Report on Whooping Crane Recovery Activities
(2015 breeding season-2016 spring migration)

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Executive Summary

Whooping cranes are one of the most rare, highly endangered and intensively monitored bird species in North America. The Aransas-Wood Buffalo population (AWBP), which breeds in northern Canada and winters in Texas, is the only remaining wild, self-sustaining migratory population of whooping cranes. In summer 2015, surveys of the AWB detected 68 nests (May) and 23 chicks (August) resulting in an average number of chicks fledged per nest (0.34) that was lower than the 20-year long term average of 0.49 but within the long term natural range of variation. In winter 2015 (Dec) the peak population size of the AWB on the primary wintering grounds was estimated as 329 birds (95% confidence interval [CI] 293–371; CV = 0.073) and additional birds were located outside the survey area. This was a record high estimate for this whooping crane population. Whooping cranes faced challenging conditions due to dry conditions and forest fires during the 2015 breeding season. Several projects were undertaken by a variety of agencies to monitor and investigate the ecology of the AWBP population, including the continuation of an initiative to mark individual birds with satellite transmitters to track their movements during the annual cycle. By the end of 2015, 11 marked birds were continuing to provide data. In addition to the AWB, other populations of whooping cranes exist in Wisconsin, Florida, and Louisiana due to the efforts of many government agencies and non-governmental organizations, including the captive breeding centers where whooping cranes are reared for reintroduction. By the end of 2015 there were approximately 145 birds in reintroduced populations and 161 birds held in captivity. Nearly all of the growth in the global population of whooping cranes occurred in the wild, Aransas Wood-Buffalo population, as reintroduced populations realized minimal wild recruitment and population size was maintained via captive chick introduction. Finally, in 2015, USFWS, CWS, our partners on the International Recovery Team and other organizations initiated a process to conduct a recovery planning process including an updated Population Viability Analysis (PVA) and, for the first time, a Population and Habitat Viability Assessment (PHVA). A PVA workshop was held at the Calgary Zoo in December of 2015 (see report attached). The PVA/PHVA process, led by the Conservation Breeding Specialist Group (CBSG), provides our agencies and partners with an opportunity to develop a unified vision for whooping crane management, in order to hasten recovery of the species in cost-effective and biologically appropriate ways.

Aransas-Wood Buffalo population
Overview

The Aransas-Wood Buffalo population (AWBP) of whooping cranes is the only remaining wild, self-sustaining, migratory whooping crane (*Grus americana*) population. The AWBP breed and summer in and around Wood Buffalo National Park (WBNP) in the Canadian jurisdictions of Alberta and the Northwest Territories and migrate >2,400 miles through the Canadian prairies and US Great Plains to the mid-coast of Texas to spend the winter. Whooping cranes from the AWBP was reduced to a mere 15 individuals in 1941 and has rebounded to nearly 330 this winter, representing a > 4% annual growth rate. The ongoing recovery of this whooping crane population is perhaps one of the greatest endangered species success stories. A wide variety of local, state, federal and private conservation organizations are actively involved in planning and implementing whooping crane conservation efforts.

2015 breeding season

For the full update, see the attached report prepared by Canadian Wildlife Service

Annual precipitation (May 2014 to April 2015) at Fort Smith, NT preceding the breeding season was 104% of the 60-year average, however precipitation in the seven-month period from October 2014 to April 2015 was 79% of the 60-year average. Dry conditions persisted throughout the breeding season; precipitation in the five-month period from May to September 2015 was 62% of the 60-year average. During juvenile surveys in August 2015, observers noted that many breeding-area ponds were dry.

Warm and dry conditions contributed to an active wildfire season in breeding areas and the surrounding region. Fires burned 15,839 ha or 3.88% of the area designated as critical habitat, greatly exceeding the 25-year average of 0.90%. Additionally, wildfire affected 372,450 ha or 8.16% of WBNP (vs. the 25-year average of 1.26%) and 280,880 ha of the South Slave Region of the Northwest Territories. Surveys to locate and count whooping crane breeding pairs and nests in and around WBNP were coordinated by the Canadian Wildlife Service in partnership with Parks Canada Agency. During surveys, 68 nesting pairs of whooping cranes were detected. In addition to nesting pairs, 20-24 territorial pairs were detected suggesting potential for substantial population expansion in upcoming years. Six nests were found outside of WBNP; two in the Lobstick Creek area (Salt River First Nation reserve lands), and four north of the Nyarling River. Surveys to locate and count fledged whooping cranes detected 23 fledged young; no pairs had two juveniles. The number of fledged young per nest was 0.34, lower than the 20-year average of 0.49 but within the long term natural range of variation.

Whooping Crane tracking partnership (WCTP)

Note: This is a summary of U.S. Geological Survey's July 2016 Remote tracking of Aransas-Wood Buffalo Whooping Cranes. Past tracking partnership updates are available *here:* https://www.platteriverprogram.org/PubsAndData/Pages/ProgramLibrary.aspx *(search under Target Species/Whooping Crane)*

WCTP overview

The study was conducted by a partnership of researchers from multiple organizations using GPS devices to track individual whooping cranes of the Aransas –Wood Buffalo population.

Efforts focused on putting tracking devices on adult whooping cranes captured on Aransas National Wildlife Refuge NWR, where the birds winter on the Texas coast, and on chicks at Wood Buffalo National Park, the birds' nesting grounds in Canada.

The GPS units are attached to a bird's upper leg and record four to five locations every 24 hours, information that is uploaded to a satellite every two and half days. These data reveal migration routes, habitat use, nesting locations, and much more. Biologists in the United States and Canada will use results of this work to identify management and conservation priorities in both countries.

The research partnership is made up of governmental and non-profit partners that include the U.S. Geological Survey, U.S. Fish and Wildlife Service, Canadian Wildlife Service, Platte River Recovery Implementation Program, Crane Trust, Parks Canada, Gulf Coast Bird Observatory, and International Crane Foundation.

2015 WCTP Breeding Season

Nineteen marked whooping cranes provided 9,100 locations during the summer of 2015. Surveys conducted by the Canadian Wildlife Service (CWS) confirmed that eleven marked cranes successfully nested and were observed with young during August fledgling surveys; comparison of survey data (i.e., nest locations) and satellite locations of marked birds suggest that another five marked birds likely nested. During fall staging surveys conducted by CWS, nine marked birds were observed to have offspring, providing further support that the WCTP's effort to mark birds has not interfered with reproduction. No mortalities were identified from the data prior to the onset of migration.

2015 WCTP Fall migration

During fall migration, transmitters from 14 marked whooping cranes provided location data. Five transmitters stopped providing data prior to the initiation of fall migration. Six transmitters provided intermittent data during migration. Whooping cranes began departing WBNP on 2 September 2015 and the last marked bird left on 27 October 2015, with the average departure date of 22 September 2015. Fall migration of marked birds took an average of 58 days during 2015, with a range of 13 to 83 days. For comparison, average migration time during fall 2010 was 36 days (12–70 days; n = 10), fall 2011 was 36 days (9–63; n = 19), fall 2012 was 45 days (9–67 days, n = 25), fall 2013 was 35 days (9–78, n = 25) and fall 2014 at 42 days (14-86 days, *n*

= 24). During migration, the WCTP documented 181 stopover locations (sites where cranes stopped for >1 night) from every province and state in the Great Plains migration corridor. Whooping cranes spent the greatest amount of time at staging sites in Saskatchewan, Nebraska, Kansas, North Dakota, and Alberta during fall migration. Other significant stopover sites during fall 2015 migration included one site along the Central Platte River in Nebraska, one bird stopping at Quivira National Wildlife Refuge in Kansas and nine birds stopping at Salt Plains National Wildlife Refuge in Oklahoma. No mortalities of marked birds were detected during fall migration.

2015 Wintering grounds

Additional information from this past winter can be found here:

http://www.fws.gov/refuge/Aransas/wwd/science/updates.html

2015 winter habitat conditions

The first marked whooping crane to arrive on the Texas coastal wintering grounds in and around Aransas National Wildlife Refuge was on 27 October 2015. Drought conditions in the wintering grounds, which have been present off and on since 2008, subsided in 2015 as an active El Nino weather pattern emerged. The 2015 precipitation total (44 inches recorded at Aransas NWR RAWLS) was above the annual average of 38 inches for the Refuge (USFWS Aransas NWRC CCP, 2010), with the wettest month of the year (9.27 inches) occurring in May of 2015 (http://www.wrcc.dri.edu/cgi-bin/rawMAIN.pl?sdTARA). Most traditional freshwater wetlands and ponds on and around Aransas NWR remained full during the wintering season and San Antonio Bay salinities remained moderate (< 20 ppt) during most of the 2015-2016 wintering season (http://lighthouse.tamucc.edu/pq/127). Thus, the severe drought conditions that had been in place on and off since 2008 finally subsided in 2015. The first portion of 2016 continues to be wet, with January–May 2016 rainfall totaling 17.21 inches, with May 2016 totaling 9.96 inches.

Staff at Aransas NWR used prescribed fire to improve whooping crane foraging opportunities and overall prairie upland condition. The uplands adjacent to high-use salt marsh areas, both on the Blackjack and Matagorda Island Units of the Refuge were burned during the winter season. Staff completed burning on 8 units for a total of 5,822 ac over the winter of 2015-2016, which was 1,100 ac shy of the target. This year's prescribed burn season was difficult in terms of meeting objectives, smoke management and weather windows. The season started off very wet from the effects of the above average rainfall in calendar year 2015 and the anticipation of a predicted wet winter from El Nino conditions. The first prescribed fire of the winter season was met with poor results due to the wet conditions. The wet conditions persisted into early January and then rapidly changed. The predicted El Nino event never materialized for Jan/Feb and many dry fronts came through South Texas resulting in conditions outside of prescription with RH's in the teens. Wildlife response on the units burned in January and February continue to exhibit excellent results. Crane units 6 and 7 along with the burns on the south end of Matagorda Island have shown prolonged whooping crane use with unique large groupings.

2015 winter abundance survey

During winter 2015–2016, the primary survey area (approximately 153,950 acres) was surveyed six times between 7 December and 17 December 2015. During the same period, the secondary survey area (approximately 169,300 acres) was all surveyed twice. We also conducted training surveys in March as new staff members were trained as survey observers. We continue to survey and expand secondary survey areas to monitor ongoing expansion of the whooping crane's winter range. Specifically, South San Jose Island was added as a secondary survey area this winter based on reports of whooping crane use in the area the previous winter.

Terry Liddick, pilot/biologist from our migratory birds program, served as pilot for the surveys, flying a U.S. Fish & Wildlife Service Cessna 206. Observers were Wade Harrell and Beau Hardegree (Coastal Program Biologist, Corpus Christi FWS office). Doug Head (Refuge Inventory & Management biologist) served as ground survey coordinator and Diane Iriarte (Refuge biologist) served as data manager.

Preliminary analyses of the survey data indicated 329 whooping cranes (95% CI = 293–371; CV = 0.073) inhabited the primary survey area (Figure 1). This estimate included 38 juveniles (95% CI = 33–43; CV = 0.078) and 122 adult pairs (95% CI = 108–137; CV = 0.071). Recruitment of juveniles into the winter flock was 13 chicks (95% CI = 12–14; CV = 0.036) per 100 adults, which is comparable to long-term average recruitment. The precision of this year's estimate achieved the target set in the whooping crane inventory and monitoring protocol (i.e., $CV < 0.10$).

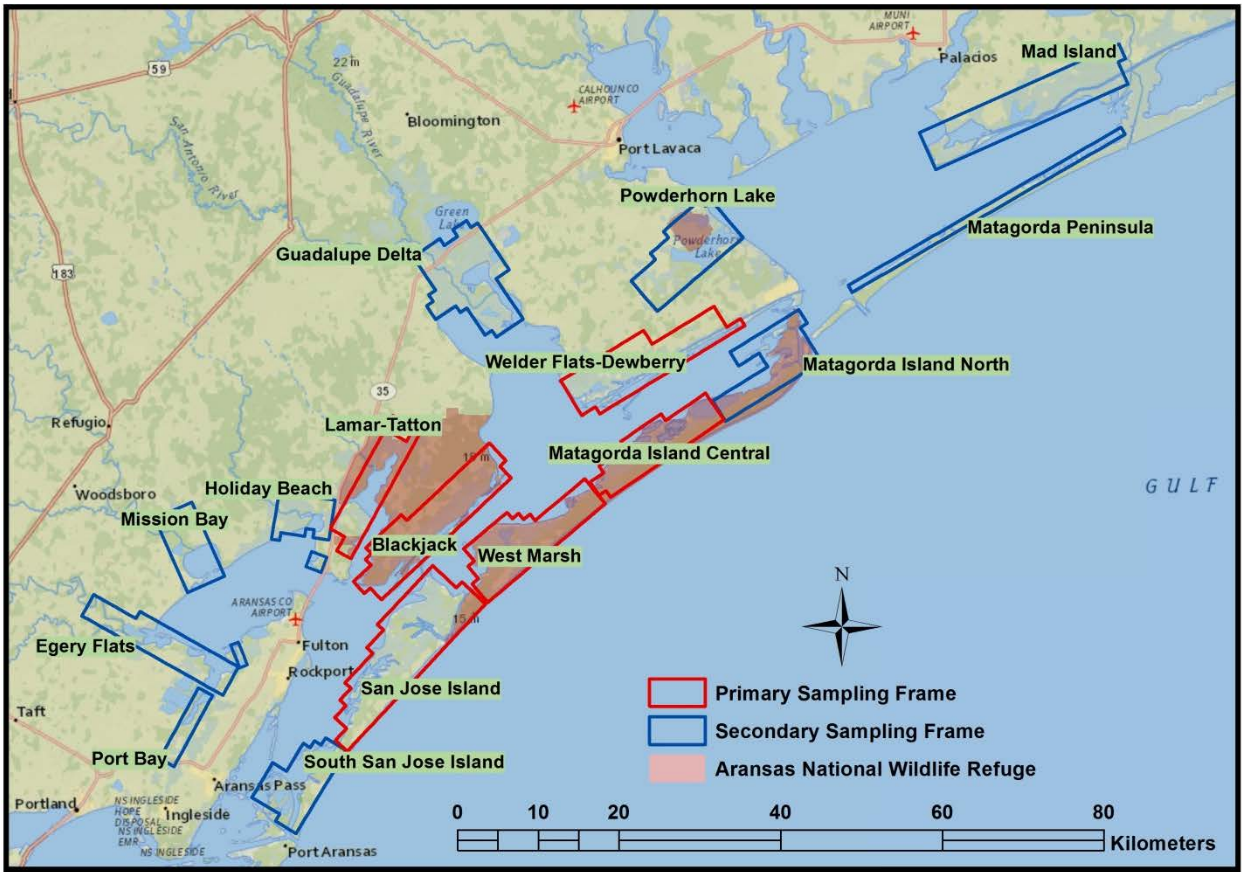

Figure 1. The sampling frame used to monitoring whooping crane abundance on their wintering grounds along the Texas coast of the Gulf of Mexico, USA.

A continued upward trend in whooping crane abundance over the last five years was observed (Table 1), which is consistent with the long-term trend of approximately 4% growth per year. Examination of the 78-year trend in whooping crane abundance shows an increase with occasional, periodic declines occurring, on an approximate 10-year cycle (Figure 2).

Table 1. Preliminary whooping crane abundance estimates for the Aransas-Wood Buffalo population on their wintering grounds, winter 2011–2012 through winter 2015–2016.

Survey year	Abundance[a]	CV	95% CI LCL	95% CI UCL	No. assumed beyond primary survey area[b]
winter 2011–2012	254	0.126	198	324	13
winter 2012–2013	257	0.186	178	362	22
winter 2013–2014	304	0.078	260	354	6
winter 2014–2015	308	0.067	267	350	6
winter 2015–2016	329	0.073	293	371	9

[a] Estimated whooping crane abundance in the primary sampling area using aerial surveys and hierarchical distance sampling. CV = coefficient of variation, CI = confidence interval, LCL = lower confidence limit, and UCL = upper confidence limit.

[b] Provides our best understanding of the number of whooping cranes, at the time of the aerial surveys, that were outside of the primary survey areas. This information was based on data from Texas Whooper Watch, Ebird reports, the whooping crane GPS tracking study, and aerial surveys conducted in the secondary survey areas.

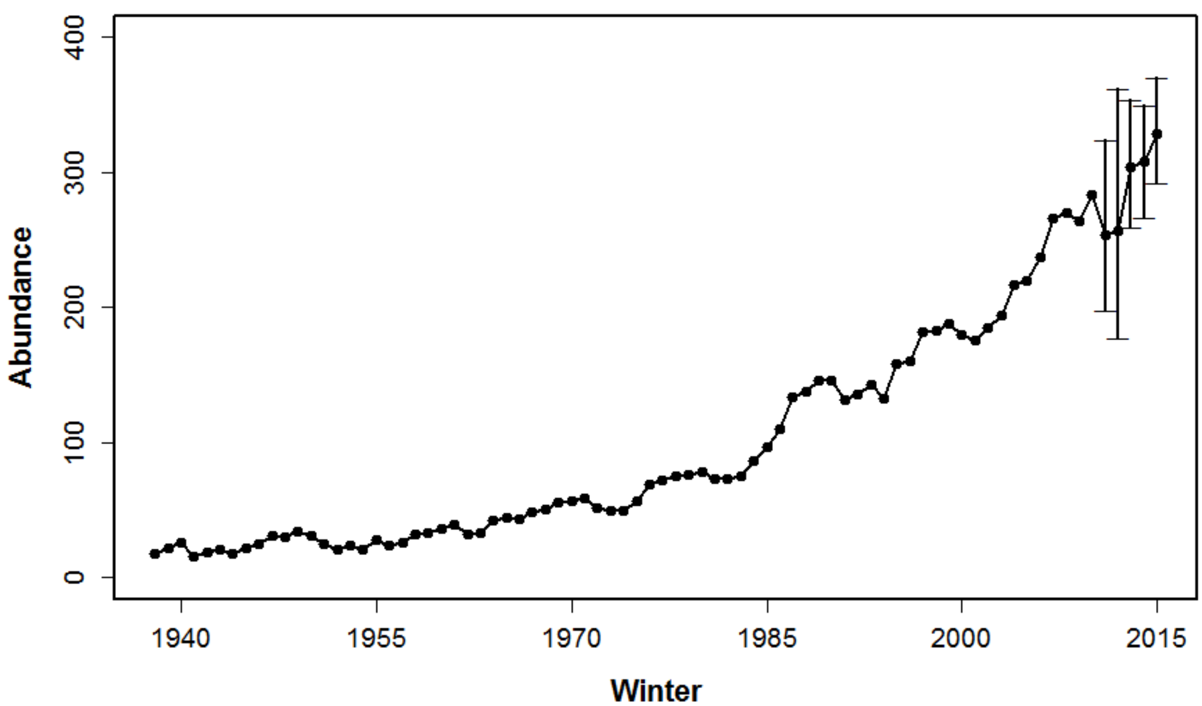

Figure 2. Time-series of whooping crane abundance estimates for the Aransas-Wood Buffalo population beginning in winter 1938–1939. Starting in winter 2011–2012, the precision of abundance estimates were displayed as 95% confidence intervals (these are preliminary estimates). During years prior to winter 2011–2012, the precision of abundance estimates was unknown.

During the survey period, some whooping cranes were observed outside of the primary survey area. These data were based on information from Texas Whooper Watch, Ebird reports, the whooping crane GPS tracking study, and aerial surveys conducted in the secondary survey areas. Compared to winter 2011–2012 and winter 2012–2013, few whooping cranes were observed outside of the primary survey area (Table 1).

Table 2 provides our best understanding of whooping cranes that were outside the primary survey areas during the mid-December survey period. Some birds may have been missed. It is impossible to be absolutely certain that individuals did not move between these locations and to/from the primary survey area during the survey period.

Table 2. Whooping cranes documented outside of the primary survey area during December 7 through December 17, 2015.

General area	Data source	Adults	Chicks	Total	Notes
North Matagorda Island (secondary survey area)	Aerial survey	1	0	1	Individual detected twice during aerial surveys on different days at same location.
Holiday Beach (secondary survey area)	Aerial survey	2	0	2	Pair detected once during aerial surveys.
Powderhorn Lake (secondary survey area)	Aerial survey	2	1	3	Group detected twice during aerial surveys on different days at same location.
Mad Island (secondary survey area)	Aerial survey	2	0	2	Pair detected once during aerial surveys.
Kleberg County (south of Kingsville near Ricardo, TX)	Texas Whooper Watch, Ebird	1	0	1	Reported on November 20th, December 6th, and again on multiple dates in January and February.
Fayette County (near La Grange, TX)	GPS tracking study	1	0	1	Observed near La Grange on December 10th but was observed within the primary survey area beginning on

December 11th.

Additional information from Texas Whooper Watch can be found here:

http://www.tpwd.state.tx.us/huntwild/wild/wildlife_diversity/texas_nature_trackers/whooper-watch/

Documented mortality on wintering grounds

This season we did not document any mortalities on the wintering grounds of whooping cranes in the Aransas Wood-Buffalo population.

Documented morbidity on wintering grounds

On 24 April 2016, a local birder reported an injured whooping crane near the Powderhorn Ranch, recently acquired by Texas Parks & Wildlife Foundation. The marked bird was spotted from FM 1289, crossing Coloma Creek. Photographs were provided to the whooping crane recovery coordinator. Bands on the bird indicated it was marked as a juvenile (female) in the summer of 2012 (PTT ID 119229), although the radio transmitter was no longer functional. After conferring with Barry Hartup, veterinarian with the International Crane Foundation, the bird was suspected to have a lower body condition consistent with its prominent keel and poor condition plumage. The bird appeared to be moving around and foraging normally and was active and alert. The most recent observations of this whooping crane occurred on 3 May 2015, with no subsequent observations or reports.

Ongoing wintering ground research efforts

Establishing a landscape conservation strategy for whooping cranes on the Texas Gulf Coast

Note: In 2014, the U.S. Fish & Wildlife Services Refuges Biological Sciences Team developed a draft landscape strategy for conserving important wintering habitat for an expanding whooping crane population that is facing threats related to human development and sea level rise. The following is the project summary from the report. Please see appended report for more detailed information on this study.

Shoreline and inland habitats of the Texas Gulf Coast house a diverse spectrum of species, whose populations are threatened by anthropogenic stressors, climate change, and sea-level rise. The conservation response to preserve these species and mitigate threats lies in identifying the prospective areas to conserve and subsequently protect. The challenge becomes understanding species needs and diagnosing the present and future threats to species, in order to steer conservation to the right places. This project meet this challenge by designing a sustainable strategy of landscape stewardship centered on whooping cranes (Grus Americana). Our approach took four steps. First, we identified the most important conservation lands for cranes. We relied on GPS telemetry and regression tree models to build species-habitat associations in a resource selection framework. Second, we performed a vulnerability assessment on habitats across the gulf coast by building and integrating predictions of sea level rise and land conversion through the year 2100. Next, we coupled the results of these two steps to identify sustainable conservation lands for whooping cranes and other fauna presumed to rely on similar habitats. Finally, we combined density estimates of whooping cranes with the prediction of sustainable conservation lands, to estimate the maximum number of cranes that could inhabit the project region, inside and outside of protected areas.

Our model outputs identify the area of whooping crane habitat required to downlist the whooping crane from endangered to threatened. Currently, the estimated carrying capacity inside protected areas (159,689 acres) is 646 cranes. However, by the year 2100, the estimated carrying capacity inside protected areas is 397 whooping cranes. To meet the downlisting criteria, an additional 225,577 ac (95% CI 182,646 ac, 274,850 ac) is necessary to support 603 more cranes. This amount is predicted to be 56% of the remaining whooping crane habitat (399,569 ac) within the project area by the year 2100. This project establishes a robust, repeatable, and flexible decision support system to identify, compare, and prioritize habitats for the long-term and sustained conservation of whooping cranes wintering along the Texas Gulf Coast through the year 2100. Such information advances landscape conservation design and implementation by identifying the places that will best support wildlife now and into the future.

WCTP 2015 wintering season

Note: This is a summary of U.S. Geological Survey's July 2016 Remote tracking of Aransas-Wood Buffalo Whooping Cranes. Past tracking partnership updates are available here: https://www.platteriverprogram.org/PubsAndData/Pages/ProgramLibrary.aspx *(search under Target Species/Whooping Crane)*

No trapping or marking of additional whooping cranes on the wintering grounds was conducted in 2015 as the research objectives were met the winter of 2013. Sixty-eight whooping cranes were been marked with GPS transmitters during the past five years. During the winter of 2015, 11 birds were still being actively tracked.

GPS-marked cranes provided >6,300 locations during winter 2015, of which over >5,000 were within the boundaries of Aransas National Wildlife Refuge. The first date a marked bird arrived on the Texas coast, or nearby wintering areas, was 27 October 2015, with the last to arrive on 13 December 2015. Average arrival date was 20 November, 2015. Birds used a variety of ecologically distinct areas including coastal salt and brackish marsh communities, agricultural and ranching areas, and inland freshwater wetlands. Less than 1% of locations were outside of Aransas and Calhoun counties. The first bird departed the wintering grounds on 22 March 2016 and the last bird left 4 April 2016. One bird remained at Aransas NWR as of 1 June and is the same bird that did not initiate spring migration until 22 June in 2014.

WCTP 2016 spring migration

Cranes departed wintering sites in Texas between 22 March and 4 April with an average departure date of 30 March. Forty percent of the birds departed by 1 April and 100% departed by 15 April. The first birds arrived at summer use sites on 17 April, and the last marked crane arrived on 28 April. Average arrival date was 21 April. Total time spent migrating between wintering and summering areas during spring 2015 ranged from 18 to 31 days and averaged 23 days. For comparison, we estimated average migration time during spring 2011 at 30 days (21–38 days; n = 11), spring 2012 at 26 days (15–46; n = 25), spring 2013 at 37 days (16–69 days, n = 32), spring 2014 at 28 days (15–47, n = 27) and spring 2015 at 20 days (14-28 days, n = 19).

We monitored 10 birds successfully migrating to summer areas. We documented whooping cranes using 109 stopover locations (geographic areas where cranes remained ≥1 night), which occurred in every state and province in the Great Plains. As in other years, Saskatchewan contained the majority of sites used, and other northern Great Plains states and provinces received relatively similar use. Cranes spent the most time at staging sites in Saskatchewan followed by Kansas and South Dakota. Staging in the remaining states and provinces accounted for only 35% of overall stopover time. The general migration corridor used by whooping cranes during spring 2016 was similar to past migrations and other published reports. Three birds stopped at or near Quivira National Wildlife Refuge in Kansas and one bird stopped along the Central Platte River in Nebraska. Two birds used stopover sites along the Central Platte River in Nebraska. All cranes with active transmitters terminated migration in the traditional summer use area in and around Wood Buffalo National Park. No mortalities were detected during spring migration.

Other ongoing AWBP issues

The Aransas Project v Bryan Shaw et al.

On 10 March 2010, The Aransas Project, a 501-(c)-3 organization, filed suit against the Texas Commission on Environmental Quality (TCEQ) for illegal harm and harassment of whooping cranes in violation of the Endangered Species Act. The Aransas Project alleged that TCEQ was responsible for the take of 23 whooping cranes during the winter of 2008-2009 via their permitting of surface water rights from the San Antonio and Guadalupe river basin. The Aransas Project claims that over-allocation of surface water led to decreased freshwater inflows into San Antonio Bay, leading to increased salinity levels and declines in food and water resources for whooping cranes, causal factors implicated in the “taking” of 23 whooping cranes. A bench trial was held in December 2011 in US District Court, Corpus Christi with Judge Janice Jack presiding. Judge Jack issued a ruling in favor of The Aransas Project on 11 March 2013, which included an order preventing TCEQ from approving or issuing new water permits affecting the Guadalupe or San Antonio Rivers “until the state of Texas provided reasonable assurances that new permits would not result in harm to whooping cranes.” TCEQ was ordered to seek an incidental take permit from US Fish & Wildlife Service. TQEQ appealed the decision and the

Fifth Circuit Court of Appeals in New Orleans granted and emergency stay and agreed to hear oral arguments in August 2013. Appellant briefs were provided to the Fifth Circuit in May 2013. The Fifth Circuit heard oral arguments on August 8, 2013 and issued a 34 page opinion on June 30, 2014 that reversed the earlier District Court's ruling. In summary, the Fifth Circuit found that "The District Court either misunderstood the relevant liability test or misapplied proximate cause when it held the state defendants responsible for remote, attenuated, and fortuitous events following their issuance of water permits." The Aransas project filed a cert with the U.S. Supreme Court on 16 March 2015, asking the justices to uphold the district court and overturn the Fifth Circuit. That request was declined by the Supreme Court on 22 June 2015. The Guadalupe Blanco River Authority and The Aransas Project jointly released a "white paper" entitled "*Water, Habitat, Economy – A Shared Vision of the Future for the Guadalupe River System and San Antonio Bay*" on 16 February 2016 (http://www.gbra.org/news/2016/022401.aspx). This document is intended to address human and environmental issues for the benefit of the Guadalupe River system, including San Antonio Bay and Estuary, and to secure funding for studies related to this endeavor.

The US Fish & Wildlife Service was not a named party in the lawsuit and did not taken a position on the issue, but still stands to assist all interested parties in developing strategies that provide adequate freshwater inflows to sustain coastal wintering habitat in Texas used by endangered whooping cranes.

Whooping Crane wintering habitat acquisitions

On 21 August 2014, a multi-partner coalition including the Texas Parks and Wildlife (TPW) Foundation announced the purchase of the 17,351-acre Powderhorn Ranch along the Texas coast in Calhoun County. The acquisition conserves a spectacular piece of property that is one of the largest remaining tracts of unspoiled coastal prairie in the state. At $37.7 million it is the largest dollar amount ever raised for a conservation land purchase in the state and represents a new partnership model of achieving conservation goals in an era of rapidly rising land prices. Texas Parks & Wildlife is currently in the planning stages for the development of a state park and wildlife management area at Powderhorn Ranch (for more information, see the press release: https://tpwd.texas.gov/newsmedia/releases/?req=20140821a).

The Powderhorn Ranch has had occasional whooping crane use for many years and supports coastal marsh habitat preferred by wintering whooping cranes, primarily along its northern boundary with Powderhorn Lake. This area is included in our secondary aerial survey area (Figure 1) and is expected to provide additional habitat for a growing whooping crane population in future years (see landscape conservation strategy section above).

In September of 2015, the Service awarded $316,800 in non-traditional, recovery land acquisition funding via Section 6 of the Endangered Species Act to the Guadalupe Blanco River Trust for the acquisition of 218 acres of habitat via conservation easement in the Guadalupe

Delta area of Refugio and Calhoun County, Texas. This area is included in our secondary aerial survey area (Figure 1) and is expected to provide additional habitat for a growing whooping crane population in future years (see landscape conservation strategy section above).

In August of 2016, the Coastal Bend Bays and Estuaries program closed on a fee-title acquisition of a 261 acre tract along the Mission River Delta in Refugio County, Texas with partial funding from the Coastal Impact Assistance Program. We have verified wintering whooping crane use of this area via the tracking study and it and appears to be resilient in the face of future sea level rise. This area is also included in our secondary aerial survey area (Figure 1) and is expected to provide additional habitat for a growing whooping crane population in future years (see landscape conservation strategy section above).

