

U.S. Fish and Wildlife Service
U.S. Department of the Interior

National Wildlife Refuge System



Observations of Whooping Cranes During Winter Aerial Surveys: 1950–2011

Aransas National Wildlife Refuge



Digital Object Identifier: 10.7944/W3RP4B

Please cite this document and associated dataset as:

Taylor, L. N., L. P. Ketzler, D. Rousseau, B. N. Strobel, K. L. Metzger, and M. J. Butler. 2015.
Observations of whooping cranes during winter aerial surveys: 1950–2011. Aransas National Wildlife
Refuge, U.S. Fish and Wildlife Service, Austwell, Texas, USA. <http://dx.doi.org/10.7944/W3RP4B>.

Cover art created by L. N. Taylor

Observations of Whooping Cranes During Winter Aerial Surveys: 1950–2011

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February 2015

Author Contributions

This document describes whooping crane (*Grus americana*) data collected on paper maps during aerial surveys conducted during winter 1950–1951 through winter 2010–2011. L. P. Ketzler, D. Rousseau and B. N. Strobel were responsible for digitizing the spatial data and attributing them with the information record on the paper maps. L. N. Taylor organized the spatial and attribute data into a single file and created the metadata. L. N. Taylor, B. N. Strobel, M. J. Butler, K. L. Metzger and L. P. Ketzler contributed to the writing of this document.

Acknowledgements

The U.S. Fish and Wildlife Service provided financial support for this work. Many have been involved in the collection of these data. Pilots and observers endured thousands of uncomfortable hours in aircraft to enumerate the last remaining wild population of whooping cranes. We especially thank Thomas V. Stehn, long-time whooping crane biologist and surveyor from winter 1982–1983 through winter 2010–2011. Their efforts have resulted in an extensive dataset that continues to be valuable to the conservation and recovery of whooping cranes. The findings and conclusions in this document are those of the authors and do not necessarily represent the views of the U.S. Fish and Wildlife Service. The use of trade, firm or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Executive Summary

The Aransas-Wood Buffalo population of whooping cranes (*Grus americana*) declined to near extinction by the 1940s. Starting in winter 1950–1951, annual aerial surveys were conducted to observe and record the number of whooping cranes wintering on Aransas National Wildlife Refuge (NWR) and surrounding areas. This effort resulted in 38,332 observations of whooping crane groups being marked on paper maps between winter 1950–1951 and winter 2010–2011. We digitized those locations by matching the ArcMap 10 screen display as close as possible with the paper maps and approximating points in each of the marked locations. The resulting digital data were archived in single file, “WHCR_Aerial_Observations_1950_2011.txt”, which is available for download at <http://dx.doi.org/10.7944/W3RP4B>. These data are freely available to the public. However, we caution that these data have quality issues and limitations due to, but not limited to, inconsistencies and lack of documentation on how data were collected, reliance on perceived knowledge of unmarked birds’ identities, and inaccuracies introduced during both recording and digitization. We discuss weaknesses of these data in this document. We request that proper credit to the compilers of this dataset is explicitly included in any work using these data.

Introduction

The last remaining non-reintroduced, migratory population of whooping cranes (*Grus americana*) overwinters on and around Aransas National Wildlife Refuge (NWR), Texas, USA, and nests on and around Wood Buffalo National Park, Northwest Territories and Alberta, Canada (Canadian Wildlife Service [CWS] and United States Fish and Wildlife Service [USFWS] 2007). This population, known as the Aransas-Wood Buffalo population, declined to near extinction by the 1940s (CWS and USFWS 2007, Butler et al. 2013). This precipitous decline in abundance occurred due to anthropogenic threats including destruction of nests and over-hunting (CWS and USFWS 2007). The whooping crane is listed as an endangered species in both the United States and Canada (CWS and USFWS 2007).

In 1937, Aransas NWR was established near Austwell, Texas, to protect the wintering grounds of the whooping crane and other migratory birds (Alonso et al. 2010). Aerial surveys of whooping cranes on and around Aransas NWR were initiated during winter 1950–1951 (Stehn and Taylor 2008, Strobel and Butler 2014). Surveys were conducted to monitor whooping crane abundance and recruitment (see Butler et al. 2013, 2014*a, b*) but also resulted in spatially-explicit occurrence data (i.e., location data) and resighting of color-marked birds. For 61 winters, the data were only archived on paper maps. We initiated a project to digitize and compile the survey data into a single digital file. This document describes methods used to conduct the aerial surveys, how data were recorded in the field, and methods used to convert data stored on paper maps into a digital format.

