continued

Unique group icon	PRRIP					USFWS				
	PRRIP Group ID[a]	**Dates present**	**Adults: juveniles**	**No. days present**	**Crane use days**[c]	**USFWS Group ID**[b]	**Dates present**	**Adults: juveniles**	**No. days present**	**Crane use days**[d]
	2023SP48	4/3	6:0	1	12	23A-27	4/3	6:0	1	12
	2023SP47	4/3	2:1	1	6	23A-30	4/2 - 4/3	2:1	2	9
	2023SP49,53	4/4 - 4/5	4:1	2	15	23A-31	4/4 - 4/5	4:1	2	15
	2023SP51,57	4/4 - 4/7	2:0	4	10	23A-33	4/4 - 4/7	2:0	4	10
	2023SP54	4/6	10:1	1	22	23A-37	4/6 - 4/9	10:1	4	55
	2023SP59,60	4/7 - 4/8	3:1	2	8					
	2023SP55	4/6	1:0	1	2	23A-38	4/4 - 4/6	1:0	3	4
	2023SP58	4/7	4:1	1	10	23A-39	4/7	4:1	1	10
	2023SP61	4/13	2:1	1	6	23A-47	4/13	2:1	1	6
	2023SP62	4/13	3:0	1	6	23A-48	4/13	3:0	1	6
	Total		**53:4**	**76**	**210**	**Total**		**67:5**	**85**	**272**

[a] PRRIP assigns a new whooping crane group ID each day a group is observed.
[b] USFWS assigns a whooping crane group ID based on an initial sighting basis of identification and subsequent following of groups.
[c] Crane use days based on PRRIP observations are calculated by multiplying the number of individual cranes in each group by the number of days the group was present, plus one day per crane. This is because each crane observed during early morning PRRIP aerial surveys is assumed to have been present the evening prior to the morning of the first observation.
[d] Crane use days based on USFWS public sighting observations are calculated by multiplying the number of individual cranes in each group by the number of days the group was present, plus one day per crane only for observations made prior to 11:59 a.m.

Table 8. Whooping crane decoy sets placed in river channel and off-channel habitats throughout the Associated Habitat Reach of the central Platte River between Lexington and Chapman, Nebraska during PRRIP's spring 2023 systematic aerial surveys. Provided for each decoy set are the date the set was placed, date of the first flight after decoy placement, UTM x and y coordinates, number of decoys in the set, habitat type at the location of placement, and whether aerial surveyors detected the set.

Date placed	Date of flight	UTM x	UTM y	No. of decoys	Habitat type	Detected
3/7	3/12	518101	4505808	1	Wetted Channel	No
3/7	3/12	501423	4502043	2	Open Water Pit/Pond/Lake	No
3/15	3/17	470756	4504069	3	Wetted Channel	Yes
3/20	3/21	462157	4504044	3	Grassland - Lowland	No
3/22	3/24	443893	4504343	1	Wetted Channel	Yes
3/24	3/25	443109	4505460	2	Grassland - Lowland	No
3/29	3/30	443196	4505710	2	Grassland - Lowland	No
3/30	3/31	447251	4504788	3	Grassland - Lowland	Yes
4/3	4/4	448030	4504014	3	Wetted Channel	No
4/5	4/6	534989	4511835	2	Grassland - Lowland	No
4/5	4/6	510084	4502968	3	Grassland - Lowland	No
4/6	4/7	507111	4501972	2	Grassland - Lowland	No
4/7	4/8	450772	4503011	2	Wetted Channel	No
4/10	4/11	545601	4514976	1	Wetted Channel	Yes
4/10	4/11	510975	4503026	2	Wetted Channel	Yes
4/11	4/13	504928	4500932	2	Grassland - Lowland	No
4/11	4/13	547093	4515486	1	Grassland - Lowland	No
4/11	4/12	444553	4504183	2	Wetted Channel	Yes
4/17	4/18	558853	4522142	3	Wetted Channel	Yes
4/19	4/21	534433	4510661	2	Wetted Channel	Yes

Discussion

Over the duration of the Program, the migratory AWB whooping crane population has increased from an estimated 237 birds in 2006–2007 to 536 birds (95% CI = 444, 644) in 2022–2023 based on surveys on the winter range (USFWS 2023; Appendix D). During the same period, whooping crane stopover metrics on the AHR of the central Platte River as determined through PRRIP's surveys have demonstrated considerable annual variability (Figs 4, 5). The number of whooping cranes, proportion of population, and number of crane use days have increased over the past two years from recent observed lows in these metrics during spring of 2019 through 2021. However, spring 2023 values remained within the ranges of annual variability of the metrics since 2007.

The high amount of variability in whooping crane stopover metrics over time makes it challenging to quantify whether significant changes in these metrics have occurred. We found no relationship between the proportion of the AWB population stopping over on the AHR and year during 2014 through 2023. Likewise, we found no correlation between the number of crane use days and year during 2014 through 2023. PRRIP's EDO and the USFWS have documented years of peak spring whooping crane use of the AHR such as that which occurred during 2018 as well as years of low use before and after that peak (Figs 4, 5). The factors affecting stopover decisions, locations, and durations during bird migration are complex and may be related to resource availability on wintering and breeding ranges, habitat and resource availability at stopover locations, individual body condition, weather, and other environmental cues (Anderson et al. 2019, Schmaljohann et al. 2022). It is hypothesized these factors influence whooping crane migratory behavior and decisions on the AHR (PRRIP 2022; Appendix A). Based on a sample of 58 total whooping cranes from the AWB population marked between 2010 and 2016 and studied across the entire migration corridor, Pearse et al. (2020) documented time spent at stopover sites was positively associated with duration of migration bout and negatively associated with time spent at previous stopover sites. These findings suggest whooping cranes used resources at stopover sites to fuel their migration as needed and stopover characteristics depended on resource availability at individual sites in addition to previously used sites (Pearse et al. 2020). Whooping cranes showed low fidelity to individual stopover sites across the migration corridor (Pearse et al. 2020), which likely contributed to the lack of relationships we found between proportion of the AWB population stopping over on the AHR and year, and number of crane use days and year. If whooping cranes demonstrated fidelity to specific stopover sites, such as the central Platte River, then we would have expected a positive relationship between stopover metrics and year as the AWB population increased.

We found no relationship between the number of whooping cranes enumerated on the AHR and the estimated size of the AWB population during 2016 through 2023 (Appendix D), suggesting there were no density-dependent effects on decisions made to stop on the AHR during this period. This lack of relationship also coincides with the findings of Pearse et al. (2020) documenting lack of fidelity to stopover sites by whooping cranes. However, the high extent of variability in the USFWS population estimates (Fig. D1, Appendix D) and use of data only from 2016 through 2023 make elucidating relationships between population size and stopover metrics difficult. Although using a longer time series of data than 2016 through 2023 may be helpful to assess relationships between the number of whooping cranes stopping on the AHR and population size, USFWS survey dates and methodology changed on the winter range in 2015, which resulted in more whooping cranes being observed the following winter beyond what occurred with a growing population.

The majority of whooping crane groups observed during PRRIP's spring 2023 surveys were distributed on the eastern half of the AHR (Fig. 3). Of the 62 group locations recorded by PRRIP surveyors, only six were observed along the river west of Kearney. The distribution and higher intensity of use of the eastern half of the AHR is consistent with previous years and is likely due to differences in river channel geomorphology, habitat characteristics in and surrounding the river, and position of the eastern AHR relative to the primary migratory flyway for whooping cranes (Johnson 1994, Murphy et al. 2004, Farnsworth et al. 2018, Pearse et al. 2018, PRRIP 2022). Along the western half of the AHR, the Platte River channel generally is narrower, has steeper banks with woody vegetation, is more incised, has deeper stretches of water even at low flow, and is considered to have less suitable whooping crane riverine stopover habitat (Johnson 1994, Murphy et al. 2004, Farnsworth et al. 2018, PRRIP 2022). In contrast, the Platte River channel from Kearney through Chapman follows a wider, braided planform that is more conducive to areas of shallow water that are preferred by whooping cranes (Eschner et al. 1981, Murphy et al. 2004, PRRIP 2022).

We found most whooping crane groups used Platte River riverine stopover locations associated with low to moderate discharge (i.e., <1,000 cfs) during spring 2023 (Figs. 6–10) with discharge recorded at the gage nearest to the group location. Although these discharge measurements lack spatially explicit information of river depth and flow at the whooping crane group location itself, they do provide an indication of river conditions during the stopover. Given the high variability in flow and depth in portions of the Platte River, especially in reaches with braided channels, whooping cranes may select stopover sites that combine shallow depths, more gentle flow, and habitat attributes preferred for predator protection within an area characterized by deeper, faster flow during periods of high discharge (Faanes et al. 1992, Baasch et al. 2019). Individual whooping cranes that remained for multiple days (e.g., groups 23A-03 and 23A-06) were generally associated with a range of low to high discharge at the nearest gage (Fig. 9).

Mean unobstructed channel width at 50 riverine whooping crane group locations was 645 ft with a range of 129 to 1,470 ft. This range included the 689 ft unobstructed channel width predicted by Baasch et al. (2019) to have the maximum relative selection ratio for whooping crane riverine habitat use in the Platte River. Similarly, mean distance to the nearest forest at the 50 locations was 373 ft with a range of 47 to 1,011 ft, which included the 594 ft distance to the nearest forest predicted by Baasch et al. (2019) to have the maximum relative selection ratio. Whooping crane selection of riverine stopover sites with greater unobstructed channel widths and distance to nearest forest provides increased visibility to detect predators and protection from avian predators that use trees as hunting perches and mammalian predators that use forest as cover (Faanes et al. 1992, Baasch et al. 2019).

Finally, in this report we also provided the first assessment of how the 5th and 95th percentiles of dates of spring whooping crane group observations from the USFWS public sighting database for Nebraska varied over time, whether PRRIP spring survey dates during 2007 through 2023 were within these percentiles, and adjustments to stopover metrics to correspond with observations recorded only during dates corresponding to the 5th through 95th percentiles. We found PRRIP surveys during 2007 through 2013 did not include the 5th percentile date for the corresponding 10-year period evaluated. Therefore, it is likely the proportion of population and number of crane use days reported for 2007 through 2013 underestimate whooping crane stopover metrics during spring of those years (Fig. 4). Additionally, comparing stopover metrics from 2007–2013 with those from 2014–2023 is problematic due to the shorter spring survey monitoring period prior to 2014. Surveys during 2007 through 2011 began on March 21 or March 22 and 5th percentile dates for the corresponding 10-year periods were at least six days before the survey start date. In our examination of possible temporal trends in metrics over time, we only used PRRIP data from 2014 and later. We suggest future analyses of spring whooping crane stopover data do the same and treat data from 2007–2013 separately than that from 2014 through the current year.

Use of the 5th and 95th percentiles of dates to calculate whooping crane stopover metrics resulted in adjustments being made to metrics in 2018, 2021, 2022, and 2023 (Figs. 4, 5). In most of these years the adjustments were minor. However, in 2018 when peak spring whooping crane stopover use was documented on the AHR, the number of individual whooping cranes observed, proportion of population that stopped on the AHR, and number of crane use days decreased from 118 to 101 birds, 0.234 to 0.200, and 501 to 464 crane use days, respectively, when accounting for whooping cranes observed only during the 5th through 95th percentiles of dates from the 2009–2018 period (Figs. 4, 5). This type of assessment is needed for fall whooping crane migration data, particularly for years of above average stopover use, and will be incorporated into the fall 2023 report.

Incidental Take

The USFWS in its 2006 Biological Opinion (USFWS 2006) and 2018 Supplemental Biological Opinion (USFWS 2018) on the Program developed an incidental take statement addressing incidental take for whooping cranes associated with monitoring and research as well as land management and habitat restoration conducted in the Platte River basin covered by the Program. Such take includes harm caused by harassment of individuals, and effects to fitness of adults resulting in loss of productivity. Six instances of take in the form of harassment of whooping cranes is exempted during the First Increment and 13-year Extension of the Program. The total amount of take that would remove an individual from the migrating population (i.e., lethal or crippling) exempted is one whooping crane during the First Increment and 13-year Extension of the Program. The USFWS requires documentation of any human activity that occurred in the proximity of whooping cranes that could constitute "take" as defined by the Endangered Species Act (i.e., "*…to harass, harm, pursue, hunt, shoot, wound, kill, capture, or collect, or attempt to engage in any such conduct"*). Because harassment interrupts essential feeding or sheltering behaviors, the definition includes disturbance of whooping cranes sufficient to result in cranes taking flight. Since the Program's initiation in 2007, the Program has not observed take (lethal, crippling, harm, harassment, etc.) of any whooping cranes due to monitoring or research activities or due to habitat restoration and land management activities.

During the spring 2023 monitoring period, PRRIP documented no instances of take as defined above. Specifically:

- *Lethal or crippling take*
  There were no observations of crippling or lethal take of whooping cranes this season resulting from the monitoring conducted by PRRIP.
- *Harassment*
  PRRIP staff did not observe or engage in any activity that could be construed as harassment as defined by USFWS.
- *Public disturbance*
  PRRIP staff did not observe any incident of public disturbance of whooping cranes.

Past Research Synthesis

In addition to implementation of the Program's monitoring protocol, directed research has been conducted by the Program since 2007 to provide data to evaluate the Program's management objectives and priority hypotheses. Design and implementation of research activities was guided by the Program's EDO and Technical Advisory Committee (TAC), reviewed by the Program's Independent Scientific Advisory Committee (ISAC), and ultimately approved by the Program's Governance Committee (GC). Whooping crane monitoring and research conducted along the central Platte River were designed and implemented to provide information on an array of topics relevant to species management, including:

- Methods for monitoring whooping cranes and using detection data for drawing conclusions
- Whooping crane use of the central Platte River and the Great Plains migratory corridor
- Identification and characterization of riverine use sites
- Identification and characterization of diurnal use sites
- Whooping crane habitat selection analyses
- Management of river hydrology and morphology for whooping crane habitat
- Whooping crane use of off-channel palustrine wetlands

Links to these studies and other research relevant to the Program's objectives for whooping cranes can be found in Appendix E. Previous data and analyses are included in seasonal reports produced by the Platte River Cooperative Agreement (2001–2006) and the Program (2007–present), and are available in the Program's online Public Library (https://platteriverprogram.org/program-library), located by selecting "whooping crane" as the target species and using "Monitoring Report" as the Title Keyword Search terms. Long-term monitoring and research are used to evaluate progress toward the management objective and to support adaptive management decisions related to our target species (see Appendix E which provides a synthesis of past Program research). Data collected by the Program are available in published form or upon request for use by other programs to provide information on whooping crane use of the central Platte River that may be helpful for broader scale interpretation of migratory habitat use and factors to be considered when making management decisions.

Supplements

QA/QC of database was performed by PRRIP EDO staff.
Original datasheets – Retained at PRRIP EDO office.

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United States Geological Survey (USGS). 2023d. United States Geological Survey National Water Information System: Web Interface. USGS 06770500 Platte River near Grand Island, Nebraska. https://waterdata.usgs.gov/usa/nwis/uv?site_no=06770500

Appendix A. Whooping Crane Extension Big Questions and Hypotheses

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

Management Hypothesis: Probability of WC stopping within the AHR is a function of discharge.

Underlying Physical Processes Hypothesis – The probability of a WC stopover is a function of the relationship between wetted width and the percent of the channel that is of suitable depth for roosting (< 1 ft deep).

Alternative Hypotheses:

- Time of day is the primary driver of WC stopovers with probability of use increasing with decreasing time until dark.
- The probability of WC stopping over is a function of MUCW and unforested corridor width.
- The probability of WC stopping over is a function of land cover or habitat suitability within a biologically relevant radius of flyover location.
- Weather (wind speed and direction, precipitation, temperature) encountered since the last stopover is an important predictor of WC stopovers with the probability of use of the AHR increasing as weather conditions become less favorable for flight.
- Length of stay at previous stopover (inverse relationship) and distance traveled since last stopover (direct relationship) are important predictors of WC stopovers.
- Point in migration (proportion of migration completed) is an important predictor of WC stopovers with the probability of use of the AHR demonstrating a quadratic relationship with proportion of migration completed.

Extension Big Question #5: What factors influence WC stopover length within the AHR?

Management Hypothesis: Length of WC stopover within the AHR is a function of discharge.

Underlying Physical Processes Hypothesis – WC stopover length is a function of the relationship between wetted width and the percent of the channel that is of suitable depth for roosting (< 1 ft deep).

Alternative Hypotheses:

- Length of stay within the AHR has an inverse relationship with length of stay at the previous stopover and a direct relationship with distance traveled since last stopover.
- WC stopover length is inversely related to daily variability in flow.
- WC stopover length is a function of MUCW and unforested corridor width.
- WC stopover length is a function of land cover or habitat suitability within a biologically relevant radius of use location.
- Weather (wind speed and direction, precipitation, temperature) is an important predictor of WC stopover length with the length of stay within the AHR increasing as weather conditions become less favorable for flight.
- The length of a WC stopover within the AHR is longer during the Fall migration. Stopover length within the AHR recapitulates the overall migratory pattern with longer Fall stopovers than Spring stopovers.
- Point in migration (proportion of migration completed) is an important predictor of WC stopover length with stopover length demonstrating a quadratic relationship with proportion of migration completed.
- WC group size, composition (adults, sub-adults, juveniles), and whether or not they are associated with sandhill cranes are important predictors of WC stopover length.