Reintroduced flocks

Florida non-migratory flock

Current status and future plans

Reproduction milestones for the Florida project include the first nest established in 1996, the first eggs laid in 1999, the first egg hatched in 2000 and the first chick reared to fledging in 2002. Intensive monitoring of the flock was discontinued in June 2012 by the Florida Fish and Wildlife Commission. Since then, monitoring efforts have been opportunistic and have relied heavily on public observations. At this time, the flock size is estimated at 15 birds, however, only 11 birds (4 males and 7 females) were reported by the public in 2015. At least five wild hatched chicks that fledged from this population still survive on the Florida landscape; the oldest fledged in 2004. One nest was reported during 2016, with twins still alive at the time of this report. A colt from a 2015 nest is a candidate for translocation into the Louisiana flock. The wild-hatched colt was captured in February 2016 for tagging and a health exam, then released back with its parents. An unsuccessful attempt was made to recapture the colt for translocation after a clean bill of health was determined from samples collected during the health exam. We continue to monitor this individual and will attempt a recapture and translocation in the fall of 2016.

The International Whooping Crane Recovery Team will continue to evaluate how eggs and adult whooping cranes from the Florida non-migratory flock may be integrated into other existing recovery efforts.

Louisiana non-migratory flock

For the full report, see attached prepared by Louisiana Department of Wildlife and Fisheries

Executive Summary from full report:

The Whooping Crane reintroduction program in Louisiana reached an important milestone this year with the successful hatching of two chicks. This marked the first time in over 75 years that

Whooping Crane chicks hatched in the wild in Louisiana. As expected, we observed an increase in nesting activity during the 2016 breeding season, with five pairs producing nine nest attempts. The majority of nest attempts in 2016, including the successful nest, occurred on actively farmed crawfish ponds. We remain encouraged at the ability of the cranes to incubate nests to full term despite ongoing farming operations and by the cooperation of the crawfish farmers who grant us access to their properties so we may monitor nests. As a result of the nest locations, we were able to monitor all nest attempts this year for a total of 123 observation hours. Additional monitoring efforts were achieved through the use of trail cameras deployed at several nests that photographed the nest area throughout the day and night.

The maximum size of the Louisiana non-migratory population at the end of the reporting period was 36 adult birds (14 males, 22 females), with 30 birds in Louisiana, 4 in Texas, and 2 long-term missing. We continue to monitor crane locations via remote monitoring devices, which remain a critical tool for tracking a highly mobile population. During this report period, we documented cranes utilizing areas in 16 parishes in Louisiana and 15 counties in Texas. The time spent in any one county/parish is highly variable not only in terms of length of stay but also by cohort affiliation. However, the majority of all locations (~83%) occurred within five parishes – Allen, Avoyelles, Cameron, Jefferson Davis, and Vermilion. Currently, the population has a 48% survival rate (36 out of 75 individuals). Survivorship after one year continues to be high for the 2011-2015 cohorts (70-75% survival). However, we did observe an increase in mortality among older birds during this report period compared to last year, and unfortunately, four mortalities were the result of deliberate shootings.

Public education remains a high priority of the reintroduction program with staff participating in over 40 festivals and public outreach events. A major focus of the education efforts centered on three professional development workshops attended primarily by middle and high school teachers from Louisiana. In addition, outreach efforts expanded to include the use of social media as a method to provide the public with frequent and timely news and information. The Whooping Crane public awareness media plan for 2015-2016, funded by a grant from Chevron, included the use of billboard space provided by Lamar Advertising and radio commercial space purchased through the Louisiana Association of Broadcasters. New markets were targeted with billboards including north Louisiana (Monroe area) and southeast Louisiana (New Orleans area). The billboards were estimated to reach more than 900,000 views per week. Radio ads were broadcast over 5,000 times across Louisiana and into portions of Mississippi.

We committed resources to the construction of a new release pen that was completed in October 2015. The pen was built in a recently refurbished 90 acre unit on the Rockefeller Wildlife Refuge. Except for a change in fencing material the pen is identical to the one successfully used since 2011 at the White Lake Wetlands Conservation Area. The addition of a second release pen will enable us to accommodate multiple cohorts and provide us with more flexibility in managing future releases. We remain steadfast in our goal to establish a self-sustaining, non-migratory Whooping Crane population in Louisiana and will continue to engage other agencies, corporate partners, private landowners, and the general public to succeed in this endeavor.

Eastern migratory population

For the full report, see attached 2015 Condensed Annual Report prepared by Whooping Crane Eastern Partnership

www.bringbackthecranes.org

Overview

The eastern migratory population (EMP) of whooping cranes was established in 2000 with the goal of establishing a migratory, self-sustaining population in Eastern North America. This fits into the overall recovery strategy of working to establish one or more additional whooping crane flocks that are distinct from the AWBP as outlined in the International Whooping Crane Recovery plan (USFWS 2007). More specifically, the initial goal of this reintroduction project was to establish a minimum of 120 adults consisting of at least 30 breeding pairs if only one reintroduced population is successfully established or 100 adults consisting of at least 25 breeding pairs if two or more reintroduced populations are established. The EMP has met the latter goal with the maximum size of the population currently at 102 adult whooping cranes consisting of 27 nesting pairs (May 2016). At the end of 2011, the EMP numbered 104 birds, so the population has remained relatively stable to slightly declining over the past 5 years.

Since the initiation of this project, 250 whooping cranes have been released into the wild, with slightly less than 40% of those surviving to date. Additionally, the project has had 10 wild hatched chicks that have survived to fledging (one in 2006, two in 2010, two in 2012 one in 2013, one in 2014 and three in 2015). Significant milestones in this reintroduction effort include the establishment of two nests established in 2005 and the first fledged chick in 2006. Since 2006, only 9 additional chicks have been fledged in the wild. Overall, survival of released whooping cranes has been acceptable, but successful reproduction, particularly recruitment of wild young, of released cranes has been too low for the flock to be considered self-sustaining.

The Whooping Crane Eastern Partnership (WCEP) was formed at the onset of this project to guide and implement all aspects of the reintroduction effort. Founding members of WCEP include the International Crane Foundation (ICF), Operation Migration Inc., Wisconsin Department of Natural Resources, US Fish & Wildlife Service, the US Geological Survey's Patuxent Wildlife Research Center (PWRC) and National Wildlife Health Center, the National Fish and Wildlife Foundation, the Natural Resources Foundation of Wisconsin and the International Whooping Crane Recovery Team. WCEP has established several project teams that guide various aspects of the reintroduction effort. The teams established within WCEP with a set of specific tasks include the Research & Science Team, Rearing & Release Team, Monitoring & Management Team and Communications & Outreach Team. The team leaders serving on the aforementioned teams all serve on the Operations Team, which provides overall oversight and direction for the reintroduction project. The Operations Team provides regular updates on decisions, needs and operations to the Guidance Team, which assists in making decisions that cannot be settled at a lower level.

Beginning in 2016 WCEP will be releasing captive, parent-reared chicks into the wild, with a focus on releases in the Eastern Rectangle area of Wisconsin. This shift in rearing and release methodology was recommended by the US Fish & Wildlife Service in order to reduce artificiality and hopefully increase long-term reproductive success in this population. 2015 marked the last year that Ultralight-led Migration was used as a release method. WCEP is currently developing plans for how to implement releases of parent-reared chicks.

Major research findings thus far

Reproductive Success experiment

The WCEP research and science team has established research projects aimed at understanding factors that limit the reproductive success of the EMP. Hypotheses investigated include harassment of nesting adult whooping cranes by black flies leading to nest abandonment, nest predation, parental age and experience impacts on nest success and limited crane energy reserves resulting from low wetland productivity. To compare overall reproductive performance, data from the EMP is compared to historical data from the AWBP and Florida non-migratory populations. In order to test the black fly harassment hypothesis, black fly larvae in several targeted river segments in Wisconsin were treated with *Bti* over two years (2011 and 2012). 2009 and 2013 were control, no-treatment years. *Bti* treatments resulted in significantly lower black fly abundance and improved hatching success when compared to control years. Unfortunately, reproductive success, as measured by the number of chicks fledged to fall migration per territory, remained too low to produce a sustainable population in the long term. Other factors, as stated above, that may influence reproductive factors are still under investigation.

In 2014, WCEP began two experiments in order to better understand whooping crane breeding ecology at Necedah NWR. The first experiment, to be conducted through 2016, investigates the effects of forced re-nesting on reproduction. Past data on the EMP (2005-current), comparing initial nest to re-nest attempts, demonstrates that re-nesting whooping crane pairs have higher full-term incubation rates (54% vs. 18%), hatching rates (39% vs. 11%) and fledge rates (21% vs. 0.1%). Thus, salvaging eggs from initial nests may increase the probability of re-nesting by 25% and increase overall reproductive success. Additionally, removing eggs from whooping crane nests prior to the emergence of parasitic insects may synchronize the initiation of second nests with the decline of parasitic insect populations. Results from the forced re-nesting study will focus on 1) determining if egg salvage induced nest failure can increase re-nesting rate 2) the ability to avoid peak black-fly levels with a modified nesting timing and 3) comparing the reproductive success of forced re-nests and first nests of whooping cranes. In 2015, whooping cranes at Necedah NWR initiated 21 first-nests and 10 re-nests. An additional six nests were initiated outside of Necedah NWR. Eight of the 21 first-nests were subject to forced renesting, of these, 100% re-nested. Black fly abundance was monitored throughout the summer 2015 season using artificial nests, and far fewer black flies were detected compared to 2014.

The second experiment at Necedah NWR compares the breeding ecology and nesting success of whooping cranes and sandhill cranes. If black flies are the primary causal factor for low reproductive success in whooping cranes, it is expected that sandhill crane reproductive success at the same location may be low as well. If the study does not find this to be the case, other ecological, biological or behavioral differences may be important factors to consider in future research. In 2015, biologists at Necedah NWR located 27 whooping crane nests and 35 sandhill crane nests. Excluding nests that were part of the forced-renesting management strategy, the apparent nest success of whooping cranes was 38%, slightly less than the 51% apparent nest success of sandhill cranes. Most of whooping crane nest failures were of unknown causes, while sandhill crane nest failures causes were variable. Nesting chronology of whooping cranes and sandhill cranes appeared similar in 2015.

WCEP Science Reboot

In March 2015, an expert elicitation workshop was convened to develop and evaluate hypothesis on low reproductive success in the EMP. In a follow-up meeting, management actions designed to improve reproductive success in the EMP were considered. In the short term (3 years), results indicate that valuable hypotheses related to increasing nest survival included black fly, genetic structure and costume rearing. For chick survival, predation, lack of experience and genetic structure were the most valuable hypotheses. In the longer term (10 year), valuable hypotheses to improve nest survival included genetic structure and black fly. For chick survival, most valuable hypotheses were genetic structure and predator hypothesis.

Education and outreach efforts

The WCEP communication and outreach team (COT) issued several press releases and statements highlighting major reintroduction activities. These events were communicated through a variety of venues including print and television media, internet and social media and directed outreach. For example, 169 stories were shared via Facebook. Presentations were delivered throughout the year to partner organizations, schools, conservation and birding clubs, professional conferences, civic organizations and zoos. A number of regional and national outreach festivals were attended in 2015.

The International Crane Foundation has established a “Keeping Cranes Safe” initiative that focuses on reducing human-caused whooping crane mortality across all populations (https://www.savingcranes.org/road-to-recovery.html). The initial focus of this initiative is in Northern Alabama, near Wheeler NWR, an important overwintering area for the EMP. A number of outreach activities including billboard placement, radio and television announcements, teacher workshops and providing hunter education materials were conducted in 2015.

In 2016, the COT plans to draft a new communications plan for WCEP that will include a set of core messages to help define public perception of WCEP's work. This plan will also include a schedule for press releases, social media posts and other major communications. The COT will also continue to develop a new website based on a WordPress platform in 2015.

Current status and future plans

As of May 2016, there were 102 birds (52 males and 48 females) in the EMP.

2015 Breeding Season

A total of 14 chicks were introduced into the EMP in 2015, six chicks were allocated to Ultralight-led migration release method and eight chicks were allocated to modified Direct Autumn Release (m-DAR). The origin of the reintroduced chicks included both captive breeding facilities (Patuxent and ICF) and eggs collected from wild EMP nests. Twenty-seven pairs of whooping cranes in the EMP initiated 37 nests in the EMP in 2015. These nests produced 24 chicks. Three of these chicks fledged, two of which successfully migrated in the fall of 2015. One male whooping crane paired, nested and hatched a chick with a sandhill crane at Horicon National Wildlife Refuge in 2015. This chick was placed into captivity at the International Crane Foundation.

2015 Fall migration

This year, fall migration began with the first crane documented leaving Wisconsin on 9 October 2015. Of the 85 cranes with known migration dates or ranges, 27% departed the breeding grounds by 15 November and an additional 28% by 30 November. The remaining 45% left Wisconsin by the end of December 2015. The last sighting of a Whooping Crane in Wisconsin was on 27 December at Horicon NWR. One bird (no. 12-09) summered at his normal winter location in Indiana and did not migrate.

2015 Wintering season

Maximum size of the EMP through 31 December 2015 was 100 birds. Estimated distribution at the end of the report period included 38 whooping cranes in Indiana, 16 in Illinois, 5 in Kentucky, 2 in Tennessee, 14 in Alabama, 2 in Georgia, 12 in Florida, 1 in Louisiana and 10 unknown locations. The total for Florida did not include 6 newly released juveniles.

2015 mortalities

Long-term whooping crane survival in the EMP is estimated at 39%. Fourteen mortalities were recorded in 2015, nine in WI, one in Indiana and four in FL. Additionally, 5 long-term missing were removed from population totals.

2015 Parent-rearing results

2015 was the third year of the planned parent-rearing experiment in the EMP. This experiment is designed to test the hypothesis that captive reared whooping crane chicks raised in the most natural setting possible (i.e. raised by adult whooping cranes in captivity rather than a costumed caretaker) will be more fit when released into the wild. This year, three parent-reared chicks were added to the EMP via soft release at Necedah NWR in September 2015. One of the three chicks was predated on 16 October 2016 at Necedah NWR prior to fall migration. One of the three chick released at Necedah moved to Dubuque, Iowa and had to be moved back to Wisconsin to remove it from a potentially hazardous situation near humans. That bird eventually migrated south to Louisiana in the fall of 2015 and back to Wisconsin in the spring of 2016. The final 2015 parent-reared chicks successfully completed fall migration and wintered at Wheeler NWR in Alabama with other whooping cranes.

At the start of 2015, there were five parent-reared whooping cranes in the EMP. All five whooping cranes wintered in areas with other whooping cranes or with sandhill cranes and all 5 successfully returned to Wisconsin in the spring of 2015. One of the five parent-reared whooping cranes died in Wisconsin in September 2015, with predation a likely cause.

Captive population

**Note: This section was prepared by Bill Brooks, USFWS SE Region*

2015 breeding season overview

Captive Breeding Facility updates

Patuxent Wildlife Research Center held 78 whooping cranes (39 males and 39 females) in 2015, including 28 behavioral pairs. Nineteen of those pairs have laid eggs in the past, but only 14 pairs were productive in 2015. Patuxent Whoopers produced 43 eggs, with 13 of them being fertile. Although production improved from 2014, we had low fertility but were surprised to see 2 pairs that had not laid in several years lay and we had 3 new productive pairs with one pair laying at 4 years of age. These newly productive pairs all eventually incubated and successfully raised sandhill chicks. In September the first phase of our water and sewer upgrade began. We implemented some changes from our previous year's discussions on lack of production including changes in diets to include animal based protein and center pole extensions to increase netting height to increase natural fertility. We reduced AI to 2 times a week to reduce workload due to reduction in staffing and to reduce handling and disturbance to pairs. Supplemented by eggs from other sources, Patuxent hatched and reared 20 whooping crane chicks. In 2015, six chicks were sent to White River Marsh, WI in July for the ultra-light led migration release. Four chicks parent-reared by captive adults were shipped to Necedah NWR in WI in September for the Parent Rearing Project. Fourteen chicks were sent to White Lake, LA in December for the LA non-migratory reintroduction.   Windway Capital donated flights for all chick transfers. Five chicks died during rearing and 1 was held back from release due to possible scoliosis.

SUMMARY STATISTICS
Number of Laying Females: 17
Earliest Lay Date: 4 April
Latest Lay Date: 22 May
Eggs Laid: 43
Eggs Broken: 5
Fertile Eggs: 13 of 43 (30 %)
Fertile Eggs Sent to Other Institutions: 0
PWRC Eggs Hatched: 10 of 13 (77%)
Fertile Eggs Received from Other Institutions: 24 (3 ICF, 7 CZ, 14 EMP)
Eggs Hatched from Other Institutions: 12 of 24 (50%)
Total Chicks Hatched (PWRC + Other): 25
Chicks received from other source: 0
Chicks sent to Wisconsin for ultra light migration project: 6 (2 PWRC, 1CZ, 3 EMP)
Chicks sent to Wisconsin for parent-rearing release: 3 (1 CZ, 2 PWRC)
Chicks sent for Louisiana Release: 11(5 PWRC, 2 CZ , 4 EMP)
Holdback chicks: 1 health related possible scoliosis

The International Crane Foundation (ICF) managed 35 adult Whooping Cranes within our captive flock (16 males and 19 females) which included 11 socialized pairs. One adult male of a non-reproductive pair died in early January 2015. Nine of the nineteen females, including 2 females who hadn't produced eggs in several years and whose reproductive status was in question, produced a total of 37 eggs. Fourteen of these eggs were fertile, 17 infertile, and 6 were broken resulting in an overall known fertility rate of 45.2%. Of the 14 fertile eggs, three eggs resulted in dead embryos. Three fertile ICF produced eggs were transferred to PWRC where one hatched. Ten of the ICF produced eggs hatched at ICF and isolation reared. Two of the 8 chicks were designated as genetic holdbacks for the captive flock. The remaining 8 chicks were isolation reared at ICF's chick rearing facility as candidates for the modified Direct Autumn Release (mDAR) program. On 8 September 2015, all 8 chicks were transported to Horicon National Wildlife Refuge and on 3 November 2015 all were released into the Eastern Migratory Population using the mDAR technique.

The Calgary Zoo (CZ) managed 22 whooping cranes (10 males and 12 females) in 2015. This included 6 socialized pairs, 3 new pairs (first breeding season together), and 2 young females housed together on display at the zoo. Two of the new pairs demonstrated good breeding behavior, but failed to produce any eggs. The other new pair seemed highly compatible, and may have laid their first egg towards the end of breeding season (egg membrane only found). One pair that hasn't laid since 2010 continues to adopt and incubate eggs. This pair was given a sandhill chick to hatch out, in hopes of promoting laying again in the future, or at least promote continued foster incubation. Sadly, two females of breeding age died during the 2016 breeding season; one from a long-term infection that was well hidden, and the other was essentially egg bound, possibly related to a prior infection several years before. Three of the six socialized pairs produced 15 eggs total, of which 9 were fertile, and 6 were infertile. 1 fertile egg disappeared during late incubation before shipment, and one was late dead embryo. The remaining 7 fertile eggs were transferred to Patuxent, where 4 successfully hatched and survived at least the first week (1PR, 1UL, 2LA). No whooping crane chicks were hatched out at The Calgary Zoo in 2015.

The Freeport-McMoran Audubon Species Survival Center (formerly referred to as ACRES) managed 6 male and 5 female whooping cranes including a display pair at Audubon Zoo. This flock produced a total of 6 eggs in 2015; however none of the eggs were fertile. Successful reproduction with this flock is heavily dependent on artificial insemination. Four birds continue to have a chronic dermatitis issue. FMASSC received two abandoned eggs to incubate from the wild Louisiana population. One egg was fertile, but had died an early term death, while the second egg was too decayed to determine fertility.

The San Antonio Zoo is currently holding 3 male and 2 female whooping cranes. They have one post reproductive pair (studbook #'s 1175 & #1188). No egg production from this pair in the past few years. A Second pairing consists of younger birds of 12 years of age (studbook #1814 & #1813). This pair is not bonded and has shown no interest in breeding and no bonding behaviors noted from this pair. No eggs were produced from this pairing in 2015.

The remaining single bird (studbook #1772) is healthy and in great condition and waiting for recommendations on shipping or pairing of this male.

2015 Captive Population

	Male	Female	Total	Breeding Pairs
Patuxent Wildlife Research Center (PWRC)	39	39	78	28
International Crane Foundation (ICF)	16	19	36	11
Devonian Wildlife Conservation Center (CZ)	10	8	18	8
San Antonio Zoo (SAZ)	3	2	5	1
Audubon Center for Research on Endangered Species (ACRES)	6	5	11	2
Calgary Zoo	10	12	22	9
Homosassa Springs Wildlife State Park	1	1	2	0
Lowry Park Zoo	1	1	2	0
Jacksonville Zoo and Gardens	1	1	2	0
Milwaukee County Zoo	1	1	2	0
National Zoological Park	1	1	2	0
Audubon Zoo (New Orleans)	1	1	2	0
Sylvan Heights Waterfowl Park	1	0	1	0
Subtotal in Captivity	91	91	183	59

Acknowledgments

No one organization or individual is capable of providing all the necessary elements to recover the magnificent whooping crane. We see this recovery effort not only successful due to the great increase in the whooping crane population over the last 60 + years, but also the great deal of cooperation and collaboration that takes place amongst a wide variety of private, state and federal organizations alongside a slew of highly dedicated individuals. If not for everyone's continued effort to assist in the recovery of this species, it is likely that the species would have been extinct long ago. Our hope, as the biologists tasked by our respective agencies with the coordination of the recovery of this revered species, is that we can all continue to work together to ensure that the species is able to be removed from the endangered species list as recently occurred for the US national bird, the bald eagle. As the population continues to grow, a greater portion of the public will have opportunities to view and appreciate the majesty of the species. We want to thank all the organizations and individuals that contributed to this report along with the wide range of recovery efforts being undertaken.

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APPENDICES

Recovery Planning for the Whooping Crane

Workshop 1:
Population Viability Analysis

December 1 – 3, 2015
Calgary, AB Canada

COASTAL BEND BAYS & ESTUARIES PROGRAM

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IUCN
Species Survival Commission
CONSERVATION BREEDING SPECIALIST GROUP

Inside front cover

Recovery Planning for the Whooping Crane
Workshop I: Population Viability Analysis

1 – 3 December 2015

Workshop Report

Workshop Organization:
Whooping Crane Recovery Team
Canadian Wildlife Service
United States Fish and Wildlife Service

Workshop Design and Facilitation:
IUCN / SSC Conservation Breeding Specialist Group

Workshop Support:
Coastal Bend Bays & Estuaries Program
Calgary Zoo

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A contribution of the IUCN/SSC Conservation Breeding Specialist Group, in collaboration with the Whooping Crane International Recovery Team, the United States Fish and Wildlife Service, the Canadian Wildlife Service, and workshop participants.

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IUCN encourage meetings, workshops and other forums for the consideration and analysis of issues related to conservation, and believe that reports of these meetings are most useful when broadly disseminated. The opinions and recommendations expressed in this report reflect the issues discussed and ideas expressed by the participants in the workshop and do not necessarily reflect the formal policies IUCN, its Commissions, its Secretariat or its members.

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Recovery Planning for the Whooping Crane
Workshop I: Population Viability Analysis

1 – 3 December 2015

Draft Workshop Report

Table of Contents

Executive Summary 1

Introduction 3

- Current Whooping Crane Recovery Criteria 5
- Questions for PVA 6
- Can the PVA Help Us Evaluate and Update Our Down/Delisting Criteria for Whooping Cranes? 8

An Examination of Risk Tolerance as a Foundation for Conducting and Interpreting the PVA 10

Whooping Crane PVA Model Development 11

- Objective 11
- Model Development and Timeline 11
- General Model Description 11
- Model Inputs 13
- Summary 19

A Preliminary Exploration of Whooping Crane Management Alternatives 23

- Proposed Management Alternative Components 23
- Proposed Management Alternatives 27
  - Aransas-Wood Buffalo: “Crowd-sourcing for Cranes” 27
  - Eastern migratory: “Last Dirty Bird Costume & Colony Collapse Syndrome” 28
  - Louisiana non-migratory: “Flood Louisiana” 29
  - Captive: “Au Naturel” or “Building a Better Bird” 29

Literature Cited 31

Appendices 32

- Appendix I: Workshop Agenda 32
- Appendix II: Workshop Participants 34

Recovery Planning for the Whooping Crane Workshop I: Population Viability Analysis

Executive Summary

The Whooping Crane (*Grus americana*) was officially declared Endangered in North America in 1967, and the original Recovery Plan was completed in 1980 with the last revision occurring in 2007. Recovery planning activities mandated by the Endangered Species Act (ESA; USA) and the Species at Risk Act (SARA; Canada) are carried out by the U.S. Fish and Wildlife Service (USFWS) and the Canadian Wildlife Service (CWS), and these agencies are advised by an International Recovery Team (IRT) established under an international agreement governing co-operation among and signed by both countries. As it has already been several years since the last International Recovery Plan (IRP) was completed, the IRT wishes to update the Plan to incorporate new information and techniques, with the overall goal of downlisting and eventually fully recovering the species using efficient and effective strategies.

To initiate and inform this effort, the IRT is collaborating with the Conservation Breeding Specialist Group (CBSG), part of the Species Survival Commission (SSC) of the International Union for Conservation of Nature (IUCN), to hold population viability analysis (PVA) and population and habitat viability assessment (PHVA) workshops with members of the IRT and other invited specialists to produce information to be included in an upcoming version of the International Recovery Plan. The PVA workshop was held 1 – 3 December 2015 in Calgary, Alberta Canada and was generously hosted by the Calgary Zoo. Twenty-one participants with expertise in Whooping Crane biology and management and endangered species conservation planning attended the meeting, which was facilitated by CBSG staff.

The meeting began with a series of presentations on the current status of Whooping Crane conservation activities across the species' current range, and on the more broad issues of endangered species conservation planning and the use of quantitative risk analysis to inform those efforts. The group discussed evaluating individual risk tolerance as a means to clarify the concept of population viability and how it should be used to guide recovery planning efforts. Following these discussions, the bulk of the meeting was then devoted to working on the population demographic simulation model that is the center of the PVA. This model, using the software package *Vortex*, is a detailed simulation of the Whooping Crane metapopulation comprised at present of as many as five distinct populations: Aransas-Wood Buffalo, Eastern migratory, captive (SSP, Species Survival Plan), Louisiana non-migratory, and (if appropriate to include) Florida non-migratory. Detailed information on the demographics, genetics, and management structures for each of these populations was discussed at length both at this meeting and in a series of "virtual meetings" (conference calls) before the meeting. This information becomes input to the model, and a series of scenarios is then constructed that represent a variety of current or future population management alternatives. Workshop participants created draft management alternatives targeting selected metapopulation components that are to be assessed using the PVA modeling tool. These scenarios are designed to predict the long-term metapopulation demographic and genetic vigor – i.e., the viability – through proposed mechanisms of managed connectivity across selected metapopulation components.

Significant progress was made at this workshop on finalizing the structure and functionality of the *Vortex* Whooping Crane demographic model. Additional discussions on management scenario structure are currently ongoing as an important step towards completing the PVA in preparation for the November/December 2016 Population and Habitat Viability Assessment (PHVA) workshop. PHVA workshop participants will discuss the results of the PVA in the broader context of recovery planning, and will use the information to identify recovery actions that improve the prospects for long-term species viability in both the United States and Canada.

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Introduction

Whooping Cranes (*Grus americana*) currently exist in three free-ranging populations (Figure 1):

- The Aransas-Wood Buffalo (AWB) population summers in and around Wood Buffalo National Park in the Northwest Territories and northern Alberta, Canada and winters in and around Aransas National Wildlife Refuge in coastal Texas, USA;
- The Eastern Migratory population, established in 2001, summers in central Wisconsin and winters in the southeastern United States;
- The Louisiana non-migratory population, which was established in 2011in southwestern Louisiana.

Figure 1. Current distribution of the Whooping Crane, *Grus americana*. Remnant non-migratory flock in Florida not shown. Map graphic courtesy of International Crane Foundation.

A non-migratory flock in central Florida was re-introduced in the 1990's and early 2000's, but this effort was abandoned for many reasons including poor reproductive success and loss of wetland habitat. A few free ranging cranes remain in this area. In addition to these free-ranging populations, approximately 160 captive birds are held at captive breeding centers in the USA and Canada (e.g., International Crane Foundation in Wisconsin, the Patuxent Wildlife Research Center in Maryland, Calgary Zoo in Canada, San Antonio Zoo in Texas, and the Audubon Center for Research of Endangered Species in Louisiana).

The species was officially declared Endangered in 1967, and the original Recovery Plan was completed in 1980 with the last revision occurring in 2007. Recovery planning activities mandated by the Endangered Species Act (ESA; USA) and the Species at Risk Act (SARA; Canada) are carried out by the US Fish and Wildlife Service (USFWS) and the Canadian Wildlife Service (CWS), and these agencies are advised by an International Whooping Crane Recovery Team (IRT) established under an MOU governing co-operation among and signed by both countries.

As it has already been several years since the last International Recovery Plan (IRP) was completed, the IRT wishes to update the IRP to incorporate new information and techniques, with the overall goal of downlisting and eventually fully recovering the whooping crane using efficient and effective strategies.

Anticipated modifications to the IRP include:

- Explicit incorporation of the Eastern Migratory and Louisiana Non-migratory populations into the species recovery planning process (and to place in the proper context those references to earlier attempts to establish populations in the Rocky Mountains and in Florida);
  - Requirements: model anticipated population dynamics and long-term sustainability of current reintroduced populations to assist in decision making about their future;
  - Consider alternative objectives and roles for reintroduced populations if long-term sustainability of reintroduced populations is determined to not be a viable objective.
- Development of more rigorous species recovery criteria, using population viability analysis (PVA) to inform recovery planning by providing a defensible method of evaluating the predicted outcomes of alternative management scenarios;
  - Requirements: revise and clarify current downlisting recovery criteria and develop delisting criteria.
- Identification of the optimal role(s) for the current captive population (e.g., maintenance of genetic variation, and/or production of birds for re-introduction projects);
  - Requirements: identification of a timeline or set of demographic criteria beyond which captive populations may no longer be needed for recovery purposes, and/or minimum numbers of birds and populations for maintenance of a genetically viable legacy population; and
- Specification of options that may be considered by USFWS and CWS for recovery actions that should be taken to maximize probability of recovery of the species across its range.
  - Requirements: model and examine expected population changes under multiple scenarios involving AWBP egg collection or other management options.

To initiate and inform this effort, the IRT is collaborating with the Conservation Breeding Specialist Group (CBSG), part of the Species Survival Commission (SSC) of the International Union for Conservation of Nature (IUCN), to hold population viability analysis (PVA) and population and habitat viability assessment (PHVA) workshops with members of the IRT, and other invited specialists, to produce information to be included in an upcoming version of the International Whooping Crane Recovery Plan.