Aerial Surveys

Survey Techniques

The intent of the aerial surveys was to obtain a complete count of the Aransas-Wood Buffalo population on the wintering grounds and estimate recruitment of juveniles into the winter flock (those data are available in Butler et al. 2014*a*). This survey also resulted in a record of whooping crane locations. Though the survey did not have a formal sampling frame, the observers primarily focused their efforts on areas known to be occupied by wintering whooping cranes (Stehn and Johnson 1987, Stehn and Prieto 2010). As the Aransas-Wood Buffalo population increased, so did the area they occupied on the wintering grounds, and in turn, the surveyed area. It is unclear what threshold observers used to expand their search area to mirror the extent of the whooping crane population. However, by winter 2010–2011, the surveys were conducted on Blackjack Peninsula, Matagorda Island, Lamar Peninsula, San Jose Island, and Welder Flats.

Though more than 44 observers have been involved in the aerial surveys of whooping cranes since winter 1950–1951, the former USFWS Whooping Crane Coordinator, Thomas V. Stehn conducted

the surveys for 29 seasons (winter 1982–1983 through winter 2010–2011). The most descriptive summary of the aerial survey techniques can be found in Stehn and Taylor (2008); additional information about the techniques used are available in Butler et al. (2014*a, b*) and Strobel and Butler (2014). Since no written protocol existed until the whooping crane surveys were revised beginning in winter 2011–2012 (Butler et al. 2014*b*), there is no way to know how consistent their survey methods or results were from winter to winter.

During each winter, survey flights were conducted on multiple days. However, the extent and intensity of the search effort for each flight is unknown since flight paths were not recorded. Surveys spanned up to a 7-month period each year which included the migratory period. Survey flights began as early as October 9th and ended as late as May 24th. On average, survey flights began on October 22nd (SD = 9.3 days) and ended by April 20th (SD = 16.4 days). Approximately 63% of survey flights were conducted between November 15th and March 31st.

Each survey flight consisted of one pilot and at least one observer. The flight paths were typically oriented parallel to the coastline with transects spaced approximately 250–800 m apart in an attempt to cover the entire survey area (Butler et al. 2014*b*). Transect widths were subjectively determined based on visibility and weather conditions during the survey in an effort to maximize detection of whooping cranes (Butler et al. 2014*b*). A global positioning system (GPS) device was used beginning in winter 2001–2002 to help maintain parallel transects. However, predetermined flight paths were not used during the aerial surveys nor were flight paths archived. Thus the extent and intensity of search effort for each flight was unknown and likely inconsistent. Surveys were conducted at approximately 60 m above ground level at a speed of approximately 170 km/hr (Stehn and Taylor 2008, Strobel and Butler 2014).

Stehn and Taylor (2008) recognized that sun angle and visibility influenced their ability to detect whooping cranes. To address this issue, observers focused their attention to the side of the aircraft opposite of the sun's position (Stehn and Taylor 2008). However, it is unknown if this practice was implemented prior to winter 1982–1983. Observers attempted to determine the age and group size, and identify any unique individuals (i.e., color-marked and/or radio-marked birds) for each whooping crane group they observed. However, if identification was not obtained on the initial pass, the pilot would alter course to allow the observer additional opportunities to confirm data.

Data Recording

Upon observing a whooping crane group, their location was denoted on paper maps by the number of white-plumaged (i.e., after-hatch-year; adult) and tawny-plumaged (i.e., hatch-year; juvenile)

birds in each group. For example, a group of three birds (2 adults and 1 juvenile) would be denoted as “2+1,” indicating two white-plumaged birds and one tawny-plumaged bird were present. These observations were typically written and encircled at their approximate location on a paper map (e.g., Figures 1 and 2). However, some observers marked a dot on the paper map and wrote notes near the dot. In the event that a whooping crane was observed flying, the observer in some cases indicated this on the paper maps as “fly” or as an arrow in the direction it flew. During some surveys, paper maps were used that did not include the entire survey area (i.e., winter 1959–1960 through winter 1962–1963 did not include Matagorda Island). Whooping cranes observed in areas outside the mapped area used for the survey were written along the margin of the map.

The types of paper maps varied over the 61 years of the survey (e.g., Figures 1 and 2). Data were recorded on hand-drawn maps during winter 1950–1951 until winter 1997–1998 (Figure 1). Some hand-drawn maps had a high degree of landscape detail but most lacked detail. From winter 1998–1999 until winter 2010–2011, observations were recorded on digital orthophoto quarter quadrangle (DOQQ) maps (Figure 2), although hand-drawn maps continued to be used for some surveyed areas (e.g., Whitmire Unit, Welder Flats, Lamar Peninsula, Holiday Beach). The scale and resolution of paper maps also varied through time, though the paper DOQQs were approximately 1:46,000.