Extension Big Question #6: Why is Spring WC use of the AHR greater than Fall use?
Management Hypothesis: WC use of the AHR in the Spring is greater than during the Fall due to higher flows during the Spring.
Underlying Physical Processes Hypothesis – WC use of the AHR is a function of the relationship between wetted width and the percent of the channel that is of suitable depth for roosting (<1 ft deep).
Alternative Hypotheses: • WC use of the AHR in the Spring is greater because WC do not stage in other areas prior to reaching the Platte, WC are further along in migration when they arrive, distance traveled since last stopover is longer, and stay length at previous stopovers is shorter when compared to Fall migration. • WC stay longer in the AHR during Spring migration because daily variability in flow is lower. • WC use of the AHR in the Spring is greater because proportional wetland landcover is greater. • WC use of the AHR in the Spring is greater due to more expansive unobstructed views (wider MUCW, reduced vegetation cover, lower vegetation heights, trees without leaves) that together increase perceived area of both on and off-channel suitable habitat during this period when compared with the Fall • WC use of the AHR in the Spring is greater because they encounter the AHR later in the day during this migratory season than they do during the Fall migratory season, increasing the probability of a stopover. • WC use of the AHR in the Spring is greater because weather (wind speed and direction, precipitation, temperature) conditions are less favorable for flight (heading into colder conditions, not away from them). • WC use of the AHR in the Spring is greater because group sizes are larger, more numerous and longer stopovers by juveniles and subadults (non-reproductive), and because of the presence of sandhill cranes (more abundant with longer stopovers within the AHR in the Spring).

Appendix B. Whooping Crane Group Observations

Tables of details of whooping crane group observations recorded during spring 2023 along the Associated Habitat Reach of the central Platte River between Lexington and Chapman, Nebraska. One table is provided for each group based on the unique USFWS group identification (ID) number. Provided for each group is the unique color-coded group icon that corresponds to icons provided in tables and figures throughout the report; the USFWS group ID; date(s) of observations of the group; number of adult and juvenile whooping cranes in the group; the PRRIP group ID number; use site number; UTM x and y coordinates (zone 14N); and type of observation. When more than one observation of a whooping crane group was made in the same day, then letters (e.g., A, B, C) are placed following the group ID. Use site numbers are provided when the whooping crane group was observed in riverine, lacustrine, or palustrine land cover types. When whooping crane groups were observed in a land cover type or environment that was not riverine, lacustrine, or palustrine, then the appropriate land cover type is provided (i.e., Ag-agriculture; beans; corn). If the group was sighted in flight, then "AIR" is provided for the use site number. Observation types are provided as systematic (Sys), opportunistic (Opp), aerial (flight), and ground.

Table B.1. Data for whooping crane group USFWS ID 23A-03.

Unique group icon	USFWS group ID	Date	No. of whooping cranes (adults: juveniles)	PRRIP group ID	Use site no.	UTM x	UTM y	Observation type
	23A-03	3/8/2023	1:0	2023SP01	Corn	549795	4510333	Opp-Ground
	23A-03	3/8/2023	1:0	2023SP01B	Beans	549663	4509206	Opp-Ground
	23A-03	3/9/2023	1:0	2023SP02	1	545281	4514666	Opp-Ground
	23A-03	3/9/2023	1:0	2023SP02B	Corn	548874	4509422	Opp-Ground
	23A-03	3/10/2023	1:0	2023SP03	Corn	552017	4512798	Opp-Ground
	23A-03	3/12/2023	1:0	2023SP04	2	548972	4515303	Sys-Flight
	23A-03	3/13/2023	1:0	2023SP05	Corn	547482	4507547	Opp-Ground
	23A-03	3/14/2023	1:0	2023SP06	3	548986	4515330	Sys-Flight
	23A-03	3/15/2023	1:0	2023SP08	4	538998	4511231	Sys-Flight
	23A-03	3/15/2023	1:0	2023SP08B	Corn	538948	4510553	Opp-Ground
	23A-03	3/16/2023	1:0	2023SP10	Corn	539671	4510756	Opp-Ground
	23A-03	3/17/2023	1:0	2023SP12	6	539195	4511471	Sys-Flight
	23A-03	3/19/2023	1:0	2023SP16	6	539195	4511471	Sys-Flight
	23A-03	3/20/2023	1:0	2023SP20	11	539132	4511431	Sys-Flight
	23A-03	3/21/2023	1:0	2023SP21	12	539142	4511405	Sys-Flight

	23A-03	3/22/2023	1:0	2023SP23	12	539142	4511405	Sys-Flight
	23A-03	3/24/2023	1:0	2023SP25	15	540448	4512167	Sys-Flight
	23A-03	3/27/2023	1:0	2023SP29	19	540615	4512208	Sys-Flight
	23A-03	3/28/2023	1:0	2023SP31	21	541926	4513050	Opp-Ground
	23A-03	3/29/2023	1:0	2023SP32	22	541893	4512990	Sys-Flight
	23A-03	3/29/2023	1:0	2023SP32B	Corn	540129	4504204	Opp-Ground
	23A-03	3/30/2023	1:0	2023SP38	28	541584	4512854	Sys-Flight
	23A-03	3/31/2023	1:0	2023SP39	29	542426	4513159	Opp-Ground
	23A-03	4/1/2023	1:0	2023SP43	30	541907	4513001	Sys-Flight

Table B.2. Data for whooping crane group USFWS ID 23A-06.

Unique group icon	USFWS group ID	Date	No. of whooping cranes (adults: juveniles)	PRRIP group ID	Use site no.	UTM x	UTM y	Observation type
	23A-06	3/15/2023	1:0	2023SP09	5	554294	4518005	Sys-Flight
	23A-06	3/15/2023	1:0	2023SP09B	Corn	554505	4517095	Opp-Ground
	23A-06	3/16/2023	1:0	2023SP11	Corn	554595	4517696	Opp-Ground
	23A-06	3/17/2023	1:0	2023SP13	7	554749	4518563	Sys-Flight
	23A-06	3/18/2023	1:0	2023SP14	7	554749	4518563	Sys-Flight
	23A-06	3/19/2023	1:0	2023SP15	7	554749	4518563	Sys-Flight
	23A-06	3/20/2023	1:0	2023SP19	10	548970	4515328	Sys-Flight
	23A-06	3/24/2023	1:0	2023SP24	14	559384	4523279	Sys-Flight
	23A-06	3/25/2023	1:0	2023SP26	16	559849	4523613	Sys-Flight
	23A-06	3/27/2023	1:0	2023SP28	18	560093	4523677	Sys-Flight
	23A-06	3/29/2023	1:0	2023SP33	23	557711	4520722	Sys-Flight
	23A-06	3/30/2023	1:0	2023SP37	27	558576	4521801	Sys-Flight
	23A-06	3/31/2023	1:0	2023SP40	Corn	559551	4519378	Opp-Ground
	23A-06	4/1/2023	1:0	2023SP44	32	558651	4521935	Sys-Flight
	23A-06	4/2/2023	1:0	2023SP45	33	557708	4520735	Sys-Flight
	23A-06	4/3/2023	1:0	2023SP46	34	557593	4520584	Sys-Flight
	23A-06	4/4/2023	1:0	2023SP50	38	557835	4520859	Sys-Flight
	23A-06	4/6/2023	1:0	2023SP56	41	559829	4523399	Sys-Flight

Table B.3. Data for whooping crane group USFWS ID 23A-07.

Unique group icon	USFWS group ID	Date	No. of whooping cranes (adults: juveniles)	PRRIP group ID	Use site no.	UTM x	UTM y	Observation type
	23A-07	3/15/2023	1:0	2023SP07	Corn	457803	4500963	Opp-Ground

Table B.4. Data for whooping crane group USFWS ID 23A-11.

Unique group icon	USFWS group ID	Date	No. of whooping cranes (adults: juveniles)	PRRIP group ID	Use site no.	UTM x	UTM y	Observation type
	23A-11	3/20/2023	3:0	2023SP18	9	564279	4529418	Sys-Flight

Table B.5. Data for whooping crane group USFWS ID 23A-12.

Unique group icon	USFWS group ID	Date	No. of whooping cranes (adults: juveniles)	PRRIP group ID	Use site no.	UTM x	UTM y	Observation type
	23A-12	3/20/2023	2:0	2023SP17	8	563589	4528631	Sys-Flight

Table B.6. Data for whooping crane group USFWS ID 23A-14.

Unique group icon	USFWS group ID	Date	No. of whooping cranes (adults: juveniles)	PRRIP group ID	Use site no.	UTM x	UTM y	Observation type
	23A-14	3/21/2023	2:0	2023SP22	13	528590	4508196	Sys-Flight

Table B.7. Data for whooping crane group USFWS ID 23A-17.

Unique group icon	USFWS group ID	Date	No. of whooping cranes (adults: juveniles)	PRRIP group ID	Use site no.	UTM x	UTM y	Observation type
	23A-17	3/27/2023	7:0	2023SP27	17	530179	4508619	Sys-Flight
	23A-17	3/28/2023	7:0	2023SP30	20	531236	4509317	Sys-Flight
	23A-17	3/28/2023	7:0	2023SP30B	Corn	531568	4508833	Opp-Ground
	23A-17	3/30/2023	7:0	2023SP36	26	532023	4509780	Sys-Flight
	23A-17	3/31/2023	7:0	2023SP42	AIR	530440	4508727	Opp-Ground

Table B.8. Data for whooping crane group USFWS ID 23A-23.

Unique group icon	USFWS group ID	Date	No. of whooping cranes (adults: juveniles)	PRRIP group ID	Use site no.	UTM x	UTM y	Observation type
	23A-23	3/29/2023	1:0	2023SP34	24	565411	4530522	Sys-Flight
	23A-23	3/30/2023	1:0	2023SP35	25	565385	4530314	Sys-Flight
	23A-23	3/31/2023	1:0	2023SP41	Corn	568160	4528494	Opp-Ground
	23A-23	4/1/2023	1:0	2023SP52	31	564235	4529370	Sys-Flight

Table B.9. Data for whooping crane group USFWS ID 23A-27.

Unique group icon	USFWS group ID	Date	No. of whooping cranes (adults: juveniles)	PRRIP group ID	Use site no.	UTM x	UTM y	Observation type
	23A-27	4/3/2023	6:0	2023SP48	36	472404	4503582	Sys-Flight
	23A-27	4/3/2023	6:0	2023SP48B	Ag	472583	4504290	Opp-Ground

Table B.10. Data for whooping crane group USFWS ID 23A-30.

Unique group icon	USFWS group ID	Date	No. of whooping cranes (adults: juveniles)	PRRIP group ID	Use site no.	UTM x	UTM y	Observation type
	23A-30	4/3/2023	2:1	2023SP47	35	541073	4512730	Sys-Flight

Table B.11. Data for whooping crane group USFWS ID 23A-31.

Unique group icon	USFWS group ID	Date	No. of whooping cranes (adults: juveniles)	PRRIP group ID	Use site no.	UTM x	UTM y	Observation type
	23A-31	4/4/2023	4:1	2023SP49	37	438738	4508321	Sys-Flight
	23A-31	4/5/2023	4:1	2023SP53	Corn	443503	4504105	Opp-Ground

Table B.12. Data for whooping crane group USFWS ID 23A-33.

Unique group icon	USFWS group ID	Date	No. of whooping cranes (adults: juveniles)	PRRIP group ID	Use site no.	UTM x	UTM y	Observation type
	23A-33	4/4/2023	2:0	2023SP51	39	562146	4526922	Sys-Flight
	23A-33	4/7/2023	2:0	2023SP57	43	565156	4530358	Sys-Flight

Table B.13. Data for whooping crane group USFWS ID 23A-37.

Unique group icon	USFWS group ID	Date	No. of whooping cranes (adults: juveniles)	PRRIP group ID	Use site no.	UTM x	UTM y	Observation type
	23A-37	4/6/2023	10:1	2023SP54	40	472194	4503627	Sys-Flight
	23A-37	4/6/2023	10:1	2023SP54B	Corn	471887	4501645	Opp-Ground
	23A-37	4/7/2023	3:1	2023SP59	Corn	471743	4501736	Opp-Ground
	23A-37	4/7/2023	3:1	2023SP59B	Corn	471743	4501736	Opp-Flight
	23A-37	4/8/2023	3:1	2023SP60	Corn	471887	4501656	Opp-Ground
	23A-37	4/8/2023	3:1	2023SP60B	Corn	471887	4501656	Sys-Flight

Table B.14. Data for whooping crane group USFWS ID 23A-38.

Unique group icon	USFWS group ID	Date	No. of whooping cranes (adults: juveniles)	PRRIP group ID	Use site no.	UTM x	UTM y	Observation type
	23A-38	4/6/2023	1:0	2023SP55	42	556812	4520100	Sys-Flight

Table B.15. Data for whooping crane group USFWS ID 23A-39.

Unique group icon	USFWS group ID	Date	No. of whooping cranes (adults: juveniles)	PRRIP group ID	Use site no.	UTM x	UTM y	Observation type
	23A-39	4/7/2023	4:1	2023SP58	44	538061	4511368	Sys-Flight

Table B.16. Data for whooping crane group USFWS ID 23A-47.

Unique group icon	USFWS group ID	Date	No. of whooping cranes (adults: juveniles)	PRRIP group ID	Use site no.	UTM x	UTM y	Observation type
	23A-47	4/13/2023	2:1	2023SP61	45	560012	4523790	Sys-Flight

Table B.17. Data for whooping crane group USFWS ID 23A-48.

Unique group icon	USFWS group ID	Date	No. of whooping cranes (adults: juveniles)	PRRIP group ID	Use site no.	UTM x	UTM y	Observation type
	23A-48	4/13/2023	3:0	2023SP62	46	529665	4508378	Sys-Flight

Appendix C. Enlarged Maps of Whooping Crane Use Locations and Photographs of Groups

Maps of whooping crane group use locations observed during spring 2023 are presented from west to east beginning with Fig. C1 and ending with Fig. C12. The distribution of historical spring observations of whooping crane groups by PRRIP during 2001–2023 are provided online at https://arcg.is/01uW1v.

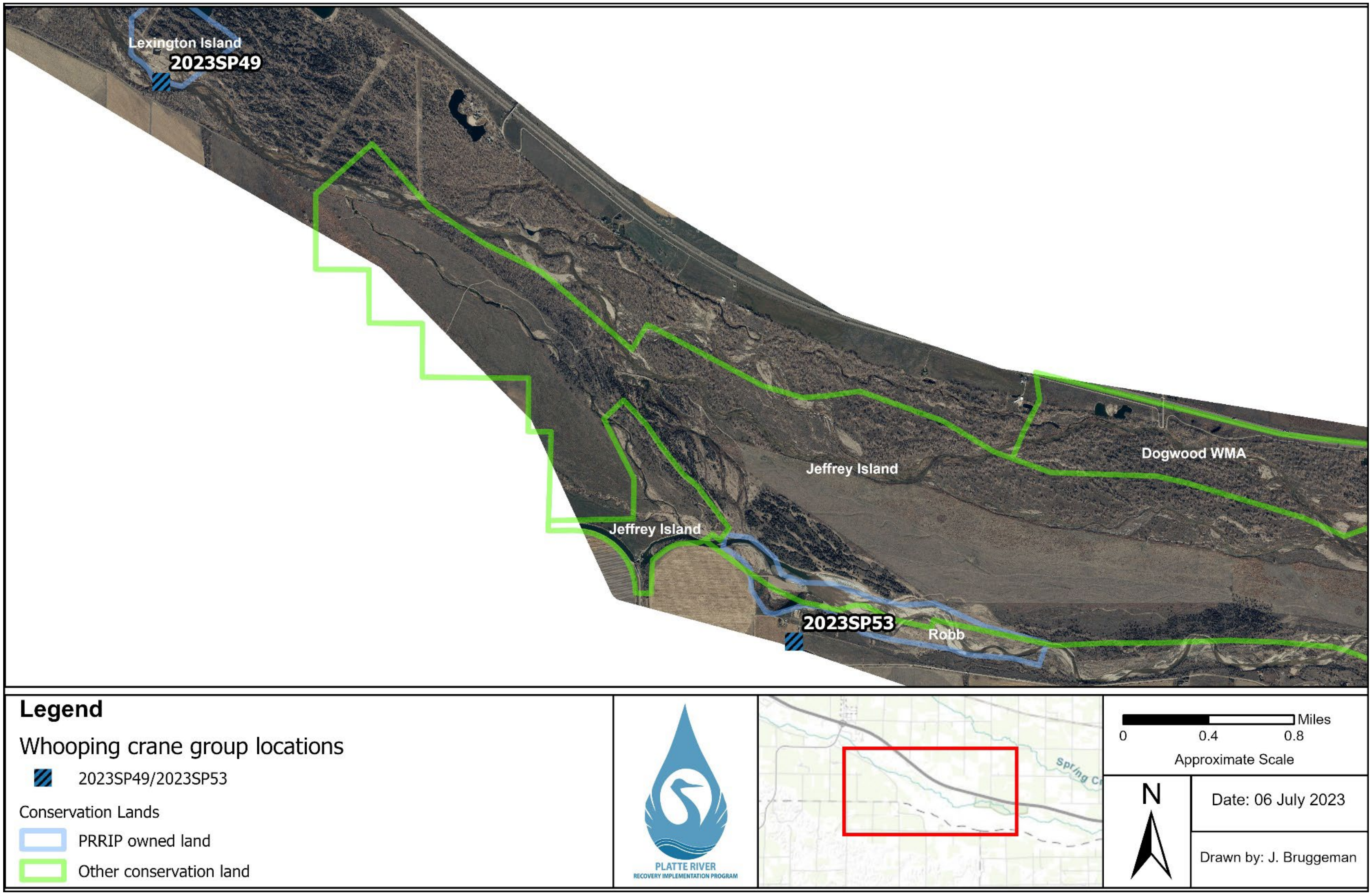

Figure C1. Whooping crane groups 2023SP49/2023SP53 (USFWS ID 23A-31; sighted 4/4–4/5) observed east of Lexington, Nebraska along the Associated Habitat Reach of the central Platte River during spring 2023. PRRIP LiDAR imagery from November 2022 is displayed for reference.