CBSG's PVA and PHVA workshops are organized to bring together a wide range (but perhaps not the full set) of stakeholders who share a strong interest in the conservation and management (or the consequence of such management) of a species in its habitat. One goal in all workshops is to reach a common understanding of the scientific knowledge available and its possible application to the decision-making process and to identify needed management actions. Through their experience in numerous workshop projects in more than 70 countries worldwide, CBSG staff has found that a workshop process driven by practical decision-making – replete with risk characterization methods, stochastic simulation modeling, management scenario testing, and deliberation among stakeholders – can be a powerful tool for extracting, assembling, and exploring information. This workshop process encourages the development of a shared understanding across a broad spectrum of training and expertise. These tools also support the creation of working agreements and instilling local ownership of the conservation problems at hand and the management decisions and actions required to mitigate those problems. As participants work as a group to appreciate the complexity of the conservation problems at hand, they take ownership of the process and of the ultimate management recommendations that emerge. This is essential if the management recommendations generated by the workshops are to succeed.

Current Whooping Crane Recovery Criteria

To provide the proper context for discussing the PVA as a tool for assisting in the revision of species recovery criteria, the current downlisting criteria as laid out in the 2007 Recovery Plan (Third Edition) are given below. Note that this Plan does not define delisting criteria, due in large part to the recognition that considerable time will be required to achieve the downlisting goals.

Objective 1 – Establish and maintain self-sustaining populations of Whooping Cranes in the wild that are genetically stable and resilient to stochastic environmental events.

Criterion 1 – Maintain a minimum of 40 productive pairs in the AWBP for at least 10 years, while managing for continued increase of the population. Establish a minimum of 25 productive pairs in self-sustaining populations at each of two other discrete locations.

A productive pair is defined as a pair that nests regularly and has fledged offspring. The two additional populations may be migratory or non-migratory. Multiple populations provide protection against stochastic, catastrophic events in nature. A single wild population remains vulnerable to extinction during singular, or a series of, adverse events, regardless of its size.

Population targets are 160 in the AWBP, and 100 each in the Florida non-migratory population and the eastern migratory population. These targets are consistent with a population viability assessment of what is needed to maintain genetic variability for the population. All three populations must be self-sustaining for a decade at the designated levels before downlisting could occur. A self-sustaining population is defined as a stable or growing population that is not supplemented with any additional reintroductions from captivity.

The AWBP has been maintained at above 40 productive pairs since 1992; however, additional populations are not yet self-sustaining. An alternative criterion may be applied for downlisting in the event that attempts to establish additional self-sustaining populations do not succeed.

Alternative Criterion 1A – If only one additional wild self-sustaining population is reestablished, then the AWBP must reach 400 individuals (i.e. 100 productive pairs), and the new population must remain above 120 individuals (i.e. 30 productive pairs). Both populations must be self-sustaining for a decade at the designated levels before downlisting could occur. This alternative is based on the principle that with the reestablishment of only one additional population separate from the AWBP, then crane numbers must be higher in both populations than if there are three distinct populations.

Alternative Criterion 1B - If establishment of second and third wild self-sustaining populations is not successful, then the AWBP must be self-sustaining and remain above 1,000 individuals (i.e. 250 productive pairs) for downlisting to occur. The *Memorandum of Understanding on Conservation of Whooping Cranes*, approved by Canadian and U.S. federal officials, recognizes a goal of 1,000 individuals in the AWBP population. This higher number ensures a better chance for survival of the AWBP in the event of a catastrophic event within its extremely limited range. The target of 1,000 is reasonable for downlisting given the historical growth of the AWBP and theoretical considerations of minimum population viability. To ensure sufficient genetic variability, the AWBP must increase to the level where the creation of new alleles through genetic mutation will offset the loss of genetic diversity. After reaching the goal of 250 pairs, the population should gain genetic variation faster than the population loses genetic material.

Objective 2 – Maintain a genetically stable captive population to ensure against extinction of the species.

Criterion 2 - Maintain 153 whooping cranes in captivity (21 productive pairs). Genetic analysis suggests that 90% of the genetic material of the species can be maintained for 100 years at this population size (Jones and Lacy 2003). To achieve this, this Plan recommends having 50 captive breeder pairs of whooping cranes by 2010, including 15 pairs at PWRC, 12 at ICF, 10 at CZ, 10 at SSC, and 3 at SAZ. A breeder pair (as differentiated from a productive pair) is defined as a pair that breeds or is intended to breed in the future. Production from CZ, ICF, PWRC, SAZ, and SSC will be the principal source of birds for release to the wild for reintroduced populations. However, sources of release birds should be based on the optimal genetic mix to ensure long-term population viability.

Questions for PVA

In preparation for the workshop, members of the IRT were asked to provide questions that they hoped could be addressed through the population viability analysis framework. While not exhaustive, the list below is valuable for helping to guide the decisions on model structure and function that will result in a more useful risk assessment tool. These questions are summarized below.

- How many populations of Whooping Cranes are needed over how large of a geographic range with what size populations?

  We will need a separate downlisting and delisting criteria, with each including targets defined by the above at a minimum. As an example, consider something like this:

  Criterion 1: At least X geographically distinct whooping crane populations that have a population of at least Y individuals for at least Z years. Annual recruitment of new individuals into each population needs to be a minimum of ??? to maintain or increase population size. (PVA would be used to determine the criteria that would reduce extinction risk to some acceptable level, agreed upon by IRT members, over a specified time period).

  Questions that we will need to answer to formulate Criteria 1 above:

  - How many separate populations covering what % of historic habitat are enough to reasonably reduce the threat of catastrophic loss associated with small, geographically isolated populations?
  - Could the above be accomplished with a single population if occupying a large enough geographic area? (i.e. wintering across X square miles on the Gulf Coast)

  - Does a migratory population increase or decrease risk of catastrophic loss given a larger geographic distribution?
  - How can captive populations (either field-based or zoo-based) be best utilized to meet and maintain the goal of reducing risk from catastrophes? Interestingly, the black-footed ferret plan actually has separate captive population criteria. What is the best strategy for managing captive populations? (i.e. managing for genetic diversity or maximizing #s for reintroduction)
  - At what point do additional populations no longer add benefit per question #1?
  - How can egg harvest/relocation or live bird translocation assist in achieving criteria? How does this impact donor populations?
  - How might predator management on the breeding grounds assist recovery?

- What does "geographically distinct population" mean from demographic/genetic perspectives? How important is this designation from the perspective of recovery?

- Will a permanent self-sustaining captive population really be needed, or is there now or in the future sufficient opportunity to harvest fertile second eggs to augment and (re)create the captive population that is needed?

  If there is to be a permanent captive population,

  - How many adults/pairs should be in the population?
  - Should this be one population (geographically or by genetic material exchange) or several (and if so, how many)?
  - What should be the rate of reproduction in this population? Should it be for replacement? For serving as a source for release? For other roles?

Given current demographic/genetic profiles of each current reintroduced population (are they pretty similar?):

  - Are the stated numerical goals for total birds/pairs still reasonable?
  - After meeting those goals, assuming a numerically self-sustaining level of reproduction, will any additional augmentation from the captive population or other wild populations be useful?
  - For each population, what are the pros/cons of using larger release cohorts over a shorter period of time, compared with the use of smaller release cohorts for a longer period of time?

- If recovery criteria are chosen that include two (or more) reintroduced populations, and if the EMP population is not successful, what are the pros/cons of choosing to establish another non-migratory population on the Gulf Coast?

- What are the pros/cons of harvesting second eggs from WBNP nests for use in reintroduction projects?

- What, if any, demographic or genetic impact would there be of harvesting second eggs on the AWB population?

- What would be the result of the numerical input for the reintroduction population(s)? What, if any, demographic or genetic advantage would there be for the reintroductions?

- What value, if any, is there in incorporating birds and eggs from the FL reintroduced population in the captive population or the current reintroduction projects?

- Should expansion of the breeding and wintering ranges of the WBNP population be attempted by soft releases of captive-reared cranes on the former breeding areas of Whooping Cranes in southern Saskatchewan that are along the migration route and autumn staging areas of the WBNP cranes?

Released birds would be expected to join WBNP cranes or Sandhill Cranes to migrate to the south, and to return to release areas to breed. This would provide opportunities to establish some new wintering sites (a positive outcome considering the threats at ANWR), and establish breeding south of the tar sands areas south of WBNP (another positive).

- How would each of the Recovery Criteria under Recovery Objective 1 influence needs for egg collection?

  We are interested in understanding whether pursuit of Criteria 1, 1A or 1B, under Objective 1 of the Recovery Plan, would imply different needs for collection of wild eggs.

Can the PVA Help Us Evaluate and Update Our Down/Delisting Criteria for Whooping Cranes?

Mark Bidwell, Canadian Wildlife Service

Reviewing and possibly updating the criteria used to assess the status of Whooping Cranes (i.e., down/delisting criteria) was one of our initial motivations for conducting a new PVA. Is this something the PVA can help us with? Canada and the US adopt different approaches to defining criteria for the assessment of endangered species. While the US gives recovery leads and teams more flexibility to define criteria on a species-specific basis, Canada applies the same set of criteria (details here http://goo.gl/YarJOD) to all species. To designate a species as Endangered or Threatened, at least one of five criteria must be met. The criteria are quantitative and detailed (see above link), but can be summarized as follows:

Criterion A: Decline in total number of mature individuals

Criterion B: Small distribution range; and decline or fluctuation in range

Criterion C: Small and declining number of mature individuals

Criterion D: Very small or restricted total Canadian population

Criterion E : Quantitative analyses, e.g. PVA

So, it's not necessary to define criteria for assessment of the species in Canada, i.e., under SARA, because the above criteria will be used (i.e., not those in the international recovery plan, IRP). Criteria defined by both countries in the IRP would be used to assess status in the USA, under the ESA, and could result in a different assessment than one carried out in Canada. This is probably unavoidable to some degree, because a Canadian assessment will not consider US reintroduced populations (they are not part of the designatable unit under jurisdiction of Canada), so the species is perceived to be a greater risk when only the AWB population is considered vs. when AWB plus other populations are considered. The flip side of this is that an assessment under the ESA is akin to a continental (and, for whooping cranes, a species-wide) assessment, because no population exists solely outside of the US.

The latest application of the Canadian criteria to whooping cranes in Canada was conducted in 2010 (report here http://goo.gl/ip6USL) and retained Endangered status on the basis of meeting criteria B and D (summary below, details at the above link).

Criterion B was met because the extent of occurrence in Canada is small, the species occurs at only one location (Wood Buffalo) and quality of wintering habitat is in decline (this may be debatable; the report cited observed, inferred and projected decline in the quality of wintering habitat owing to a combination of droughts and a series of anthropogenic threats such as development and erosion; it did not consider potential impacts of sea level rise);

Criterion D was met because the population has fewer than 250 mature individuals;

Criteria A and C were not met because the population is not in decline and Criterion E was not met because extinction risk was low (1% in 100 years).

Unless the AWB begins to decline rapidly, which is not likely given rapid growth in recent years, it seems likely that future assessments will focus on the same criteria (B, D). Therefore, to recover the species in Canada, recovery planning could focus on 3 strategies:

- Increase each of the breeding and wintering extents of occurrence of the AWB (to >5000 km^2 ~ 1900 mi^2 to downlist, and to >20,000 km^2 ~ 7700 mi^2 to delist). The cranes are doing this to some extent by expanding their range outside of WBNP and ANWR, but there is not likely enough habitat in either location (much less both) to support extents of occurrence this large (and especially not the larger threshold). So this is not likely a viable strategy;
- Increase the number of locations where whooping cranes occur in Canada (to > 5 locations to downlist, and to >10 locations to delist). Although reintroduction has been considered in Canada and may be considered again, it is not likely that Canada will have >5, much less >10 populations, so this strategy is not likely viable;
- Halt the continuing decline in wintering habitat quality; although not directly manageable by Canada, this is likely one of our best avenues for recovery (see note below);
- Increase the number of AWB individuals (to >250 adults to downlist, and to >1000 adults to delist). At current annual growth rates, recent modeling suggests these numbers may be reached in the next few decades; it is possible that management (e.g., egg collection and subsequent augmentation of AWB) could increase growth rates and reduce time to recovery/. These kinds of questions will likely be addressed by our PVA and other modeling efforts.

Note: Given that neither the breeding or wintering extent of occurrence of the AWB is ever likely to exceed 5000 km^2 ~ 1900 mi^2 and that Canada is unlikely to ever see >5 populations (i.e. Canadian downlisting thresholds), then the only apparent ways to down/delist the species is to halt the decline in wintering habitat and increase the number of AWB individuals (both must occur to down/delist). This is because the Canadian criteria allow for down/delisting even with a small extent of occurrence and one population, so long as there is not a continuing decline in wintering habitat quality and the AWB reaches 250 adults to downlist, and 1000 adults to delist.

Some of the down/delisting criteria in Canada and in the IRP appear to echo each other, suggesting that authors of the IRP criteria may have considered the Canadian criteria. For example, the IRP currently sets a target of 1000 AWB individuals if no other population is successful (and this target is repeated in the international MOU) while the Canadian criteria (for any species) require >1000 adults for delisting. But the units are different (i.e., adults ≠ individuals) so it’s not clear if or how the IRP criteria considered the Canadian criteria.

As noted above, disagreement in assessment is possible inherently (i.e., because SARA and the ESA would consider different designatable units) but if we’re going to update the IRP criteria, then we should consider making them consistent with the criteria that will be used in Canada, if we think they are biologically meaningful and attainable for Whooping Cranes.

Can the PVA help us rationalize these differences in the assessment criteria? One possibility may be to examine how extinction risk varies under different sets of down/delisting criteria (e.g., current IRP criteria vs. Canadian criteria if applied continentally).

An Examination of Risk Tolerance as a Foundation for Conducting and Interpreting the PVA

Recent contributions to the conservation biology literature (e.g., Doak et al. 2015) point out the importance of defining the concept of acceptable level of extinction risk as an element of a robust species recovery plan. This is necessary since the U.S. Endangered Species Act does not explicitly define this concept. The process of defining an acceptable level of risk is largely normative, requiring a structured method for eliciting individual perspectives on acceptability and merging this body of information into a coherent picture of a group's definition of tolerance to risk. This measure of tolerance then underpins the derivation of recovery criteria that confer an acceptably low level of extinction risk, as determined by the population viability analysis.

Sarah Converse (U.S. Geological Survey) led the body of workshop participants through an elicitation process designed to generate a group measure of tolerance for Whooping Crane extinction risk across the species' range. Statistical analysis of the elicitation results (detailed results available upon request) revealed that Recovery Team members strongly converged on 50-100 years as a reasonable time horizon to consider extinction risk. The actual threshold values of risk across that time horizon that would equate with Endangered or Threatened status – values that could be associated with downlisting and delisting activities – are not elicited through this particular exercise; additional normative discussions would be required to determine these thresholds through consensus.

The work of Doak et al. (2015) can be helpful in this regard. A review of ESA recovery plans published between 2009 and 2013 revealed that 100 years is a common time horizon to consider for both Endangered and Threatened status, with risk thresholds typically in the range of 5 – 10%. However, there is considerable variability in the time horizon chosen in these plans, with a substantial subset of plans employing a 20-year horizon to define the threshold between Endangered and Threatened. Interestingly, the results from the recovery plan analysis showed considerable overlap with the risk thresholds used by the International Union for Conservation of Nature (IUCN) in making status determinations for their Red List of Threatened Species, although the risk thresholds used in recovery plans tended to be more restrictive (i.e., lower risk) than the IUCN standards.

Whooping Crane PVA Model Development

Model Team led by Kathy Traylor-Holzer, IUCN/SSC Conservation Breeding Specialist Group

The following report is a summary of the development of the *VORTEX* model for whooping cranes prior to and during the December 2015 PVA workshop, including recommendations resulting from workshop discussions for model revision and future development.

Objective

The objective of this modeling effort is to develop a population simulation model to be used to conduct a Population Viability Analysis (PVA) for the whooping crane (*Grus americana*), incorporating all existing wild and captive populations of this species into a single meta-population. A PVA using this model will provide long-term viability projections for each population and for the species meta-population under current threat and management conditions. These projections also can be used to estimate the probability of reaching program goals under current management. Additional uses of this model include: 1) to evaluate the impact of alternative management strategies; 2) to inform discussions of revising program goals; 3) to provide an estimate of the type and degree of management needed to reach program goals; 4) to identify the role of various populations within the management of this meta-population (particularly the role of the captive population); and 5) to identify criteria or thresholds for action. Example of specific questions to be addressed by the model can be found in the *Introduction* section of this workshop report.

Model Development and Timeline

Discussion of model parameters and structure took place through a series of conference calls from July to November 2015 with many of the wildlife managers and content experts for population data for the various whooping crane populations. These calls focused on model structure, input values and data resources. Numerous reports and publications, as well as data tables in some cases, were provided along with the studbook database for the captive population (i.e., historical database that includes sex, pedigree, and life event information for individual birds). This enabled the development of a preliminary meta-population model that was the focus of further discussion and refinement at the PVA workshop on 1-3 December in Calgary. Many of the conference call participants also attended the PVA workshop.

The base meta-population model (including population-specific components) will be finalized and results reported in late summer of 2016. A preliminary discussion of alternative management model scenarios was initiated by population-specific working groups at the 2015 PVA workshop (see *Preliminary Exploration of Whooping Crane Management Alternatives* section of this report). These suggestions will provide a basis for further (electronic) discussions in late summer of 2016. Management scenario modeling will be conducted in fall 2016. The model and PVA results will support discussions surrounding recovery goals and management discussions at the PHVA workshop in late 2016.

General Model Description

***VORTEX* Description**

A stochastic, individual-based population model was developed for the whooping crane using the *VORTEX* 10.1.5 (Lacy and Pollak 2015) software program. *VORTEX* is a Monte Carlo simulation of the effects of deterministic forces as well as demographic, environmental, and genetic stochastic events on wild or captive small populations. *VORTEX* models population dynamics as discrete sequential events that occur according to defined probabilities. The program begins by either creating individuals to form the starting population or importing individuals from a studbook database and then stepping through life cycle events (e.g., births, deaths, dispersal, catastrophic events), typically on an annual basis. Events such as breeding success, clutch size, sex at birth, and survival are determined based upon designated probabilities that incorporate both demographic stochasticity and annual environmental variation. Consequently, each run (iteration) of the model gives a different result. By running the model hundreds of times, it is possible to examine the mean and range of probable outcomes.

Relevant characteristics or options available in the *VORTEX 10* modeling software include:

- Individual age-based model incorporating both sexes and pedigree relationships
- Incorporates demographic stochasticity and environmental variation directly
- Can incorporate parameter uncertainty
- Can incorporate cyclical or random events, including catastrophes
- Can include multiple populations (isolated or connected)
- Can incorporate different demographic rates and characteristic for different populations
- Can apply different demographic rates based on individual characteristics (e.g., rearing type)
- Can incorporate density-dependent impacts
- Can use studbook data to establish the initial population
- Can set initial kinships and/or inbreeding levels and/or starting allelic frequencies
- Can include various types of population management (e.g., genetic management, harvest, reinforcement, translocation)
- Can simulate different future conditions (e.g., declining carrying capacity over time)

Most, if not all, of these features will be incorporated in the whooping crane PVA model, dependent upon expert opinion and desired alternate management scenarios.

Population Structure

The whooping crane model has been developed as a meta-population model, which will provide viability assessments for each individual population as well as the species meta-population (i.e., all individuals of the species) as a whole over time. The meta-population includes the following populations:

1) Aransas-Wood Buffalo wild migratory population (AWB)
2) Eastern migratory population (EMP)
3) Louisiana non-migratory population (LA)
4) Florida non-migratory population (FL)
5) Captive population (SSP)

Each of these populations has its own demographic rates, initial population structure and management options. The default base model has been developed with no interaction among these five populations (i.e., treated as isolated populations). However, the model has been structured to allow population interactions in alternative scenarios. Examples of such interactions include, but are not restricted to, the following:

- Removal of eggs from wild nests (for translocation to another wild population or to be brought into captivity)
- Translocation of birds of specific age and sex from one wild population to another
- Periodic natural dispersal of birds from one wild population to another
- Release of captive-reared juveniles into wild populations

Any such population interactions can be restricted to occur only when certain conditions are met (e.g., source population is ‘healthy’ and recipient population falls below some defined threshold).

The working base model is being designed to incorporate substructure in the captive population to simulate the presence of core breeding facilities, with the initial model developed using six subpopulations (International Crane Foundation-ICF, Patuxent Wildlife Research Center, Calgary Zoo, San Antonio Zoo, Audubon CRES, All Others). In the model, breeding occurs primarily within each sub-population with some exchange among them (rather as acting as a panmictic population in the model).

Model Timeline

The model operates on a one-year time step, with most events (e.g., breeding) occurring once per year. Two census counts and two mortality events occur in the model each year so that first-year summer vs winter events can be altered separately in the model. Generally speaking, the model begins each 'year' in spring with breeding and egg/chick/fledgling mortality and then imposes separate mortality during migratory/ wintering phase. The order of model events is:

- Set mean demographic rates for the year based on EV
- Reproduction (mating, egg laying)
- Egg/chick/fledgling mortality to ~ age 6 months (winter count for AWB)
- Harvest and/or supplementation if appropriate
- Dispersal (natural) among populations if appropriate
- Census 1 (winter, approximate)
- Annual mortality for all bird over 6 months of age
- Increase ages by 1
- Calculate stochastic r
- Truncate population (probabilistically) if over K
- Update state variables to calculate population demographic summaries
- Census 2 (pre-breeding, post spring migration)

Model scenarios are currently set to project for 100 years, with results available for intermediary points in time. Final model scenarios can be run for a longer timeline if desired. Test scenarios are run for 100-500 iterations; final model scenarios will be run for 1000 iterations.

Model Inputs

Most model development effort prior to the PVA workshop focused on the wild AWB population and the captive population, as these represent very different population demographic rates and management strategies and have the most data available to inform the model. The AWB model was used as a base for the other wild populations (EMP, LA, FL), with revisions to input parameters as appropriate (e.g., demographic rates, initial population, carrying capacity). Additional information on these populations was discussed and provided at the PVA workshop as well as via post-workshop communications.

Key resources for demographic rates included Gil-Weir *et al.* 2012, Moore *et al*. 2012, Butler *et al*. 2014, Servanty *et al*. 2014, Wilson *et al*. (2016), the WHOOPERS SPARKS studbook database (Jones 2015), and others, as well as expert opinion on conference calls and at the PVA workshop.

Aransas-Wood Buffalo Population (AWB)

This population is initiated with 329 birds of equal sex ratio and approximate age-class structure based on data from the USFWS winter 2015-2016 survey report and from a stable age distribution based on model demographic rates and model data provided by S. Wilson. Current carrying capacity for wintering grounds (on protected lands) is set at 646 birds with an additional K = 1992 for birds on private lands, for a total K = 2638 (based on 2008 estimates of K by Metzger *et al*. 2014). Workshop participants accepted the projection by Metzger *et al.* (2014) of a loss in K due to projected sea level rise with climate change (with no further development) down to 1554 birds (397 in protected areas, 1147 in unprotected areas) by 2100. The population is truncated in the model when it exceeds K by removing birds that have not yet reproduced (i.e., juveniles, sub-adults, non-reproductive adults), producing a density-dependent effect of lower survival of non-established breeding pairs and lower recruitment (fewer surviving offspring).

Reproduction is modeled as long-term monogamous pairs, with reproduction (i.e., laying of eggs) beginning as early as age 4. Maximum lifespan is 30 years with no reproductive senescence. One clutch with up to 2 eggs may be produced per year (Wilson *et al.* 2016), with 96% of the clutches (405/421) consisting of two eggs (Gil-Weir *et al*. 2012). For modeling purposes, first vs second eggs were separated into individual ‘clutches’ in order to apply differential mortality rates (high mortality of second eggs) and the ability to model management strategies (e.g., removal of second eggs). Sex ratio of eggs was assumed to be 50:50 based on Wilson’s data and Gil 2006. Percent of adult females producing a clutch each year was based upon age, with essentially all females age 8-16 breeding (based on Gil-Weir *et al*. 2012 and modified to produce an average of 87.6% paired females breeding based on model mortality rates, as reported by Wilson *et al.* 2016.) – see Figure 2 for curve of age-specific rates. No effects were included based on reproductive experience or history for the AWB population.

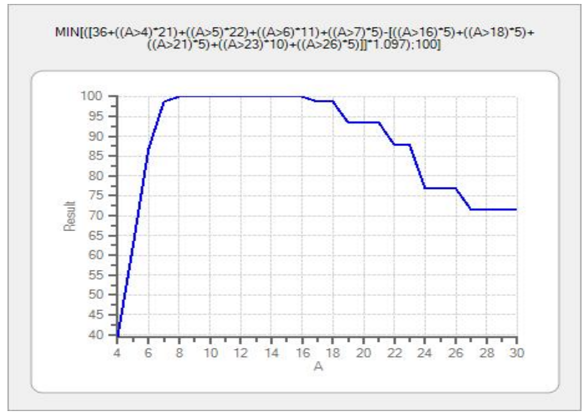

Figure 2. Age-specific % of adult females breeding used in AWB model.

Mortality for sub-adults and adults was based primarily on Wilson *et al*. (2016) and occurs as an annual event (13.9% for sub-adults and 7.2% for adults), with no sex-specific differences in mortality (Servanty *et al*. 2014). First-year mortality is divided into mortality from egg to fledgling to migration to wintering grounds (54% for first egg and 95% for second egg), with additional mortality (8.1%) during the remainder of the first-year. These rates were developed based primarily on Gil-Weir *et al*. 2012 and Wilson *et al*. (2016) (as well as raw data tables) and proportioned into first and second eggs to produce overall comparable survival and fledgling production rates.

Note: Demographic rates (reproduction and mortality) cited above from Wilson et al. (2016) were based on an early draft of the paper. Model rates will be refined slightly based on these revised published rates.

Demographic stochasticity is an inherent property of the model, and environmental variation (annual fluctuation in demographic rates) is explicitly added. Current EV is set at COV = 10% for mortality rates (used by Tischendorf 2004). EV for reproduction (% females breeding) was set at COV = 16% based on partitioning of EV from observed variance in AWB nesting data provided by Bidwell. EV for reproduction and mortality were not correlated in the model. Uncertainty in mean input values will be addressed through sensitivity testing of model results to these values within plausible biological bounds.

Catastrophic events were discussed at the PVA workshop. Four types of catastrophes were identified to be included in the base model: oil spill, hurricane, disease and (large) fire. Differential risks and impacts were estimated for each of the crane populations. All four catastrophes were suggested as impacting the AWB population primarily by leading to increase mortality at different times and/or age classes and by reducing K – see Table 1 for details. It was suggested that the type, frequency and impacts of catastrophes be discussed via more formal expert elicitation subsequent to the PVA workshop.

While this model is primarily a demographic model, genetic aspects have been or will be included. O’Grady *et al.* (2006) concluded that 12.29 lethal equivalents (LE) spread across survival and reproduction is a realistic estimate of inbreeding depression for wild vertebrate populations. The default value suggested for use in *VORTEX* is to incorporate 6.29 LE in the model as a conservative estimate, 50% of which are assigned to lethal alleles and subject to purging. Given the historical bottleneck experienced by this population, the current genetic load may be lower than average. An assumption of 3 LEs (1 as a lethal and 2 as non-lethal effects) was chosen as a starting point, and is applied as lower juvenile survival in inbred individuals. Currently the population is initiated with individuals unrelated to each other and also unrelated to other whooping crane populations. Options exist for setting a general level of kinship among the initial population and for relatedness to other populations and will be considered. Care must be taken when setting inbreeding effects and starting kinships when applied in concert with demographic rates that include past inbreeding effects, so as not to 'double count' the impact of future inbreeding. The preliminary AWB model prior to PVA discussions gives a stochastic growth rate of r = 0.046. Retrospective modeling of the population starting with 72 individuals and running for 37 years (simulating growth from spring 1978 to spring 2015) results in stochastic r = 0.038 and mean N_{2015} = 306, closely matching field observations (2015 survey count = 308).

Eastern Migratory Population (EMP)

The primary differences in this population model from the AWP model are initial population, carrying capacity, reproductive rate, mortality rates, and catastrophes. Model inputs not discussed below are the same as for the AWB model.

The initial population is based on data from the studbook and currently is set at 99 individuals with the sex and age structure indicated in the studbook, but may be revised based on more current estimates. Carrying capacity was discussed at the PVA workshop and was estimated by the participants to be 2000 birds (summer K), with ~1350 breeding adults (675 pairs).

Female reproductive rates for the EMP were changed to be based on female (pair) reproductive experience instead of female age, with 'virgin' pairs having a 50% chance of producing a clutch and 'proven' females (pairs) (i.e., those that had produced eggs in the past) having a 95% chance of producing a clutch, based on Servanty *et al*. (2014).

Mortality rates were also estimated primarily from Servanty *et al.* (2014). Sub-adult and adult annual mortality rates were lower than those for the AWB population (e.g., 3% annual mortality for adults age 4-19 years, then switched to AWB rates starting at age 20). First-year mortality for parent-reared offspring, specifically egg to fledgling mortality, was significantly higher for the EMP, based on the production of 3 fledglings resulting from 80 clutches (3.75% survival or less from egg to fledgling). In the absence of headstarting/releases and given these demographic rates (good breeding and post-juvenile survival but low fledgling recruitment), the population exhibits decline, with a stochastic r = -0.074.

At the PVA workshop, S. Converse provided information on the current headstarting efforts, including probabilities of various reproductive and management events and survival rates. For modeling purposes it was assumed in the base model that active management (headstarting) would be implemented for the first 10 years of the model and then cease. Headstarted young were given lower mortality rates (30% mortality from removal to release) than wild parent-reared young. Details can be found in Table 1 and Figure 3.

These rates need to be reviewed and validated before the final EMP base model is completed. It is apparent, however, that these preliminary rates will lead to both higher reproduction (over 4-fold increase in second clutches) and higher survival of young (70% survival of headstarted chicks to release vs 5% for parent-reared chicks) under the proposed headstarting management scheme in the model. A preliminary run of this model at the PVA workshop (with no catastrophes and K=2000) suggested strong population growth (~22% annually) for the first 10 years due to headstarting. The population then stabilizes around 1100 birds when releases end, as low (natural) reproductive success essentially balances the low adult mortality of released birds. Over time as the release cohorts age, the model shows strong decline (up to 10% per year), slowing to 3-4% annually once the last of the released birds die (see Figure 4). While the exact input values and results may be refined, these preliminary exploratory results viewed at the PVA workshop suggest the inability of the EMP to be sustainable without management intervention unless reproductive success and/or juvenile survival are improved.

Catastrophes considered for the future EMP base model include oil spills (low impact, in wintering grounds) and disease (low probability, potentially high impact). Discussions will continue to parameterize these rates. Retrospective validation is underway but is complicated by the need to incorporate past headstarting efforts and releases. This will be completed as part of model validation for this population.