Uniquely identifiable individuals

Beginning in the late 1970s, the Aransas-Wood Buffalo population of whooping cranes contained uniquely identifiable marked birds (e.g., color bands). To read the color bands, observers would employ a slow, landing-type approach (Stehn 1995, Stehn and Johnson 1987). The technique involved the pilot decreasing the altitude of the airplane to approximately 15 m above ground level (Stehn and Taylor 2008). As reported by Stehn, the bands were most often read with the naked eye and, on occasion, with instruments (i.e., binoculars, cameras; Stehn 1995). The color combinations worn by each whooping crane were indicative of the year the bands were placed on the whooping crane (e.g., the nine birds banded in 1977 carried at least one red band; Kuyt 1979).

Observers used specific notation to describe and record the identity of color-marked individuals observed during the aerial surveys. The notation conventions were color- and case-specific. Capital letters represented 80-mm long bands and lowercase letters represented 40-mm long bands (Kuyt and Goossen 1987, Stehn 2001). Bands were read left to right leg from top to bottom where a “-” separates each leg and a “/” separates bands on the same leg. For example, the color combination “G-w/r” represents a bird with a green, 80-mm band on its right leg and white, 40-mm band above a red, 40-mm band on its left leg. For an individual to be positively identified based on their color band, the use of

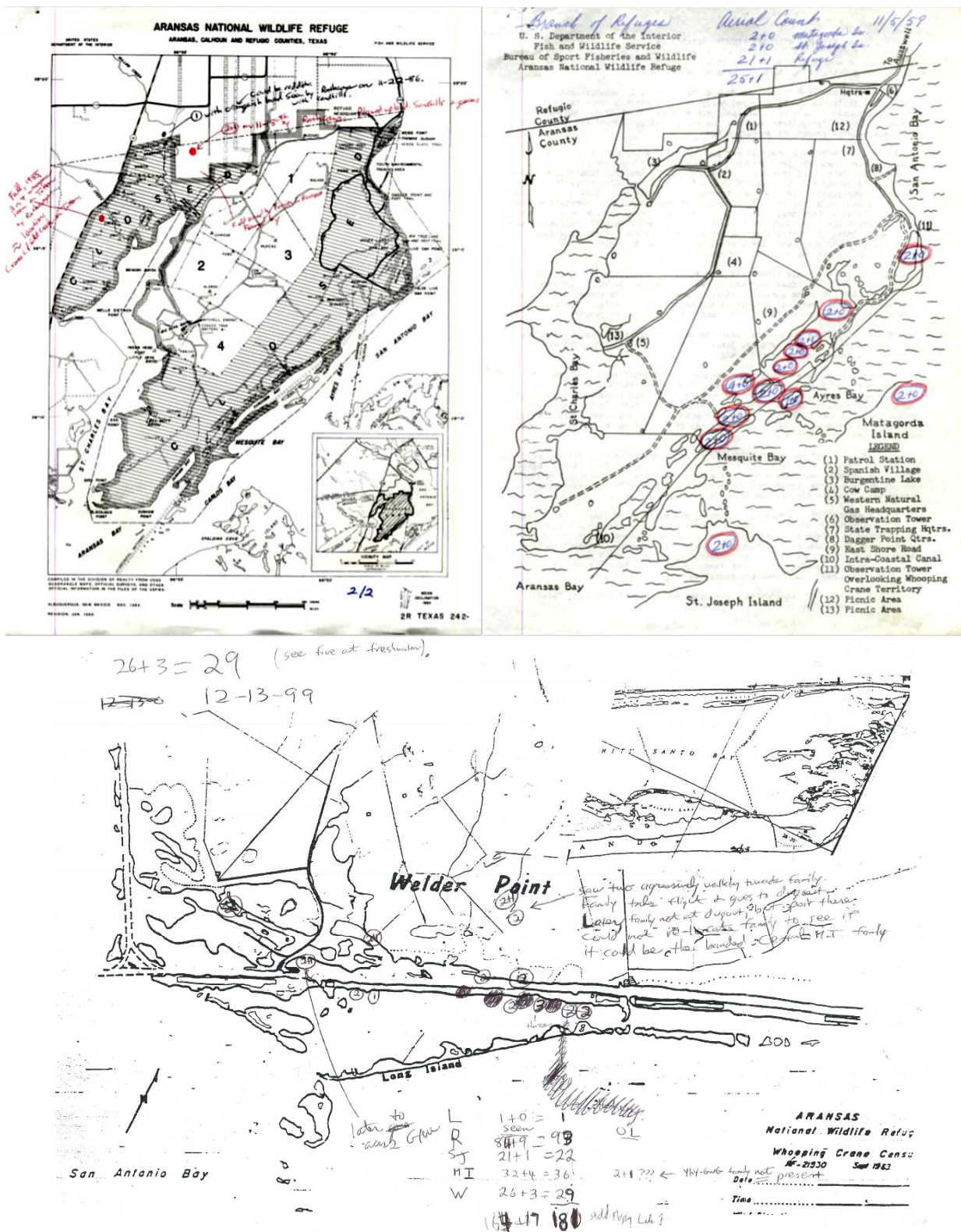


Figure 1. Examples of hand drawn maps used to record whooping crane observations during the aerial surveys. Prior to the use of digital orthophoto quarter quads (DOQQ), hand-drawn maps of varying scales were used. Hand-drawn maps often covered the entire survey area (e.g., Refuge tour guide maps) but more detailed hand-drawn maps were also used.

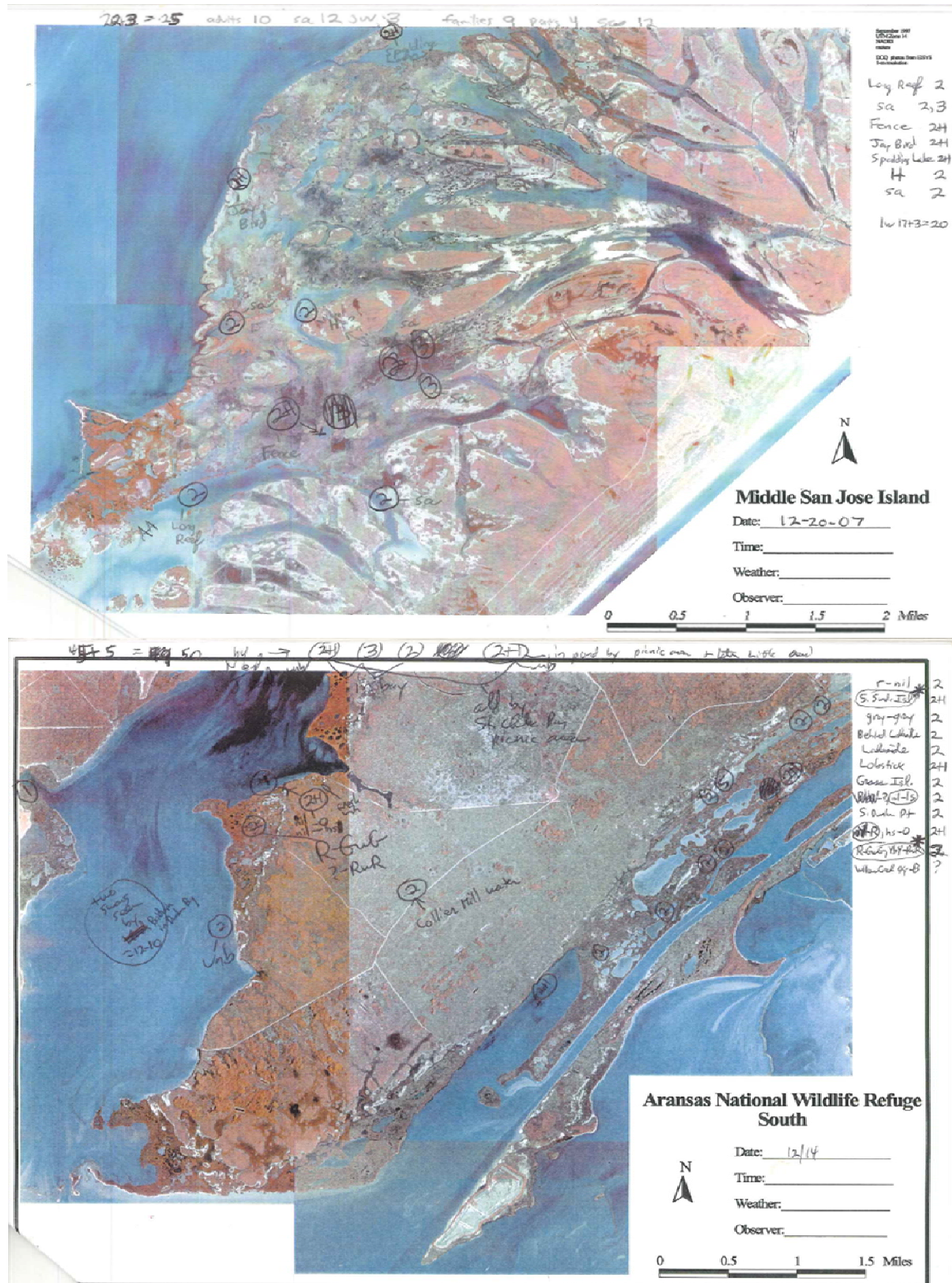


Figure 2. Examples of digital orthophoto quarter quads (DOQQ) used to record whooping crane observations during the aerial surveys. The DOQQs were consistently used beginning winter 1998–1999 until winter 2010–2011.