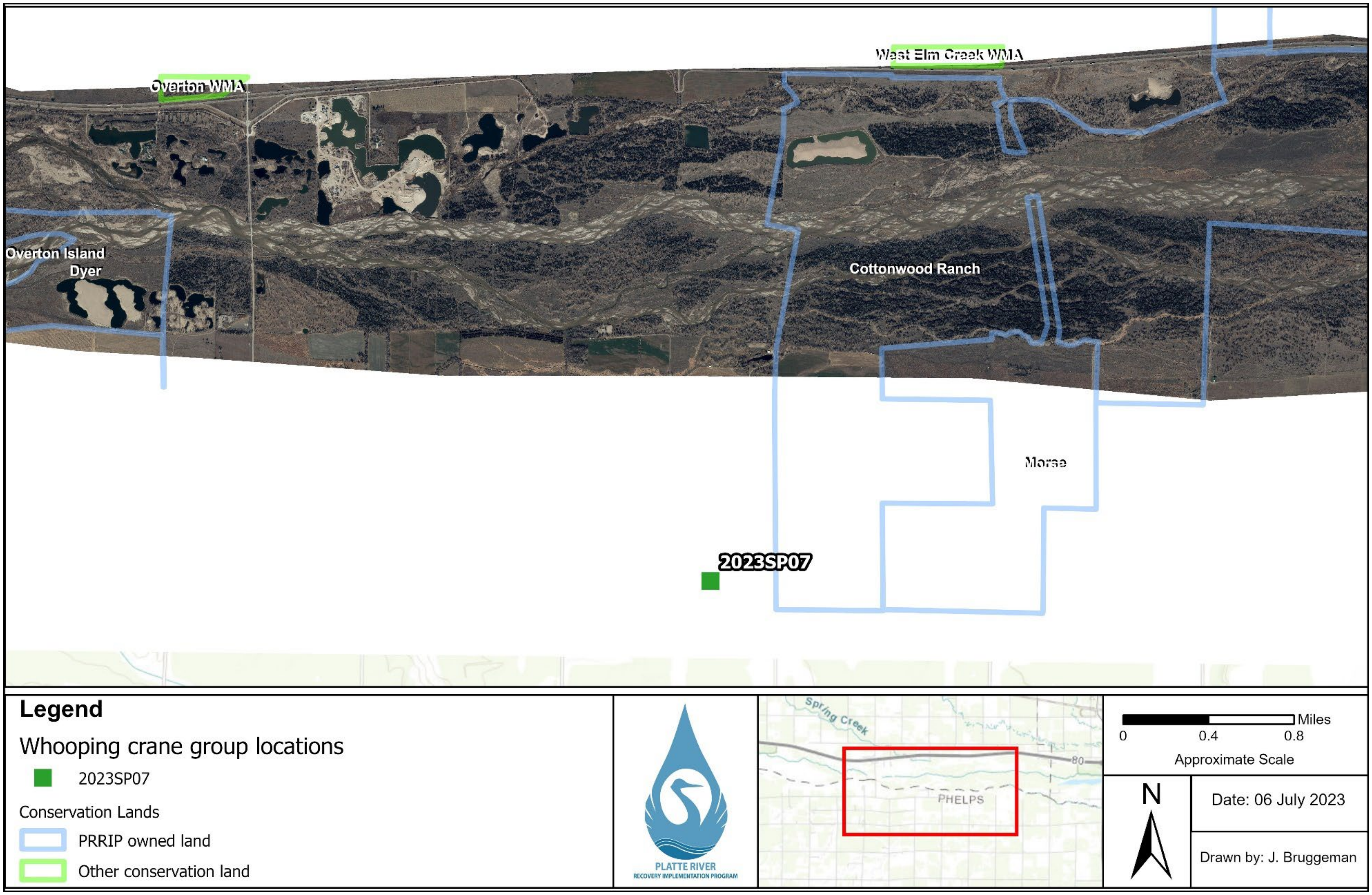

Figure C2. Whooping crane group 2023SP07 (USFWS ID 23A-07; sighted 3/15) observed south of Cottonwood Ranch between Overton and Trued, Nebraska along the Associated Habitat Reach of the central Platte River during spring 2023. PRRIP LiDAR imagery from November 2022 is displayed for reference.

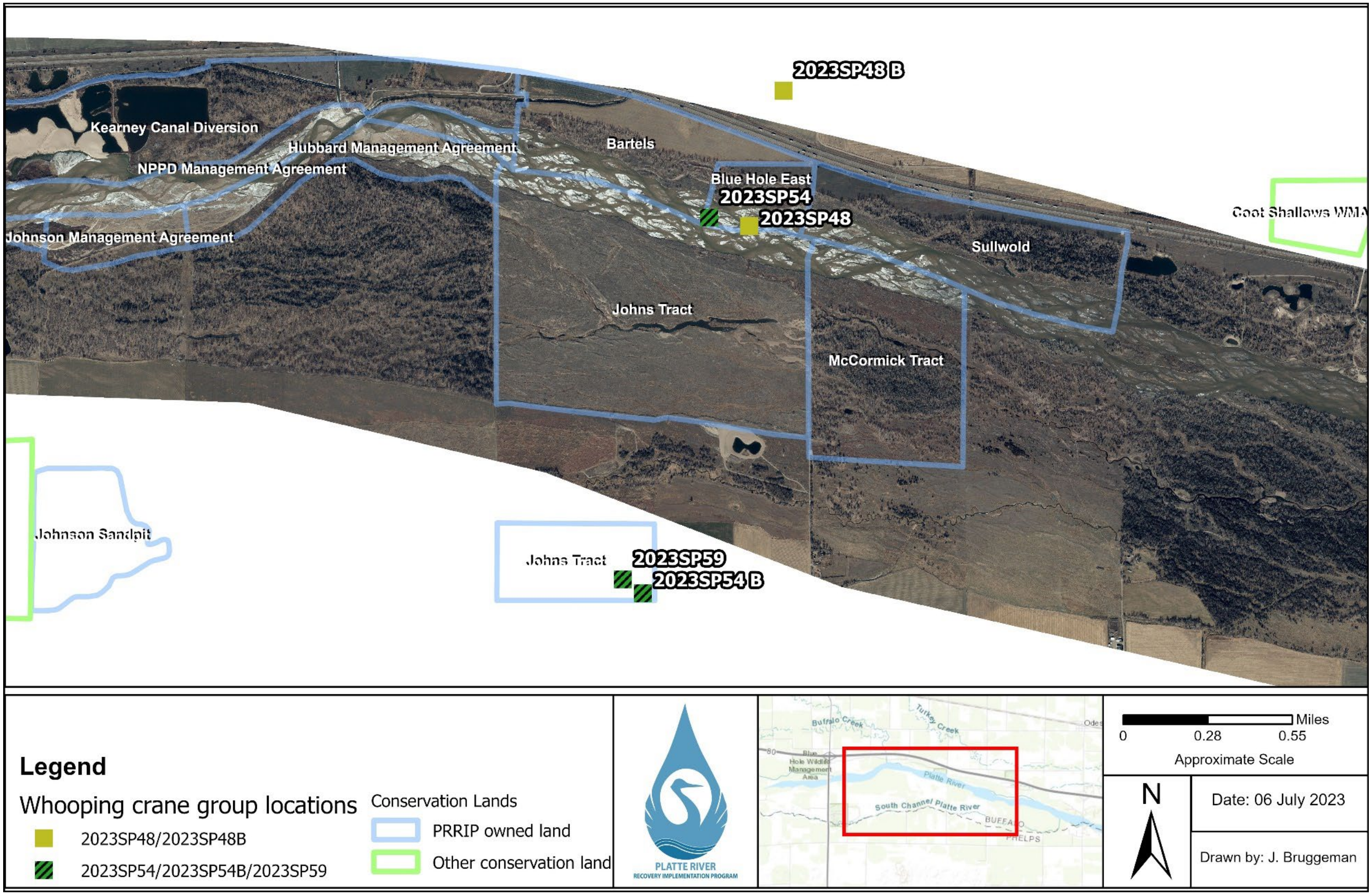

Figure C3. Whooping crane groups 2023SP48/2023SP48B (USFWS ID 23A-27; sighted 4/3) and 2023SP54/2023SP54B/2023SP59 (USFWS ID 23A-37; sighted 4/6–4/7) observed between Elm Creek and Odessa, Nebraska along the Associated Habitat Reach of the central Platte River during spring 2023. PRRIP LiDAR imagery from November 2022 is displayed for reference.

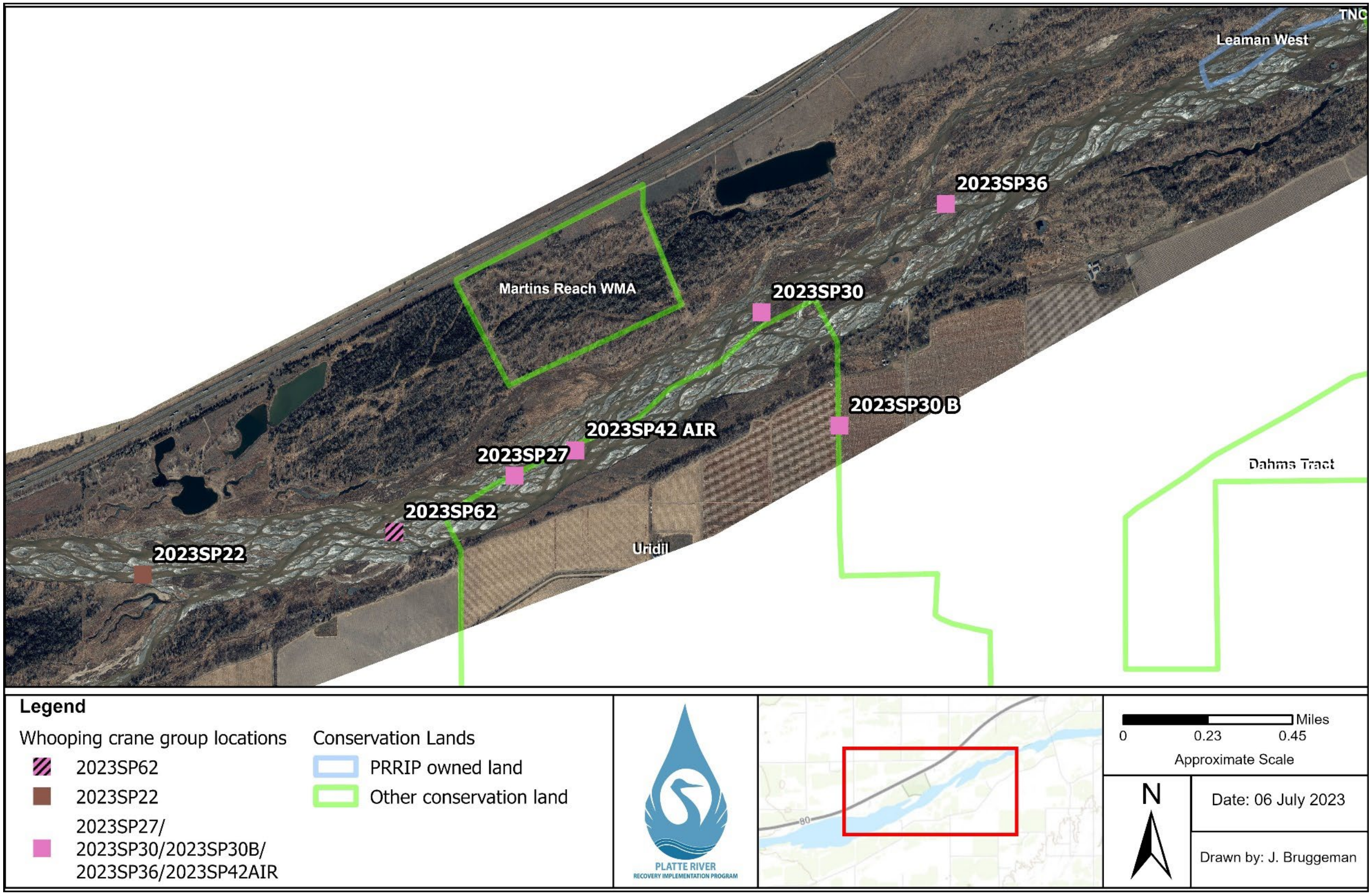

Figure C4. Whooping crane groups 2023SP22 (USFWS ID 23A-14; sighted 3/21), 2023SP27/2023SP30/2023SP30B/2023SP36/2023SP42AIR (USFWS ID 23A-17; sighted 3/27–3/31), and 2023SP62 (USFWS ID 23A-48; sighted 4/13) observed west of Wood River, Nebraska along the Associated Habitat Reach of the central Platte River during spring 2023. PRRIP LiDAR imagery from November 2022 is displayed for reference.

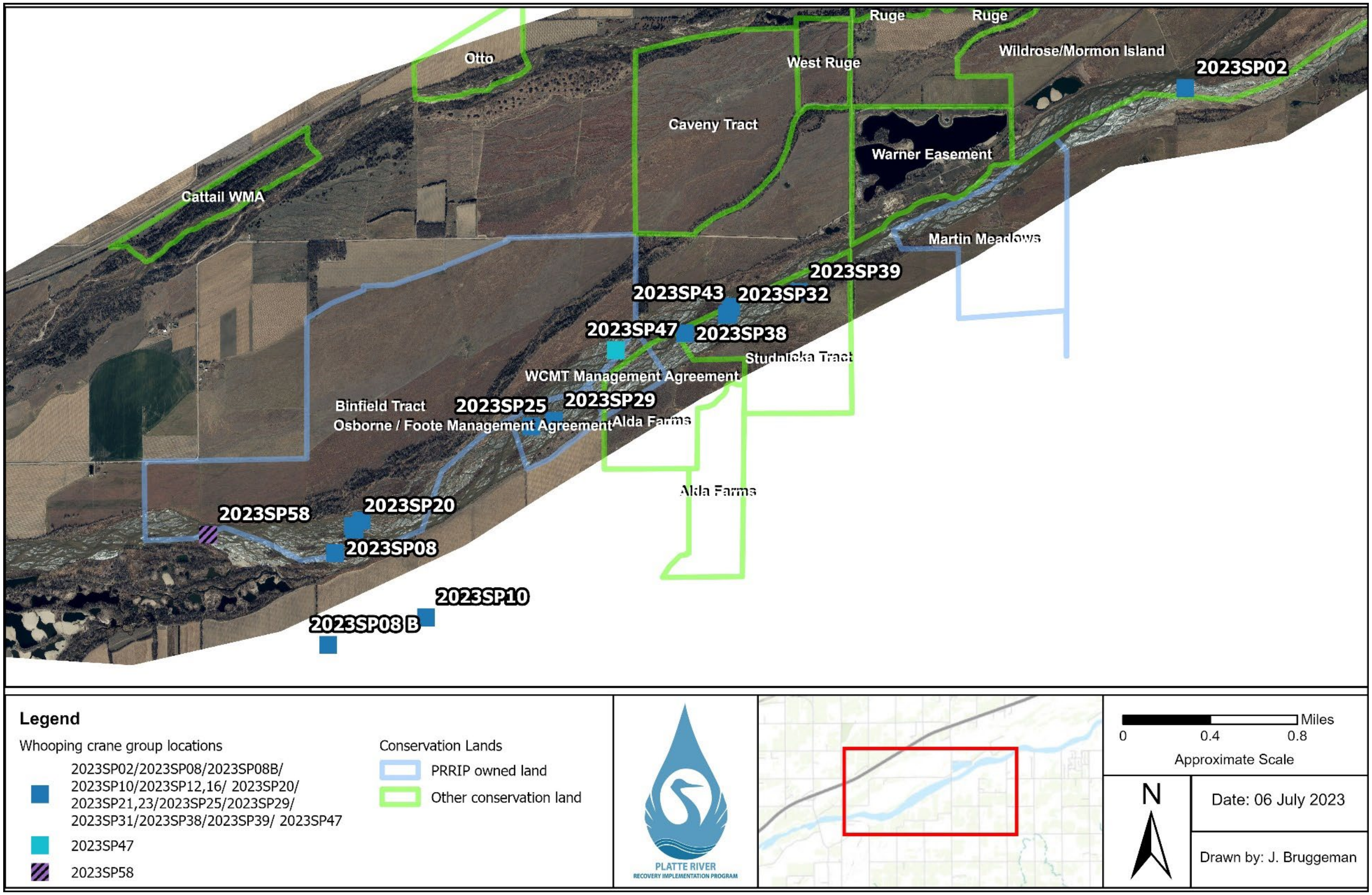

Figure C5. Whooping crane groups 2023SP02/2023SP08/2023SP08B/2023SP10/2023SP12,16/2023SP20/2023SP21,23/2023SP25/2023SP29/2023SP31/2023SP38/2023SP39 (USFWS ID 23A-03; sighted 3/9; 3/15–3/17; 3/19–3/22; 3/24; 3/27–28; 3/30–31; 4/3), 2023SP47 (USFWS ID 23A-30; sighted 4/3), and 2023SP58 (USFWS ID 23A-39; sighted 4/7) observed between Wood River and Alda, Nebraska along the Associated Habitat Reach of the central Platte River during spring 2023. PRRIP LiDAR imagery from November 2022 is displayed for reference.