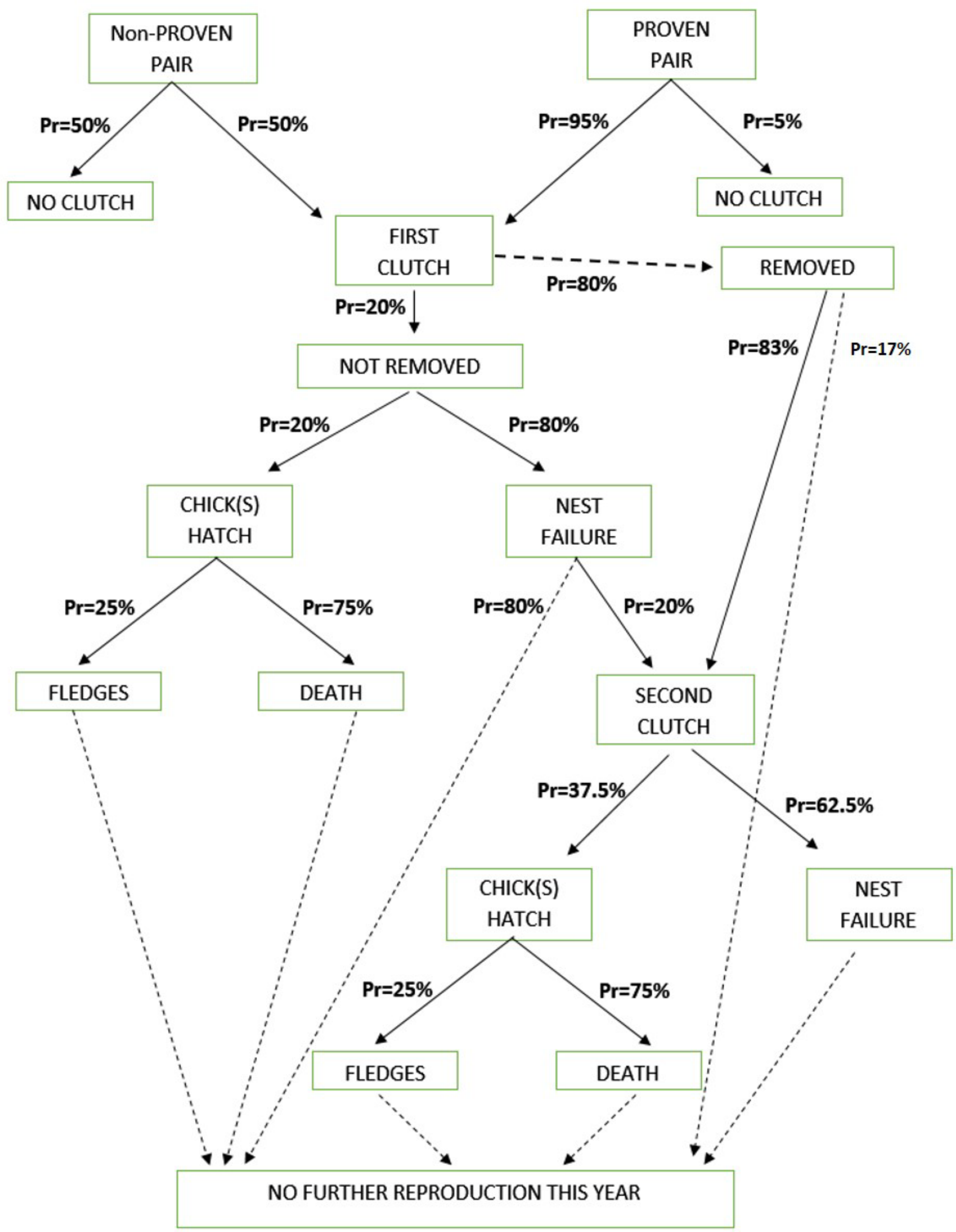

Figure 3. Diagram of reproductive rates (i.e., probability of pair producing 0, 1 or 2 clutches within a year used for the EMP model.

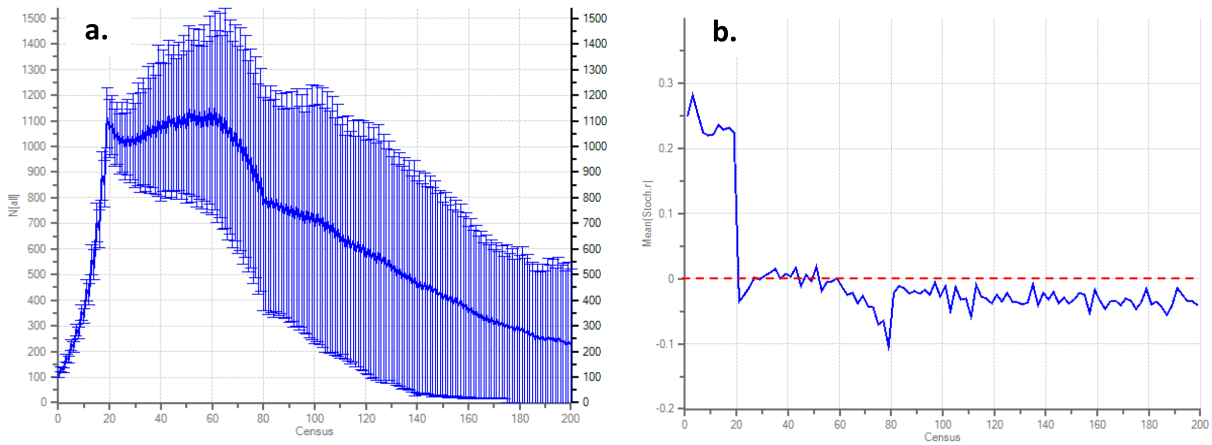

Figure 4. Projected population size (left panel) and stochastic growth rate (right panel) for EMP over 100 years, with 10 years of headstarting following by cessation of efforts. Based on preliminary input values. Bars on (a) indicate SD. Dashed red line on (b) indicates r = 0 (no growth or decline).

Non-migratory Louisiana Wild Population (LA)

Relatively little effort was spent prior to the PVA workshop to develop specific inputs for this non-migratory population. Some data on current population size and structure are available from the studbook data but are out of date. As this is a newly established population (releases began in 2011), it is challenging to predict future demographic rates for this population. Demographic rates for other wild whooping crane populations (AWB and EMP) differ most substantially from each other on the survival of offspring from egg to arrival on the wintering grounds (higher survival for AWB), followed by sub-adult and adult survival rates (higher survival for EMP). Participants discussed possible scenarios that would use EMP/FL reproductive success rates (worst case), AWB reproductive success rates (best case), or an intermediate reproductive success rate (the strategy chosen for the LA base model).

The suggested strategy at the workshop was to use the following data to initially parameterize the LA base model: 1) use EMP data for the % females breeding (which is based on reproductive experience); 2) use an intermediate survival rate (30%) for the first 6 months (egg to wintering grounds); and 3) use EMP survival rates for other age classes (see Table 1 for details). This leads to a positive stochastic growth rate of 5-6% annually. Historical data for this population needs to be examined to better develop this model, including reviewing data from the 2014 Louisiana Whooping Crane Report and follow-up discussions with other biologists with expertise on this population. Follow-up expert elicitation may be conducted to refine input values for LA. Parameter uncertainty will be a consideration to project the range of possible futures for this population.

Carrying capacity was discussed at the workshop; participants believe that Allen's 1952 historical estimate of K=2500 is still the best available. Expert opinion (by W. Selman) based on literature review following the PVA workshop suggests that Allen's estimate was for tallgrass prairie only and was not inclusive of coastal marshes. The estimated 762,000 acres of coast marsh could support an additional 500-1000 cranes (conservative estimate) and perhaps up to an additional 2500 cranes (W. Selman, pers. comm.) Oil spills, hurricanes and disease are anticipated to potentially affect the population. Hurricanes may promote early successional marsh and may increase crane habitat for 3-5 years post hurricane. Elicitation of rates and impacts for all potential catastrophes is needed for this population.

Non-migratory Florida Wild Population (FL)

Relatively little effort was spent to develop specific inputs for this non-migratory population prior to the PVA workshop. Some data on releases and current population size and structure are available from the studbook data but are out of date; additional data were provided at the workshop. Moore *et al.* 2012 provide estimates of demographic rates and the impact of uncertainty in those rates for the FL population. This population has demonstrated poor reproduction and high mortality and is not considered sustainable. It is included in the meta-population model primarily for sake of completeness (to include all populations of the species) but may not play a role in whooping crane recovery. Parameterization of the FL population will be discussed electronically to finalize this population model.

Captive Population (SSP)

The captive population was developed based on the whooping crane studbook data currently to January 2015. The studbook was used to set the initial population (age, sex, pedigree and location) of 158 individuals, and the data were analyzed using the PMx population management software program for captive populations to determine age- and sex-specific reproductive and mortality rates. The population was divided into six sub-populations, or 'centers': ICF, Patuxent, Calgary, San Antonio, Audubon, and All Others. Breeding occurs in all centers except for 'All Others'.

Breeding is modeled as short-term polygyny since essentially all breeding is done by artificial insemination (AI). All adult females at the five breeding centers have a 70% chance of producing a clutch in a given year (i.e., there is no limitation of breeding due to space constraints). Male sperm donors are selected based on their genetic value within the SSP (i.e., low mean kinship (MK) value). Sires (i.e., male sperm used in AI) are selected from males in the same center, with a limitation of no more than four females inseminated with sperm by the same male in a given year.

Excess offspring (i.e., those above carrying capacity) are removed from the population, with the restriction that their MK value is greater than the mean population MK (i.e., genetically overrepresented individuals). These excess offspring are tallied and then currently are removed from the meta-population, but alternate scenarios could supplement these juveniles into wild populations.

Preliminary mortality rates are 39%, 15%, 10%, 7%, and 4% for first-year, age1, age2, age3, and adults age-4+, respectively, but need further refinement. No EV is currently included in demographic rates, as annual environmental fluctuations are typically mitigated in captive conditions. Kinship data are available from recent molecular analysis and will be applied to better estimate kinships and gene diversity in the population.

Hurricanes (weather) and disease are estimated to be risks to the captive population. A potential additional risk to this population is the unexpected loss of one or more facilities.

More discussion is needed to refine the captive population model, but a model structure is in place to provide flexibility in refining both the base model and alternative management scenarios. One potential area of discussion is "breeder quality" in the captive population. Some periodic transfer of birds among the centers should be added into the model and will be discussed electronically. Modeling questions will include exploration of management options for the captive population as well as the role of this population in species recovery, and associated timelines and management strategies appropriate to meet that role.

<u>Summary</u>

Early model development has focused on the creation of a general model structure that incorporates key aspects of whooping crane biology and management to allow for population-specific inputs in demographic rates and management actions. Specific inputs values (e.g., demographic rates, initial population, carrying capacity, catastrophes) were discussed and in some cases modified at the PVA workshop. Additional data will be examined and electronic discussions held as appropriate to inform the final refinements to the base models in the coming months and completion of the base PVA.

Alternative scenarios were discussed prior to and during the PVA workshop to ensure that the model structure can accommodate all desired model scenarios. Once the final revisions to the model input values have been made, the final base PVA scenarios, retrospective analyses, and sensitivity testing will be conducted in the summer of 2016. Exploration of alternative management scenarios will be conducted in fall 2016, and the PVA results will be available prior to the PHVA workshop currently scheduled for November/December 2016.

Table 1. Summary of model inputs for each of the five whooping crane populations (see list of references 1-9 below the table). *Note: new data have become available since the PVA workshop (revised demographic rates in Wilson et al. (2016) and USFWS 2015-2016 winter survey) and will be incorporated into the model.*

Parameter	**Aransas-Wood Buffalo (AWB)**	**Eastern Migratory (EMP)**	**Louisiana Non-Migratory (LA)**	**Florida Non-Migratory (FL)**	**Captive (SSP)**
Initial population	N=329; equal sex ratio; stable age distribution (*based on USFWS 2015-16 winter survey and Wilson model (4))*	N=99 *(from Jan 2015 SPARKS studbook (7))*	N=35 *(from Jan 2015 SPARKS studbook (7))*	N=12 (based on best available data)	N=160 *(from Jan2015 SPARKS studbook (7))* Divided into 6 centers (ICF, Patuxent, Calgary, San Antonio, Audubon, Others)
Reproduction					
First age of reproduction	4 years *(1)*				
Max. age of reproduction	30 years *(1)*				
Maximum age	30 years *(1)*				35 years *(7)*
Mating system	Long-term monogamy (permanent pairs until mate dies)				Short-term polygyny (primarily by AI)
% females reproducing	Based on female age *(1,2)*: 87.6% of paired females (ages 8-16)	Based on reproductive experience *(5):* Proven: 95% Naïve: 50%	Based on reproductive experience *(5):* Proven: 95% Naïve: 50%	5% (based on data)	Based on reproductive experience and facility: Proven: 100% Naïve: 45%
Male mates	Can be paired with any male in the population	Can be paired with any male in the population	Can be paired with any male in the population	Can be paired with any male in the population	Sire (sperm donor) selected among males at same center based on mean kinship value
Offspring production and survival					
Clutch number and size	One clutch/year	Up to 2 clutches/yr *(8)* Years 1-10 (w/ mgt): 30% lay one clutch 70% lay two clutches Years 11+ (no mgt): 84% lay one clutch 16% lay two clutches	One clutch/year	One clutch/year Follow-up with Vasseur and King re: 2 clutches?	Up to 3 clutches/year *(7)* 67% lay one clutch 29% lay two clutches 4% lay three clutches
Clutch size	1-2 eggs/clutch *(1)* 4% with one egg 96% with two eggs	1-2 eggs/clutch 4% with one egg 96% with two eggs	1-2 eggs/clutch *(1)* 4% with one egg 96% with two eggs	1-2 eggs/clutch *(1)* 4% with one egg 96% with two eggs	1-2 eggs/clutch *(7)* 1st clutch: 88% 2 eggs 2nd clutch: 92% 2 eggs 3rd clutch: 100% 2 eggs

Mortality: egg to winter grounds (first egg)	54% *(1,2,3)*	95% if parent reared *(8)* 30% if headstarted	70%	70%	39% first year mortality; same for both eggs *(7,8)*
Mortality: egg to winter grounds (second egg)	95% *(1,2,3)*	Same as first egg	95% *(1,2,3)*	95% *(1,2,3)*	
Mortality rates					
Wintering grounds to end of first year	8.1% *(1,2,3)*	8.1% *(1,2,3)*	8.1% *(1,2,3)*	8.1% *(1,2,3)*	
Sub-adults (annual)	13.9% at workshop; Changed to 15% (age 2) and 10.8% (ages 3 & 4) based on new estimates *(2)*	Females: 7.4% (age 1); 7.2% (ages 2 & 3) Males: 6.4% (age 1); 3% (ages 2 & 3)	Females: 7.4% (age 1); 7.2% (ages 2 & 3) Males: 6.4% (age 1); 3% (ages 2 & 3)	32.8% (age 1); 23.4% (age 2); 17.9% (age 3) *(6)*	15% (age 1); 10% (age 2); 7% (age 3) *(7)*
Adults (annual)	7.2% *(2)*	3% (age 4-19); 7.2% (20+) *(2,5)*	3% (age 4-19); 7.2% (20+) *(2,5)*	18.4% (non-breeders); 6.4% (breeders) *(6)*	4% *(7)*
Environmental variation	COV=16% for % breed COV = 10% for mortality	COV=16% for % breed COV = 10% for mortality	COV=16% for % breed COV = 10% for mortality	COV=16% for % breed COV = 10% for mortality	None
Catastrophes					
Oil spill	Increased winter (migration) mortality (of concern)	Yes? (low impact)	Yes (low impact)	No?	No
Hurricane	Reduces K; winter mortality? (of concern)	No	Change in K (increase?)	No?	Increases mortality (low Pr)
Disease	Increases mortality (low Pr)	Yes? Increases mortality (low Pr)	Yes? Increases mortality (low Pr)	No?	Increased mortality (higher Pr)
Fire (large)	Maybe (reduced fledgling success)	No	No	No?	No
Genetics					
Inbreeding impact	LE = 3 ; 34% lethal	LE = 3 ; 34% lethal	LE = 3 ; 34% lethal	LE = 3 ; 34% lethal	LE = 3 ; 34% lethal
Initial relatedness	None; may consider incorporating available data	None; may consider incorporating available data	None; may consider incorporating available data	None; may consider incorporating available data	From studbook that incorporates molecular data *(7)*
Connectivity with other populations	None (isolated)	None (isolated)	None (isolated)	None (isolated)	None (isolated)
Carrying capacity	K=2638 (winter) *(9)* 646 (protected lands) 1992 (unprotected)	K=2000 (summer) ~1350 breeding adults ~ 675 pairs	N=2500 *(10)*	N=40	N=190 (need to refine)

K truncation method (removal of excess > K)	Only birds that have not yet reproduced	Only birds that have not yet reproduced	Only birds that have not yet reproduced	Only birds that have not yet reproduced	Excess offspring with MK > population MK
Loss of K due to climate change	Decrease in K to 1554 by 2100 *(9)*	Not yet incorporated	Not yet incorporated	Not yet incorporated	

Data sources used in developing inputs:

1 = Gil-Weir *et al.* 2012
2 = Wilson *et al.* 2016
3 = Wilson (raw data tables)
4 = USFWS 2016
5 = Servanty *et al*. 2014
6 = Moore *et al*. 2012
7 = 2015 studbook data (Jones 2015)
8 = Converse, pers. comm.
9 = Metzger *et al.* 2014
10 = Allen 1952

A Preliminary Exploration of Whooping Crane Management Alternatives

Proposed Management Alternative Components

An important step in the PVA process is the creation and evaluation of alternative management strategies that can be employed across one or multiple Whooping Crane populations for the purpose of increasing overall species viability across its range. These alternative strategies can be ultimately defined in terms of demographic, genetic, and/or ecological parameters that make up the Whooping Crane PVA model. The scenario that defines any given alternative can then be assessed against a “status quo” baseline scenario according to the appropriate model output metric (stochastic growth rate, extinction probability, genetic diversity retention, etc.).

Ideally, a management alternative will be defined as a collection of individual activities that target specific threats to the one or more components of the Whooping Crane metapopulation. Therefore, the first step towards developing alternatives is brainstorming the various specific management components that might make up a set of alternatives. Table 2 below summarizes the result of this brainstorming exercise. The components are distributed and organized within columns that correspond to the high-level targets of management: the habitat across each of the three wild populations (Aransas – Wood Buffalo, Eastern Migratory, and Louisiana); the birds comprising those three wild populations; the animals comprising the captive population; and the animals comprising the overall metapopulation.

Following the presentation of the potential management components, working groups were formed to begin creating more broad management alternatives that included some of the previously-identified components. These alternatives are presented here, following the component table.

Table 2. Proposed components of Whooping Crane recovery management alternatives.

AWBP Habitat	EMP Habitat	Louisiana Habitat	AWBP Population	EMP Population	Louisiana Population	Captive Population	Metapopulation
Increased protection of winter / migratory habitat	Improved black fly management	Seasonal water management	Reduced shooting mortality through (education, law enforcement, legal efforts)	Reduced shooting mortality through (education, law enforcement, legal efforts)	Reduced shooting mortality through (education, law enforcement, legal efforts	Explore mate choice methods and options for improving behavioral profiles of pairs	Facilitate movement of birds between populations
Increased inflows	Impoundment management	Private land management incentives	Reduced collision mortality	Training on predator avoidance post-release	Relocate birds that are moving outside normal range	Increase/decrease capacity/production	Egg collection / Head-starting within/between populations
Reduction in invasives during winter			Reduced human disturbance	Reduced human disturbance	Reduced human disturbance	Increasing/decrease number of institutions	Translocate from/to populations (for genetic or demographic improvements)
Increased food availability in winter			Disease management	Short-stopping migrating birds		Reduce re-clutching intensity	Identify various release locations within the EMP
Reduction in toxic spill risks			Short-stopping migrating birds	Predator management		Increase parent rearing (related to rearing method under ex situ management)	Employ different durations/intensities of release
Reductions in greenhouse gases			Egg-swapping within the population	Relocate birds that are moving outside normal range		Employ bird relocations within facilities depending on identified roles	Employ various release and rearing methods

AWBP Habitat	EMP Habitat	Louisiana Habitat	AWBP Population	EMP Population	Louisiana Population	Captive Population	Metapopulation
Wildfire prevention (breeding grounds) / Fire management (wintering grounds)			Egg switching (fertile vs. infertile)			Increase outreach practices to public, etc.	Employ various chick training methods
			Predator management			Shut down any movements from captivity to wild	Release adults or family groups/pairs from SSP or other populations
						Shut down any movements from captivity to wild but maintain headstarting capacity	Initiate additional reintroduced populations
						Redesign captive habitats	
						Maximize productivity of difficult birds	
						Employ cross-fostering with Sandhill Cranes	

						Use genetic analysis of captive population to increase genetic variation in the wild OR to increase success in the wild	

Proposed Management Alternatives

Aransas – Wood Buffalo National Park Population
"Crowd-Sourcing for Cranes"

Management on Wintering Areas

- Freshwater management
    - This may the most difficult component.
    - Important to restore natural pulses of water into the bay. This will likely reduce winter mortality; will improve condition of breeders, thereby creating cross-seasonal effects on breeding success (hypothesis); and will maintain winter habitat carrying capacity.
- Protect existing habitat in and around the Aransas NWR, i.e., the Texas central coast.
    - Expand the protected areas network using different conservation tools (e.g., easements).
    - This will maintain the overall habitat carrying capacity, and will also reduce mortality.
- (Research note: It may be valuable to better understand sea level rise and its impacts on cranes in order to potentially influence policy decisions.)

Migration Management

- Spring (fall) – enhance migratory stop-over areas (food availability; reduce disturbance).
    - This will improve breeding success in the spring (propensity and/or nesting success), and will improve juvenile survival in the fall.
- Fall (winter) – education and outreach programs, with selected hunting closures
    - This will reduce shooting mortality.

Breeding Management

- Head-starting (egg collection)
    - Increase the number of juvenile releases directly to the appropriate target populations (Aransas – Wood Buffalo, Louisiana, Eastern Migratory, others?).
- Use conservation tools to protect areas outside the National Park boundaries.
    - Increase breeding success (suitable nesting sites).
    - Increase habitat carrying capacity (hypothesis).
- Work with First Nations and Territorial governments to achieve successful habitat conservation within and outside National Park boundaries.
- (Research note: it may be good to model possible impacts of ongoing climate change on boreal wetland systems and the implications for future Crane habitat quality and distribution. Demonstrated climate impacts may influence policy decisions related to climate change and greenhouse gas emissions.)

Addressing Climate Change

Though halting anthropogenic climate change may be beyond scope of this group, it would facilitate long term recovery of wild WHCR populations, by operating **at multiple life-stages**, specifically to maintain carrying capacity on breeding and wintering grounds, and reduce the risk of catastrophic events (oil spills and hurricanes).

Implications for the SSP Population

- Will be important to build facility capacity and techniques to handle head-start project successfully.
    - Must increase post-release survival.
    - Must increase overall population abundance.
    - Must increase the future breeding success of surviving Cranes.

Eastern Migratory Population
"Last Dirty Bird Costume & Colony Collapse Syndrome"

Goals: Focus on building a better released bird with a more natural rearing experience and 'wild' genetics with the idea that this will improve their performance as breeders in the wild post-release; use habitat management to improve rearing habitat and thus chick survival (both for first and later generation birds); and continue to work to reduce adult/subadult mortality due to shooting.

Habitat Management

- Implement an impoundment management scheme to improve rearing habitat. This would involve a program to lower pools to reduce contact with predator cover / concentrate food / maintain moist soil.
- Create habitats that encourage birds to form bonds post-release.
  Use feeders? Chick calls? Fencing? Siting in best locations in adult territories

Population Management

- Reduce shooting mortality through educational programs, improved law enforcement, and better legal protection.

Captive Population Management

- Shut down any movements of birds from captivity to the wild, but maintain the capacity for head-starting (possibly at new sites, even at release sites).
- Redesign captive habitats for better overall bird performance (e.g., wetland pens).

Metapopulation Management

Collect eggs from Wood Buffalo National Park as available.
- Modify rearing and release methods – initiate an early parent-rearing methodology or the "regular" parent-rearing method.
- Consider a summer or fall quick soft release. Learn about the pros and cons of an early vs. late release method, and use adaptive management approach to evaluate each method and revise accordingly.

Louisiana Population
"Flood Louisiana"

The goal of this scenario is to increase juvenile survivorship and increase the size of the LA population.

Component A: Decrease Mortality in Age 0-1 Juveniles

- Alternate Strategy: Increase survivorship by increasing site fidelity (i.e., decrease juvenile wandering and mortality incurred this time period). This could be explored by using different release techniques (e.g., larger top-netted pen, longer period in the pen).

Component B: Increase Cohort Sizes to Increase Population, while also testing Captive Selection Theory
Increase cohort numbers through captive x AWBP experiment to determine if captive selection is strong (e.g., 15 AWBP eggs vs. 15 SSP eggs reared at the same facility and same conditions). If these birds are added to already large cohorts, this will provide a "surge" into the population for ~5 years with 40-50 birds added per year

Captive Population
"Au Naturel" or "Building a Better Bird"

The goal of the scenario is to increase fecundity of the captive flock ***and*** improve the quality of the chicks produced for release.

Component A: Measurement of success: Captive breeding Centre culture

- Shift in strategy: annual success of captive breeding is not measured by the number of eggs, chicks or fledglings produced, but on a longer time scale by the number of reproducing individuals in the released population as well as improved survivorship in the wild. (This facilitates a move away from management for numbers to management for quality.)

Component B: Masterplan and Captive Centre Protocols

- Complete a new Masterplan for the captive flock using SSP resources.
  Re-shuffle the captive flock to maximize potential for production from under-represented animals/genes. (A move that may decrease numbers produced at least initially). Although genetic management is important, behavioural compatibility to improve production and increase parent rearing are also important.

- Review protocols at all 5 breeding institutions and standardize these with a goal of increasing the similarity of life stages in captivity to the natural history cycle of the species.

- Identify each holding space for production, chick rearing and other program purposes. The core breeding program would remain at primary breeding centers. Birds not considered core may need to be relocated to other new holding facilities.

- Clarify the role of each bird in the captive population (e.g. maturing, breeding, mentor, model, incubation and rearing, surplus/display). While roles will not be static throughout life, this will simplify population-wide management decisions.

- Assist breeding centers in decisions to separate established but non-egg laying pairs based on fecal hormonal profiles. (Research at Patuxent/SCBI has produced information on the hormonal output of egg laying pairs. By comparing the output of unsuccessful pairs, lack of appropriate hormonal activity could be used to make earlier decisions to break and re-form adult pairs.)

Component C: Steps to increase the resilience and fecundity of released birds

- Increase production of parent-reared chicks. (The research to date does not strongly support this as a better option than costume rearing; however the group felt this would be a positive step in reducing captive selection and potentially on reproductive and chick raising performance of released birds.)

- Investigate the potential for twin rearing within the captive flock (this has the potential to double the annual output of parent reared chicks, including possible headstarting of wild laid eggs/chicks).

- Vigilance training of chicks prior to release

Component D: Steps to increase the reproductive rates in the captive flock

- Develop resources and protocols to support more natural mate selection. The literature supports this to be most important for females. Examples include using adjacent pens to give a female the choice of two possible males to either side; and setting up large multi-acre community pens where several males and females could co-exist and be monitored for more natural pair formation.

- Wherever possible, create breeding pens that are more distant from other breeding pairs to decrease the potential for dominance suppression by nearby bonded pairs. Separation could include physical distance as well as sound and sight barriers.

Component E: Steps that may benefit all captive life stages

- Re-examine components of pen design and annual management, e.g. pen size, inclusion of ponds and other natural feeding opportunities, “migration” from winter to summer pen.

- Review diet and pre-breeding flushing components as well as opportunities for natural feeding behavior/ecology between institutions to build on previous work that has been done.

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Appendices

Appendix I: Workshop Agenda

Recovery Planning for Whooping Crane
Workshop I: Population Viability Analysis

1-3 December, 2015
Enmax Conservatory, Calgary Zoo
Calgary Zoo, Calgary, AB, CANADA

WORKSHOP AGENDA

DAY ONE: Tuesday, 1 December

9:00 Welcome and workshop opening
(*Clément Lanthier and Axel Moehrenschlager, Calgary Zoo; Mark Bidwell, CWS and Wade Harell, USFWS)*

9:10 Participant introductions (name, affiliation, involvement with whooping cranes)

9:20 Background presentations

1. Where have we come from? Recovery planning over the years (15m)
(*John French, USGS*)
2. Where are we now? Current issues in wild, re-introduced and captive populations (40m)
Aransas-Wood Buffalo Population (10m) (*Felipe Chavez-Ramirez, GCBO*)
Captive Population (10m) (*Sandie Black, Calgary Zoo*)
Eastern Migratory Population (10m) (*Julie Langenberg, ICF*)
Louisiana Population (10m) (*Will Selman, LDFW*)
3. Where should we go? The future of recovery planning for whooping cranes (30m)
(*Mark Bidwell, CWS and Wade Harrell, USFWS)*

10:45 Coffee / tea break

11:00 Background presentations cont'd

4. How might we get there? The role of population viability analysis and species conservation planning in the recovery planning process (*Phil Miller, CBSG*)

11:30 An elicitation of risk tolerance among workshop participants (*Sarah Converse, USGS*)

12:30 Lunch, provided by Calgary Zoo

1:30 An elicitation of risk tolerance among workshop participants, contd. (*Sarah Converse, USGS*)

3:00 Coffee / tea break

3:15 A technical introduction to population viability analysis modeling and the Whooping Crane demographic model development process to date (*Kathy Traylor-Holzer, CBSG*)

4:00 Discussion of Whooping Crane PVA model structure, function, input data and interpretation of output (*Kathy Traylor-Holzer, CBSG*)

5:00 Adjourn

DAY TWO: Wednesday, 2 December

8:30 Continued review of model structure, function, input data and interpretation of output

10:30 Coffee / tea break

12:30 Lunch, provided by Calgary Zoo

1:00 Continued review of model structure, function, input data and interpretation of output

3:00 Coffee / tea break

3:15 Begin discussion of proposed population management alternatives and methods for simulating within PVA framework (conducted in working groups)

4:00 Adjourn

DAY THREE: Thursday, 3 December

8:30 Continued discussion of proposed population management alternatives and methods for simulating within PVA framework

10:30 Coffee / tea break

11:00 Next steps – timeline for proposed work between PVA and PHVA workshops

12:30 Lunch, provided by Calgary Zoo, followed by a field trip to whooping crane captive breeding facility at the Devonian Wildlife Conservation Centre. Participants should dress warmly and expect to be outside (bring warm hat, coat and footwear). The trip will last until 3:30, returning to Calgary by 4:00.

OR

For IRT members, a working lunch and meeting of the International Whooping Crane Recovery Team. We expec the meeting will last until about 4:30.