consistent notation was imperative. For example, “r-Y” represented a bird banded in 1983, while “R-Y” represented a bird banded in 1986. Further, some bands were striped (e.g., YbY was a yellow band with a horizontal black stripe; Stehn 2001) or became discolored over time, making positive identification difficult from the aircraft. This resulted in observers using prior knowledge of behavior and presumed territory-fidelity to confirm color band identification (Stehn 1992, 1995, 2001). These identifications were based on unverified presumptions and, in turn, the validity of these identifications is questionable. Additional information on color-banded individuals is available as supplementary material to Gil-Weir et al. (2012) and can be downloaded at onlinelibrary.wiley.com/doi/10.1111/j.1557-9263.2011.00349.x/supinfo.

In addition to color-marking individuals, 15 hatch-year birds were equipped with Very High Frequency (VHF) radio transmitters between 1981 and 1983 (Howe 1989, Kuyt 1992, Takekawa and Orthmeyer 2001; Table 1). Those cranes were tracked until their VHF radios were no longer operational. Subsequently, they were identified by their color bands. During aerial surveys, observations of radio- and color-marked individuals were interchangeably recorded as either their VHF radio frequency or color-band combination.

Table 1. Fifteen whooping cranes were radio-marked between 1981 and 1983 at Wood Buffalo National Park and only five were observed on the wintering grounds. The aerial survey dataset contained observations of the color bands of the radio-marked birds and the “comments” field contained the frequencies as well as any additional information (i.e., signal strength).

Bird id ^a	USFWS band	Color Combination ^b	Radio frequency	Fate of bird
3/81	629-01809	G-r/w	164.605–164.607	Alive as of March 1991
2/82	629-01812	G-w/r	164.621–164.623	Died 15 November 1984
10/82	629-01810	W-R	164.565–164.568	Alive as of March 1991
9/83	599-09832	Y-y/r	164.750–164.751	Disappeared 21 November 1984
19/83	599-09822	r-Y	164.440–164.444	Alive as of March 1991

^a Bird id was based on nest identification number/hatching year.

^b Band colors were green (g), red (r), white (w), and yellow (y) where capital letters were 80-mm bands and lowercase letters were 40-mm bands. The “-” separates each leg and the “/” separates bands on the same leg. Bands are read left to right leg from top to bottom.

Digitizing locations of crane observations

To transcribe whooping crane observations into a digital record, technicians visually georeferenced the observations recorded on each paper map using “heads-up” manual digitizing techniques to approximate the locations of observed birds. They digitized all data using ArcMap 10 by matching the land features in a digital aerial image (2010 images from National Agriculture Imagery Program [NAIP]) as close as possible to the features on the paper maps. Background features (i.e., distinctively shaped ponds, marsh topography) identified both on NAIP images and the paper map were used as spatial references to determine coordinates of each observation. Maps with fewer details (i.e., hand-drawn maps with coarser scale) were more difficult to identify and match features. Technicians recorded each whooping crane group’s location as the approximate center of each observation marked on the paper maps. The spatial data were projected as North American Datum (NAD) 1983 Universal Transverse Mercator (UTM) Zone 14. Typically the locations of observed whooping cranes were denoted with number(s) that represented the number of individuals observed and enclosed by a circle (see Figures 1 and 2). In the event that a whooping crane flew to a different location (sometimes indicated as “fly” or marked with an arrow in the direction flown), only the original location of the sighting was recorded. In some instances, whooping crane groups were observed but their locations were not record on the paper maps (e.g., no paper maps of the area were available so recorded on the margin of other maps). Observations lacking spatial information were entered as “LOCUNK” in the comments field of the attribute table.

When present, additional information provided by the observer such as landcover type and comments was included in supplementary data fields in the attribute table (Table 2). The aircraft type and the names of each pilot and observer were taken from the weekly and annual survey reports (e.g., Stehn 1986, 2001, 2009) and were also entered into the attribute table. The legibility of handwriting varied across observers, survey weather conditions, and survey duration. Therefore, it is likely that misinterpretation caused some error. After the technicians digitized each winter’s data, all data were merged into a single feature class containing an aggregate data table with the coordinates of each location. The attribute table from the feature class was exported as a tab-delimited text file (i.e., WHCR_Aerial_Observations_1950_2011.txt) which is available for download at <http://dx.doi.org/10.7944/W3RP4B>. The attributes of that file are described in Table 2. Please credit the compilers of this dataset in any work using these data.