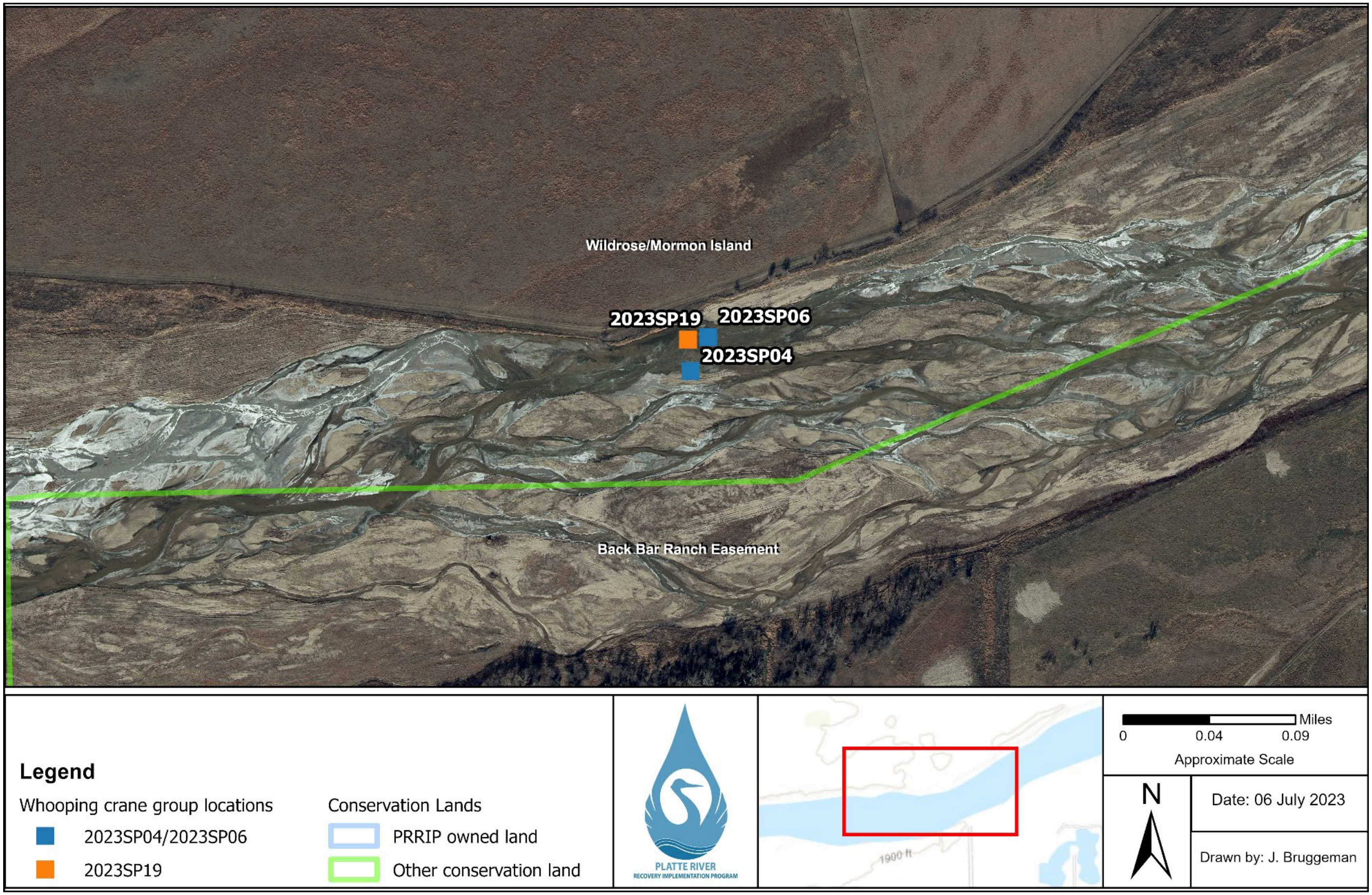

Figure C6. Whooping crane groups 2023SP04/2023SP06 (USFWS ID 23A-03; sighted 3/12 and 3/14) and 2023SP19 (USFWS ID 23A-06; sighted 3/20) observed near Morman Island along the Associated Habitat Reach of the central Platte River during spring 2023. PRRIP LiDAR imagery from November 2022 is displayed for reference.

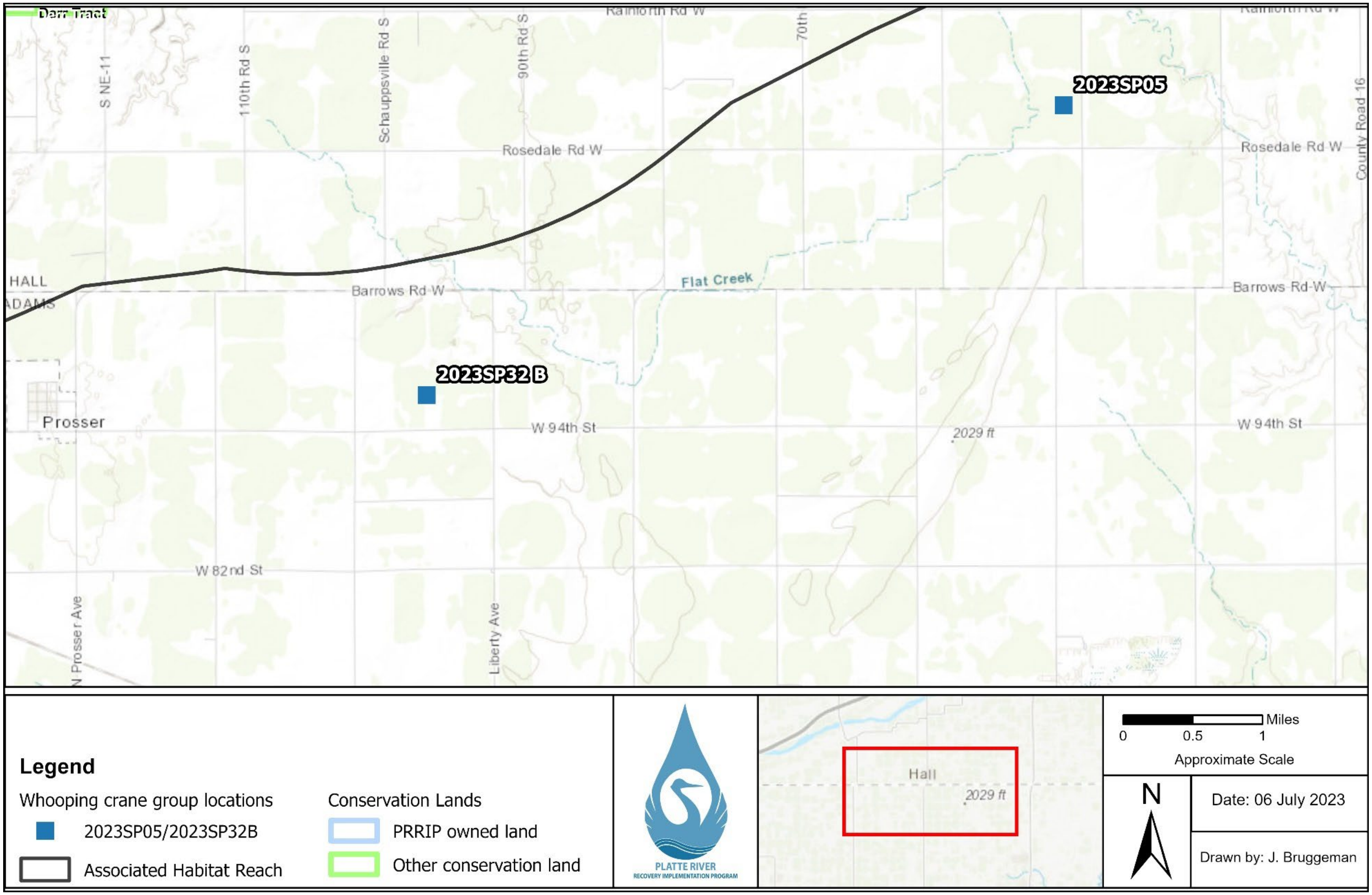

Figure C7. Whooping crane groups 2023SP05/2023SP32B (USFWS ID 23A-03; sighted 3/13 and 3/29) observed between Prosser and Doniphan, Nebraska along the Associated Habitat Reach of the central Platte River during spring 2023. PRRIP LiDAR imagery from November 2022 was not available for this area.

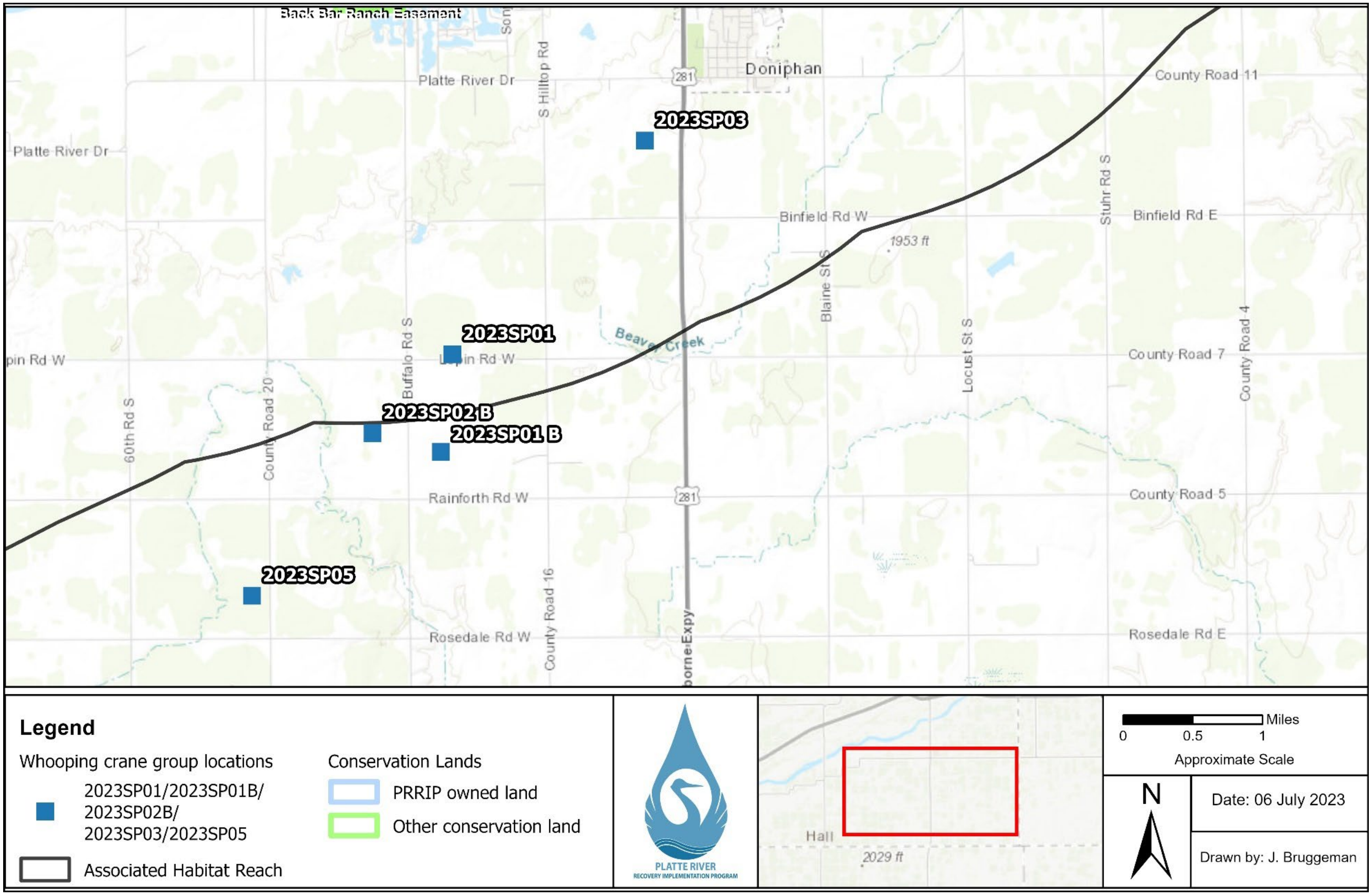

Figure C8. Whooping crane groups 2023SP01/2023SP01B/2023SP02/2023SP02B/2023SP03/2023SP05 (USFWS ID 23A-03; sighted 3/8–3/10; 3/13) observed near Doniphan, Nebraska along the Associated Habitat Reach of the central Platte River during spring 2023. PRRIP LiDAR imagery from November 2022 was not available for this area.

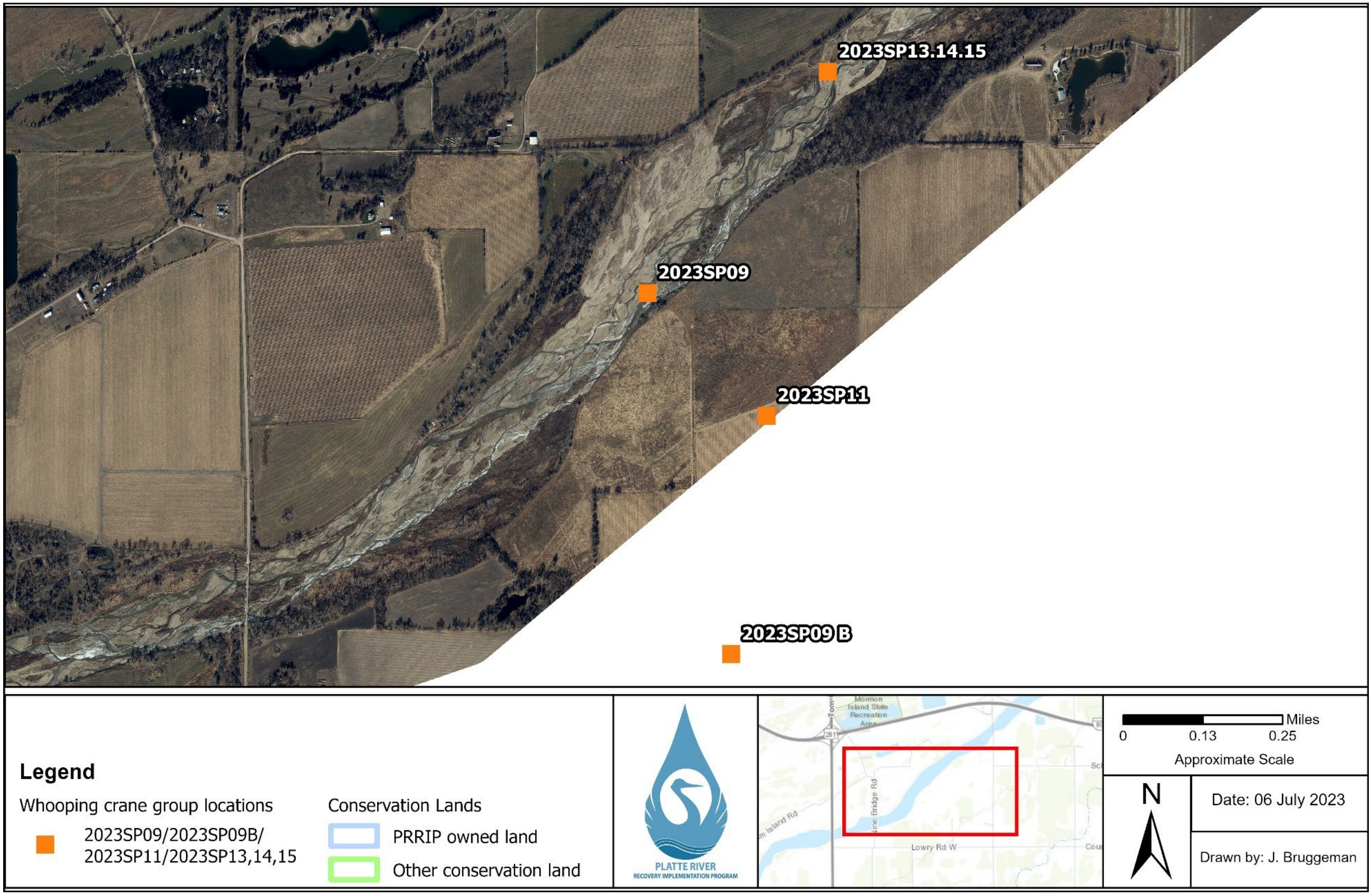

Figure C9. Whooping crane groups 2023SP09/2023SP09B/2023SP11/2023SP13,14,15 (USFWS ID 23A-06; sighted 3/15–3/19) observed southeast of Mormon Island SRA, Nebraska along the Associated Habitat Reach of the central Platte River during spring 2023. PRRIP LiDAR imagery from November 2022 is displayed for reference.