Appendix II: Workshop Participants

Recovery Planning for Whooping Crane
Workshop I: Population Viability Analysis

1-3 December, 2015
Enmax Conservatory, Calgary Zoo
Calgary Zoo, Calgary, AB, CANADA

WORKSHOP PARTICIPANTS

Workshop leads (2)
Phil Miller (Conservation Breeding Specialist Group)
Kathy Traylor-Holzer (Conservation Breeding Specialist Group)

International Recovery Team (7)
Mark Bidwell (Canadian Wildlife Service)
Wade Harrell (US Fish & Wildlife Service)
Sandie Black (Calgary Zoo)
Felipe Chavez-Ramirez (Gulf Coast Bird Observatory)
John French (US Geological Service, Patuxent Wildlife Research Center)
Julie Langenburg (International Crane Foundation, proxy for George Archibald)
Stu MacMillan (Parks Canada, Wood Buffalo National Park)

Aransas-Wood Buffalo Population (3)
Aaron Pearse (US Geological Survey, Northern Prairie Wildlife Research Center)
Elizabeth Smith (International Crane Foundation)
Jason Straka (Parks Canada, Wood Buffalo National Park)

Captive Populations (2)
Kim Boardman (International Crane Foundation, Species Survival Plan)
Sandra Elvin (Association of Zoos & Aquariums, Saving Animals from Extinction initiative)

Reintroduced Populations (4)
Sarah Converse (US Geological Service, Patuxent Wildlife Research Center)
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Barry Hartup (International Crane Foundation; Whooping Crane Health Advisory Team)
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Recovery and Modeling (5)
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Bob Clark (Environment Canada)
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Recovery and Ecology of Whooping Cranes:
Monitoring of the Aransas-Wood Buffalo Population during the Breeding Season
2015 Report

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Summary

Annual monitoring of the Aransas-Wood Buffalo Population (AWBP) of whooping cranes (*Grus americana*, hereafter cranes), which numbers approximately 300 individuals, is a key element of Canada's efforts to recover the species under the *Species at Risk Act* (SARA). In 2015, the Canadian Wildlife Service (CWS) and Parks Canada (PCA) conducted surveys for whooping cranes in breeding areas in southern Northwest Territories (NT) and northern Alberta (AB), in and adjacent to Wood Buffalo National Park (WBNP). Breeding pair surveys in May detected 68 nests, 13 of which were outside the area designated as critical habitat and six of which were outside WBNP; 20-24 pairs without nests were also observed. Surveys in August detected 23 juveniles; 23 pairs had one juvenile each and no pairs had two juveniles. Annual productivity was 0.34 juveniles per nest, lower than the 20-year average of 0.49 but within the long term natural range of variation. Of 16 cranes banded with satellite transmitters that were confirmed to nest, nine were re-sighted with juveniles and five without juveniles. Of 18 banded cranes that did not appear to nest, 11 spent the summer in or adjacent to WBNP. Results from monitoring of the AWBP in 2015 highlight the continued increase in the breeding population, although it is still well below Canadian and international recovery goals, and the ongoing expansion of the breeding range into areas not currently designated as critical habitat.

Background and Rationale

The Government of Canada and its partners, via implementation of the Recovery Strategy for the Whooping Crane in Canada (hereafter RS; Environment Canada 2007) and the joint US-Canada International Recovery Plan (hereafter IRP; CWS and USFWS 2007), aims to protect, restore, and manage the whooping crane (*Grus americana*) to be self-sustaining in the wild by establishing 1,000 individuals in North America by 2035 (Environment Canada 2007). By reaching this goal and achieving other recovery criteria, the species may be considered for re-designation from Endangered to Threatened under the *Species at Risk Act* (SARA) in Canada, and under the *Endangered Species Act* (ESA) in the United States. Coordination of activities designed to recover the species, including establishment and operation of a joint International Recovery Team (IRT), is governed by a memorandum of understanding (MOU) between the Canadian Wildlife Service (CWS) of Environment Canada (EC), Parks Canada Agency (PCA), the US Fish and Wildlife Service (USFWS) and the US Geological Survey (USGS).

The only naturally occurring and self-sustaining population of whooping cranes, the migratory Aransas-Wood Buffalo Population (AWBP), which numbers about 300 individuals (USFWS 2015), spends half of its annual cycle in Canada. During the summer breeding season (May-Sept) breeding adults and some non-breeding sub-adults reside in and adjacent to Wood Buffalo National Park (WBNP) in Alberta (AB) and the Northwest Territories (NT). During fall

(Sept-Oct), adults, sub-adults and juveniles spend up to 4-6 weeks staging in central Saskatchewan (SK) before migrating to the Texas Gulf Coast, where they spend winter (Nov-Mar) in and near the Aransas National Wildlife Refuge (ANWR). During spring migration (Mar-Apr), cranes return to WBNP and adjacent areas via SK, for initiation of breeding in May.

Annual monitoring of the AWBP by CWS and our partners is a key element of Canada's implementation of the RS and IRP, and is specified in those recovery documents as an activity required to achieve recovery goals. Data collected annually are used to (1) track progress towards the recovery goal of 250 breeding pairs (Environment Canada 2007) by estimating the abundance and productivity of breeding pairs annually; (2) identify and designate areas as critical habitat (i.e., areas vital to the survival or recovery of cranes) under SARA; and (3) predict future population dynamics and range expansion of the AWBP. Most breeding pairs nest inside WBNP, but the population has expanded its range outside the national park with up to 6 pairs nesting annually in the NT, and up to two pairs on Salt River First Nation reserve lands.

Given the population's small size, we monitor almost all breeding individuals by conducting annual aerial surveys of the abundance of (1) breeding pairs and nests in late spring and (2) juveniles in mid-summer. Information obtained from both surveys is used to derive metrics required by the RS and IRP to track progress towards recovery (i.e., number of breeding pairs, annual productivity). Aerial surveys are conducted in the core breeding areas within WBNP, and in areas outside the national park. This monitoring work has been conducted annually since 1966 by CWS, and in close cooperation with PCA since 2011.

Habitat Conditions in Breeding Areas

During the 2015 breeding season, habitat conditions in the whooping crane nesting area were exceptionally dry. Annual precipitation (May 2014 to April 2015) at Fort Smith, NT preceding the breeding season was 104% of the 60-year average, however precipitation in the seven-month period from October 2014 to April 2015 was 79% of the 60-year average (Figure 1; Environment Canada 2015). In May 2015, observers noted that water levels in the nesting area were low relative to recent years. Dry conditions persisted throughout the breeding season; precipitation in the five-month period from May to September was 62% of the 60-year average (Figure 1, Environment Canada 2015). During juvenile surveys in August 2015, observers noted that many breeding-area ponds were dry (Appendix 1).

Warm and dry conditions contributed to an active wildfire season in breeding areas and the surrounding region. Fires burned 15,839 ha or 3.88% of the area designated as critical habitat (Figure 2), greatly exceeding the 25-year average of 0.90% (Figure 1). Outside the area designated as critical habitat, 13 nests were detected and two of these occurred within 5 km of fires. Additionally, wildfire affected 372,450 ha or 8.16% of WBNP (vs. the 25-year average of 1.26%) and 280,880 ha of the South Slave Region of the NT (GNWT 2015).

Abundance of Breeding Pairs and Juveniles

In 2015, aerial surveys to estimate abundance of breeding pairs with and without nests were conducted from May 25-29, using methods described in Johns (2010). Observers detected 68 nests and 20-24 pairs without nests (Table 1, Figure 3), suggesting the potential for substantial expansion of the breeding population. Because most cranes are not individually banded yet may move during the 5-day survey, the range of non-nesting pairs reflects the possible number of unique pairs. Of the 68 nests detected, 13 were outside the area designated as critical habitat (CH) and six of these were also outside WBNP. Of the 62 nests in WBNP, seven were outside the area of the park identified as CH and, for the first time ever, a nest was detected in the Salt Plans area. Of the six nests outside WBNP, where CH has not yet been identified, four were north of the Nyarling River where two pairs without nests were also observed, and two nests were on Salt River First Nation reserve lands (i.e., Lobstick Creek) east of WBNP. In 2015, breeding pair surveys were conducted by John Conkin (CWS; May 25-29), Sharon Irwin (PCA; May 25-29), Lana Cortese (PCA; May 26, 28), John McKinnon (PCA; May 25) and Tom Lynn (International Crane Foundation, ICF, May 27) over 25.8 hours using a EC-120 helicopter piloted by Mark Rayner of Phoenix Heli-flight (Fort McMurray, AB).

Aerial surveys to estimate abundance of juveniles were conducted from Aug 7-11, 2015. Observers detected 23 juveniles; 23 pairs had one juvenile each, no pairs had two juveniles, and 46-50 pairs did not have juveniles (Table 1). Using information collected during the breeding pair survey in May, 2015, we determined that annual productivity was 0.34 juveniles per nest, lower than the 20-year average of 0.49 but within the long term natural range of variation of about 0.20 to 0.80 and consistent with the recent trend (Figure 4). In 2015, juvenile surveys were conducted by John Conkin (CWS; Aug 7-11), Sharon Irwin (PCA; Aug 7-11), Jane Peterson (PCA; Aug 7-8) and John McKinnon (PCA; Aug 9-11) over 27.3 hours using a EC-120 helicopter piloted by Devon Stoof of Phoenix Heli-flight (Fort McMurray, AB).

Nesting Success of Banded Cranes

From 2009 to 2014, 71 whooping cranes were banded and fitted with satellite transmitters by members of the multi-agency, cooperative Whooping Crane Tracking Partnership, composed of the Canadian Wildlife Service, the United States Geological Survey, the United States Fish and Wildlife Agency, The Crane Trust, and the Platte River Recovery Implementation Program with support from the Gulf Coast Bird Observatory, the International Crane Foundation and Parks Canada. The partnership's main objective is to advance our knowledge of the breeding, wintering, and migration ecology of whooping cranes (e.g., by monitoring movements and identifying threats during migration) which are activities specified by the RS and IRP as required to meet recovery goals. See USGS (2015) for the latest update from this cooperative project.

During the 2015 breeding season, 26 banded cranes with satellite transmitters provided positional data which facilitated searches during our surveys for breeding pairs, nests and juveniles. Additionally, eight cranes with inactive transmitters were re-sighted in summer or during fall migration; in total, 34 banded cranes provided data. Of those 34 cranes, nesting was observed directly in 11 cases and in five cases it was inferred from subsequent re-sighting of banded birds with offspring; in total 16 banded cranes provided evidence of nesting. Of those 16 cranes, nine were re-sighted in summer or fall with juveniles, five were re-sighted without juveniles, and two cranes with inactive transmitters were not re-sighted. Of the remaining 18 cranes that did not appear to nest, 11 spent the summer in or adjacent to WBNP and 7 had poorly performing transmitters meaning their summer location could not be determined reliably.

Nesting success of most banded cranes is confirmed during aerial surveys in mid-summer. Several cranes, however, were not re-sighted until fall, when they were observed during ground-based surveys conducted by CWS to monitor crane movements and habitat use during migration; results of monitoring during migration are presented in a separate report. In 2015, ground-based surveys which confirmed nesting success of several cranes were conducted in SK from Sept-Nov by Jessica Rempel (CWS), John Conkin (CWS), and Mark Bidwell (CWS).

Management Considerations

We confirmed nesting by 68 pairs in late spring, producing an average of 0.34 juveniles per nest by mid-summer. While the number of confirmed nests has increased steadily since surveys began in 1966, it also varies annually (Figure 4) possibly in response to environmental conditions during the breeding season. The ratio of juveniles to nests, which is an estimate of breeding success for the population, also varies annually (Figure 4) but in a periodic manner that tracks the 10-year boreal hare-lynx cycle (Boyce et al. 2005), likely because of periodicity in abundance of potential predators (e.g., wolves, lynx, red fox). In 2015 there were fewer nests than in the previous two years, possibly because weather was unusually hot and dry, and juvenile success was relatively low. In 2014, however, more nests were confirmed than in any previous year, highlighting the gradual but steady increase in the breeding population over the last sixty years (Figure 4). Even so, the Aransas Wood Buffalo Population (AWBP) is many years away from achieving the Canadian down-listing goal of 125 pairs (i.e., 250 mature individuals; COSEWIC 2010) or the international goal of 250 productive pairs (CWS and USFWS 2007). Recovery of the species depends mainly on growth of the AWBP, so monitoring should continue until recovery goals are reached (CWS & USFWS 2007).

Thirteen breeding pairs with nests were detected outside the area designated as critical habitat (CH; Environment Canada 2007) under the *Species at Risk Act* (SARA), and six of these were also outside Wood Buffalo National Park (WBNP), highlighting the ongoing expansion of the AWBP's breeding range. The first nest outside WBNP was detected in 1982 on reserve lands of the Salt River First Nation, east of WBNP, and in 1998 cranes were detected nesting north of WBNP, in the Northwest Territories. Currently, up to 20% of nests occur outside CH annually and, although cranes and their nests are protected under SARA and the *Migratory Birds Convention Act* (MBCA) wherever they occur, breeding habitat is not protected unless it is identified as CH (i.e., habitat required for the survival or recovery of the species). In particular, SARA prohibits destruction of CH in federal protected areas (e.g., WBNP) and includes measures that could protect CH in other areas. Moreover, up to 11% of nests occur outside WBNP annually, and these nests and associated habitat are not protected under the *Canada National Parks Act* (CNPA) or related regulations. Because the breeding range of whooping cranes has expanded outside the CH, including into areas which could be impacted by human development, Environment Canada is undertaking work to update the CH to ensure it more closely corresponds to current and probable future breeding ranges of the species.

Acknowledgements

Many people contributed to this report. We are particularly grateful to colleagues who conducted fieldwork, including Lana Cortese, Sharon Irwin, Tom Lynn, John McKinnon, Jane Peterson, Devon Stoof, Mark Rayner, and Jessica Rempel. We thank other colleagues and members of the public who located or re-sighted banded cranes or provided other useful information, including Bob Clark, Bob Godwin, Val and Kim Mann, Kathy Meeres, Mitch Weegman and Michael Williams. We thank Ron Bennett (CWS), Stu MacMillan (WBNP), Lea Craig-Moore (CWS) and Mark Wayland (CWS) for reviewing an earlier draft of this report. The work described here was conducted under Environment Canada Scientific/SARA permit NWT-SCI-13-03, Environment Canada Animal Care Permit 15MB01, Northwest Territories Wildlife Research Permit WL500330, Parks Canada Agency Research and Collection Permit WB-2015-18376, and Wood Buffalo National Park Restricted Activity Permit WB2015-005.

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Table 1. The number and type of observations of whooping cranes that were detected during breeding pair and juvenile surveys in May and August 2015, respectively.

Observation type	**May**	**August**
Nests	68	n/a
Adults on or near nests	91	n/a
Pairs without nests	20-24	n/a
Pairs with juveniles	n/a	23
Juveniles	n/a	23
Pairs without juveniles	n/a	46-50
Lone cranes	44-47	7
Grouped cranes	0	3
Total cranes	155-162	125-129

Notes:

(i) Because cranes may move over the duration of the survey, ranges reflect the possible number of unique individuals or unique pairs. The main objectives of the surveys are to obtain estimates of (a) nests and (b) pairs with juveniles, which are reported with more precision.

(ii) Many lone cranes observed in May are likely mates of adults detected on nests.

(iii) Grouped cranes refer to three or more cranes at one location. In 2015 the maximum number of adults observed at one location was three.

Figure 1. The amount of the whooping crane nesting area burned by wildfire annually (left vertical axis, dashed red line represents 25-year mean), and the total precipitation recorded at Fort Smith, NT before (October-April) and during (May-September) the breeding season (right vertical axis, dashed blue lines represent 60-year means), 1955 to 2015.

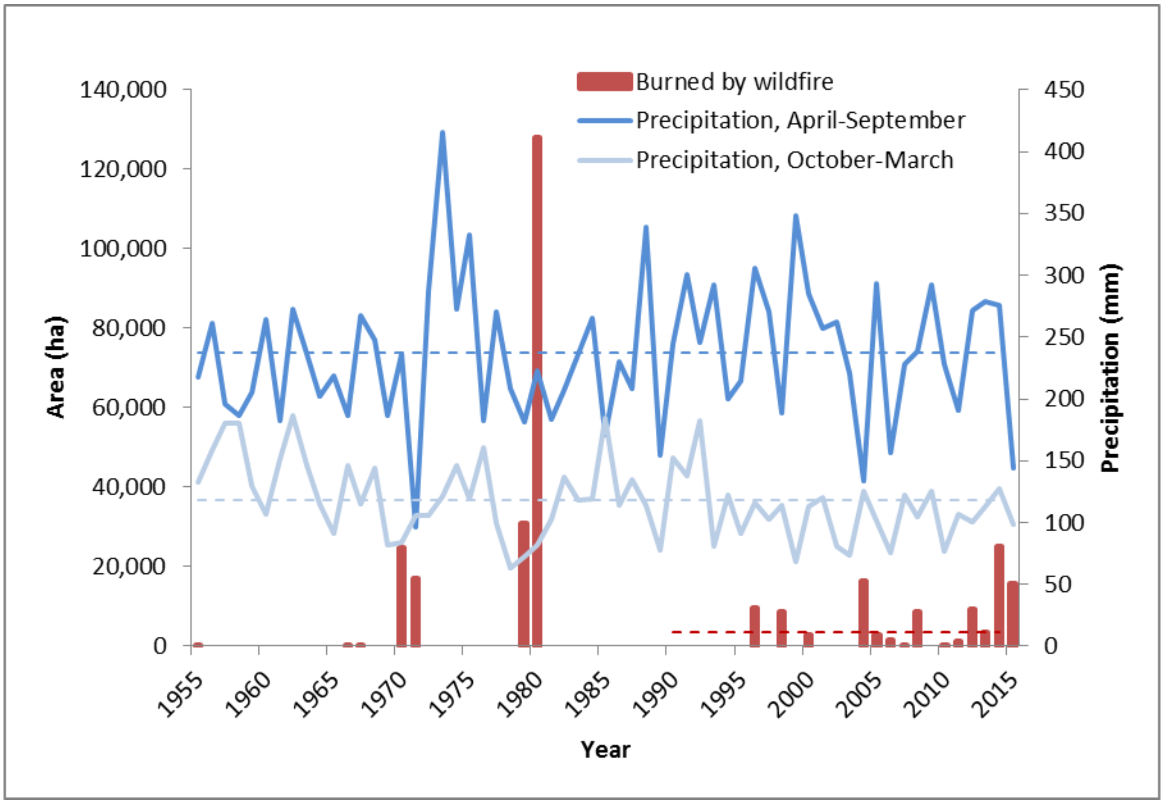


Figure 2. The location and extent of wildfires that occurred in and adjacent to Wood Buffalo National Park in summer 2015, in relation to the area identified as critical habitat.

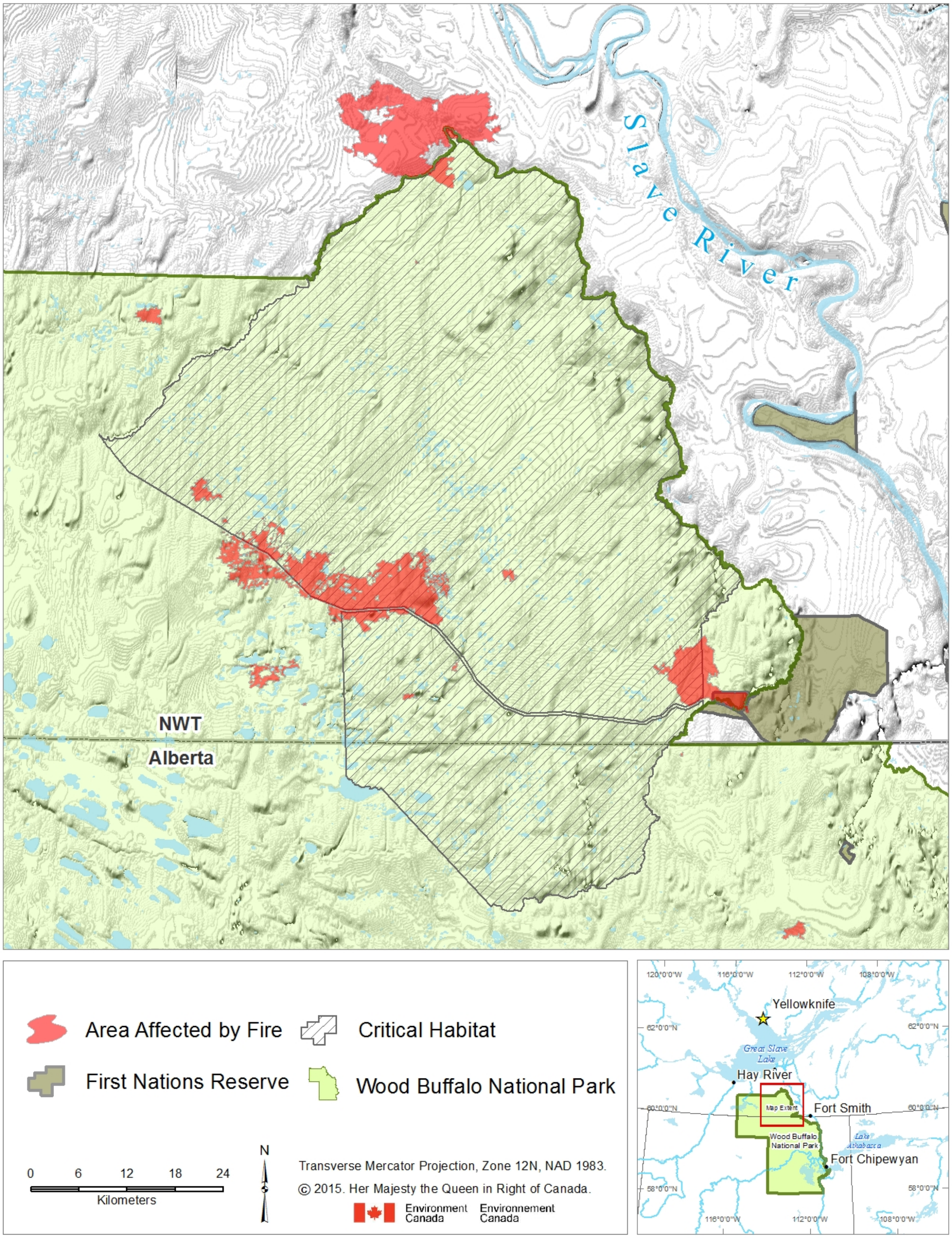


Figure 3. The density per 10 km^2 of whooping crane pairs, with and without nests, detected during the breeding pair survey in May 2015.

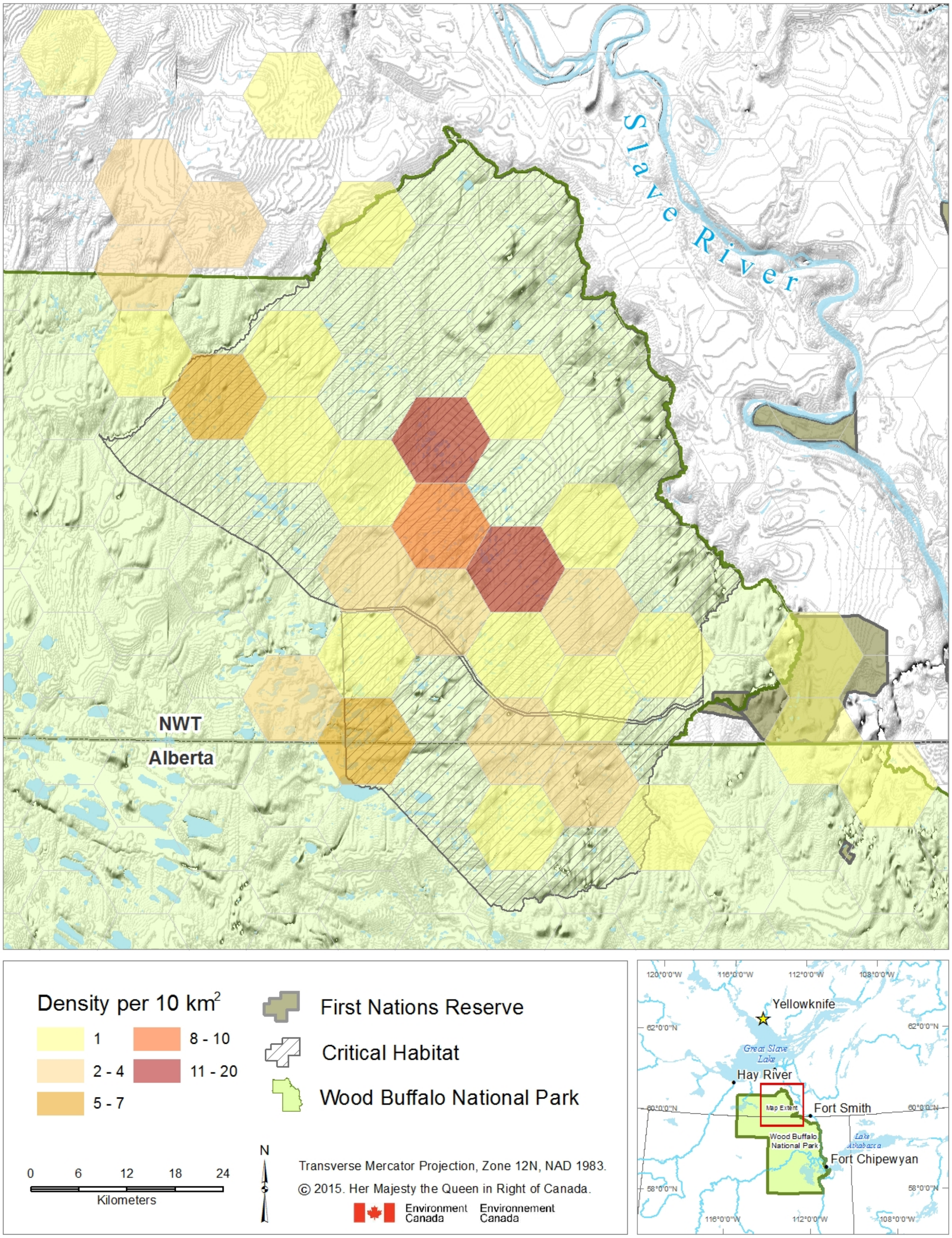
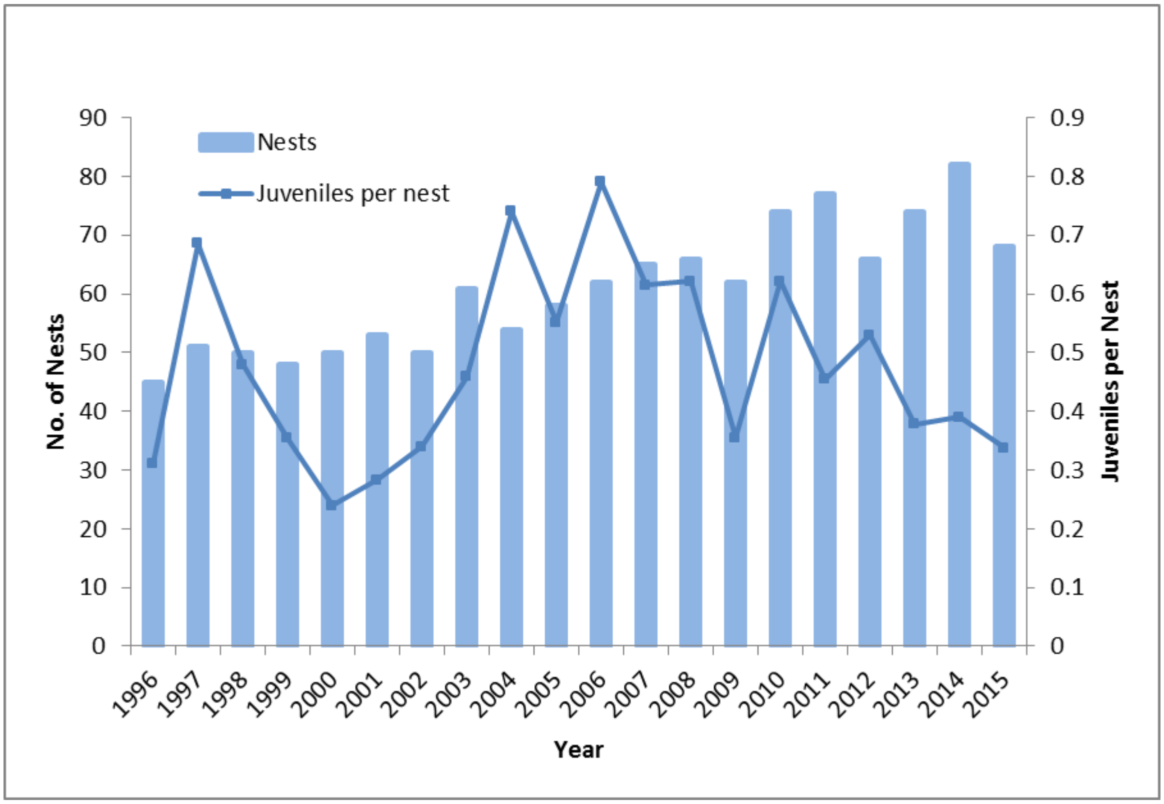


Figure 4. The number of whooping crane nests, and juveniles per nest, detected during aerial surveys from 1996-2015. The number of nests and juveniles are estimated during breeding pair (April-May) and juvenile (July-August) surveys, respectively; the number of juveniles per nest is calculated using information from both surveys.



APPENDIX 1

Photo 1. Low water conditions in the Klewi nesting area, 10 Aug 2015. Photo: John McKinnon, Parks Canada Agency.

Photo 2. Pair of whooping cranes with a juvenile in a near-dry pond in the Sass nesting area, 9 Aug 2015. Photo: Sharon Irwin, Parks Canada Agency.

2015-2016 Louisiana Whooping Crane Report

Louisiana Department of Wildlife and Fisheries

Coastal and Non-game Resources

1 July 2015 to 30 June 2016

15 September 2016

TABLE OF CONTENTS

LIST OF TABLES iii

LIST OF FIGURES iv

EXECUTIVE SUMMARY 1

RECENT COHORT SUMMARIES, PEN MANAGEMENT, AND SOFT RELEASE 2

COHORT DISTRIBUTION 4

USE OF TEXAS HABITAT BY CRANES IN THE LOUISIANA POPULATION 4

MOLTING 6

CAPTURES 6

PAIRING AND REPRODUCTION 6

MORTALITY, MORBIDITY, AND HEALTH ISSUES 10

EDUCATION, OUTREACH, AND MEDIA 13

RESEARCH PRODUCTS 14

APPENDIX 28

LIST OF TABLES

Table 1. Distribution of location data points collected via remote transmitter devices for the Louisiana non-migratory Whooping Crane population, 1 July 2015 – 30 June 2016. Numbers in parentheses indicate percentage of total points 15

Table 2. Total number of nights spent in Texas by individuals in the Louisiana non-migratory population, 1 July 2015 – 30 June 2016 15

Table 3. Summary of captures of free-flying Whooping Cranes in the Louisiana non-migratory population, 1 July 2015 – 30 June 2016 16

Table 4. Nesting and renesting attempts of Whooping Crane pairs in the reintroduced Louisiana non-migratory population, 2014 – 2016..... 17

Table 5. Nest monitoring data compiled for the Louisiana non-migratory Whooping Crane population, 2014 – 2016. Monitoring sessions consisted of 3-hr observation periods alternated among 3 time periods – morning, midday, and late afternoon 18

Table 6. Maximum post-release survival of each cohort through 30 June 2016. Green shaded cells represent current survivorship of last five cohorts..... 19

LIST OF FIGURES

Figure 1. Locations of reintroduced Whooping Cranes in Louisiana and Texas, 1 July 2015 – 30 June 2016 20

Figure 2. L11-12 (on right) missing secondary feathers on each wing prior to molting in 2016 21

Figure 3. Approximate locations of reintroduced Whooping Crane pairs that nested in 2016 22

Figure 4. Nest camera photo of L8-11 incubating despite disturbance from crawfish boat during routine farming operation (Avoyelles Parish) 23

Figure 5. First family – parents, L6-12 & L8-13, with newly hatched chicks LW1 & LW2-16 on 13 April 2016 (crawfish pond, Jefferson Davis Parish) 24

Figure 6. New Whooping Crane mascot, 'Mac' 25

Figure 7. New table display sign comparing Whooping Crane height to that of two egret species commonly found throughout Louisiana 26

Figure 8. Billboard design used again in fall 2015 26

EXECUTIVE SUMMARY

The Whooping Crane reintroduction program in Louisiana reached an important milestone this year with the successful hatching of two chicks. This marked the first time in over 75 years that Whooping Crane chicks hatched in the wild in Louisiana. As expected, we observed an increase in nesting activity during the 2016 breeding season, with five pairs producing nine nest attempts. The majority of nest attempts in 2016, including the successful nest, occurred on actively farmed crawfish ponds. We remain encouraged at the ability of the cranes to incubate nests to full term despite ongoing farming operations and by the cooperation of the crawfish farmers who grant us access to their properties so we may monitor nests. As a result of the nest locations, we were able to monitor all nest attempts this year for a total of 123 observation hours. Additional monitoring efforts were achieved through the use of trail cameras deployed at several nests that photographed the nest area throughout the day and night.