Table 2. The aerial survey data provided in “WHCR_Aerial_Observations_1950_2011.txt” contains the locations of whooping crane observations as well as the additional data outlined below.

Attribute	Definition
Year	Year of the aerial survey.
Month	Month of the aerial survey.
Day	Day of the month of the aerial survey.
Survey_Year	Survey year coincides with the year beginning each winter season, which varied in duration from October through May. For example, surveys conducted from October 1986–March 1987 corresponded with the survey year 1986.
Coordinates	Indicates whether or not a data point has X and Y coordinates. For points that do not have coordinates, the location is unknown (LOCUNK). Locations are listed as unknown when they were recorded as “off the map” or when the specific location of the observation could not be approximated.
X	X-coordinate of the point recorded (UTM, NAD83, zone 14).
Y	Y-coordinate of the point recorded (UTM, NAD83, zone 14).
WHITE	Number of white-plumaged (after-hatch-year [i.e., adult]) whooping cranes observed at the location.
JUVE	Number of tawny-plumaged (hatch-year [i.e., juvenile]) whooping cranes observed at the location.
UNK	Number of whooping cranes observed at the location for which plumage coloration could not be determined.
Band	Colored bands placed on whooping cranes above the knee; bands are read upper/lower left leg-upper/lower right leg. Band colors included red (r), green (g), white (w), orange (o), yellow (y), blue (b), black (horizontal black stripe in WbW and YbY), Blue white spiral (BWsp), gray, no color (nil), low silver (ls), high silver (hs), and unknown where capital letters were 80-mm bands and lowercase letters were 40-mm bands. The “-” separates each leg and the “/” separates bands on the same leg. “Unknown” represents individuals wearing a band where definitive/positive identification was not made or the leg on which the band was located was not specified. The partial identification of unknown banded birds can be found in the “comments” field. More than one band may be included per data point; each band is separated by commas. The color-band notation is described in Kuyt and Goossen (1987), Stehn (2001), and Gil-Weir et al. (2012).
Band_condition	Indicates the condition of the color bands; the condition of the band is indicated next to the color that is affected (defined by Stehn 1995): Faded: indicates the color band was faded and was indicated as [f] in the “comments” field. Worn: refers to portions of color missing from a band (e.g., a worn “YbY” may appear completely black except for a little yellow on one side) and was indicated as [w] in the “comments” field. Slippage: refers to two bands on the same leg that may have one positioned inside of the other, so that only one may be visible. Splitting: indicates the band was splitting apart.
Observer	Name of the observer(s) present during the survey flight.

Table 2. Continued.

Attribute	Definition
Pilot	Name of the aircraft pilot.
Aircraft	The type of aircraft used to conduct the surveys.
Area	Name of the survey area where cranes were observed. Cardinal directions are included in some area descriptions as well as specific regions within the area. The areas included: Aransas NWR (NE, S), Austwell Fields, Burgentine Lake, Farm Fields, Hynes Bay, Indianola, Lamar, Matagorda Island, Mustang Island, San Jose Island, Saint Joseph Island, Tatton, and Welder Flats.
Land_cover	Description of the land cover type based on approximate whooping crane locations and knowledge of the area: Marsh: brackish water and high vegetated marsh located inland or near the coast. Shoreline: refers only to exterior water such as bays. Pond: freshwater source, if comments indicate “dugout”, “pond”, “fresh”, or “freshwater”. Open water: deeper water including bays, lakes, and intracoastal waterways, not shallow interior marshes. Burn: whooping cranes were located on recently burned areas. However, the time since burn was not indicated. Prairie: dry upland areas.
Time	Time recorded on a 24-hour clock; it is unknown whether the time was recorded before, during, or after the flight or at the time of observation.
Weather	Weather conditions recorded on the day of the survey, it is unknown if the weather conditions were recorded before, during, or after the flight or at the time of observation.
Temperature	Temperature (°F) recorded on the day of the survey; it is unknown whether the temperature was recorded before, during, or after the flight or at the time of observation.
Comments	Observer’s comments transferred verbatim from the day of the survey and parenthetical statements were placed in brackets. Occasionally, the data technician added comments; these post-hoc comments were placed in parentheses. Comments may include historic family groups of whooping cranes or relevant behavior (i.e., territorial chases or feeding behavior). Name of family group was typically listed first. “sa” refers to sub-adults. “HolBch” refers to the community of Holiday Beach, which is the most common location for LOCUNK during the 2000–2011 timeframe. “Radio chick” refers to radio-marked chicks (strength of signal available in “comment” field). “Dupe” refers to duplicate records (same whooping crane marked in two different spots).