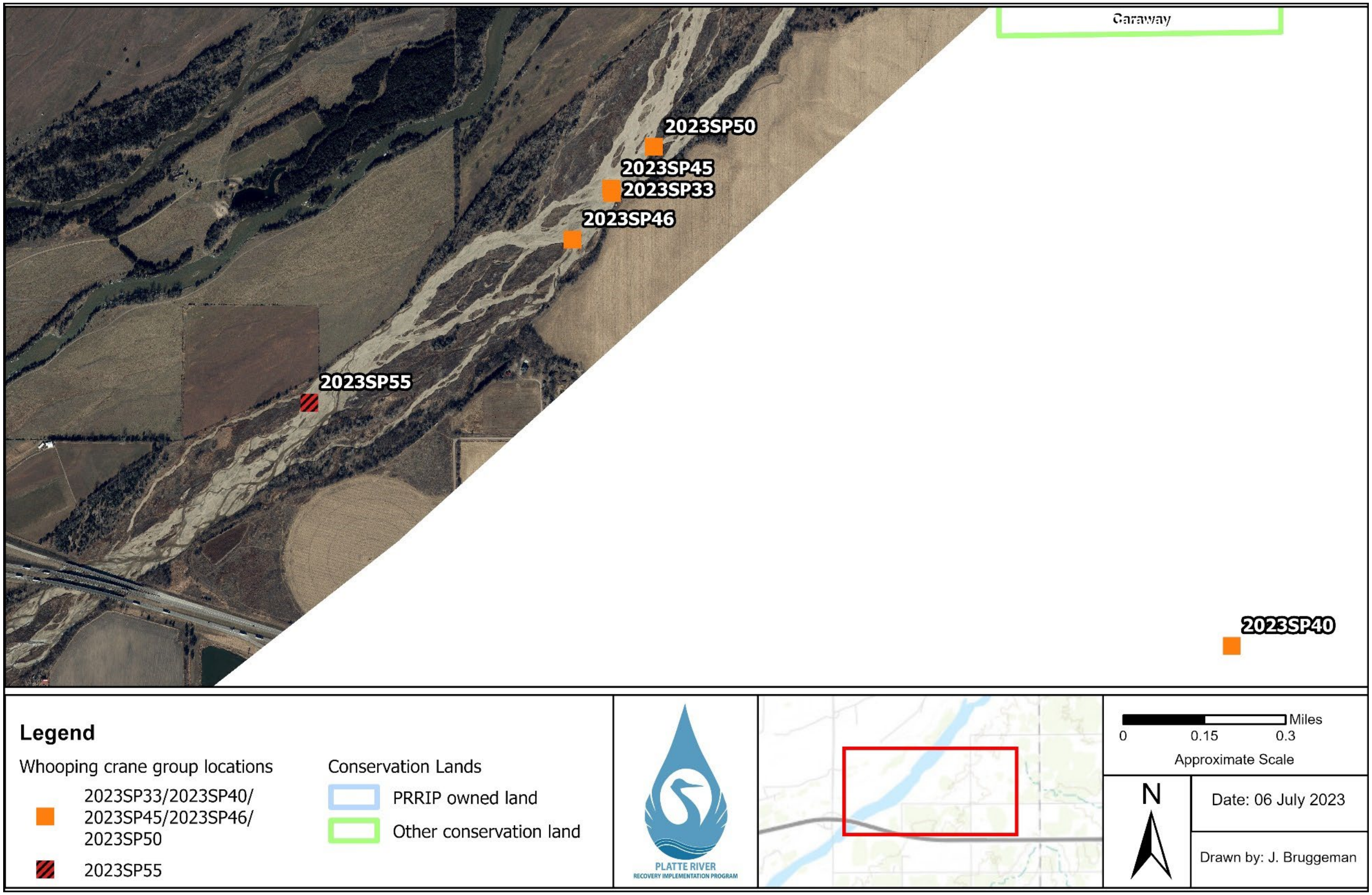

Figure C10. Whooping crane groups 2023SP33/2023SP40/2023SP45/2023SP46/2023SP50 (USFWS ID 23A-06; sighted 3/29; 3/31; 4/2–4/4) and 2023SP55 (USFWS ID 23A-38; sighted 4/6) observed east of Grand Island, Nebraska along the Associated Habitat Reach of the central Platte River during spring 2023. PRRIP LiDAR imagery from November 2022 is displayed for reference.

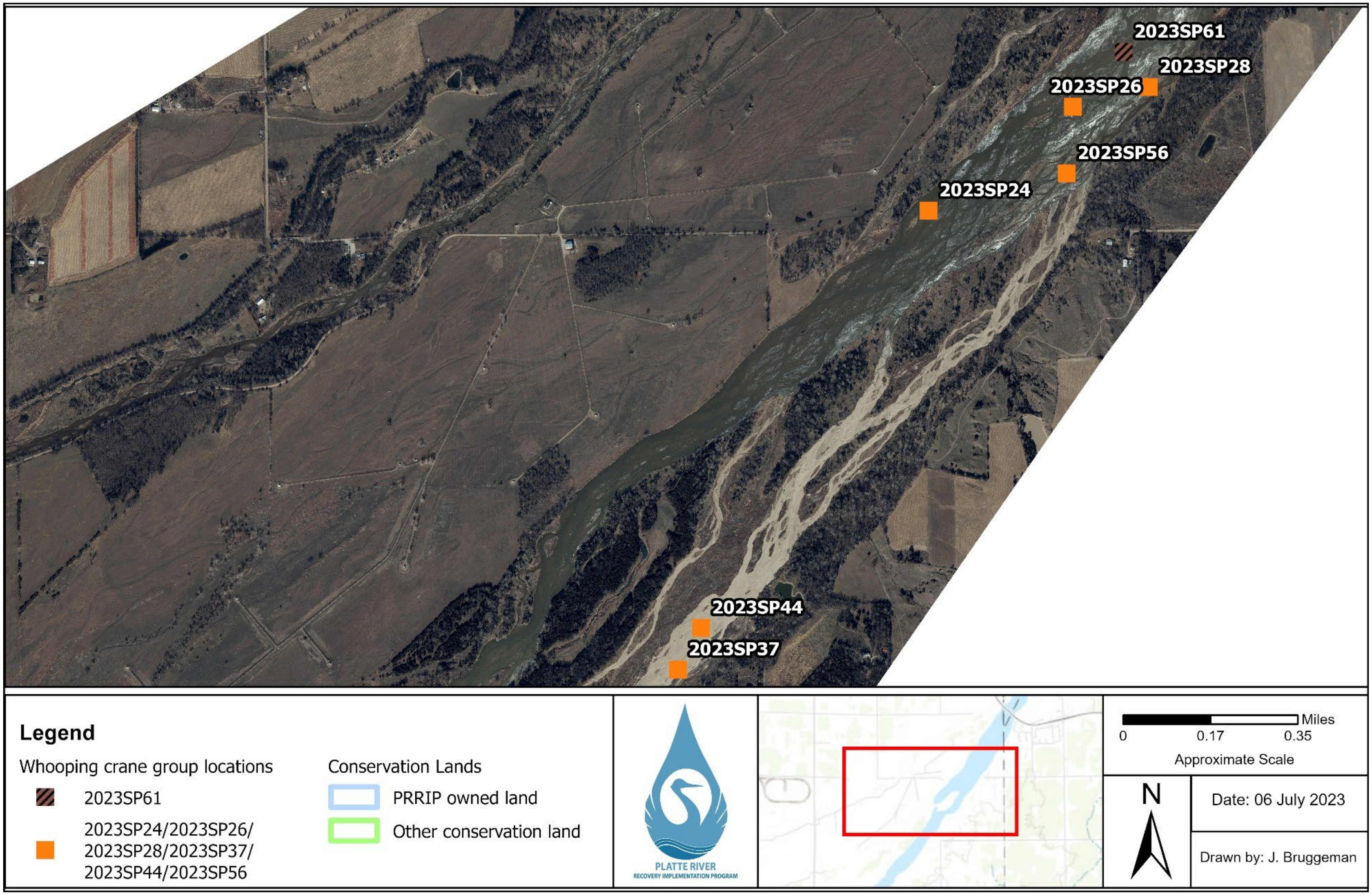

Figure C11. Whooping crane groups 2023SP61 (USFWS ID 23A-47; sighted 4/13) and 2023SP24/2023SP26/2023SP28/2023SP37/2023SP44/2023SP45/2023SP56 (USFWS ID 23A-06; sighted between 3/24 and 4/6) observed east of Grand Island, Nebraska along the Associated Habitat Reach of the central Platte River during spring 2023. PRRIP LiDAR imagery from November 2022 is displayed for reference.

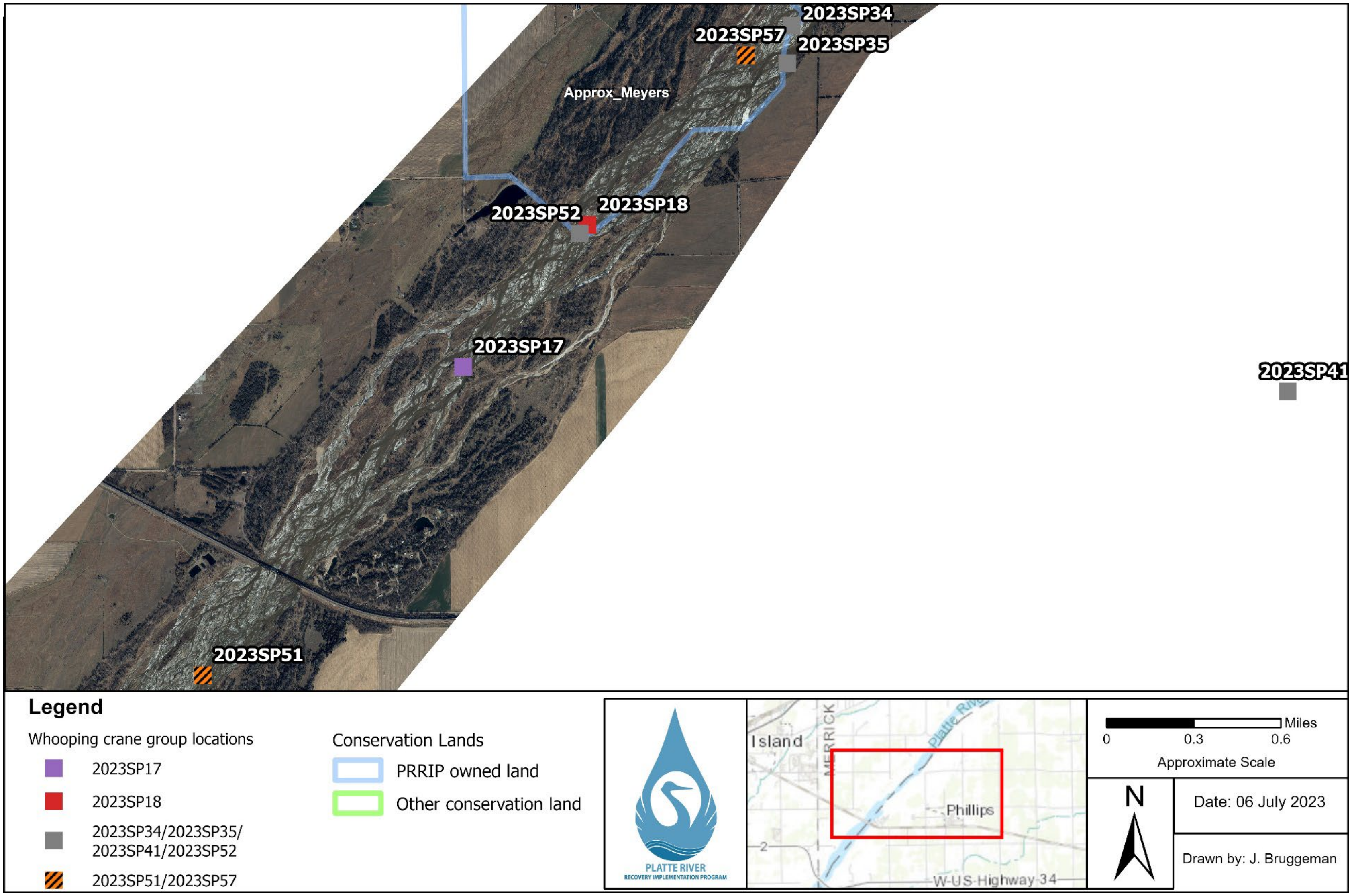

Figure C12. Whooping crane groups 2023SP17 (USFWS ID 23A-12; sighted 3/20), 2023SP18 (USFWS ID 23A-11; sighted 3/20), 2023SP34/ 2023SP35/2023SP41/2023SP52 (USFWS ID 23A-23; sighted 3/29–4/1), and 2023SP51/2023SP57 (USFWS ID 23A-33; sighted 4/4; 4/7) observed near Phillips, Nebraska along the Associated Habitat Reach of the central Platte River during spring 2023. PRRIP LiDAR imagery from November 2022 is displayed for reference.

Figure C13. Photograph of whooping crane group PRRIP ID 2023SP04 (USFWS ID 23A-03) on 3/12/2023. The whooping crane was observed during systematic aerial surveys.

Figure C14. Photograph of whooping crane group PRRIP ID 2023SP09 (USFWS ID 23A-06) on 3/15/2023. The whooping crane group was observed during systematic aerial surveys.

Figure C15. Photograph of whooping crane group PRRIP ID 2023SP07 (USFWS ID 23A-07) on 3/15/2023. The whooping crane group was observed during ground surveys and was considered an opportunistic location.

Figure C16. Photograph of whooping crane group PRRIP ID 2023SP18 (USFWS ID 23A-11) on 3/20/2023. The whooping crane group was observed during systematic aerial surveys.

Figure C17. Photograph of whooping crane group PRRIP ID 2023SP17 (USFWS ID 23A-12) on 3/20/2023. The whooping crane group was observed during systematic aerial surveys.

Figure C18. Photograph of whooping crane group PRRIP ID 2023SP22 (USFWS ID 23A-14) on 3/21/2023. The whooping crane group was observed during systematic aerial surveys.

Figure C19. Photograph of whooping crane group PRRIP ID 2023SP27 (USFWS ID 23A-17) on 3/27/2023. The whooping crane group was observed during systematic aerial surveys.

Figure C20. Photograph of whooping crane group PRRIP ID 2023SP34 (USFWS ID 23A-23) on 3/29/2023. The whooping crane group was observed during systematic aerial surveys.

Figure C21. Photograph of whooping crane group PRRIP ID 2023SP48 (USFWS ID 23A-27) on 4/3/2023. The whooping crane group was observed during systematic aerial surveys.

Figure C22. Photograph of whooping crane group PRRIP ID 2023SP47 (USFWS ID 23A-30) on 4/3/2023. The whooping crane group was observed during systematic aerial surveys.

Figure C23. Photograph of whooping crane group PRRIP ID 2023SP49 (USFWS ID 23A-31) on 4/4/2023. The whooping crane group was observed during systematic aerial surveys.

Figure C24. Photograph of whooping crane group PRRIP ID 2023SP51 (USFWS ID 23A-33) on 4/4/2023. The whooping crane group was observed during systematic aerial surveys.

Figure C25. Photograph of whooping crane group PRRIP ID 2023SP54 (USFWS ID 23A-37) on 4/6/2023. The whooping crane group was observed during systematic aerial surveys.

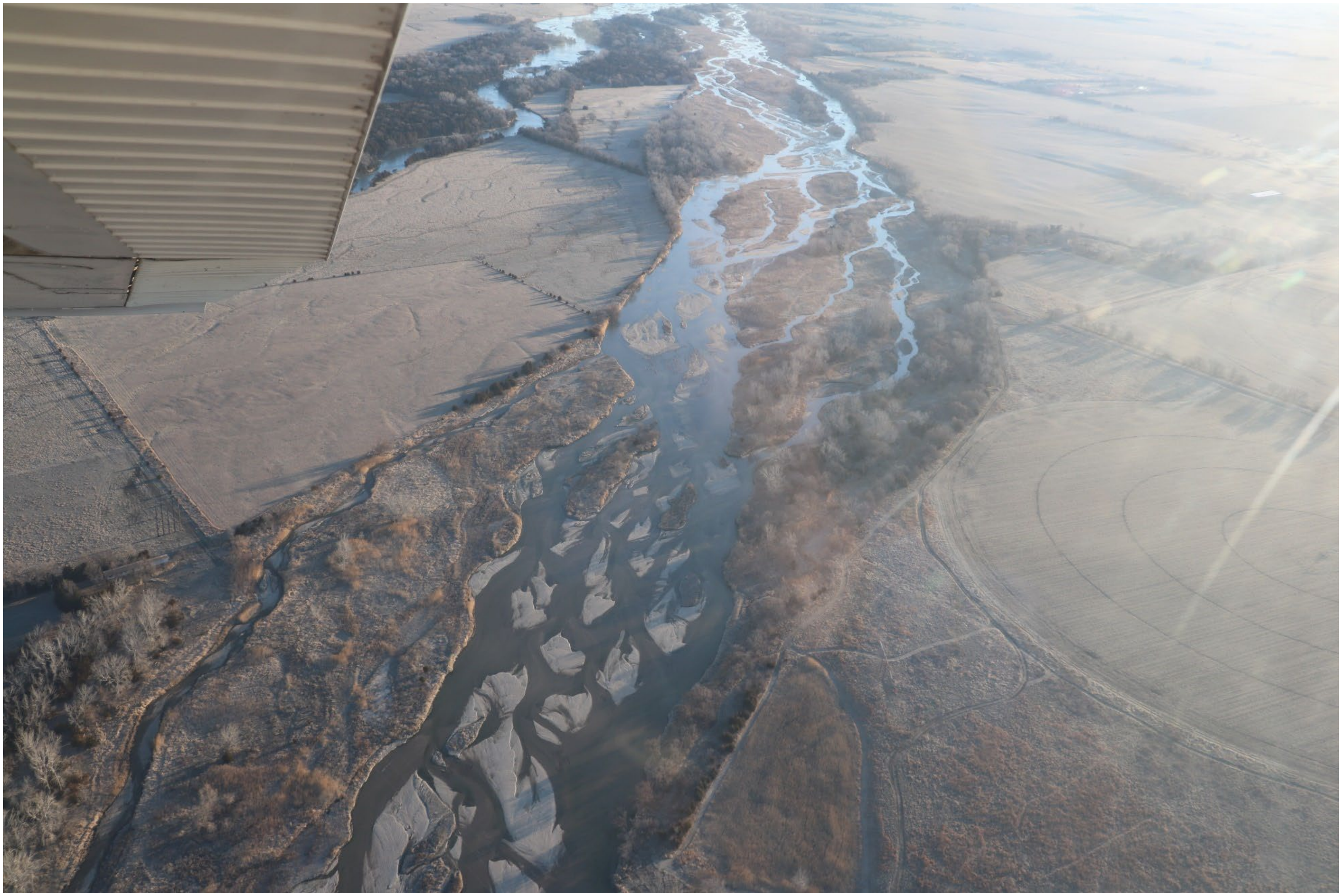

Figure C26. Photograph of whooping crane group PRRIP ID 2023SP55 (USFWS ID 23A-38) on 4/6/2023. The whooping crane group was observed during systematic aerial surveys.