The maximum size of the Louisiana non-migratory population at the end of the reporting period was 36 adult birds (14 males, 22 females), with 30 birds in Louisiana, 4 in Texas, and 2 long-term missing. We continue to monitor crane locations via remote monitoring devices, which remain a critical tool for tracking a highly mobile population. During this report period, we documented cranes utilizing areas in 16 parishes in Louisiana and 15 counties in Texas. The time spent in any one county/parish is highly variable not only in terms of length of stay but also by cohort affiliation. However, the majority of all locations (~83%) occurred within five parishes – Allen, Avoyelles, Cameron, Jefferson Davis, and Vermilion. Currently, the population has a 48% survival rate (36 out of 75 individuals). Survivorship after one year continues to be high for the 2011-2015 cohorts (70-75% survival). However, we did observe an increase in mortality among older birds during this report period compared to last year, and unfortunately, four mortalities were the result of deliberate shootings.

Public education remains a high priority of the reintroduction program with staff participating in over 40 festivals and public outreach events. A major focus of the education efforts centered on three professional development workshops attended primarily by middle and high school teachers from Louisiana. In addition, outreach efforts expanded to include the use of social media as a method to provide the public with frequent and timely news and information. The Whooping Crane public awareness media plan for 2015-2016, funded by a grant from Chevron, included the use of billboard space provided by Lamar Advertising and radio commercial space purchased through the Louisiana Association of Broadcasters. New markets were targeted with billboards including north Louisiana (Monroe area) and southeast Louisiana (New Orleans area). The billboards were estimated to reach more than 900,000 views per week. Radio ads were broadcast over 5,000 times across Louisiana and into portions of Mississippi.

We committed resources to the construction of a new release pen that was completed in October 2015. The pen was built in a recently refurbished 90 acre unit on the Rockefeller Wildlife Refuge. Except for a change in fencing material the pen is identical to the one successfully used since 2011 at the White Lake Wetlands Conservation Area. The addition of a second release pen will enable us to accommodate multiple cohorts and provide us with more flexibility in managing future releases. We remain steadfast in our goal to establish a self-sustaining, non-migratory Whooping Crane population in Louisiana and will continue to engage other agencies, corporate partners, private landowners, and the general public to succeed in this endeavor.

RECENT COHORT SUMMARIES, PEN MANAGEMENT, AND SOFT RELEASE

2014 Cohort

Females L9 & 11-14, who had been in northeast Louisiana since mid-April 2015, returned south to Vermilion Parish by 30 July. They spent several days on private land just north of the White Lake Wetlands Conservation Area (hereafter WLWCA) before moving to farm land in Jefferson Davis Parish. During a routine aerial survey on 26 August, L11-14 was observed at this location and appeared to be injured and incapacitated. She was picked up and taken to a local veterinarian to be euthanized due to the severity of her injuries. (See Morbidity and Mortality section for additional details.) Her companion, L9-14, returned to the refuge at WLWCA several times, spending a few days there before returning to Jefferson Davis Parish each time. Unfortunately, her remains were found on 25 September at a farm close to where she had spent time with L11-14.

The trio of L5, 6, & 10-14 spent several months during the spring and summer of 2015 in Jefferson Davis and Allen parishes in the vicinity of several older cranes. In mid-September, they began associating more closely with males L3 & 6-13. On 22 September, all five returned to the WLWCA refuge then went back to their previous location in northern Jefferson Davis Parish several days later, and were joined by female L8-12, who was previously alone. Males L3 & 6-13 separated from the group on 29 October when they returned to WLWCA. L3-13 remained at WLWCA while L6-13 returned north a couple of days later and rejoined L5, 6, & 10-14 and L8-12 in Jefferson Davis Parish on 8 November. They spent the next few weeks on farm land in southern Jefferson Davis Parish before returning to a prior location in the northern part of the parish on 4 December. This group of five spent the better part of the next two months in Jefferson Davis and Allen parishes until L5, 6, & 10-14 and L6-13 returned to WLWCA on 3 February (L8-12 remained behind). They moved just across the Louisiana-Texas border into Newton County on 7 February. Their stint in Texas was brief as they returned to Jefferson Davis Parish the following day. On 29 February, male L6-14 was found with a badly fractured leg and was subsequently euthanized (see Morbidity and Mortality section below). The remaining group members, females L5 & 10-14 and male L6-13, returned to WLWCA on 4 March but soon went back to Jefferson Davis Parish. Over the next several weeks, they made frequent movements around southwest Louisiana and a couple of forays into Texas that included stops in Hardin, Newton, Sabine and Smith counties. In early May, L5-14 separated from L10-14 and L6-13 leaving them as a potential breeding pair.

Males L3 & 4-14 also spent some time last summer in southeast Texas. During that time L3-14's GSM/cell transmitter did not work well and data transmissions were sparse. New location data received on 26 August indicated he was in Louisiana and he was observed with female L8-14 at WLWCA the following day. (Backlogged data transmitted on 23 September indicated L3-14 had actually returned to Louisiana on 25 June 2015.) Since then they have been close associates, primarily utilizing farm land near the border of Cameron and Vermilion parishes, with occasional return trips to WLWCA. Unfortunately, L4-14 was last observed on 3 June and his transmitter stopped working after 8 June 2015. With no additional data or observations and the return of L3-14 to Louisiana, L4-14 was presumed dead and removed from the population totals.

Female L7-14 was observed during an aerial survey on 23 March 2015 at WLWCA and her platform transmitter terminal (hereafter PTT or satellite transmitter) failed on 14 June 2015. Despite repeated attempts to relocate her, we were unable to do so and after a significant period of time without location data or visual observations she was presumed dead. Fortunately, this was not the case. L7-14 was seen near the release pen on 23 January and her GPS transmitter was replaced two days later. She associated closely with male L13-14 until 29 April when he left WLWCA. L7-14 remained at WLWCA, mostly by herself in the northwest corner of the refuge, until the end of May. At that time she moved to farm land in Cameron Parish near L3 & 8-14. By the end of the report period, she had moved to private marshland in Jefferson Davis Parish near the Mermentau River.

From July through December 2015, four cranes (L1, 12, 13, & 14-14) inhabited areas in Jefferson County, Texas southwest of Beaumont. They utilized mostly crawfish and rice fields as well as pasturelands. On 19 December, male L12-14 separated from the group and on 29 December he returned to WLWCA (having returned to Louisiana the previous day), spending time in and around the release pen. Sadly, female L1-14 and male L14-14 were intentionally shot and killed in Jefferson County on 11 January. Male L13-14 survived the shooting and returned to Louisiana several days later, arriving at WLWCA on 17 January. L12 & 13-14 then rejoined one another and moved to farm land in Cameron Parish. They were together until L13-14 went back to WLWCA on 8 February where he soon began associating with female L7-14. Female L10-13 joined L12-14 in Cameron Parish shortly after L13-14's departure. L10-13 & L12-14 made several return trips to WLWCA over the following weeks. In early May, they left WLWCA, apparently with L13-14, and returned to Cameron Parish. All three moved west to the Jefferson County, Texas location on 7 May where they remained a trio through the end of the report period.

2015 Cohort

The 2015 Whooping Crane cohort (n = 11; 3 males, 8 females) was transported on 3 December from the Patuxent Wildlife Research Center (PWRC) in Maryland to Louisiana. Once at the WLWCA release site, each bird was unloaded and examined by state wildlife veterinarian, Dr. Jim LaCour, before being released into a small, temporary section of the 100 foot diameter top-netted section of the pen. On 7 December, they were banded with their permanent colored leg bands and transmitters . All birds received a remote tracking device (Microwave Telemetry GSM/GPS or a GPS PTT) and six birds also received VHF transmitters. After banding, the temporary fence was rolled back and the birds were given access to the entire top-netted pen. Food was provided in gravity feeders and the birds were checked daily.

On 29 December, the birds were released into the 1.5 acre open pen and allowed to begin exploring the surrounding marsh. One female (L1-15) split from the group that day and moved east of the canal adjacent to the pen but was still within 200 m of her cohort. She rejoined the cohort at the pen on 7 January. Supplemental food was provided in the open pen and the birds continued to be checked each day. Evening roost checks, consisting mainly of observing and documenting where birds settled for the night, were conducted on 14 consecutive nights after the birds were released. Given the adequate roosting habitat surrounding the pen, little effort was made to encourage them to roost inside the pen.

Again, several birds from prior cohorts returned to WLWCA around the time the new cohort arrived and many remained at or in the vicinity of the pen after the juveniles were released from the top-netted section, so there were frequent interactions between juveniles and adults. Several pairs of adults were successful in driving the juveniles out of the pen or preventing them from accessing the feeders necessitating an adjustment to our management of the supplemental food. In order to encourage the adults to leave and not become territorial over the pen, the feeders at the platform were removed periodically. Costumed caretakers provided direct access of food to the juveniles and prevented adults from interfering with them at feeders daily. The juveniles remained in the area and eventually most of the adults moved elsewhere in the marsh or left the area entirely. With time the juveniles gained confidence and were later able to defend themselves, the pen, and the feeders from some older birds. We discontinued providing supplemental food after 10 February and allowed it to run out over the next few days. Shortly thereafter, most juveniles spent the majority of time in nearby Unit 3, which is referred to as the east side marsh and consists of >28,000 acres of unimpounded freshwater marsh.

Although the presence of the adults created management challenges, it also created opportunities for interactions and new associations between various adults and allowed us chances to observe those interactions. As predicted, there were numerous opportunities to capture adults in order to replace their old or failed transmitters with new ones and we did so on multiple occasions.

On 22 February, transmitter data for L1-15 indicated possible mortality and we found her isolated, weak, and unable to fly. Because of her poor condition and ongoing respiratory illness, the decision was made to have her euthanized. (See Morbidity and Mortality section below for more details.)

Female L4-15 split from the main cohort on 18 February and moved the following day to privately owned marsh just east of WLWCA. She returned to WLWCA a day later and rejoined the other juveniles but then moved to marsh in Cameron Parish near the WLWCA western boundary. She remained in this area for several days before returning to Unit 3 on 4 March, however data indicates that she did not rejoin her cohort. She was last observed during an aerial survey on 29 February and no data have been received from her transmitter since 9 March. She is currently classified as long-term missing but is still counted in the population totals.

During an aerial survey of WLWCA on 22 March, two loosely associated groups were observed in Unit 3. One consisted of male L7-15 with females L8, 9, 10, & 11-15. The other group consisted of males L2 & 3-15 with females L5 & 6-15. The latter group left WLWCA on 14 April and settled on farm land in Acadia Parish. Unfortunately, L3 & 5-15 were shot and killed at this location on 20 May. L2 & 6-15 moved to another farm a few miles east in Acadia Parish on 22 June where they remained as of the end of the report period.

Female L9-15 was last observed on 5 May at WLWCA during an aerial survey and no location data have been received since 21 May. She is currently classified as long-term missing but is still counted in the population totals. Female L10-15 left the refuge on 12 May and moved to private land a few miles north of WLWCA where she remained by herself as of the end of the report period. The remains of male L7-15 were found ~100 m south of the release pen along a canal levee on 26 May. Females L8 & 11-15 were the last of the 2015 cohort to leave WLWCA, doing so on 6 June. They spent several days on private land just north of WLWCA before continuing to northern Jefferson Davis Parish on 19 June. After a couple of days they moved to ag fields in the southern part of Evangeline Parish then continued in a northeast direction on 24 June settling on a farm in St. Landry Parish where they remained as of the end of the report period.

COHORT DISTRIBUTION

Crane movements were monitored weekly through the use of remote monitoring devices. During this report period, two types of remote transmitters were deployed on the cranes. Most cranes (n=36) had Microwave Telemetry GPS satellite transmitters and a smaller number (n=8) received Microwave GSM transmitters. Two additional cranes started the reporting period with GPS satellite transmitters which failed and were replaced with GSM transmitters. The satellite transmitters are programmed to collect data at three time periods every day (8AM, 4PM and midnight local time) and transmit the data every 48 hours. GSM transmitters collect numerous points throughout the day and transmit data when cranes are within range of cellular towers for a long enough period of time to establish a strong connection. Only data points that match those collected via the GPS satellite transmitters as closely as possible are included in the analysis. When GPS data were unavailable, high quality Doppler readings were used to indicate location. These readings are included in the distribution information.

Of the more than 22,000 data points transmitted by remote monitoring devices between 1 July 2015 and 30 June 2016, 89.2% were located in Louisiana, mainly occurring within five parishes (Table 1, Figure 1). Figures for hatch year (HY) 2015 birds are skewed in favor of Vermilion Parish because new cohorts are released at WLWCA and remain close to the release pen for a period of time (usually a few months) before making exploratory movements into other parishes. The remaining 10.8% of data points occurred in Texas with HY2014 cranes spending the most time there.

Eastern Migratory Population (EMP) Crane No. 20-15

EMP no. 20-15 was part of the eastern migratory population's parent-reared release in the fall of 2015. Whooping Cranes in this program are reared by adults in captivity and released at the Necedah NWR in Wisconsin near pairs of older birds. After leaving Necedah shortly after release, no. 20-15 ended up in Dubuque, Iowa, in a location with lots of human activity. He was captured by staff from the International Crane Foundation on 13 October and released back in Wisconsin. He moved the day after he was re-released, flying south into Illinois and then continuing south into Louisiana (see Figure 1). On 17/18 October, no. 20-15 arrived NE of Tallulah, East Carroll Parish, Louisiana. He moved south into Madison Parish on 19/20 October and into Pointe Coupee Parish on 8/9 November. On 22/23 November, he continued south into St. Martin Parish where he remained for the rest of the winter. He began spring migration north on 27/28 March, roosting in Concordia Parish and departed Louisiana on 29/30 March after spending over 5 months in the state.

USE OF TEXAS HABITAT BY CRANES IN THE LOUISIANA POPULATION

Some individuals from each of the first five cohorts have made short, exploratory trips into eastern Texas but typically returned to Louisiana within several days. This is likely to continue as young birds tend to move around and explore new areas before settling down, and the Texas border is less than 80 miles from our release pens at WLWCA and the Rockefeller Wildlife Refuge.

Beginning in 2013, a small number of birds spent a significant amount of time in Texas. Initially, this consisted of seven members of the 2012 cohort who spent approximately six months in areas around Dallas before returning to Louisiana in the fall. A smaller number of those original seven HY2012 birds have continued to return to the same areas each year. Additionally, in 2015 four HY2014 birds spent an extended amount of time in areas around Beaumont, moving there in the spring and remaining through the end of the year. Unlike the areas around Dallas, much of the habitat in southeast Texas consists of rice and crawfish fields which is similar to the landscape found in southwest Louisiana. Unfortunately, two of the birds near Beaumont were shot and killed in January. The remaining birds separately returned to Louisiana but later joined back up and returned to their previously used areas near Beaumont along with a HY2013 female.

Eleven individuals from the Louisiana population were recorded in Texas during this report period; four of whom (L6 & 10-13; L5 & 10-14) had not been documented in the state previously. Details by bird and groups of birds can be found below and in Table 2.

L5-12 (female)

- History of spending extended time in Texas in 2013, 2014, & 2015
- Left Denton County, TX on 26 August – 1 September, roosting 55 miles E in Hunt County
- Moved slightly E in the same county on 17 September
- Continued SE on 18 September, roosting near the border of Shelby/Panola counties, TX
- Returned to Louisiana (Acadia Parish) on 19 September and then to WLWCA in early December
- Current status/location is unknown due to failure of her PTT after 20 February 2016

L6-12 (female)

- History of spending extended time in Texas in 2013, 2014, & 2015
- left Ellis County, TX on 15 October, roosting 115 miles SE in Nacogdoches County, TX that night
- Returned to Louisiana (Jefferson Davis Parish) on 16 October
- Paired with male L8-13 by 24 January and set up territory in Jefferson Davis Parish where they nested and hatched 2 chicks
- Unlikely to return to Texas in the future for an extended amount of time

L8-12 (female)

- History of spending extended time in Texas in 2013 & 2014
- Left Evangeline Parish, LA on 28 March – 2 April, arriving in Hardin County, TX and remained here through at least the morning of 11 April
- Returned to Louisiana (Jefferson Davis Parish) by 22 April
- Departed Allen Parish, LA on 28 April, roosting in NW Henderson County, TX that night
- Moved slightly NW to the border of Kaufman/Ellis counties, TX by the morning of 3 May and remained here through at least the morning of 11 May
- Moved ~70 miles NNW to southern Grayson County, TX on 11/12 May where she remained through the end of the reporting period

L6-13, L5 & 10-14 (1 male, 2 females)

- Left Jefferson Davis Parish, LA on 20 March, roosting in Newton County, TX that night
- Returned to Louisiana (Jefferson Davis Parish) the following day
- Left Vermilion Parish, LA on 3 April, flying into Hardin County, TX, but turned back towards Louisiana and roosted in Newton County, TX that night
- Returned to Louisiana (Allen Parish) on 4 April
- Left Vermilion Parish, LA on 23 April, roosting in Smith County, TX that night
- Moved 100 miles SE to Sabine County, TX for roost on the night of 24 April
- Returned to Louisiana (Allen/Jefferson Davis Parishes) on 25 April

<u>L10-13, L12 & 13-14</u> (1 female, 2 males)

- L12 & 13-14 have a history of spending extended time in Texas in 2015
- left Cameron Parish, LA on 7 May, traveling to Jefferson County, TX where they remain

<u>L1, 12, 13 & 14-14</u> (2 males, 2 females)

- Began the reporting period in Jefferson County, TX
- Male L12-14 separated from the group on 19 December and returned to Louisiana (St. Landry Parish) on 28 December
- Female L1-14 and male L14-14 shot in Jefferson County, TX on 11 January
- Male L13-14 returned to Louisiana (Cameron Parish) on 13 January
- L12 & 13-14 have since returned to this area (see above)

MOLTING

Although we did not visually confirm any birds molting during spring/summer 2015, there were a number of birds who could have molted and a few are suspected to have molted. Based on lack of movement, we suspect that L3-13 and/or L6-13 may have molted but neither was captured and handled to examine the condition of their feathers. Therefore, their recent molt status could not be confirmed. During winter captures the feather condition of L6-12 and L14-12 indicated both of these birds had recently molted. L14-12 had a non-functional transmitter and his location and status was unknown for a number of months so the timing and location of where he molted will remain unknown.

During spring/summer 2016, we documented seven birds molting, ranging from 3-5 years of age (L1, 6, & 11-11, L11-12, L8-13 and at least one of the members of the following pairs: L7 & 8-11 and L3-11 & L1-13). This was the second known molt for several of the five year olds and the first known molt for the remaining birds. Molting was confirmed through visual observation of birds with missing or new, growing feathers, as well as lack of movement, change in behavior, discovery of molted feathers, or visual confirmation of new feathers once birds were able to fly again. In two instances involving pairs, we know at least one bird in each pair molted (L3-11 and/or L1-13 and L7 and/or 8-11). It is also possible that both members of the pairs molted. Some of these birds will likely be handled this winter for transmitter replacement, allowing us the opportunity to examine their feather condition.

In April 2015, L11-12 was confirmed to be missing quite a few secondary feathers on each wing, but never appeared to have trouble flying. During capture for transmitter replacement at the WLWCA pen on 30 December, her wings were closely examined and she was found to have five secondaries broken off several inches from the base on her left wing and 10 secondaries missing from her right wing (Figure 2). One feather that was broken and barely attached was cut off and sent for testing which revealed fungal growth though the cause and significance remain unknown. She was observed with complete sets of secondaries on each wing after completing her molt.

CAPTURES

On 24 days of attempts, 19 captures were made during the report period (16 for transmitter/band replacement; 3 due to injury). Thirteen captures were made by hand and six were via a leg noose. Six were conducted at the WLWCA pen site while the 2015 juveniles were still present and being provided supplemental food. Additional capture information is presented in Table 3.

Additional information (e.g., individual band colors, etc.) on surviving reintroduced Whooping Cranes is summarized in the Appendix.

PAIRING AND REPRODUCTION

Nesting activities in 2016 included ten potential breeding pairs (with another pair forming later in the spring) and nine nesting attempts by five pairs. Nesting took place in three parishes (Allen, Avoyelles, and Jefferson Davis) in central and southwestern Louisiana (Figure 3). Details of nesting, reproduction, and nest monitoring are presented below and in Tables 4 and 5.

Nest Monitoring

During the breeding season (February through late June) known and potential pairs were monitored for signs of reproductive behavior including pair formation, territory establishment, copulation, nest building, and egg laying. Once an active nest was located, it was monitored several times throughout the incubation period. After the nests concluded, data was collected at the nest, at any additional platforms constructed in the territory, and at randomly selected points in the territory. Data collected include nest dimensions, water depths, percent open water around the nest, plant species near the nest, plant height, visual obstruction readings, and nest coordinates. Any unhatched eggs were also collected and measurements were taken. The eggs were later examined to determine fertility and the approximate age of any embryos.

In 2016, a total of 41 nest monitoring sessions (123 observation hours) were conducted on the nine nest attempts (Table 5). As in previous years, nest monitoring was alternated among three time periods – morning (0700 – 1000 hrs.), midday (1100 – 1400 hrs.), and late afternoon (1500 – 1800 hrs.). The amount of time an adult spent at the nest was recorded and detailed notes were made on the behavior of the incubating adult, as well as that of the non-incubating adult and its distance from the nest. General habitat conditions, weather, potential predators, bird species in the nest vicinity, and any disturbances were also documented. Beginning in 2016, trail cameras were tested and used to supplement monitoring efforts and were deployed at six nests. Cameras were attached to a metal post positioned, on average, 17.8 m from the nest and programmed to photograph the nest every minute.

Overall, the mean nest attendance time was 2 hr. 52 min per 3 hr. observation period. Female nest attendance averaged 1 hr. 39 min while males averaged 1 hr. 13 min. Total incubation (i.e., time spent sitting on eggs) was not significantly different for either sex (female avg = 1 hr. 36 min; male avg = 1 hr. 9 min).

The earliest 1st nest attempt of the season was initiated on 12 February, which is the earliest nest attempt by approximately two weeks for the Louisiana non-migratory population. In comparison, the latest 1st nest attempt was initiated around 1-4 April. Four of the five 1st nest attempts did not hatch any chicks, although fertile eggs were produced by two additional pairs. One pair (L7 & 8-11) continues to produce infertile eggs. A newly formed pair (L6-12 & L8-13) successfully hatched two eggs and raised both chicks to approximately one month of age and one chick to fledging age. There were four 2nd nest attempts (renests), the earliest of which was initiated on 8-11 April. The latest renest was initiated on 18-19 May. Unfortunately, none of the renests resulted in hatched chicks. The average number of days between 1st and 2nd nest attempts has been 20.3 days.

The majority of nests (7 of 9) produced in the 2016 nesting season were located in actively fished crawfish ponds in Allen, Avoyelles, and Jefferson Davis parishes (Figure 3), including the successful nest attempt by L6-12 & L8-13. Furthermore, 11 of 16 nest attempts since 2014 have been located in crawfish ponds. The timing of crawfish production in Louisiana coincides with the Whooping Crane breeding season, and crawfish ponds are typically maintained at constant water levels that are well-suited to their nesting requirements. More investigation into nest-site selection is warranted but it is not surprising that several pairs have chosen to nest in these areas given the reliable source of shallow water and available food supply. In addition, it has been encouraging that no nests so far have been abandoned due to farming operations and farmers have been able to continue their routine without interference from nesting cranes (Figure 4).

Chick Hatch and Monitoring

On the morning of 11 April, the behavior of L6-12 and L8-13 did not indicate any change in the status of the nest and eggs but later that evening a newly hatched chick was observed. The following morning the chick was observed moving around on the nest as the adults continued to take turns incubating the second egg and caring for their new chick. During a check on the afternoon of 13 April, a second chick was observed, not quite as mobile, but already dry and moving around. Daily checks on the new family continued during the first week and on 15 April the family was observed in the southeast corner of the field, estimated to be over 350 m from the nest. After the first week, the family was typically checked and observed three times per week. By 29 April, we observed a noticeable difference in the size of the two chicks though we had not observed any difference in behavior or fighting between them and had always observed the adults being equally attentive to both. Both chicks were last observed on 11 May, but only one (LW1-16) was seen on the 13th. On 25 May, an abnormality of LW1-16's left wing was observed – see Morbidity section below for additional details. Transmitter data from the adults indicated they continued to use their nest to roost in the evening through the end of May though they did later build a new roosting platform in a different section of the field and were seen using it by 24 June. It was the only additional platform seen in the field so the family likely began using it when they stopped using the nest though we were not able to confirm through observations or transmitter data. Finally, using transmitter data points, we estimated that the family used approximately 49 acres during the first month after the chicks hatched. The area used by the family increased as the surviving chick grew and was up to approximately 114 acres by the end of the report period when LW1-16 was ~2.5 months old. The areas used by the family consisted of a large, actively fished crawfish pond, the levees and field roads bordering this field, a dry, fallow field immediately south of the nest field that held shallow water following rainfall, and a second crawfish field immediately to the east of the nest field that was drawn down and provided shallower water and mud flats and was later planted with rice.

Pair Information

L1 & 6-11

- Paired since January 2015
- Copulation attempt observed 24 February 2015 in the WLWCA release pen
- Nested for the first time in ~early April 2015 at WLWCA
    - nest flooded - 2 eggs produced; 1 intact – fertile but early dead embryo and 1 eggshell piece
- Did not find evidence of nesting in 2016 (birds spent all spring at WLWCA but transmitter data were lacking so only observed during periodic flights and not seen with or near a nest during any of those observations)

L2 & 13-11

- Paired since late April 2015
- Nested for the first time in Allen Parish in 2015
    - built multiple platforms in April; found incubating mid-May – number of eggs unknown and birds no longer incubating and only one piece of eggshell found on 12 June – cause of failure unknown
- Nested on same farm in Allen Parish early-mid March 2016
    - abandoned nest due to human disturbance (nest camera deployment); single fertile but already dead egg collected (late dead embryo)
- Renested early-mid May 2016 but nest failed or abandoned by 6 June
    - 1 intact, infertile egg found, eggshell from 2nd egg found in water near nest and on nest

L3-11 & 1-13

- Paired since early-mid May 2015
- Nested for the first time in Allen Parish in 2015 but abandoned for unknown reasons
    - 2 eggs produced; 1 intact – fertility undetermined (therefore likely infertile), 2nd missing
- Nested in new location but within previously used areas in Allen Parish 2016
    - nested ~3 months earlier than 2015; sat past full term; 2 eggs produced – 1 middle dead embryo & 1 late dead embryo
- Renested 2-3 weeks later; sat past full term but then abandoned; 2 eggs produced – 1 missing, 2nd fertile (late dead embryo) found in water near nest

L7 & 8-11

- Paired since late December 2013
- Nested for the first time in Avoyelles Parish in 2014
- Nested again in 2015 and 2016 on the same farm in Avoyelles Parish, each time in an active crawfish field
- Renested each year 18 days after the eggs from the first nest were collected
- Incubated past full term with each nesting and renesting attempt

- Produced 2 eggs in each clutch – 11 that were recovered were determined to be infertile (one egg from the renest in 2016 was apparently broken during the first 2 weeks of incubation (not present when nest camera deployed on 6 May, and the shell was found buried in the nest during the nest closeout data collection)

L10 & 11-11

- Paired since late December 2013
- Built a nest platform in the refuge at WLWCA in spring 2015 but no eggs were produced
- Nested for the first time in Jefferson Davis Parish in 2016
    - built several nest platforms on private property in Jefferson Davis Parish in March 2016
    - nested in an active crawfish field in Jefferson Davis Parish in early April 2016, incubated full term but egg disappeared
- Renested ~2 weeks later, incubated past full term, single egg was collected and determined to be infertile

L1 & 7-12

- Paired since spring 2014
- Copulation attempts observed 21 January (private property, Cameron Parish) and 11 February 2015 (WLWCA release pen)
- No nest building or nesting activity documented to date
- Pair is full siblings

L6-12 & 8-13

- Paired as of 24 January 2016
- Nested for the first time in 2016
    - observed nest building on 11 March 2016
    - found incubating on 14 March 2016
    - hatched 2 chicks on 11 & 13 April (Figure 5)
        - successfully reared both chicks for 1 month before one of them disappeared
        - successfully reared remaining chick to fledging (fledging = ~90 days = ~11 July 2016)

L11-12 & 3-13

- Paired as of early November 2015 (pair separated for ~1 week in February)
- No nesting activity documented

L2 & 14-12

- Paired as of 5 March 2016
- Observed actively building a nest platform in the WLWCA hunting marsh during a flight on 19 April
- No additional nesting activity documented

L12-12 & 7-13

- Paired in March 2016
- No nesting activity observed
- Both members of the pair died in late June-mid July 2016

L6-13 & 10-14

- Paired as of 5 May 2016
- Observed building nest platforms in crawfish field in Jefferson Davis Parish in July 2016; 3 platforms later confirmed

MORTALITY, MORBIDITY, AND HEALTH ISSUES

Overall survival continues to be satisfactory and generally appears to level off after the initial months following the release of juvenile cohorts (Table 6), though we did have higher mortality among older birds during this report period compared to last year. As transmitters fail it will become increasingly difficult to keep track of every individual and our certainty about the size of the population and the survivorship of the various cohorts will not be as strong. Unfortunately, shooting continues to be a problem for Louisiana Whooping Cranes with four birds shot and killed during the report period. Three past cases remain unsolved including the most recent case from May in Acadia Parish. Fortunately, the case from January in Jefferson County, Texas was solved, prosecuted, and is now in the sentencing phase. Below is a summary of mortalities observed throughout the reporting period.

Total survivorship for all cohorts is 48% (36 out of 75), but one year survivorship has increased dramatically since the first cohort (Table 6). Ten mortalities are attributed to wanton shooting by people (25% of mortalities), 10 to presumed predation (25%), 4 birds were euthanized due to illness or injury (10%), 2 to power line collision (5%), 1 to disease (2.5%), and 12 for unknown causes, primarily due to the remains not being recovered (31%).

Whooping Cranes that are handled for any reason (primarily transmitter change) receive a cursory physical examination and samples are obtained for the following routine tests: fecal parasite examination, cloacal culture, complete blood count, serum chemistry, and serological testing for Inclusion Body Disease of Cranes (IBDC). To date, fecal examinations have detected *Capillaria* spp. (nematodes) and *Salmonella* Litchfield was cultured from the cloaca of L6-11 but was not causing disease. IBDC tests have been negative and the only hematological abnormality detected has been an eosinophilia possibly attributable to parasite infestation. Fifteen birds were caught for transmitter replacement between October 2015 and April 2016 with samples (blood and/or feces) collected from 14 of them. Though our sample size is still relatively small these samples continue to add to what we know about the health of this population. Additionally, extra serum and blood samples are saved for future testing, research, or disease screening.