Description of the Data

Aerial surveys were conducted from winter 1950–1951 through winter 2010–2011 (Stehn and Taylor 2008, Butler et al. 2014*b*, Strobel and Butler 2014). During these surveys, 38,332 whooping crane groups were observed. On average, 23.3 (SD = 8.75) flights were conducted per winter, with an average of 628.4 (SD = 380.58) observations per winter. Approximately 1.4% of the observations had no coordinates associated with them (i.e., LOCUNK). There was an average of 12.5 (SD = 4.29) flights conducted during December through March (i.e., period of peak winter abundance on the Texas gulf coast; Butler et al. 2014*a, b*) per winter, with an average of 440.1 (SD = 289.66) observations during this period. The average group size was 2.3 whooping cranes (SD = 1.21; Figure 3). The maximum group size recorded was 44 birds. A total of 132 color-marked birds were in the population spanning the period of winter 1977–1978 through winter 2010–2011 (Gil-Weir et al. 2012). Whooping cranes marked with color bands were resighted in 17.2% of observations. The attribute table from the digitized data contains 21 fields and 38,332 records.

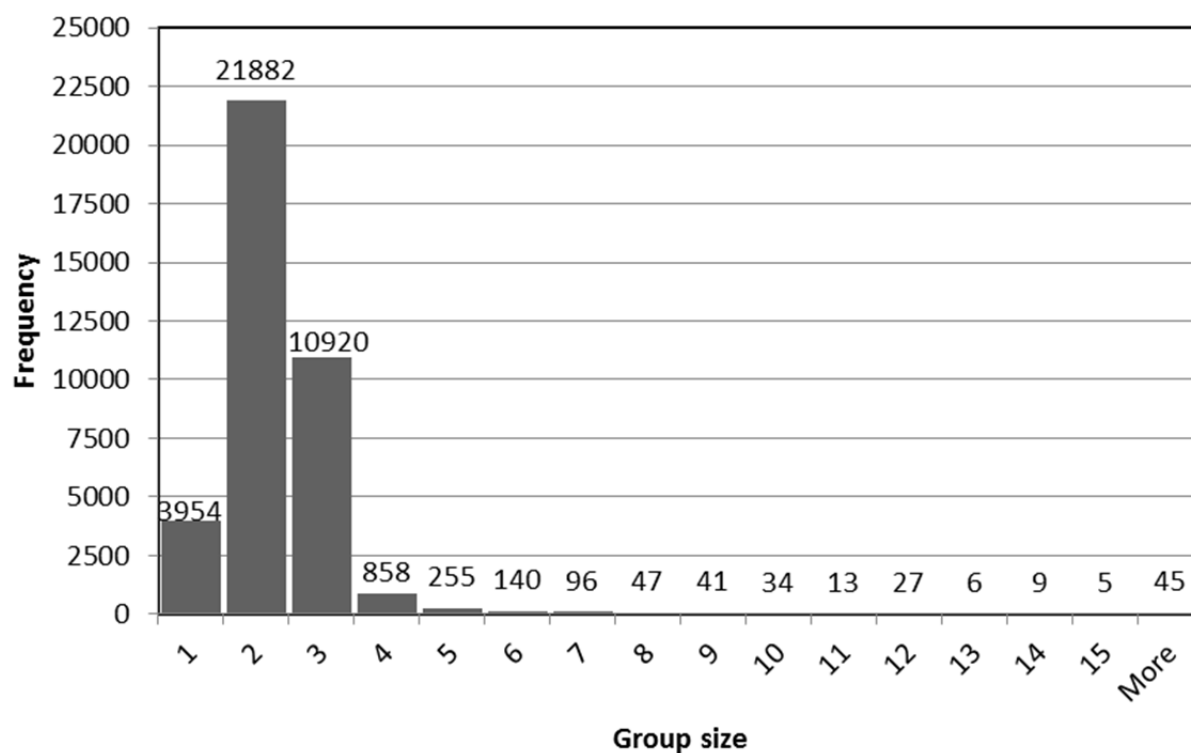


Figure 3. Whooping crane group sizes observed in the Aransas-Wood Buffalo population during aerial surveys, winter 1950–1951 through winter 2010–2011.

Weaknesses of the Data

This dataset contains 61 years of data collected by numerous observers which resulted in unknown and unquantifiable errors from multiple sources. Further weaknesses include the lack of a formal protocol for the aerial surveys, unknown and inconsistent search effort (both spatially and temporally), changing scale and resolution of paper maps over the years of data collection, and difficulty reading color-band combinations, among others. The appropriateness and value of these data depend wholly on the research question being asked. We strongly urge the users of these data to review the weakness outlined below and recognize that additional weaknesses likely exist.