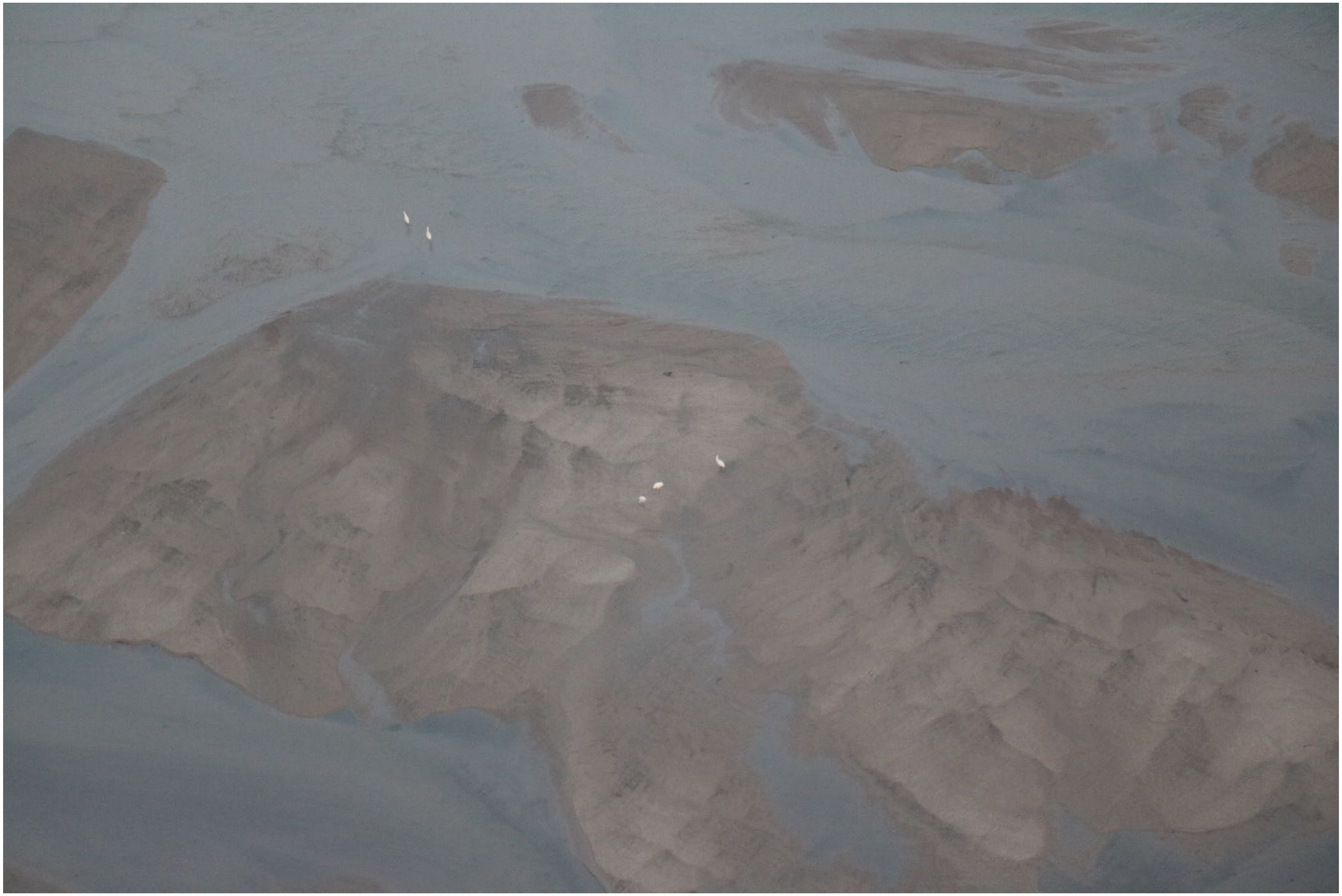

Figure C27. Photograph of whooping crane group PRRIP ID 2023SP58 (USFWS ID 23A-39) on 4/7/2023. The whooping crane group was observed during systematic aerial surveys.

Figure C28. Photograph of whooping crane group PRRIP ID 2023SP61 (USFWS ID 23A-47) on 4/13/2023. The whooping crane group was observed during systematic aerial surveys.

Figure C29. Photograph of whooping crane group PRRIP ID 2023SP62 (USFWS ID 23A-48) on 4/13/2023. The whooping crane group was observed during systematic aerial surveys.

Appendix D. Aransas-Wood Buffalo Population Estimates

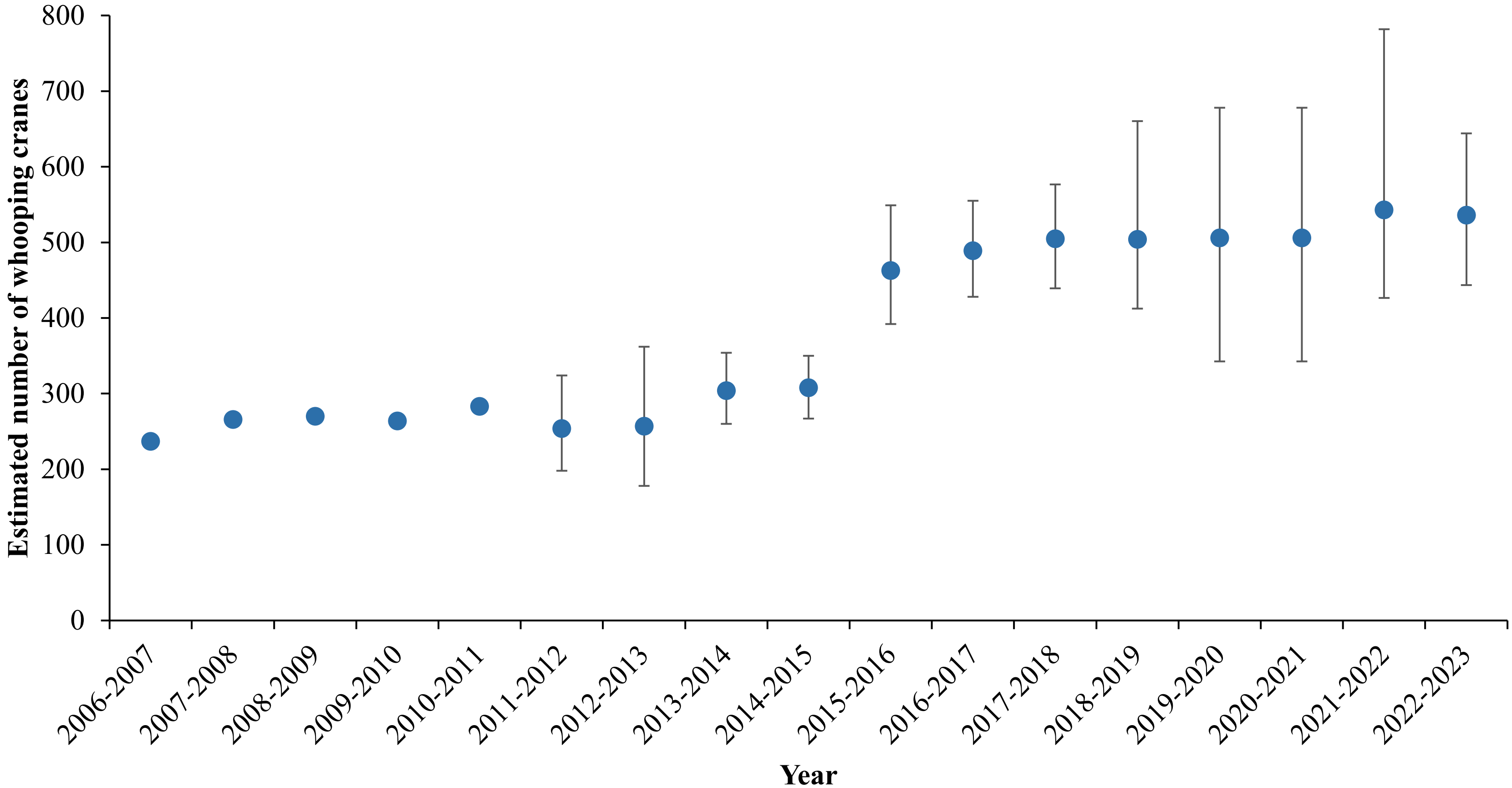

Figure D1. Estimated size of the migratory Aransas-Wood Buffalo whooping crane population based on surveys on the winter range on the Texas Gulf Coast of Mexico during 2007–2023 (USFWS 2023). A change in survey methodology occurred after 2014–2015, which resulted in an increase in the number of whooping cranes observed during 2015–2016. 95% confidence intervals are provided for 2011–2023. For the 2020–2021 estimate, the estimated AWB population from winter 2019–2020 was used (506 birds) because no winter survey was completed during 2020–2021.

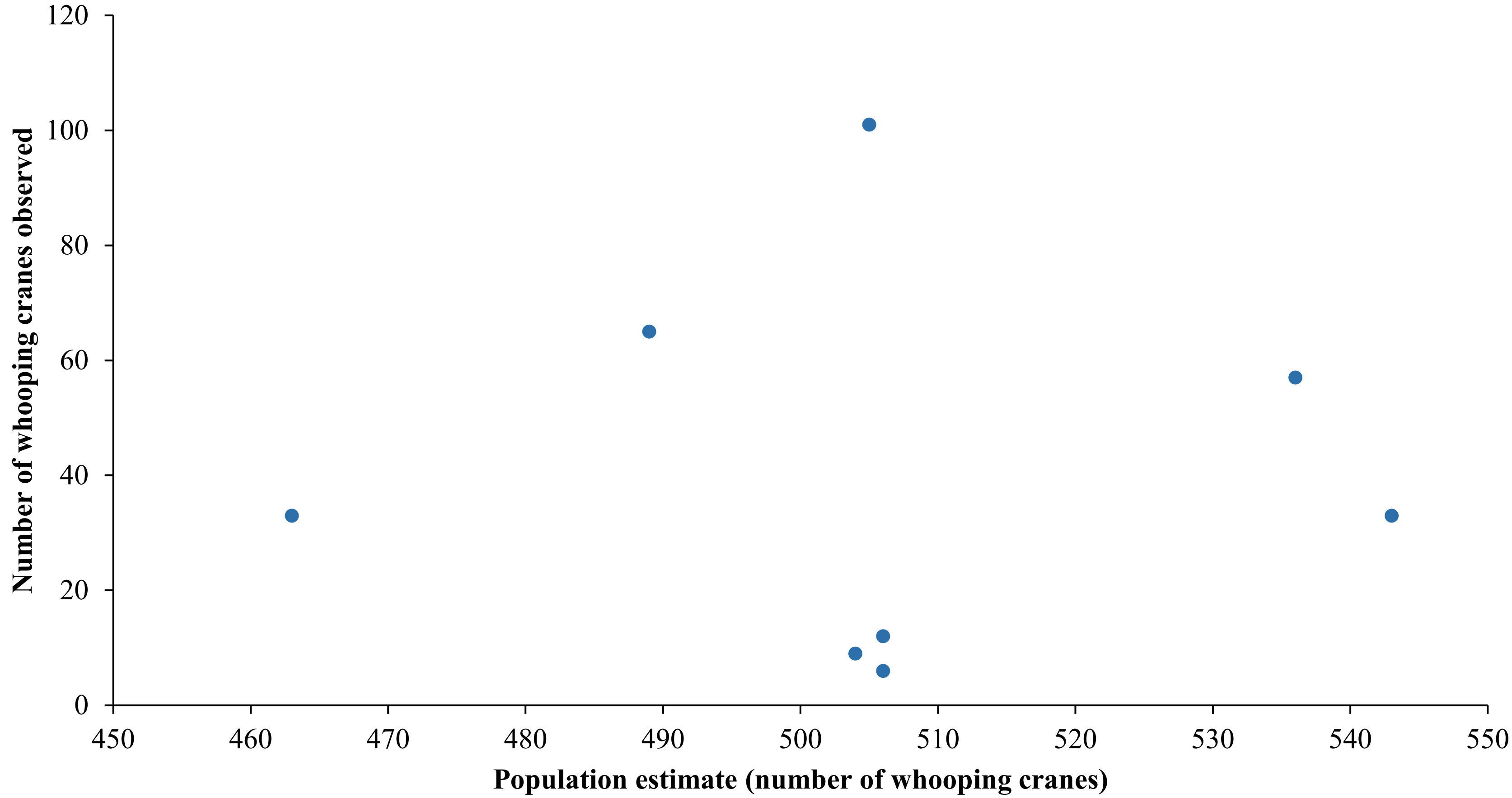

Figure D2. Relationship between the number of individual whooping cranes enumerated during PRRIP spring surveys on the Associated Habitat Reach of the central Platte River and the estimated size of the Aransas-Wood Buffalo population based on surveys on the winter range during 2016–2023. For the 2020–2021 estimate, the estimated AWB population from winter 2019–2020 was used (506 birds) because no winter survey was completed during 2020–2021.

Appendix E. Past Research Synthesis

Published	Study Topic	Document Title	Summary	Principal Findings	Citation
2023	Conservation and endangered species	Biological case against downlisting the whooping crane and for improving implementation under the Endangered Species Act.	In response to potential downlisting of WCs from endangered to threatened status by the USFWS, the authors examined the status of WCs in the context of population status and current threats. The authors concluded that proposed downlisting is unwarranted before WC recovery plan population criteria have been met.	The authors examined the current status of WCs in the context of Endangered Species Act (ESA) threat factors, USFWS's Species Assessment framework, and similar avian downlisting actions to determine if downlisting the WC from endangered to threatened is biologically warranted. The authors noted that WCs are the rarest of 15 crane species worldwide with 702 birds estimated in fall 2022. The authors noted five major threats to WCs including habitat loss, environmental conditions, physical harm, disease, and pollution. The authors documented 17 avian species that have been downlisted under the ESA and found only one was downlisted from endangered status with a population <3,000 birds. The authors concluded WCs are facing an intensification of threats across their ranges, the population is still small relative to other crane species and most avian species of conservation concern, and that downlisting before WC population criteria for recovery have been met would be inconsistent with previous population management actions for avian species under the ESA. The authors concluded that downlisting WCs is objectively unwarranted.	Caven AJ, Thompson HL, Baasch DM, Hartup BK, Hegg AM, Schmidt, SM, Louque I, Allen CR, Crouch CG, Davis CA, Jorgensen JG, Austin, JE, Ostrom, BL, Beilfuss RD, Archibald GW, Lacy AE. 2023. Biological case against downlisting the whooping crane and for improving implementation under the Endangered Species Act. Papers in Natural Resources 1655. https://digitalcommons.unl.edu/natrespapers/1655?utm_source=digitalcommons.unl.edu%2Fnatrespapers%2F1655&utm_medium=PDF&utm_campaign=PDFCoverPages

Published	Study Topic	Document Title	Summary	Principal Findings	Citation
2023	Diurnal behavior	Whooping crane diurnal behavior and natural history during migration in the central Great Plains: summary report—Spring 2019 – Fall 2022	Studied WC diurnal activity and behavior in south-central Nebraska during the spring 2019 through fall 2022 migration seasons. Documented behaviors in different land cover types, responses to disturbance, and species on which WCs were foraging.	Used scan sampling to study WC activity and responses to disturbance and predators during 2019–2022. Observed 69 WC groups comprised of 248 birds and collected 5,017 instantaneous cane samplings totaling 23,676 individual behaviors. WC were observed foraging on multiple species, including fish, frogs, turtles, and arthropods. WC exhibited more alert and defensive behaviors in cornfields than other land cover types. WC were documented loafing and preening more often in palustrine and lacustrine wetland land cover types. Observed 15 aircraft-WC interactions involving 90 WCs with 57 birds having no reaction, 30 birds exhibiting alert responses, and three birds flushing. Baasch suggested wetland habitats provide valuable habitat for WCs to forage and rest, and provide security to perform important social interactions.	Baasch DM. 2023. Whooping crane diurnal behavior and natural history during migration in the central Great Plains: summary report—Spring 2019 – Fall 2022. Final Report, Platte River Whooping Crane Maintenance Trust, Inc. Wood River, NE. https://cranetrust.org/file_download/684f620c-2142-429a-a0e2-d70a04f376c9
2023	Wind energy and bird conservation	Forecasting suitable areas for wind turbine occurrence to proactively wildlife conservation	Identified conservation priority areas for WC, golden eagles, and lesser prairie-chickens across an eight-state region using a combination of a wind turbine suitability model with animal movement, relative abundance, and population density models.	Authors used GPS locations from WC tagged with satellite transmitters from 2009–2018 to estimate whooping crane space use along migration corridor. They used a biased random bridge estimator to estimate utilization distributions of WCs during spring and fall migration. Multiplied spring and fall utilization distributions with wind turbine suitability predictions to develop a joint probability of intensity of use and wind turbine suitability, and considered areas with highest joint probabilities as high conservation priority areas. Fig. 8 in the paper provides spatially explicit maps of conservation priority areas in relation to wind turbine suitability.	Boggie MA, Butler MJ, Sesnie SE, Millsap BA, Stewart DR, Harris GM, Broska JC. 2023. Forecasting suitable areas for wind turbine occurrence to proactively wildlife conservation. Journal for Nature Conservation 74(2023) 126442. https://doi.org/10.1016/j.jnc.2023.126442