Mortality

L14-11 – Mortality unconfirmed, missing and presumed dead. Last observed by LDWF staff in Allen Parish 31 March 2015 and by a local landowner in Vernon Parish ~20 May 2015. Transmitter failed after 19 May 2015. After one year with no subsequent data or observations she is now considered dead and was removed from the population total in spring 2016.

L12-12 – Non-functional PTT. Last observed alive with mate in WLWCA refuge during a tracking flight on 23 June. Remains recovered 18 July after mate's PTT stopped functioning. Not molting based on primaries located with remains. Estimated date of death 24 June – 17 July, though likely closer to the beginning of the time frame based on the condition of the remains. Cause of death unknown due to the small amount of remains recovered though based on location in WLWCA most likely causes are predation or illness/disease.

L7-13 - Last observed alive with mate in WLWCA refuge during a tracking flight on 23 June. Remains recovered 18 July after PTT stopped functioning. Last GPS PTT reading was from 4PM on 27 June. Based on data and lack thereof, death occurred 28 June – 5 July, when GPS PTT completely stopped working. Cause of death unknown due to the small amount of remains recovered though based on location in WLWCA most likely causes are predation or illness/disease. No primary feathers were found so unable to determine if bird was molting and if that was a factor in his death

L9-13 – Mortality unconfirmed, missing and presumed dead. Transmitter failed after 25 May 2015. Last observed by LDWF staff in Jefferson Davis Parish on 27 July with male L8-13. By 13 August data from L8-13 indicated he had moved back to WLWCA but left again with a new female (L10-13) a day or two later. His movement and association with a new female indicated L9-13 was likely dead. Searches were made from the air as well as the ground but no remains were ever found.

L1-14 – Last seen 10 January 2016 with L13 & 14-14 in Jefferson County, Texas. Shot and killed on 11 January along with L14-14. Culprit was caught and prosecuted – plead guilty to one count of violating the ESA and is currently awaiting sentencing.

L4-14 – Mortality unconfirmed, missing and presumed dead. Last observed in Liberty County, Texas on 3 June with L3-14. Transmitter failed after 8 June 2015. Last known locations were searched from the air but nothing was ever found. The reappearance of L3-14 in Louisiana in August without L4-14 was further confirmation of his death.

L6-14 – Last seen uninjured by LDWF staff on 4 February. During a routine tracking flight on 29 February he was found injured with a fracture of his lower left leg. Transported to Baton Rouge on 1 March for exam and was euthanized due to poor chance of recovery.

L9-14 – Last seen alive on 9 September. Remains recovered 25 September. Based on transmitter data, her death may have occurred as early as 21 September, when the readings from her PTT all remained in the same general area, though indicated some short distance movements the following day. If death did not occur on 21 September, it had occurred by roost on the following night as all readings beginning with roost on the night of 22 September until collection were from the exact same spot. Predation is the suspected cause of death.

L11-14 - Appeared normal during last observation on 20 August. Found injured during a routine tracking flight on 26 August. Transmitter data indicated the injury occurred that morning. Picked up alive but with severe compound fractures of both legs below the hocks. Due to the severity of her injuries she was transported to a local veterinary clinic and was euthanized.

L14-14 – Last seen 10 January 2016 with L1 & 13-14 in Jefferson County, Texas. Shot and killed on 11 January along with L1-14. Culprit was caught and prosecuted – plead guilty to one count of violating the ESA and is currently awaiting sentencing.

L1-15 - Last seen on the evening of 11 Feb at the release pen with the rest of the cohort and 3 pairs of adult cranes. Food was allowed to run out over the next few days and was not replenished. Transmitter data indicated normal movement until the morning of 22 February when data received indicated no movement over the previous ~1.5 days. The bird was found alive but clearly debilitated, hiding in thick, tall sawgrass and basically unable to fly. She was captured and found to be weak and struggling to breathe. Due to her separation from other birds, lack of movement, clearly debilitated condition, and history of chronic respiratory illness she was transported to a local veterinary clinic and was euthanized.

L3-15 – Last observed with three companion birds by a local landowner on morning of 18 or 19 May 2016. On the morning of 21 May 2016, this bird and another were found dead from gunshot wounds. The case remains open but currently unsolved.

L5-15 - Last observed with three companion birds by a local landowner on the morning of 18 or 19 May 2016. On the morning of 21 May 2016, this bird and another were found dead from gunshot wounds. The case remains open but currently unsolved.

L7-15 - Transmitter failed to provide GPS data after 5 April 2016. Lack of data from GSM transmitter was not necessarily a cause of concern since these transmitters often do not work well in areas of the WLWCA marsh. Last observed alive during an aerial survey on 5 May 2016 in the vicinity of four other cohort members in the WLWCA refuge. Transmitter last turned on and sent a 'low voltage' reading on 6 May2016. During an aerial survey on 26 May the signal for this bird was detected in the WLWCA refuge but the bird was not seen. An investigation from the ground found the carcass S of the release pen. Cause of death was likely predation and most likely occurred shortly after the bird was last seen alive.

Morbidity

L11-14 – Found injured (lying down with head up, wings out, and short blood trail in water near bird) during an aerial survey on 26 August 2015. Bird was unable to move and was easily captured due to compound fractures of both legs below the hocks. Due to the severity of the injury she was taken to a local veterinary clinic and was euthanized.

L1-15 – Bird had a history of respiratory illness as a chick and was treated. Treatment was eventually stopped; bird seemed to be doing well and at the last minute was included in cohort shipment to LA. Upon arrival in LA on 3 December her breathing was wheezy and audible and she was open mouth breathing. This seemed to improve over the next few days/weeks but then became worse in mid-January when her breathing was again noticeable; she would open mouth breathe and at times didn't seem to have a voice. Her attitude was good and she was capable of flying in and out of the release pen with the other birds. She was taken to the LSU vet school on 28 January for examination. Her breathing immediately sounded bad when she was caught and carried to the crate but she did fine during transport and anesthesia for radiographs. Although a difference was noted in the sound of her left lung compared to her right and her breathing sounded labored as she recovered from anesthesia, nothing definitive was seen on the radiographs so she was taken back to WLWCA and released in the pen with the other birds. She did well and seemed good for the most part over the next few weeks though was still noted to occasionally open mouth breathe or have slightly wheezy, audible breathing. Last seen on the evening of 11 February and appeared normal. Data over the next few days indicated she moved around with the other birds. Starting on 16 February, GPS points indicated she was moving to some new, previously unused areas, including one point ~3.5 miles to the W before returning later in the day. By the afternoon of the 18th she had moved ~5 miles to the E (close to the location she was eventually captured) and moved less than 0.3 miles over the next almost 2 days. Between 8AM & 4PM on 20 February she moved 0.5 miles farther E. After that the coordinates from her transmitter did not change starting with the night of the 20th until we noticed the lack of movement on 22 February and went out to investigate. She was alive but hiding in thick, tall sawgrass and though she ran and flew a short distance (obviously struggling and barely clearing the vegetation) she was clearly debilitated. She was next found collapsed in another patch of sawgrass and attempted to move again but got no more than ~30 m before getting stuck/giving up at which time she was captured. She was clearly struggling to breathe, gasping, wheezing, and was weak. Once hooded and wrapped up she was calm, did not struggle, and her breathing was not audible and she only occasionally opened her mouth to breathe. Due to her separation from other birds, lack of movement, and clearly debilitated condition she was transported to a local veterinary clinic to be euthanized.

L6-14 – Found injured (lying down with head up and one wing partially extended) during an aerial survey on 29 February 2016. On our arrival he became alert and as we approached (in costume) he got up and tried to move away, revealing the injury was to his lower left leg, just above the toes. He hobbled a short distance away and when the other birds flew over him he flew, but low and with difficulty and with his left leg hanging down. He landed a short distance away and then did not really try to escape again and was captured. A wrap was placed around him and he was hooded and kept lying down in a sternal position overnight in a crate. On 1 March he was taken to Baton Rouge to be examined by Dr. LaCour, at which time the decision was made to euthanize him due to his poor chance of recovery. Given the lack of data from his transmitter after 22 February and based on Dr. LaCour' s exam of wounds (infection and granulation tissue), we suspect initial injury occurred about one week prior, possibly on the 22nd, but likely by the 23rd because the transmitter was probably not getting enough sunlight to turn on as scheduled on the 24th.

L10-11 – After being handled on 6 January for a transmitter replacement, his left wing appeared to droop slightly at the shoulder. By that evening the droop was slightly worse and when he stretched or flapped his wings the left one did not fully extend. He remained a bit lethargic, wary/nervous, and unable to fly until he was discovered inside the release pen and then later seen flying out of the pen on 8 January. Over the next few days we observed additional flights and an improvement in attitude. On 16 January, data from his transmitter indicated he had left the marsh and returned to previously used agriculture fields ~35 miles north in Jefferson Davis Parish.

During nest observations beginning on 15 April we observed some right leg lameness. He would sometimes have difficulty standing up after sitting on the nest, would often stand and rest with his right leg up off the ground and would sometimes be less active and reluctant to move around. The lameness improved and disappeared after the conclusion of the first nest but reappeared when the pair renested. Because a wound had been seen on his right leg during the nest closeout data collection and the issue appeared to be related to the position of the transmitter while sitting on the nest, he was caught on 2 June so the GSM transmitter could be removed. The lameness quickly resolved following removal of the transmitter.

LW1-16 - On 25 May, at 44 days old an abnormality of the chick's left wing was observed. Initially, it appeared the growing primary feathers were drooping from the wrist portion of the wing. Follow up observations the next day indicated this was likely a more serious issue as the distal portion of the wing appeared to also be twisted or displaced and unable to be tucked into a normal position. The chick seemed to be slightly lethargic over the next few days and was almost constantly adjusting the left wing. As the chick grew, the position of the wing would occasionally appear better and eventually the constant adjusting of the wing decreased and stopped. On 27 May we noticed two primary feathers on the left wing had failed to emerge. Eventually new feathers grew in and though the wing was still not positioned normally, on 26 July we observed a short, low flight by the chick. Since then we have seen several other short flights including one of over 100 m which is the distance used to consider a chick fledged. Additionally, on 15 August the chick was found with its parents on an adjacent farm separated by a steep-sided irrigation canal, indicating it had flown over the canal to get to the new location. While we have observed flights of short distances, we have not yet determined if the chick is capable of flying at higher altitudes or covering longer distances.

EDUCATION, OUTREACH, AND MEDIA

Landowner Sentiment

We continue to be pleased by landowner cooperation and enthusiasm for the project and thus far, no landowner has denied our request to access their property. The vast majority of landowners have been fully engaged and excited about cranes on their land. Once a crane is located on a new property and remains there for several days, we attempt to find the owner or farmer for the property, then contact them and set up a meeting to discuss the project. We discuss the individual bird or birds that are on their property, as well as our needs or requests for accessing their property in order to monitor the birds. Additionally, we gather information on the management activities in their fields (to assist with habitat evaluations), while providing them with information about the project and landowner appreciation gifts (e.g., coffee mugs and t-shirts). Additionally, a thank you card from LDWF's administration is sent to the landowner or farmer thanking them for their support of the project and our efforts. To date, we have met and worked with ~150 individual landowners and farmers.

Teacher Workshops

Similar to previous years, the 2015-2016 Whooping Crane education and outreach program centered around hosting "Give a Whoop!" educator workshops. Three workshops were provided across Louisiana in January. A total of 52 participants from Louisiana attended the professional development workshops, with the attendees primarily consisting of middle and high school teachers. Two of the workshops were for formal/non-formal educators while the third was for Master Naturalists in the New Orleans and Acadiana chapters. The Master Naturalist workshop provided participants with six hours to be used toward their certification. The agenda for this particular workshop was modified to reflect the needs of this specific group.

Outreach

A large component of the education initiative is devoted to outreach. LDWF staff participated in over 40 festivals and outreach efforts where literature and information were delivered to the public. An estimated 3,000 individuals were exposed to information regarding Whooping Cranes in Louisiana. Outreach efforts typically consist of exhibits with related items and literature at state-wide festivals/events. Participation in state-wide events is vital in both informing and updating the residents of Louisiana about the reintroduction project. As with our education strategy, outreach will be ongoing in order to increase the level of awareness and appreciation by the general public. In keeping with that idea, the Louisiana Department of Wildlife and Fisheries-Whooping Crane Facebook page was created. At minimum, weekly updates are posted and include updates and photos of the Louisiana birds. This method of outreach has been well received and over 3,000 individuals have 'liked' the page since its creation in August 2015.

During this report period several new items were created to help promote the project and spread our message. These items were used during the "Give a Whoop!" educator workshops as well as various outreach events around the state. New items for 2015-2016 included "Mac", the Whooping Crane mascot (Figure 6). The name is significant in that it is the name given to the last wild Whooping Crane captured in Louisiana in 1950 as well as one of the submissions we received during our "name the mascot" Facebook contest. Also new for 2015-2016 was a table sign which asks "How Do They Measure Up?" (Figure 7). This sign helps to alleviate the frequent misidentification of Whooping Cranes in comparison to other white bird species which are commonly seen throughout Louisiana.

Media Public Awareness
The LDWF public outreach media plan included the use of billboard space provided by Lamar Advertising and radio commercial space purchased through Louisiana Association of Broadcasters (LAB).

LDWF purchased 10 vinyl signs from Lamar in September with sizes ranging from 10 x 36 to 14 x 48 feet (Figure 8). These were displayed in three markets around the state on billboard space donated by Lamar. The targeted markets (and no. of boards per market) included Monroe (3), the North Shore of Lake Pontchartrain (4) and the New Orleans area (3). These billboards resulted in excess of 900,000 weekly views by the traveling public during the time frame all signs were in place. The design featured a photo of a single Whooping Crane walking in a shallow marsh.

The 30-second LAB radio ad was broadcast 5,661 times around the state by LAB member stations in Alexandria, Baton Rouge, Carencro, Crowley, Eunice, Houma, Lafayette, Lake Charles, Leesville, LaRose, New Orleans, Oak Grove, Ruston, Shreveport, Ville Platte, Winnsboro and Natchez, MS, for five weeks spanning from the middle of January to the end of February. The message again stressed the presence of cranes now in the state, the need to observe them from a distance if encountered and a call to action to alert LDWF's Enforcement Division if anyone was observed harming Whooping Cranes.

RESEARCH PRODUCTS

Along with formal and informal public outreach, our program continues to work on producing peer-reviewed publications as well as making presentations at relevant professional meetings. One manuscript is currently in preparation and we have contributed a chapter on the Louisiana project to the current book project – The Biology and Conservation of the Whooping Crane.

Publications
Dinets, V. 2015. Can interrupting parent-offspring cultural transmission be beneficial? The case of Whooping Crane reintroduction. Condor 117:624-628.

Dinets, V. 2016. Predation on amphibians and reptiles by reintroduced Whooping Cranes (Grus americana) in Louisiana. American Midland Naturalist 175:134-137.

King, S.L., W. Selman, P. Vasseur, and S. Zimorski. Louisiana non-migratory Whooping Crane Reintroduction. (Grus americana) (In review for: The Biology and Conservation of the Whooping Crane).

Pickens, B.A., S.L. King, P. Vasseur, S.E. Zimorski, and W. Selman. Seasonal movements and habitat selection dynamics of reintroduced Whooping Crane (Grus americana) (In prep for Waterbirds, anticipated October 2016).

Presentations
King, S.L. 2015 Whooping Cranes and the Endangered Species Act. Louisiana Association of Professional Biologists Fall Symposium, Baton Rouge, LA.

Vasseur, P., S. Zimorski, and E. Szyszkoski. 2016. A Preliminary Survey of the Reproductive Behavior of a Non-migratory Whooping Crane (Grus americana) Population in Southwest Louisiana. Louisiana Department of Wildlife and Fisheries' Office of Wildlife Research, Management, and Education Symposium, Baton Rouge, LA.

Table 1. Distribution of location data points collected via remote transmitter devices for the Louisiana non-migratory Whooping Crane population, 1 July 2015 – 30 June 2016. Numbers in parentheses indicate percentage of total points.

Cohort	No. of Location Data Points	No. of Points in Louisiana by Parish						No. of Points in Texas[b]
		Allen	Avoyelles	Cameron	Jefferson Davis	Vermilion	Other Parishes[a]	
HY2011	4060	416	1327	6	1393	781	137	0
HY2012	3513	24	0	383	537	1843	289	437
HY2013	3764	530	0	111	1551	1456	25	91
HY2014	6480	181	0	1442	1782	1007	174	1894
HY2015	4689	0	0	34	6	3928	721	0
Totals	22506	1151 (5.1)	1327 (5.9)	1976 (8.8)	5269 (23.4)	9015 (40.1)	1346 (6.0)	2422 (10.8)

[a]Other Louisiana parishes include: Acadia, Beauregard, Calcasieu, Caldwell, Catahoula, Evangeline, Iberia, Rapides, St. Landry, St. Mary, and Vernon.
[b]Texas counties include: Denton, Ellis, Grayson, Hardin, Henderson, Hunt, Jefferson, Kaufman, Liberty, Nacogdoches, Newton, Panola, Sabine, Shelby, and Smith.

Table 2. Total number of nights spent in Texas by individuals in the Louisiana non-migratory population, 1 July 2015 – 30 June 2016.

ID	Sex	# of trips	# nights in TX	Note
L5-12	F	1	80	Current location unknown
L6-12	F	1	107	Nested in LA in 2016
L8-12	F	2	73-89	
L6-13	M	3	4	First records in TX
L10-13	F	1	55	First records in TX
L1-14	F	1	194	Killed 11 January
L5-14	F	3	4	First records in TX
L10-14	F	3	4	First records in TX
L12-14	M	2	236	
L13-14	M	2	251	
L14-14	M	1	194	Killed 11 January

Table 3. Summary of captures of free-flying Whooping Cranes in the Louisiana non-migratory population, 1 July 2015 – 30 June 2016.

ID	Sex	Date	Method	Reason	Location	Note
L11-14	F	8/26/15	Hand grab	Injury	Jefferson Davis Parish	euthanized
L7-13	M	10/2/15	Leg noose	Transmitter replacement	Vermilion Parish	
L6-12	F	11/19/15	Leg noose	Transmitter replacement	Vermilion Parish	
L11-11	F	12/4/15	Hand grab	Transmitter replacement	Vermilion Parish	at pen
L10-13	F	12/5/15	Leg noose	Banding of bare leg	Vermilion Parish	at pen
L11-12	F	12/30/15	Leg noose	Transmitter replacement	Vermilion Parish	at pen
L1-11	M	1/5/16	Hand grab	Transmitter replacement	Vermilion Parish	at pen
L10-11	M	1/6/16	Hand grab	Transmitter replacement	Vermilion Parish	at pen
L2-11	M	1/22/16	Hand grab	Transmitter replacement	Allen Parish	
L7-14	F	1/25/16	Hand grab	Transmitter replacement	Vermilion Parish	at pen
L8-12	F	2/3/16	Leg noose	Transmitter replacement	Allen Parish	
L13-11	F	2/16/16	Leg noose	Transmitter replacement	Allen Parish	
L14-12	M	2/17/16	Hand grab	Transmitter replacement	Vermilion Parish	
L1-15	F	2/22/16	Hand grab	Injury	Vermilion Parish	euthanized
L6-14	M	2/29/16	Hand grab	Injury	Jefferson Davis Parish	euthanized
L3-11	F	3/21/16	Hand grab	Transmitter replacement	Allen Parish	with nest
L7-11	F	4/5/16	Hand grab	Transmitter replacement	Avoyelles Parish	with nest
L8-11	M	4/5/16	Hand grab	Transmitter replacement	Avoyelles Parish	with nest
L10-11	M	6/2/16	Hand grab	Transmitter removal	Jefferson Davis Parish	with nest

Table 4. Nesting and renesting attempts of Whooping Crane pairs in the reintroduced Louisiana non-migratory population, 2014 – 2016.

Year	Male	Female	Nest Location - Parish	Incubation began	No. eggs	Outcome of nest, fate of eggs	Number of days of incubation	Number of days to renest
2014	L8-11	L7-11	Avoyelles	24 March	2	Full term, collected 30 April, both infertile	37	18
2015	L8-11	L7-11	Avoyelles	28 Feb	2	Full term, collected 9 April, both infertile	40	18
2015	L1-11	L6-11	Vermilion	~3-4 April	2	Failed (flooded by/on 13 April), 16 April collected 1 fertile, non-viable & shell fragment	~9-10 max	no renest
2015	L2-11	L13-11	Allen	6-14 May	1 or 2	Failed (def. incub 27d), egg fragment collected 12 June	27-37	no renest
2015	L1-13	L3-11	Allen	16-28 May	2	Failed/abandoned (prob by 13 June PM), 17 June collected 1 egg (unk fertility)	16-28	no renest
2016	L1-13	L3-11	Allen	12 Feb	2	Full term, collected 21 March, both fertile – 1 MDE, 1 LDE	39	17-21
2016	L8-11	L7-11	Avoyelles	28 Feb	2	Full term, collected 5 April, both infertile	38	18
2016	L8-13	L6-12	Jefferson-Davis	~12 March	2	Full term, 2 chicks hatched	33	no renest
2016	L2-11	L13-11	Allen	~8-14 March	1 or 2	Failed 4 April due to human disturbance, 1 fertile egg collected - LDE	22-28	31-36
2016	L10-11	L11-11	Jefferson-Davis	~1-4 April	1	Full term but failed/abandoned on 3 May, no egg or shell pieces found	30-33	15-16

Year	Male	Female	Nest Location - Parish	Incubation began	No. eggs	Outcome of nest, fate of eggs	Number of days of incubation
2014	L8-11	L7-11	Avoyelles	19 May	2	Full term, collected 26 June, both infertile	38
2015	L8-11	L7-11	Avoyelles	28 April	2	Full term, collected 4 June, both infertile	37
2016	L1-13	L3-11	Allen	~8-11 April	2	Full term, 1 egg disappeared ~12 May, no longer sitting & no egg in nest on 15 May, recovered 1 egg in water 16 May – fertile, LDE	33-37
2016	L8-11	L7-11	Avoyelles	24 April	2	Full term but failed/abandoned after 25 May, by 28 May; 1 June collected 1 infertile egg floating in water near nest & broken eggshell buried in nest	32-34
2016	L2-11	L13-11	Allen	~6-11 May	2	Poss. full term but failed/abandoned after 2 June, by 6 June; 1 infertile egg & egg shell in nest & water collected 6 June	23-31
2016	L10-11	L11-11	Jefferson-Davis	18-19 May	1	Full term, collected 21 June, infertile	34-35

Table 5. Nest monitoring data compiled for the Louisiana non-migratory Whooping Crane population, 2014-2016. Monitoring sessions consisted of 3-hr observation periods alternated among 3 time periods – morning, midday, and late afternoon.

Crane Pair	Monitoring Dates	Monitoring Sessions	Nest Attempt	Avg. Temp (°F)	Mean Nest Attendance (min)		Mean Time Nest Unattended (min)	Mean Time Spent <50 m Away From Nest (min)		Mean Time Spent >50 m Away From Nest (min)	
					Female	Male		Female	Male	Female	Male
2014											
L7 & 8-11	3 Apr – 25 Apr	7	1st	68.5	69.0	107.9	2.7	17.1	2.4	59.3	65.0
L7 & 8-11	22 May – 18 Jun	7	2nd	79.6	50.0	120.3	9.3	5.0	4.8	114.4	45.3
2015											
L7 & 8-11	13 Mar – 2 Apr	7	1st	68.0	68.0	109.9	3.0	50.1	22.4	61.9	47.7
L7 & 8-11	4 May – 1 Jun	6	2nd	79.4	123.3	51.5	5.2	7.7	58.8	43.5	75.2
L2 & 13-11	15 May – 9 Jun	5	1st	82.3	56.0	109.8	14.0	47.8	43.0	76.0	27.2
2016											
L3-11 & 1-13	18 Feb – 15 Mar	6	1st	67.8	117.0	52.8	9.8	19.3	29.5	43.3	97.7
L3-11 & 1-13	21 Apr – 11 May	6	2nd	76.1	65.0	99.3	15.3	42.3	20.8	72.3	59.8
L7 & 8-11	4 Mar – 29 Mar	3	1st	67.6	106.0	66.7	7.0	33.3	9.3	40.3	104.0
L7 & 8-11	29 Apr – 18 May	3	2nd	75.4	104.0	66.7	9.7	19.7	5.7	56.7	107.7
L2 & 13-11	22 Mar – 29 Mar	2	1st	69.1	134.0	44.5	2.0	18.5	122.5	28.0	13.0
L2 & 13-11	13 May – 25 May	3	2nd	81.5	99.7	68.3	12.0	62.7	111.7	17.7	0
L6-12 & 8-13	15 Mar – 7 Apr	6	1st	67.1	86.0	85.8	8.0	22.0	26.3	71.8	67.8
L10 & 11-11	4 Apr – 29 Apr	6	1st	74.2	114.0	61.8	3.8	16.7	65.7	49.0	52.5
L10 & 11-11	23 May – 15 Jun	6	2nd	83.9	97.0	83.0	0	33.8	25.7	49.2	71.3

Table 6. Maximum post-release survival of each cohort through 30 June 2016. Green shaded cells represent current survivorship of last five cohorts. (Dates in parentheses indicate when each cohort was released from the top-netted section of the pen.)

Post-release Survival	**2010 Cohort (3/14/11)**	**2011 Cohort (12/27/11)**	**2012 Cohort (12/17/12)**	**2013 Cohort (1/2/14)**	**2014 Cohort (12/29/14)**	**2015 Cohort (12/29/15)**
3 months	8/10 = 80%	15/16 = 93.75%	13/14 = 92.9%	9/10 = 90%	14/14 = 100%	10/11 = 90.9%
6 months	7/10 = 70%	14/16 = 87.5%	12/14 = 85.7%	8/10 = 80%	12/14 = 85.7%	7*/11 = 63.6% (L4 & 9-15 unk)
9 months	3/10 = 30%	12/16 = 75%	11/14 = 78.6%	8/10 = 80%	10/14 = 71.4%	
12 months	3/10 = 30%	12/16 = 75%	10/14 = 71.4%	7/10 = 70%	10/14 = 71.4%	
15 months	2/10 = 20%	12/16 = 75%	10/14 = 71.4%	7/10 = 70%	7/14 = 50%	
18 months	2/10 = 20%	12/16 = 75%	10/14 = 71.4%	7/10 = 70%	7/14 = 50%	
21 months	2/10 = 20%	12/16 = 75%	9/14 = 64.3%	6/10 = 60%		
24 months	2/10 = 20%	12/16 = 75%	9/14 = 64.3%	6/10 = 60%		
2.5 years	1/10 = 10%	10/16 = 62.5%	9/14 = 64.3%	5/10 = 50%		
3 years	0/10 = 0%	10/16 = 62.5%	9/14 = 64.3%			
3.5 years		9/16 = 56.3%	9*/14 = 64.3% (L5-12 unk)			
4 years		9/16 = 56.3%				
4.5 years		9/16 = 56.3%				

Figure 1. Locations of reintroduced Whooping Cranes in Louisiana and Texas, 1 July 2015 – 30 June 2016. EMP crane no. 20-15 was part of the eastern migratory population's 2015 release but is included for anecdotal purpose.

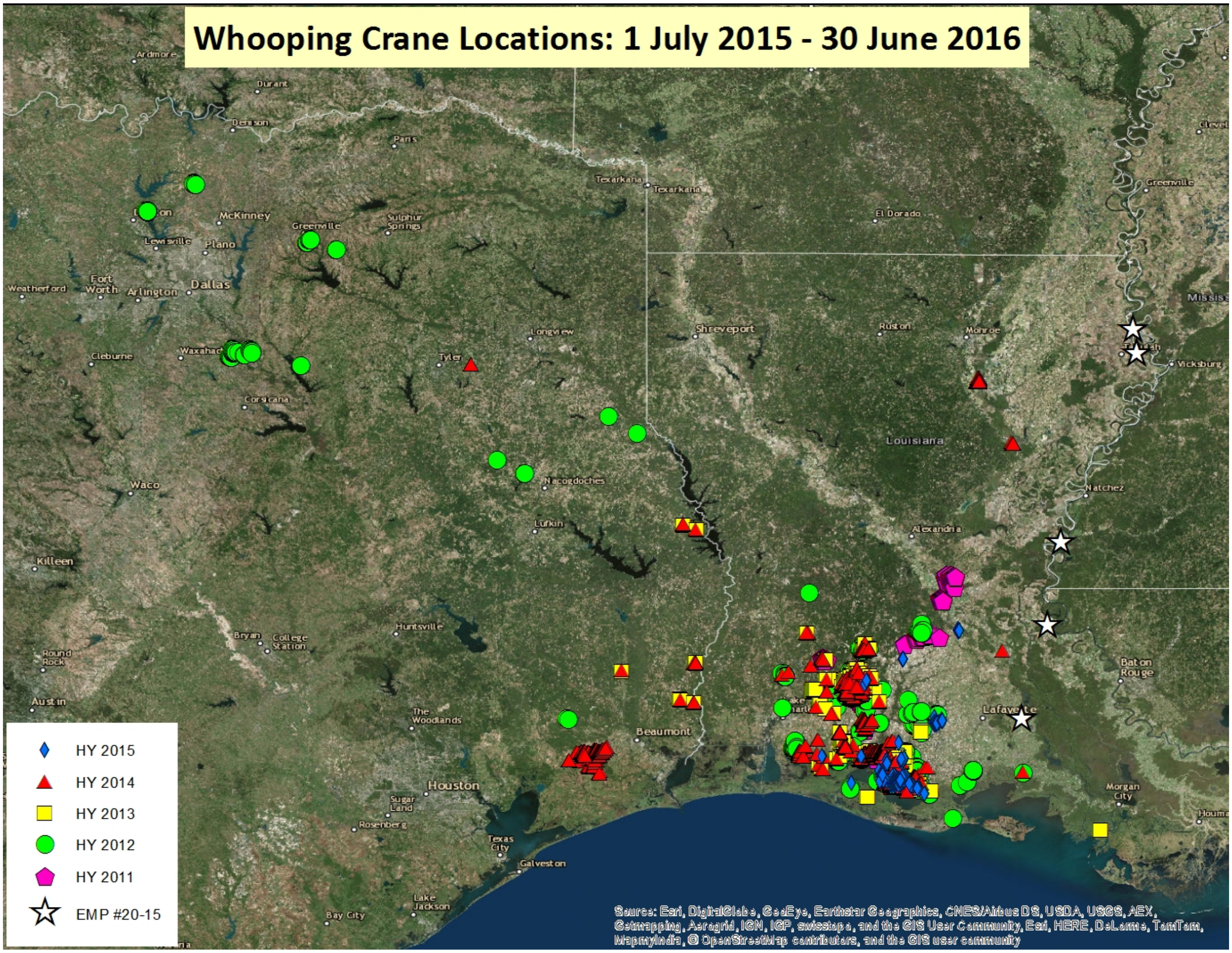


Figure 2. L11-12 (on right) missing secondary feathers on each wing prior to molting in 2016.