Lack of Protocol

Stehn and Talyor (2008) provided a description of their data collection methods used during aerial surveys from winter 1982–1983 to winter 2010–2011. However, this description was written 58 years after the aerial surveys were initiated and lacked needed detail to replicate the survey (Butler et al. 2014b). To our knowledge, no complete account of the aerial survey protocol and objectives existed prior to 2008. In the absence of a written protocol it is not possible to know how meticulously observers held to data collection standards. Sampling strategies, data recording conventions, and objectives may have changed deliberately or unintentionally throughout the 61-year duration of this survey.

Determination of Age-Class

Observers distinguished the plumage of hatch-year (HY) and after hatch year (AHY) whooping cranes. However, during some surveys observers seem to have allocated less effort to distinguish between HY and AHY whooping cranes. For example, during winter 1962–1963, approximately 87% of observed whooping cranes were classified as an unknown age-class. Prior to winter 1966–1967, 9.3% (SD = 21.5) of whooping crane observations on average were of an unknown age-class, but from winter 1966–1967 to winter 2010–2011, no whooping cranes were classified as unknown age-class. However, most HY whooping cranes become increasingly difficult to distinguish from AHY birds as the winter progresses (Stehn 1986, 1989, 2000, 2009; Stehn and Taylor 2008). For example, Stehn (2009) noted that the tawny-coloration on the body was typically gone by February during most years. Approximately 30% of survey flights were conducted during March, April and May when distinguishing HY and AHY birds would be most difficult.

Unknown Scale and Resolution of Paper Maps

The notation used for whooping crane locations and map scales made it impossible for precise locations to be established for digitization. The lack of details and unknown map-scales on the hand-drawn maps resulted in substantial error, both during the surveys and digitization. Additionally, the use

of heads-up digitization further skews the accuracy of the data points. Locations were difficult to approximate due to the legibility and size of the handwriting in relation to the map area. As depicted in Figures 1 and 2, the size of the circles containing the number of birds varied, leaving the data technician to approximate the location of the observation. Further, in some instances, data points lacked spatial information because they were recorded on the margins of the paper maps (i.e., LOCUNK).

Unknown and Inconsistent Search effort

The timespan between the first and the last survey flight during a winter ranged from 90 to 225 days (mean = 18.0 days, SD = 20.74). The number of survey flights conducted between December and March per winter ranged from 4 to 21 (mean = 12.5, SD = 4.29). Beginning in winter 2001–2002, the aircraft's flight path was recorded with a GPS device and was used to help maintain parallel transects but there was no indication flight transects were planned prior to surveys (Stehn and Taylor 2008). The GPS tracks from those survey flights were not archived after each flight was completed. Without knowing the flight path of the aircraft, we cannot know the areas searched or the intensity of the search effort within a given area. Further, we cannot know if the same area was covered during each survey flight. Thus, the lack of observations in some locations cannot be inferred as whooping crane absence since search effort and survey location is unknown and likely varied spatially and temporally. Strobel and Butler (2014) found detection probability was approximately 56% which also indicates non-detection is not necessarily absence.

Difficulty Identifying Unique Individuals

Some of the band readings contained band colors from both legs, however, the observer could not say for sure whether the band color was read correctly or if they were able to differentiate between the bird's legs. The condition of the band may have impaired the observer's ability to obtain a definitive identification of the bird as well. Initial observations indicated that blue and green, as well as orange and red bands were difficult to distinguish unless observed under excellent flight conditions and visibility (Kuyt 1979). As bands age, they become discolored and their legibility was reduced due to exposure to the elements (e.g., by 1994, color band "r/w-BWB" [1979] was read "r-nil", indicating that the band was missing portions of color; Stehn 1995). On average, bands faded within 5 to 6 years after the bird was banded. Sometimes partial band readings were recorded when a definitive identification was not made on the bird. However, identification was often based on bird behavior and presumed territory-fidelity (Stehn 1992, 1995, 2001). This method led to band and subsequent bird identification based on assumed prior knowledge of expected behavior instead of band combination (Stehn and Johnson 1987;

Stehn 1992, 1995, 2001; Stehn and Prieto 2010). Because of this circular approach, caution should be used with interpretation of resighting data.

Final Remarks

These observations were collected to contribute to the conservation and management of the Aransas-Wood Buffalo population of whooping cranes. However, we caution that these data have quality issues and limitations introduced during recording and digitization. It is important for these issues to be articulated, understood, and acknowledged to ensure appropriate use of these data.

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