Published	Study Topic	Document Title	Summary	Principal Findings	Citation
2022	Habitat use	Whooping crane (*Grus americana*) use patterns in relation to an ecotope classification in the central Platte River Valley, Nebraska, USA	Evaluation of ecotope-based landcover at 400 m and 1000m spatial scales to predict WC use of the central Platte River.	Integrated both landcover classification and hydrological factors into a finer scale ecotope data layer. USFWS public sighting WC use locations were characterized utilizing this ecotope data layer with a 400 m and a 1000 m buffer around each locational data point. Generalized linear mixed-effects models were used to assess the effects of ecotope composition, flooding frequency, and wetland status on the probability of whooping crane use. Ecotopes at the 1000 m scale explained nearly 40% of the variation in WC use. WC were present more frequently in wetland portions of both agriculture fields and grassland communities, and less likely to use upland portions of these landcover types. Use was positively associated with proximity to the main channel of the Platte River. The probability of WC use was predicted to decrease as the proportion of developed landcover increased and distance to nearest road decreased.	Baasch DM, Caven AJ, Jorgensen JG, Grosse R, Rabbe M, Varner DM, LaGrange T. 2022 Whooping Crane (*Grus americana*) use patterns in relation to an ecotope classification in the Central Platte River Valley, Nebraska, USA. https://ace-eco.org/vol17/iss2/art35/
2022	Power line collision mitigation	Mitigating avian collisions with power lines through illumination with ultraviolet light.	Tested effectiveness of two avian collision avoidance systems (ACASs) at reducing collisions of large-bodied avian species. Whooping cranes were not documented as part of this study.	ACAS illumination and environmental variables were important predictors of avian collisions with power lines. ACAS illumination reduced collisions at focal power line by 88%. Collisions were more likely at moderate wind speeds.	Baasch DM, Hegg AM, Dwyer JF, Caven AJ, Taddicken WE, Worley CA, Medaries AH, Wagner CG, Dunbar PG, Mittman ND. 2022 Mitigating avian collisions with power lines through illumination with ultraviolet light. Avian Conservation and Ecology 17(2):9. https://doi.org/10.5751/ACE-02217-170209

Published	Study Topic	Document Title	Summary	Principal Findings	Citation
2022	Wintering habitat use	Whooping and sandhill cranes visit upland ponds proportional to migration phenology on the Texas coast	Evaluated whooping and sandhill crane use of constructed freshwater ponds as alternative water sources during drought on wintering grounds.	Used camera traps to estimate visits/month of 7 constructed ponds over 3 winters with drought conditions. Used generalized linear mixed-effects models to evaluate the effect of pond type, pond salinity, distance to saltmarsh, bay salinity, tide levels, rainfall, time of year, and migration phenology on the probability of pond use each month. Examined daily activity patterns of crane use at ponds. The best fitting models (both at the pond and broader scale) suggested more whooping crane group visits occurred in January when most whooping cranes were on the wintering grounds. More whooping cranes visited ponds on the mainland than on Matagorda Island. Whooping cranes were not observed at ponds prior to sunrise and infrequently after sunset, thus upland ponds were visited by whooping cranes diurnally.	Butler MJ, Metzger KL, Sanspree CR, Cain JW, Harris GM. 2022. Whooping and sandhill cranes visit upland ponds proportional to migration phenology on the Texas coast. Wildlife Society Bulletin 46(3): e1290. https://doi.org/10.1002/wsb.1290
2022	Wintering habitat use	Space use and site fidelity of wintering whooping cranes on the Texas Gulf Coast	Evaluation of AWB whooping crane winter home ranges through time and in relation to age, sex, reproductive status, and drought.	Used telemetry data from 57 individual telemetered whooping cranes from 2009-2017 and autocorrelated kernel density estimation (AKDE) to explore variation in home range size in relation to age, sex, reproductive status, and drought. Examined overlap in and distance between home range centroids through time to examine site fidelity. Estimated 95% AKDE mean as 30.1 km^2. Home range estimates did not differ for groups with vs. without juveniles. Sub-adult male home ranges were similar in size to those of family groups. Home ranges of sub-adult females were approximately double that of family groups. Home ranges increased in size during drought on the wintering grounds. From one year to the next, home range site fidelity averaged 68% overlap, but as the number of years increased between home ranges of an individual adult whooping crane, they overlapped less. Fidelity to juvenile winter home range declined with age through the 4th winter, but the limited data available beyond the 4th winter suggested that older individuals may return to within 2 km of their juvenile home range.	Butler MJ, Stewart DR, Harris GM, Bidwell MT, Pearse AT. 2022. Space use and site fidelity of wintering whooping cranes on the Texas Gulf Coast. Journal of Wildlife Management 86(5): e22226. https://doi.org/10.1002/jwmg.22226

Published	Study Topic	Document Title	Summary	Principal Findings	Citation
2022	Stopover duration	Whooping crane stay length in relation to stopover site characteristics	Examined the relationship between habitat characteristics and stopover duration during whooping crane migration.	Quantified habitat characteristics at 605 use locations from 449 stopover sites obtained through telemetry from 58 individual whooping cranes. Performed random forest regression to estimate importance of landcover variables for predicting stopover stay length. Mean stopover duration was 3.1 days. Over half of the stopover sites assessed for habitat characteristics were used only a single day or less. Landscape level variables explained 43% of variation in stay length, whereas site level variables explained 9%. Stay length increased with latitude, proportion of land cover as open-water slough with emergent vegetation, proportion of landcover as alfalfa, and longitude. At the site level, wetted width combined over all wetland classes, landcover of nearest shoreline, distance to terrestrial bank from a wetland use location, and wetland class were better predictors of variability in stay length. Stay length increased with wetted width at riverine sites but decreased with wetted width at lacustrine and palustrine sites.	Caven AJ, Pearse AT, Brandt DA, Harner MJ, Wright GD, Baasch DM, Brinley Buckley EM, Metzger KL, Rabbe MR, Lacy AE. 2022. Whooping crane stay length in relation to stopover site characteristics. Proceedings of the North American Crane Workshop 15:6-33. https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1387&context=nacwgproc
2022	Habitat use	Balancing future renewable energy infrastructure siting and associated habitat loss for migrating whooping cranes	Evaluation of functional migratory habitat across the Great Plains relative to renewable energy infrastructure, human development and disturbance, and drought.	Used locational data from 57 individual telemetered whooping cranes from 20101-2016 in the US Great Plains to assess habitat selection and avoidance of disturbance (including renewable energy infrastructure) during migration relative to drought conditions. Land use within 800 m were the best predictors of WC use. Zones of influence distances were determined for disturbance variables. Relationships between WC use and predictor variables were compared under drought and non-drought conditions. An optimization analysis was performed to select potential sites for new wind energy development that minimize habitat loss for whooping cranes while maximizing wind energy potential.	Ellis KS, Pearse AT, Brandt DA, Bidwell MT, Harrell W, Butler MJ, Post van der Burg M. Balancing future renewable energy infrastructure siting and associated habitat loss for migrating whooping cranes. Frontiers in Ecology and Evolution 10:931260. https://doi.org/10.3389/fevo.2022.931260

Published	Study Topic	Document Title	Summary	Principal Findings	Citation
2022	Wintering habitat	Spatial and temporal predictions of whooping crane (*Grus americana*) habitat along the US Gulf Coast	Study mapping the historical spatial transformation of whooping crane habitat in and around Aransas National Wildlife Refuge.	Used exploratory spatial data analysis to document areas used by whooping cranes and how this space use has changed over time from 1990-2009. Developed a time series of ecological niche models to identify environmental factors (biotic and abiotic) correlated with crane habitat use and how importance has changed over time. Utilized multitemporal models to forecast areas along the US Gulf Coast that may provide additional wintering habitat for an expanding whooping crane population and where habitat may be lost due to rising sea levels predicted with climate change.	Golden KE, Hemingway BL, Frazier AE, Scholtz R, Harrell W, Davis CA, Fuhlendorf SD. 2022. Spatial and temporal predictions of whooping crane (*Grus americana*) habitat along the US Gulf Coast. Conservation Science and Practice 4(6): e12696. https//doi.org/10.1111/csp2.12696
2022	Agricultural land cover as habitat	Winners and losers of land use change: A systematic review of interactions between the world's crane species (*Gruidae*) and the agricultural sector	Meta-analysis of published literature on crane use of agricultural landcover and importance of agricultural crops in the diet of cranes to evaluate the bilateral effects of land use change.	Reviewed 135 articles describing 285 crane-agriculture interactions. Agricultural crops are an important dietary component for the majority of crane species with corn and wheat making the largest proportional contribution to the crane diet). Crane use of cropland as foraging habitat was identified in one-third of studies reviewed, but crop damage was identified in only ten percent of studies. Study identified two potential effects of increasing agricultural land cover: 1) habitat loss with negative effects on crane species dependent upon specific non-agricultural habitats and 2) superabundant food availability beneficial for opportunistic crane species able to utilize these resources.	Hemminger K, König H, Månsson J, Bellingrath-Kimura SD, Nilsson L. 2022. Winners and losers of land use change: A systematic review of interactions between the world's crane species (*Gruidae*) and the agricultural sector. Ecology and Evolution 12(3): e8719. https://doi.org.10.1002/ece3.8719
2022	Migratory habitat	The use of US Army Corp of Engineers reservoirs as stopover sites for the Aransas-Wood Buffalo population of whooping crane	Summary of AWB whooping crane use of USACE reservoirs as stopover sites.	Assessed AWB whooping crane stopover use of USACE reservoirs within the migratory corridor. Utilized WC stopover locations from USGS Telemetry Database from 2009-2018 together with USFWS Cooperative Whooping Crane Tracking Project database and USGS Biodiversity Information Serving Our Nation database to document significant stopover use of USACE reservoirs in both spring and fall migratory seasons. One reservoir was used as a wintering location in multiple years.	Jung JF, Fischer RA, McConnell C, Bates P. 2022. The use of US Army Corp of Engineers reservoirs as stopover sites for the Aransas-Wood Buffalo population of whooping crane. US Army Engineer Research and Development Center, Vicksburg, MS. https://apps.dtic.mil/sti/pdfs/AD1176388.pdf

Published	Study Topic	Document Title	Summary	Principal Findings	Citation
2022	Migratory habitat	Differential shortstopping behavior in whooping cranes: habitat or social learning?	Characterizes shortstopping winter habitat utilized by the Eastern migratory population (EMP) to estimate the amount of potential shortstopping wintering habitat available to the Aransas Wood Buffalo population (AWBP) within the Great Plains migratory corridor. Tests habitat availability and social learning as potential drivers leading to the difference in wintering behavior between the EMP and the AWBP populations.	Based upon habitat characteristics of shortstopping sites used by the EMP, an estimated 31.4% of the AWBP migratory corridor is suitable for wintering, reducing the likelihood that insufficient habitat suitability limits shortstopping during fall migration by the AWBP. Limited interactions among adults and juveniles of the EMP may reduce social learning of and adherence to established migratory behavior, leaving room for experience with and uptake of novel migratory behaviors such as shortstopping.	Mendgen, P, Converse SJ, Pearse AT, Teitelbaum CS, Mueller, T. 2022. Differential shortstopping behavior in whooping cranes: habitat or social learning? Global Ecology and Conservation 41: e02365. https://doi.org/10.1016/j.gecco.2022.e02365
2021	Behavior	Whooping crane diurnal behavior and natural history during migration in the central Great Plains: Interim report – Fall 2020.	Used long-range photography/videography, spotting scopes, and binoculars to document whooping crane activity, response to aircraft, and response to potential predators via scan sampling.	Observed 10 whooping crane groups, including 27 individuals. Documented foraging, preening, loafing, social, and defensive behaviors over both on and off-channel environments. Foraging/drinking was the most common behavior observed. Loafing and preening occurred most often in open-water wetland land classes. Alert or defensive behaviors were most often observed in cornfields.	Baasch DM, Caven AJ, Krohn B. 2021. Whooping crane diurnal behavior and natural history during migration in the central Great Plains: Interim report – Fall 2020. Crane Trust, Wood River, NE. https://cranetrust.org/who-we-are/what-we-do/conservation/research/publications.html
2021	Diet and foraging behavior	Whooping crane (*Grus americana*) family consumes a diversity of aquatic vertebrates during fall migration stopover at the Platte River, Nebraska	Used long-range photography, videography, and behavioral scan sampling to document forage items consumed by whooping cranes.	During an 11-day stopover along the central Platte River during the fall of 2019 three adults- and one colt were observed. They consumed 16 individual vertebrates of at least 6 different species during the stopover. The research documented 7 channel catfish (*Ictalurus punctatus*), 5 ray-finned fish (Actinopterygii), 1 sunfish (Centrarchidae), 1 carp/minnow relative (Cypriniformes), 1 perch relative (Percidae), and 1 leopard frog relative (Lithobates sp.) consumed by whooping cranes.	Caven AJ, Koupal KD, Baasch DM, Brinley Buckley EM, Malzahn J, Forsberg ML, Lundgren M. 2021. Whooping crane (*Grus americana*) family consumes a diversity of aquatic vertebrates during fall migration stopover at the Platte River, Nebraska. Western North American Naturalist 81(4): 592-607. https://digitalcommons.unl.edu/natrespapers/1460/

Published	Study Topic	Document Title	Summary	Principal Findings	Citation
2021	Habitat selection	Migrating whooping cranes avoid wind-energy infrastructure when selecting stopover habitat	Used telemetry locations from 57 whooping cranes to detect potential avoidance of wind-energy infrastructure.	Examined how wind energy infrastructure may affect stopover locations. Used whooping crane ground locations and compared habitat characteristics within a buffer around each use and 19 available locations. Predictor variables included percentage wetland, percentage cropland, road density, distance from center of migratory corridor, and distance from energy tower. Zone of influence analysis demonstrated reduced probability of use of areas within 5 km of wind towers.	Pearse AT, Metzger KL, Brandt DA, Shaffer JA, Bidwell MT, Harrell W. 2021. Migrating whooping cranes avoid wind-energy infrastructure when selecting stopover habitat. Ecological Applications 31(5): e02324. https://doi.org.10.1002/eap.2324
2021	Habitat use	Disposition of non-complex palustrine wetlands	Used PRRIP whooping crane use locations from PRRIP monitoring and telemetry data from the whooping crane tracking partnership to assess use of the off-channel non-complex palustrine wetlands managed by the Program.	Whooping Cranes have not been documented to date using the non-complex palustrine wetlands managed by the Program.	PRRIP. 2021. Diposition of Non-Complex Palustrine Wetlands. https://platteriverprogram.org/system/files/2021-10/03-Palustrine%20Wetland%20Memo_0.pdf
2020	Migratory group sizes	Trends in the occurrence of large whooping crane groups during migration in the Great Plains, USA	Used public sighting database to examine trends in migrating whooping crane group sizes over time and space.	Whooping crane group size and the amount of variation in group size has increased over time and in relation to an increasing whooping crane population with the strongest trend observed in the increasing number of groups with 7-9 and ≥10 individuals. Large groups tended to occur within the 50% migratory corridor, at staging areas closer to the ends of the migratory corridor, and disproportionately on conservation-managed habitat.	Caven AJ, Rabbe M, Malzahn J, Lacy AE. 2020. Trends in the occurrence of large whooping crane groups during migration in the Great Plains, USA. Heliyon 6(4): E03549. https://doi.org/10.1016/j.heliyon.2020.e03549

Published	Study Topic	Document Title	Summary	Principal Findings	Citation
2020	Migratory habitat	Identifying, protecting, and managing stopover habitats for wild whooping cranes on U.S. Army Corps of Engineers lakes	Evaluation of USACE lakes within the AWB population migratory corridor as potential whooping crane habitat for management.	Thirty-four USACE lakes within the migratory corridor were evaluated using the following criteria: lake, pond, wetland ≥ 0.12 ha, with shallow area 12-25 cm deep for roosting, and gradual, sloping shorelines; little/no submerged/emergent vegetation in potential roost area; glide path clear of obstruction, no trees or tall, dense vegetation, open landscape with extensive horizontal visibility; and ≥ 275 m from human development/disturbance. Within the 34 lakes, 624 locations were identified as potential whooping crane stopover sites within North and South Dakota, Nebraska, Kansas, Oklahoma, and Texas with commitments to manage the identified habitat as resources allow.	McConnell, C. 2020. Identifying, protecting, and managing stopover habitats for wild whooping cranes on U.S. Army Corps of Engineers lakes. bioRxiv 12.30.424870. https://doi.org/10.1101/2020.12.30.424870
2020	Wintering habitat	Identifying sustainable winter habitat for whooping cranes	Predicting future wintering habitat quality and quantity under scenarios of sea level rise and urban development. Calculation of potential carrying capacity over wintering habitat.	Whooping cranes used salt marsh, areas >15 km from development, and < 2 km from estuarine water more frequently. Area of salt marsh changed over time with sea rise. One to three percent of suitable habitat was predicted to be lost to urbanization by 2100. Under the scenario of higher coastal urbanization over time, carrying capacity of wintering habitat for whooping cranes was predicted to initially increase with a 0.6 m rise in sea level, but decrease as sea level rose by 1-2 m through time.	Metzger KL, Lehnen SE, Sesnie SE, Butler MJ, Pearse AT, Harris G. 2020. Identifying sustainable winter habitat for whooping cranes. Journal for Nature Conservation 57. https://doi.org/10.1016/j.jnc.2020.125892
2020	Diet	A characterization of the diets of wild and reintroduced whooping cranes (*Grus americana*)	Inventoried proventriculus and ventriculus contents from dead birds to compare diet between Wisconsin-Florida (eastern migratory) population and the Aransas-Wood Buffalo population.	Wisconsin-Florida and Aransas-Wood Buffalo populations had similar dietary compositions, including benthic invertebrates, beetles, crabs/crayfish, vegetation, seeds, mollusks and unidentified vertebrates.	Neri H. 2020. A characterization of the diets of wild and reintroduced whooping cranes (*Grus americana*). MS Thesis, Department of Environmental Biology, Hood College, Frederick, MD. http://hdl.handle.net/11603/18389

Published	Study Topic	Document Title	Summary	Principal Findings	Citation
2020	Migration telemetry	Location data for whooping cranes of the Aransas-Wood Buffalo population, 2009-2018 (data set).	Telemetry tracking locational dataset for AWB migratory population of whooping cranes from 2009-2018.	Telemetry tracking locational dataset for AWB migratory population of whooping cranes from 2009-2018.	Pearse AT, Brandt DA, Baasch DM, Bidwell MT, Conkin JA, Harner MJ, Harrell W, Metzger KL. 2020. Location data for whooping cranes of the Aransas-Wood Buffalo population, 2009-2018 (data set). US Geological Survey. https://doi.org/10.5066/P9Y8KZJ9
2020	Migration strategy	Heterogeneity in migration strategies of whooping cranes	Used telemetry to assess variation in migration strategies among 58 whooping cranes and the variables associated with those differences.	Whooping cranes showed little consistency in stopover sites used among migration seasons. Timing of migration showed consistency among age classes and reproductive cycles. Time spent at stopover sites was positively associated with distances traveled and negatively associated with time spent at previous stopover sites.	Pearse AT, Metzger KL, Brandt DA, Bidwell MT, Harner MJ, Baasch DM, Harrell W. 2020. Heterogeneity in migration strategies of whooping cranes. The Condor 122(1): 1-15. https://academic.oup.com/condor/article/122/1/duz056/5700702
2019	Riverine habitat selection	Whooping crane use of riverine stopover sites	Analyzed habitat characteristics for riverine stopover sites in the Great Plains and on the Platte River using telemetry locations for the Great Plain analysis and both PRRIP systematic aerial monitoring and telemetry for the Platte River analysis.	This analysis found that whooping crane use on riverine sites was maximized at 200m for unobstructed channel width (656 ft. UOCW), 160m for nearest forest (524ft NF), and suggested managing for unforested corridor widths of 330m (1,082ft UFCW).	Baasch DM, Farrell PD, Howlin S, Pearse AT, Farnsworth JM, Smith CB. 2019. Whooping crane use of riverine stopover sites. PLoS ONE 14 (1): e0209612. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0209612

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2019	Diurnal habitat selection	Diurnal habitat selection of migrating whooping crane in the Great Plains	This study used telemetry marked whooping cranes to assess diurnal use of landcover types throughout the U.S. migration corridor.	Diurnal habitat selection by whooping cranes was found to be influenced by land-cover type and distance to roads. Avoidance of roads varied based on land cover type. At 200 m from any road, all water-based land-cover types (river, open water, and semipermanent wetlands) were estimated to be at least three times as likely and lowland grassland was more than twice as likely to be selected as diurnal use sites than other non-water-based land-cover types (upland grass, corn, wheat, and other agriculture). Corn and semipermanent wetlands were more than 3 times as likely to be selected for at 1 km compared to 200 m from any road, whereas open water and riverine were similarly selected at 1km and 200 m from any road. Semi-permanent wetland was the only water-based land-cover type that was influence by avoidance of roads and was almost 3 times as likely selected at 1 km compared to 200m.	Baasch DM, Farrell PD, Pearse AT, Brandt DA, Caven AJ, Harner MJ, Wright GD, Metzger KL. 2019. Diurnal habitat selection of migrating Whooping Crane in the Great Plains. Avian Conservation and Ecology 14(1):6. https://doi.org/10.5751/ACE-01317-140106
2019	Diet and foraging	Adult whooping crane (*Grus americana*) consumption of juvenile catfish (*Ictalurus punctatus*) during the avian spring migration in the Central Platte River Valley, Nebraska, USA.	First observation of whooping crane consumption of fish in the Platte River.	22 March 2018 observation and photo documentation of an adult whooping crane consuming five juvenile channel catfish.	Caven AJ, Malzahn J, Koupal KD, Brinley Buckley EM, Wiese JD. 2019. Adult whooping crane (*Grus americana*) consumption of juvenile catfish (*Ictalurus punctatus*) during the avian spring migration in the Central Platte River Valley, Nebraska, USA. Monographs of the Western North American Naturalist 11(2). https://scholarsarchive.byu.edu/mwnan/vol11/iss1/2/?utm_source=scholarsarchive.byu.edu%2Fmwnan%2Fvol11%2Fiss1%2F2&utm_medium=PDF&utm_campaign=PDFCoverPages

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2018	Riverine habitat management	Investigating whooping crane habitat in relation to hydrology, channel morphology and a water-centric management strategy on the central Platte River, Nebraska	This study used annual aerial imagery to monitor effectiveness of sediment augmentation, mechanical/chemical vegetation clearing, channel consolidating, and short duration high flow releases to maintain suitable unobstructed channels for whooping cranes.	This study found 40-day mean peak discharge, wetted width of the channel, disking and herbicide application to be the best predictors of total unvegetated channel width (TUCW). Maximum unvegetated channel width (MUCW) was best explained by 40-day duration peak discharge and wetted width of the main channel. Disking and herbicide application were also included in the top model. Implementation of a short duration high flow release in a given year was predicted to increase TUCW by 0.0 – 6.7 m and MUOCW by 0.0 – 4.6 m depending on baseline river discharge at the time of the release.	Farnsworth JM, Baasch D, Farrell PD, Smith CB, Werbylo KL. 2018. Investigating whooping crane habitat in relation to hydrology, channel morphology and a water-centric management strategy on the central Platte River, Nebraska. Heliyon 4(10): E00851. https://doi.org/10.1016/j.heliyon.2018.e00851
2018	Diurnal habitat selection	Opportunistically collected data reveal habitat selection by migrating Whooping Cranes in the U.S. Northern Plains.	The study combined opportunistic whooping crane sightings from the USFWS public sightings database with landscape data to identify correlates of whooping crane occurrence along the migration corridor in North and South Dakota, USA.	The study found whooping cranes migrating through North and South Dakota select diverse wetland communities and upland (cropland) foraging opportunities. A 1.2 km buffer (radius around use and available locations) for quantification of habitat metrics was the spatial scale with best model support. Road density and distance to increased survey area were found to be important variablesto incorporate into the model to account for detection bias in the public sightings database.	Niemuth ND, Ryba AJ, Pearse AT, Kvas SM, Brandt DA, Wangler B, Austin JE, Carlisle, MJ. 2018. Opportunistically collected data reveal habitat selection by migrating Whooping Cranes in the U.S. Northern Plains. The Condor 120(2):343-356. https://doi.org/10.1650/CONDOR-17-80.1

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2017	Riverine and diurnal use site selection	Correlates of whooping crane habitat selection and trends in use in the central Platte River	Using PRRIP systematic aerial monitoring data from 2001-2014, distance to nearest forest and unobstructed channel widths were important predictors of whooping crane use. However, distance to nearest obstruction was in the top five models. The proportion of population using the Platte River is increasing faster than the population during spring migration but not for fall. Neither spring nor fall migration has a significantly increasing trend.	Statistical modeling of habitat use indicated unobstructed channel width and nearest forest were the most important predictor variables for management purposes. Nearest obstruction was in all top five models but was not included in the management list as it cannot be managed for. Statistical modeling of diurnal habitat use indicated the full model for diurnal use containing all four covariates including nearest obstruction, nearest disturbance, proximity to roosting location, and land cover. Based upon PRRIP monitoring data from 2001- 2014, statistical modeling indicated a significant increase in the proportion of the Aransas-Wood Buffalo population of whooping crane using the Platte River in spring through time. However, the statistical modeling for fall use indicated a decreasing trend through time but was not statistically different than zero. These same trends for proportion of population were seen as well for crane use days for spring and fall migration, but neither were statistically different from zero.	Howlin S, Nasman K. 2017. Correlates of whooping crane habitat selection and trends in use in the central Platte River, Nebraska. https://platteriverprogram.org/sites/default/files/PubsAndData/ProgramLibrary/Correlates%20of%20Whooping%20Crane%20Habitat%20Selection%20and%20Trends%20in%20Use%20in%20the%20Central%20Platte%20River.pdf
2017	Roost and diurnal use sites	Evaluation of nocturnal roost and diurnal sites used by whooping cranes in the Great Plains, United States	This document used telemetry marked whooping cranes to locate roost and diurnal use sites in the great plains. Characteristics of each site were measured to develop criteria to help identify habitat along the central Platte River for restoration, conservation, and management actions.	Whooping cranes were able to tolerate a wider range of habitat metrics in the larger portion of the migration corridor than defined by the Program's initial habitat criteria thresholds for the Platte River except for distance to nearest disturbance. Whooping cranes appeared to be more tolerant of disturbances on the Platte River than they were when analyzing the entire corridor.	Pearse AT, Harner MJ, Baasch DM, Wright GD, Caven AJ, Metzger KL. 2017. Evaluation of nocturnal roost and diurnal sites used by whooping cranes in the Great Plains, United States: U.S. Geological Survey Open-File Report 2016–1209, 29 p., https://pubs.usgs.gov/of/2016/1209/ofr20161209.pdf

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2017	Habitat selection	PRRIP whooping crane habitat synthesis chapters	Used Program systematic monitoring along with telemetry datasets to identify riverine habitat for whooping cranes in the Great Plains and central Platte River.	Unable to establish a relationship between whooping crane use and river flow metrics or total channel width but identified unobstructed channel width and distance to nearest forest as good predictors of whooping crane use. Selection for unobstructed channel width was maximized around 650ft and unforested corridor width was maximized at 1,000 ft. Short-duration high-flow releases will not create or maintain favorable whooping crane riverine habitat in the central Platte River.	PRRIP. 2017. Whooping crane (*Grus americana*) habitat synthesis chapters. https://platteriverprogram.org/sites/default/files/PubsAndData/ProgramLibrary/PRRIP%20Whooping%20Crane%20Habitat%20Synthesis%20Chapters.pdf
2015	Use site intensity throughout the migration corridor	Whooping crane stopover site use intensity within the Great Plains	Used five years data from 58 telemetry marked whooping cranes to analyze use site intensity throughout the migration corridor to identify landscapes important to whooping cranes during migration.	Twenty percent of the grid cells contained one or more stopovers. Thirty percent received only fall stopovers and 47% exclusively spring use. Twenty-three percent had use during both migration seasons. Lands with some type of protection covered approximately 10 percent of the migration corridor used by whooping cranes and approximately 27% of the core corridor. Based on the derived centerline of the migration corridor, 75% of stopover sites occurred within 59 km, 85% within 82 km, and 95% within 144 km of the centerline. Results were similar to those obtained from public sightings data (with known observational bias based upon location) supporting the idea that public sightings data may have value in large scale evaluation.	Pearse AT, Brandt DA, Harrell WC, Metzger KL, Baasch DM, Hefley TJ. 2015. Whooping crane stopover site use intensity within the Great Plains: U.S. Geological Survey Open-File Report 2015–1166, 12 p., https://pubs.er.usgs.gov/publication/ofr20151166

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2014	Species distribution modeling	Correction of location errors for presence-only species distribution models	Analyzed sampling bias of whooping crane locations and the effects those errors had on species distribution models.	Whooping cranes avoid development within 100 and 250 m radius but are indifferent to development at 500 m. Species distribution models rely on accurate species locational data as well as accurate measurement of environmental covariates included in the model postulated to be important for species distribution. Errors in location data can lead to biased regression coefficients for species distribution modeling. Regression calibration can reduce this bias, but can increase variance surrounding parameter estimates, widening confidence intervals associated with variables predicting species distribution. Managers should consider whether there is enough location error (either random or systematic) to warrant correction in light of the increase in uncertainty around resulting parameter estimates. Recording accurate locations from the field will greatly increase the accuracy of models.	Hefley TJ, Baasch DM, Tyre AJ, Blankenship EE. 2014. Correction of location errors for presence-only species distribution models. Methods in Ecology and Evolution 5: 207-214. https://besjournals.onlinelibrary.wiley.com/doi/epdf/10.1111/2041-210X.12144
2013	Population dynamics and recovery planning.	Influence of whooping crane population dynamics on its recovery and management	Modeled 73-year time series of WC abundance to estimate the probability of downlisting. Source for USFWS best estimates of AWB population 1938-2011 obtained through winter surveys.	AWB population experiences periodic population declines but is unlikely to go extinct if future conditions remain similar to those experienced in the past. Provides information for evaluating recovery timelines, habitat conservation targets, management triggers, and monitoring frequency.	Butler MJ, Harris G, Strobel BN. 2013. Influence of whooping crane population dynamics on its recovery and management. Biological Conservation 162: 89-99. https://www.sciencedirect.com/science/article/pii/S0006320713000980

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2013	Species distribution modeling	Non-detection sampling bias in marked presence-only data	Used whooping crane data to develop a method that corrects for non-detection sampling bias when using presence-only locational data for species distribution modeling.	Developed a marked inhomogeneous Poisson point process species distribution model that accounted for non-detection and aggregation behavior. Correcting for non-detection sampling bias requires estimates of the probability of detection which must be obtained from auxiliary data, as presence-only data do not contain information about the detection mechanism. The number of detections required may be relatively small to result in adequate correction of non-detection sampling bias. Studies documenting the relationship between environmental features and species distribution of abundance must consider the grouping behavior of individuals.	Heffley TJ, Tyre AJ, Baasch DM, Blankenship EE. 2013. Non-detection sampling bias in marked presence-only data. Ecology and Evolution 3(16):5225-5236. https://onlinelibrary.wiley.com/doi/epdf/10.1002/ece3.887
2012-present	USFWS whooping crane survey results: winter 2012 - present	USFWS Whooping crane survey results: winter 2012 - present	Source for USFWS annual estimates of AWB population obtained through winter surveys 2012-present.	The USFWS estimated the abundance of whooping cranes in the AWB population for the winter of 2021–2022 as 543 whooping cranes (95% CI = 426.5–781.8; CV = 0.182) inhabiting the primary survey area. This estimate included at least 31 juveniles (95% CI = 20.2–50.8; CV = 0.255) and 196 adult pairs (95% CI = 153.4–282.9; CV = 0.182).	Butler MJ, Harrell W. Bradley SN, Sanspree CR, Moon JA 2012-2022. Whooping crane survey results: Winter 2012 – present. https://ecos.fws.gov/ServCat/Collection/Profile/1206

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2008	Summary of WC use of central Platte River from 2001-2006	Whooping crane migrational habitat use in the central Platte River during the Cooperative Agreement period, 2001-2006	Used data collected from systematic aerial surveys during the cooperative agreement to answer five objectives related to whooping crane use of the AHR.	During the cooperative agreement period, average predicted probability of detection for each survey ranged from 0.34 to 0.78. The average distance moved (straight line distance between two consecutive locations) across the 13 crane groups was 3.22 miles, ranging from 0.49 – 21.64 miles. There was no trend found in the index of WC use during this monitoring period. Feeding behaviors were the most common activity observed during crane group monitoring. The second most observed behavior was resting. WC selected channels with large unobstructed views with probability of use maximized when unobstructed width was 343 meters (1,125 ft). A flow dependent selection model indicated that wetted width at suitable depth increased the probability of WC use, maximizing probability of selection at a wetted width of 319 meters and proportion of channel at suitable depth or sand being 0.48.	Howlin S, Derby C, Strickland D. West, Inc. 2008. Whooping crane migrational habitat use in the central Platte River during the Cooperative Agreement period, 2001-2006. https://platteriverprogram.org/system/files/Internal%20Pubs%202/WEST%20Inc.%202008_WC%20Migrational%20Habitat%20Use%20%282001-2006%29.pdf
2001-present	Annual spring and fall whooping crane monitoring reports for the central Platte River	Platte River Recovery Implementation Program: implementation of the whooping crane monitoring protocol	Results from systematic aerial monitoring of the AHR on the central Platte River for spring and fall migration.	Results from systematic aerial monitoring of the AHR on the central Platte River for spring and fall migration.	Platte River Recovery Implementation Program (PRRIP). 2001-Present. https://platteriverprogram.org/program-library?field_document_category_ref_target_id=11&field_document_focus_area_ref_target_id=17&field_document_type_ref_target_id=All&field_document_species_ref_target_id=24&title=Monitoring+Report&items_per_page=20