Figure 3. Approximate locations of reintroduced Whooping Crane pairs that nested in 2016.

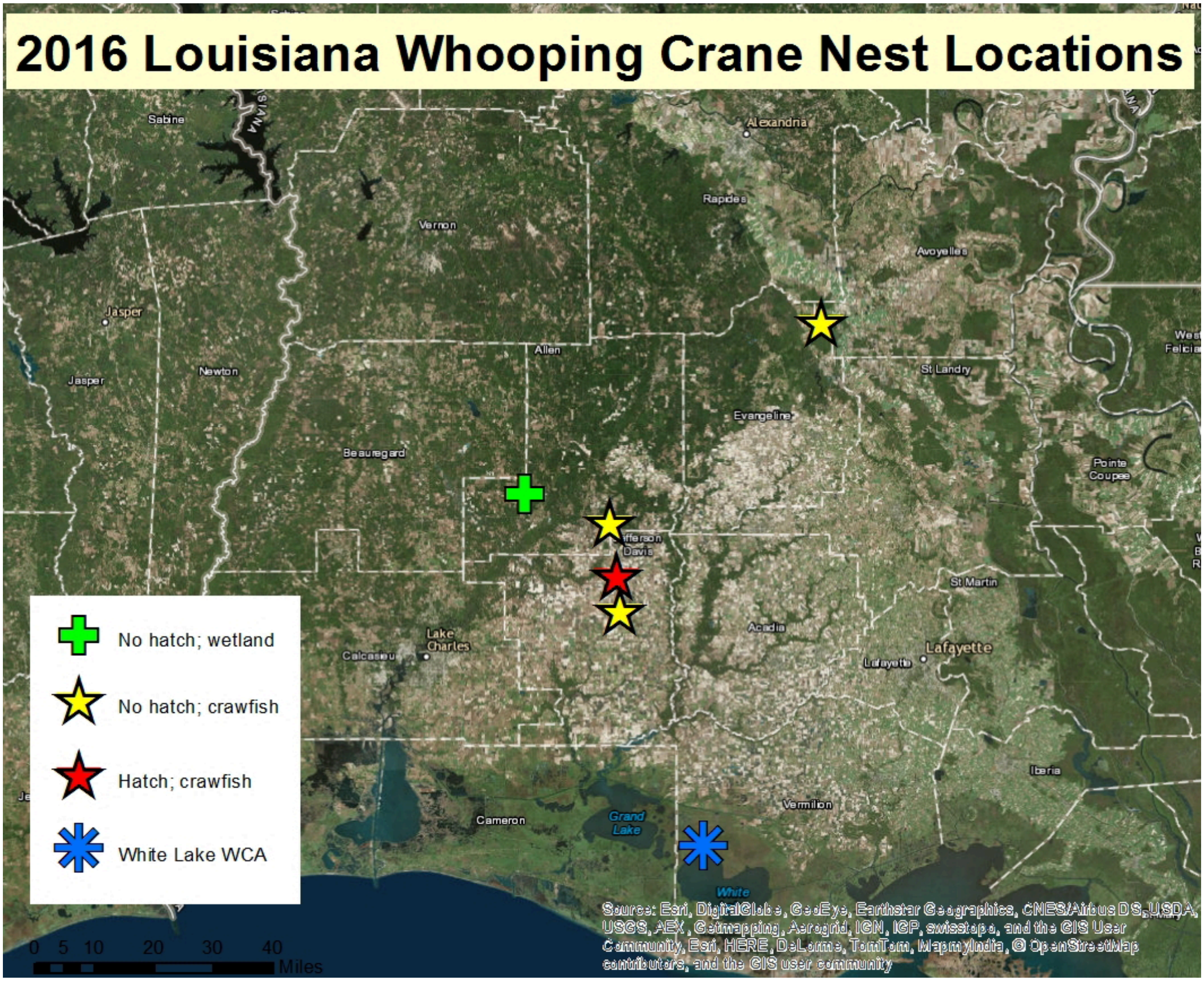


Figure 4. Nest camera photo of L8-11 incubating despite disturbance from crawfish boat during routine farming operation (Avoyelles Parish).

Figure 5. First family – parents, L6-12 & L8-13, with newly hatched chicks LW1 & LW2-16 on 13 April 2016 (crawfish pond, Jefferson Davis Parish).

Figure 6. New Whooping Crane mascot, ‘Mac’.

Figure 7. New table display sign comparing Whooping Crane height to that of two egret species commonly found throughout Louisiana.

Figure 8. Billboard design used again in fall 2015.

Appendix. ID sheet for Louisiana Whooping Cranes. Birds in dark gray are missing, presumed dead, and no longer counted in the population total. Birds in light gray are missing and current status is unknown but they are still counted in the population total.

Louisiana Whooping Cranes June 2016

Hatch year	Crane no.	PWRC ID	Sex	BBL Band no. Below left hock	Color code (left:right) T=long band with transmitter	Studbook no. Own	Sire	Dam	Mate / Potential Mate/Associate
2011	L1	8	M	1098-00882	T **B/Y**(VHF) : T **B/R** (PTT)	2103	1254	1156	6-11
2011	L2	11	M	1098-00883	T **B/R** (PTT) : T **Y/R** (VHF)	2106	1702	1904	13-11
2011	L3	14	F	1098-00884	T **B/R** (VHF) : **Y/B/Y**	2109	1717/1420	1168	1-13
2011	L6	18	F	1098-00887	T **B/R** (cell) : T **B/Y** (VHF)	2113	1127	1154	1-11
2011	L7	19	F	1098-00888	T **B/R** (PTT) : T **R/Y** (VHF)	2114	1254	1156	8-11
2011	L8	20	M	1098-00889	T **B/R** (VHF) : T **Y** (cell)	2115	1147	1119	7-11
2011	L10	22	M	1098-01101	T **R/Y** (VHF) :	2117	1147	1292	11-11
2011	L11	23	F	1098-01102	T **Y** (VHF) : T **B/R** (PTT)	2118	1165	1164	10-11
2011	L13	29	F	1098-01104	T **B/R** (VHF) : **Y/R/Y**	2124	1147	1210	2-11
2011	L14	30	F	1098-01105	T **B/R** (PTT) : **R/Y/B**	2125	1133	1135	
2012	L1	9	F	1098-01109	**B/Y/R :** T **Y/B**	2149	1127	1154	7-12
2012	L2	12	F	1098-01110	T **Y/B** (PTT) : T **R** (VHF)	2152	1674	1679	14-12
2012	L5	15	F	1098-01113	T **Y/B** (PTT) : T **R/B** (VHF)	2155	1731	1219	
2012	L6	17	F	1098-01114	T **Y/B** (cell) : T **Y/R** (VHF)	2157	1267	1261	8-13
2012	L7	18	M	1098-01115	T **Y/B** (PTT) : **Y/R/Y**	2158	1127	1154	1-12
2012	L8	19	F	1098-01116	T **R/Y** (VHF) : T **Y/B** (PTT)	2159	1267	1261	
2012	L9	21	F	1098-01117	T **Y/B** (PTT) : **R/Y/B**	2161	1189	1195	
2012	L10	22	M	1098-01118	**R/B/R :** T **Y/B** (PTT)	2162	1775/1737	1593	
2012	L11	23	F	1098-01119	T **Y/B** (PTT) : T **B/R** (VHF)	2163	1133	1135	3-13
2012	L12	24	F	1098-01120	T **R** (VHF) : T **Y/B** (PTT)	2164	1127	1154	7-13
2012	L14	28	M	1098-01122	T **R/B** (VHF) : T **Y/B** (PTT)	2176	1794	1900	2-12
2013	L1	10	M	1098-01123	T **R/Y** (PTT) : T **B** (VHF)	2195	1138	1440	3-11
2013	L3	12	M	1098-01125	T **R/Y** (PTT) : **R/B/R**	2197	1422	1366	11-12
2013	L5	14	M	1098-01127	**Y/B/Y :** T **R/Y** (PTT)	2199	1672	1904	
2013	L6	15	M	1098-01128	T **R/Y** (PTT) : **B/Y/B**	2200	1147	1119	10-14
2013	L7	18	M	1098-01129	T **R/Y** (PTT) : T **R/B** (VHF)	2202	1731	1219	12-12
2013	L8	25	M	1098-01130	T **R/Y** (PTT) : T **B/Y** (VHF)	2208	1439	1818	6-12
2013	L9	26	F	1098-01131	**B/R/B :** T **R/Y** (PTT)	2209	1731	1219	
2013	L10	29	F	1098-01132	**R/B/Y :** T **R/Y** (PTT)	2211	1100	1263	12-14
2014	L2	12	F	1098-01152	T **R/B** (cell) : T **Y** (VHF)	2245	1439	1818	
2014	L3	34	M	1098-01153	T **R/B** (cell) : T **B/Y** (VHF)	2263	1731	1219	8-14
2014	L4	35	M	1098-01154	T **R/B** (PTT) : **R/B/Y**	2264	1677	1894	
2014	L5	14	F	1098-01155	T **R/B** (PTT) : T **R/Y** (VHF)	2247	1147	1292	
2014	L7	16	F	1098-01157	T **Y/B** (VHF) : T **R/B** (PTT)	2249	1731	1219	
2014	L8	17	F	1098-01158	T **R/B** (cell) : T **Y/R** (VHF)	2250	1581/1737	1593	3-14
2014	L10	22	F	1098-01160	**B/R/Y** : T **R/B** (PTT)	2255	1267/1386	1261	6-13
2014	L12	28	M	1098-01162	T **R/B** (PTT) : **Y/R/Y**	2259	1267/1386	1261	10-13
2014	L13	30	M	1098-01163	T **B/Y** (VHF) : T **R/B** (cell)	2260	1182	1195	
2015	L2	4	M	1098-01167	**R/B/R** : T **B/Y** (PTT)	2288	1864	1993	
2015	L4	7	F	1098-01169	T **B/Y** (PTT) : **B/R/B**	2291	1746	1704	
2015	L6	12	F	1098-01171	T **B/Y** (PTT) : **R/B/Y**	2296	1216	1202	
2015	L8	24	F	1098-01173	**Y/R/Y** : T **B/Y** (PTT)	2304	1775	1593	
2015	L9	25	F	1098-01174	T **B/Y** (PTT) : **R/Y/R**	2305	1256	1293	
2015	L10	26	F	1098-01175	T **Y/R** (VHF) : T **B/Y** (PTT)	2306	1130	1292	
2015	L11	30	F	1098-01176	T **B/R** (VHF) : T **B/Y** (PTT)	2307	1560	1210	

Whooping Crane Eastern Partnership

2015 Condensed Annual Report

Table of Contents

INTRODUCTION 3
OPERATIONS TEAM 4
REARING & RELEASE TEAM 5
MONITORING & MANAGEMENT TEAM 7
RESEARCH & SCIENCE TEAM 14
COMMUNICATIONS & OUTREACH TEAM 21

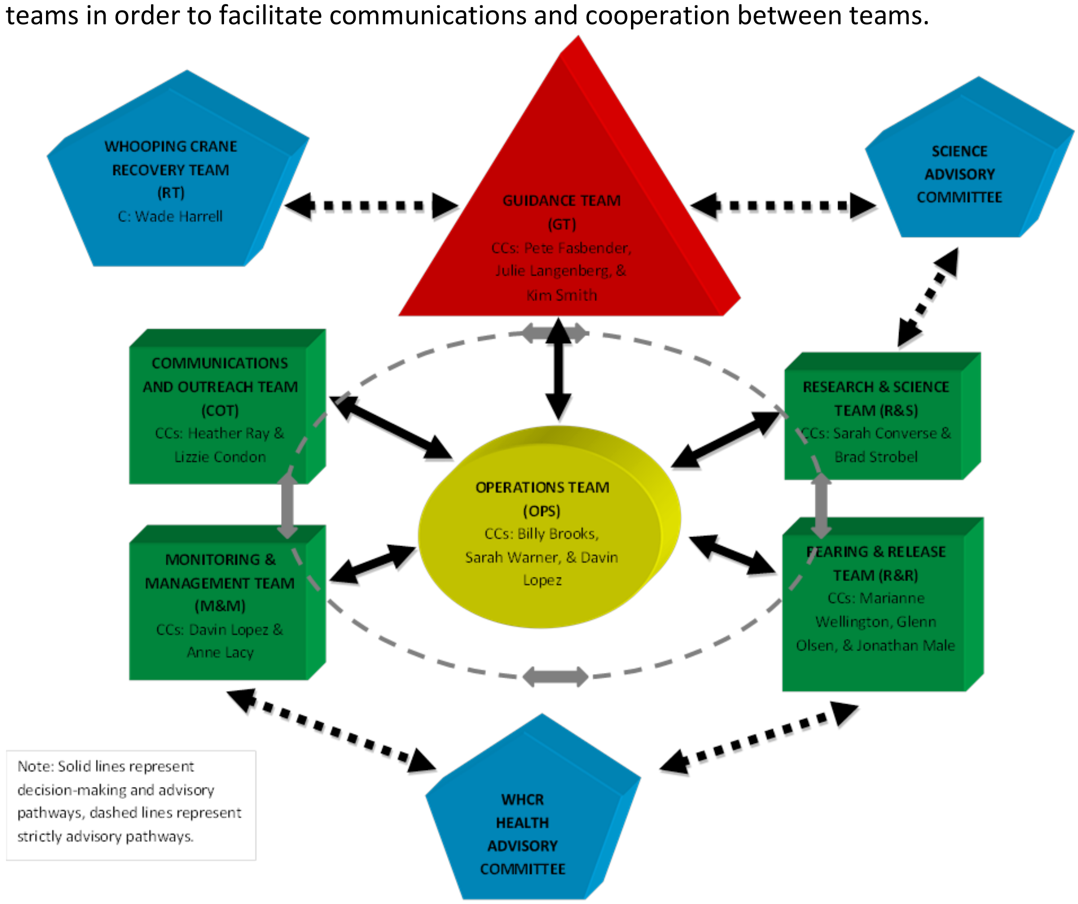
INTRODUCTION

OPERATIONS TEAM

Sarah Warner, U.S. Fish and Wildlife Service
Davin Lopez, Wisconsin Department of Natural Resources

Each WCEP operational team has co-chairs. These team leaders make up the Operations Team. Project decisions that cannot be made within a team or between teams are made by the Operations Team. Beginning in 2015, the Operation Team is attempting to have more input and discussion between teams in order to capitalize on each team's strengths and expertise. The Operations Team Co-chairs are also charged with updating the Guidance Team on the project needs, operations, and decisions. Beginning in 2015, to help facilitate communications between the Guidance Team and the Operations Team, the Operations Team Co-chairs sit in on the monthly Guidance Team calls. If the Operations Team is unable to come to agreement on a decision that involves multiple teams, they seek the support of the Guidance Team. In 2015, the Operations Team accomplishments include:

- Monthly conference calls to discuss project operations held on the third Tuesday of each month; summary notes of the call are posted to the WCEP Google Drive.
- 2014 WCEP Annual Report was drafted by Operational Teams Co-chairs; compiled by the Communications and Outreach Team; reviewed and edited by the Operations Team and Guidance Team; finalized and posted on the BringBacktheCranes.org website in May. Drafting of 2015 Annual Report was initiated in February. 2016.
- Beginning the process of writing a 5-Year WCEP Implementation Plan that will expand on the upcoming WCEP 5-Year Strategic Plan. This plan purpose is to more fully integrate the WCEP teams in order to facilitate communications and cooperation between teams.



REARING & RELEASE TEAM

Jonathan Male, USGS Patuxent Wildlife Research Center
Marianne Wellington, International Crane Foundation

Fourteen costume-reared young whooping cranes (6 ultralight-led (UL) and 8 modified Direct Autumn Release (mDAR) were released in the Wisconsin Rectangle in 2015, bringing the total to 71 birds released since 2011. We had hoped to meet the minimum release number of 15 suggested by the 2012-13 Structured Decision Making Workshop, however, one chick was pulled from the aircraft led project in order to accommodate minimum numbers for the Louisiana Release Program. Overall the 2015 releases were successful with all 2015 chicks being soft released at St. Marks NWR in Florida or Horicon NWR, WI. All of the 8 mDAR birds migrated south without human assistance.

Release Projects

Ultralight-led Led Migration

Seven chicks were originally trained for the ultralight Program. One chick was transferred to the Louisiana Non-migratory Release Program because of the high mortality of developing eggs during incubation at Patuxent.

Through the generosity of Windway Capital Corporation, 6 chicks were shipped to Wisconsin on July 2nd. The average age of the chicks at shipping was 54.7 days of age (SD±2.9 days, range 52-60 days of age). The 6 birds spent 89 days acclimating to the introduction site at White River Marsh State Wildlife Area. They fledged as a group on July 31st at a mean age of 83.8 days. They were trained with the aircraft on 53 mornings. The 6 birds began migration on September 30th, 2015. They covered 1082.4 statute miles in 32.5 hours of flying, making 20 stops on private land. The migration was completed on February 6th, 2016 when the birds arrived at St. Marks NWR. The 2015-16 ultralight migration was the longest ever, totaling 115 days not including breaks for Christmas holidays and the January WCEP meeting in WI. The long delays were a result of unusual and consistent winds from the south, driven by what was reported as one of the strongest El Niño events on record. Despite the long delays at stopovers, Operation Migration was able to encourage the birds to follow the ultralights. Long range forecasts of high winds prompted the team to transport the birds the last 23 miles to St Marks rather than keeping them penned longer than necessary.

The birds were held in a top-netted pen until they were banded February 9th and released on February 13th, 2016 into the large 4 acre pen.

In the January 2016 WCEP meeting held at the International Crane Foundatio, it was communicated by the USFWS that there would be no more Whooping Crane ultralight-led migrations.

Modified Direct Autumn Release

Eight costume-reared chicks were transferred to Horicon as part of the mDAR project. 2015 was the second year that chicks remained at the International Crane Foundation until fledging and then moved to the holding pen on the Horicon National Wildlife Refuge. The situation at Horicon was the best since the program moved there. The temporary holding pen was in close proximity to a roost site used by 18-11 and lots of Sandhill Cranes, geese, and ducks. This allowed the young Whooping Cranes to acclimate to the roosting marsh (Stony) and roost with the Whooping and Sandhill cranes at night. On October 22nd the chicks were banded. It took 12 days after banding for them to return to a pattern of flying to the roost to join the wild cranes. On November 3rd they decided to roost in the marsh, and this was considered the day of release. Costume caretakers no longer visited the pen or attempted to interact with the chicks. The gates on the pen were left open and food was no longer provided to the chicks. The chicks were observed interacting with Sandhill Cranes and Whooping Crane #18-11 in Stony as well as flying off the Refuge to forage. Three chicks migrated with Sandhill Cranes. Of these 3, only 1 bird was outfitted with a remote-tracking device (GSM). This chick migrated to central Florida. One chick was last observed at Jasper-Pulaski and the 3rd chick was last seen the day she started migration. The remaining 5 chicks stayed north of the Refuge until late December when they started their migration. Four of these chicks remained together and are wintering along the Mississippi River spending time between Missouri and Illinois. One chick, 65-15, left the group of 5 when they were in northern Illinois and migrated to Goose Pond Wildlife Area, IN with Sandhill Cranes. Since then she has been observed with a pair of Whooping Cranes.

MONITORING & MANAGEMENT TEAM

Davin Lopez, Wisconsin Department of Natural Resources
Anne Lacy, International Crane Foundation

In 2015, the majority of the older Whooping Cranes in the Eastern Migratory Population (EMP) summered in Wisconsin, in or around Necedah National Wildlife Refuge, Horicon National Wildlife Refuge, or White River Marsh State Wildlife Area (Figure 1). However, there was some considerable wandering by the yearling (hatch year 2014) cohort. Notable monitoring and management related information in 2015 included:

- In 2015, male 16-11 mated with a female Sandhill Crane near Horicon NWR. Their offspring was the first known Whooping Crane-Sandhill Crane hybrid or "whoophill" in the Eastern Migratory Population (EMP), though these crosses have been recorded elsewhere. On July 22nd the U.S. Fish and Wildlife Service (FWS) staff captured the hybrid chick from the wild and moved it to Milwaukee County Zoo. After a short time in captivity there he was moved to the International Crane Foundation where he is now being socialized with a female Sandhil Cranel who was raised by Whooping Cranes and recently lost her Whooping Crane mate.

- Fourteen mortalities were recorded in 2015: 9 in Wisconsin, 4 in Florida, 1 in Indiana.

- There were 24 chicks hatched from 37 nests (32 on Necedah NWR, 5 in other areas). There were 27 separate nesting pairs, 10 of which renested (including all 8 nests in the forced renesting experiment). Three chicks fledged, 2 of which migrated successfully and are currently with their parents on their wintering grounds.

Winter 2014/2015
The final wintering locations of the EMP were as follows (not including the 8 Ultralight cranes released in 2015 at St. Mark's National Wildlife Refuge).

- Indiana - 23
- Kentucky - 6
- Tennessee - 10
- Alabama - 35
- Georgia - 2
- Florida - 7

Captures and Banding

- The Whoophill chick was caught by USFWS staff on July 22nd and was housed temporarily at Milwaukee County Zoo. The Whoophill is now permanently housed at the International Crane Foundation (ICF). International Crane Foundation staff are attempting to pair him with a Sandhill Crane that was raised by Whooping Cranes.
- Parent-reared male 20-15 was reported being alone in highly populated area in Dubuque, IA. When it became clear he would not move on his own and was getting too close to humans and cars, WCEP personnel captured him and released him in Spring Green near 14-15, another parent reared chick. 20-15 subsequently migrated, possibly alone, straight south to Louisiana, where he spent the winter. To our knowledge, he never encountered any of the Whooping Cranes in the Louisiana Non-Migratory Population.
- Wild-hatched chick W3-15 was captured and banded on August 20th by Necedah NWR staff.

Winter 2015

- The maximum population size as of 31 December 2015 was 100 birds (52 males, 46 females, 2 unknown). This estimate does not include the 2015 Ultralight Cohort as they have not been released at St. Marks as of the end of 2015.
- Distribution as of early 2016 (Figure 2)
    - Alabama - 14
    - Indiana - 38
    - Illinois - 16
    - Florida - 12
    - Georgia - 2
    - Kentucky - 5
    - Tennessee - 2
    - Louisiana - 1
    - Unknown - 10

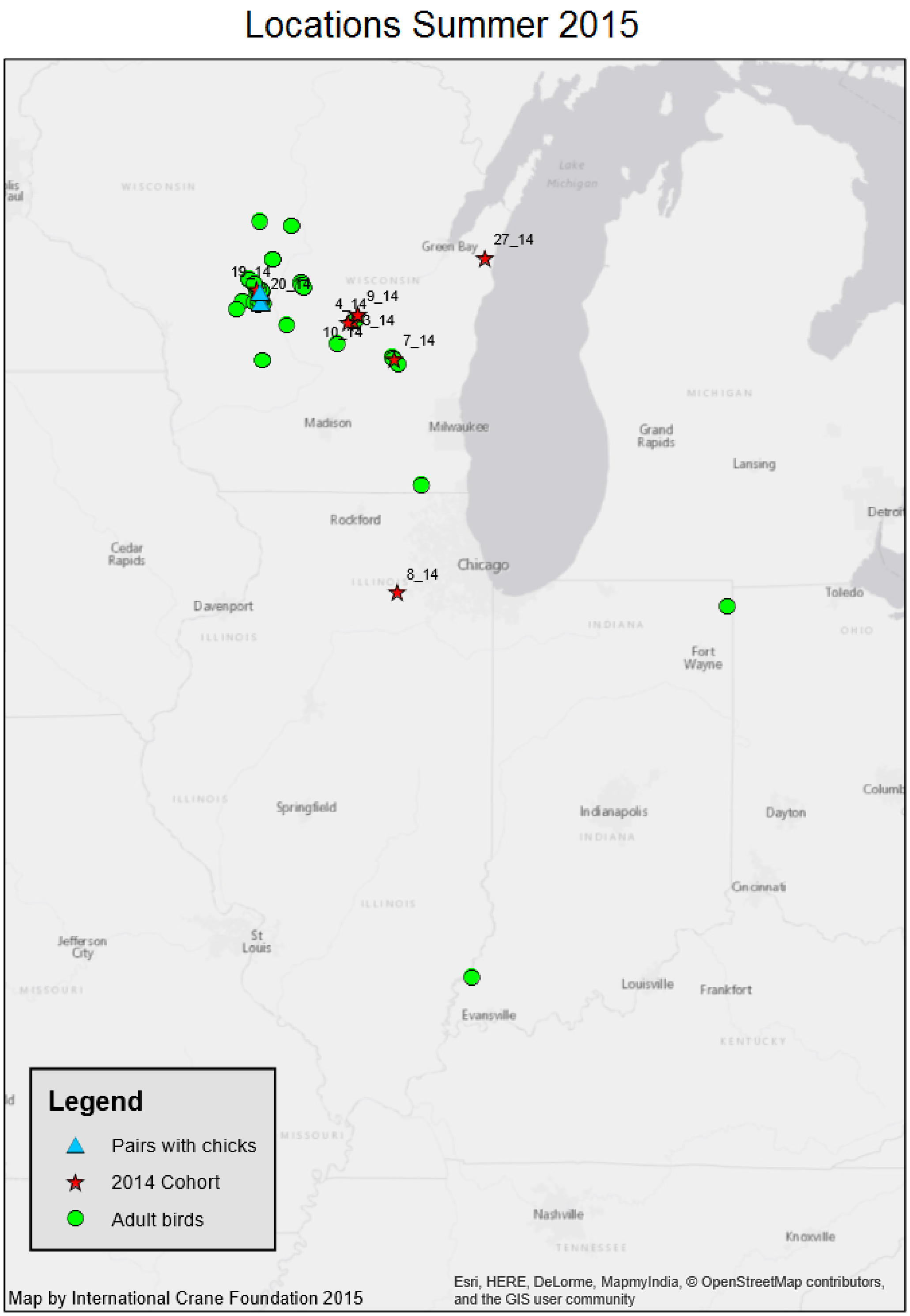


Figure 1. Summer whooping crane locations in Wisconsin, Indiana, and Illinois in the summer (July-August) of 2015. Distribution was primarily focused in Necedah National Wildlife Refuge and the Wisconsin Rectangle.

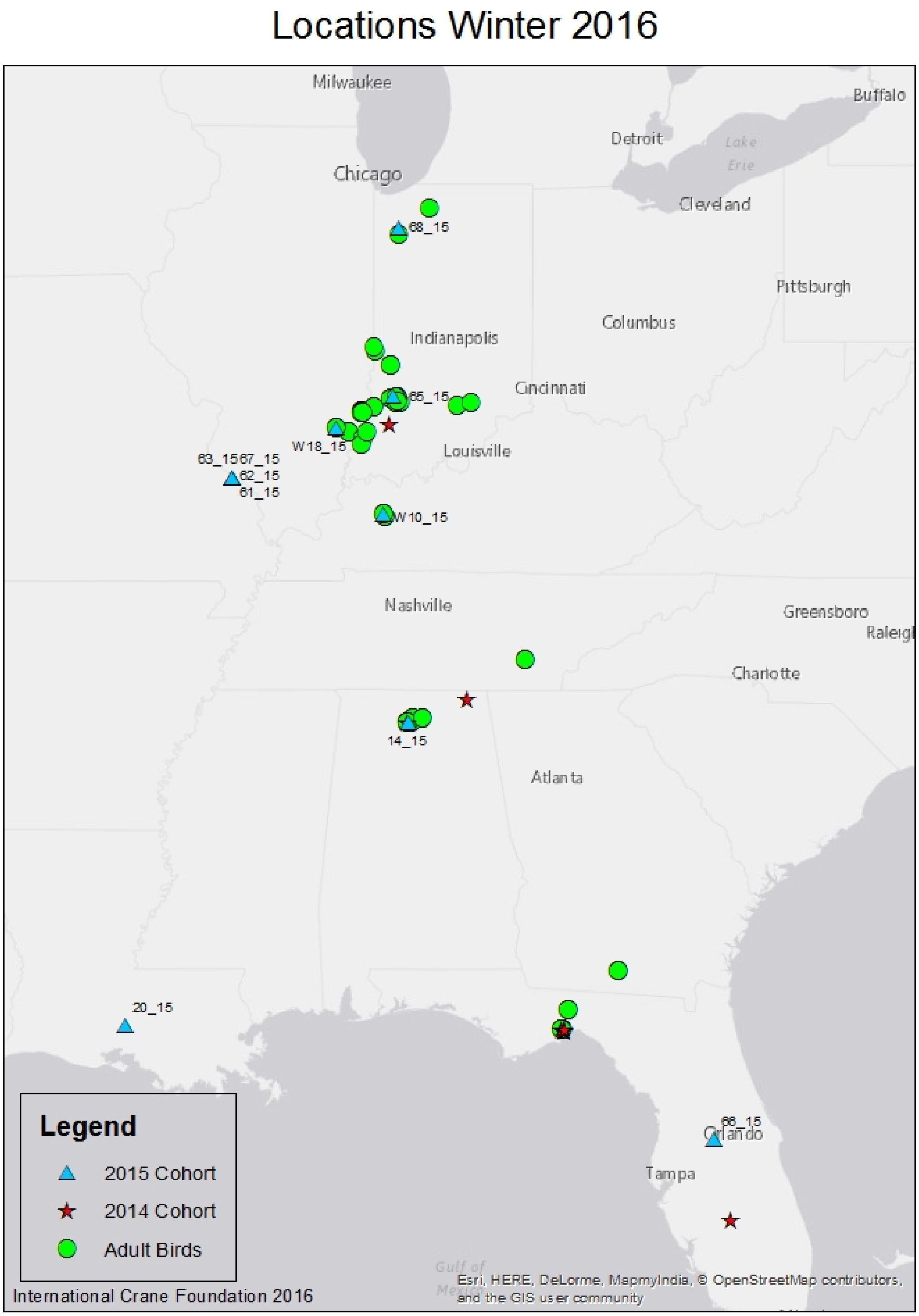


Figure 2. Winter EMP whooping crane locations as of December 31, 2015 or last report. EMP cranes continue to utilize areas throughout the Midwest and Southeast in winter.

Survival

- As of 31 December 2015, 250 Whooping Cranes have been released as juveniles since the reintroduction began in 2001. This number does not include the 17 HY2006 ultralight-led juveniles that died during confinement in a storm and one HY2007 ultralight-led juvenile that was removed from the project prior to release. It also does not include the six HY2015 ultralight-led juveniles still on migration at the end of 2015. In addition, there have been ten wild hatched chicks that survived to fledging (one in 2006, two in 2010, one in 2013, one in 2014, and three in 2015) resulted in a grand total of 260 reintroduced individuals (Figure 3), of which 100 (38.5%) may currently survive (Figure 4) in the EMP.
- There were 14 mortalities recorded in 2015:
    - 8-13: 5 January, Wakulla Co, FL – Euthanized
    - 7-13: 5 January, Wakulla Co, FL – Predation
    - 2-13: 5 January, Wakulla Co, FL – Predation
    - 2-14: 15 March, Wakulla Co, FL - Predation
    - 14-09: 17 April, Gibson Co, IN – Predation
    - W3-14: 22 April, Juneau Co, WI – Unknown
    - 26-07: 5 May, Juneau Co, WI – Unknown
    - 57-13: 10 May, Fond du Lac Co, WI – Unknown
    - 20-11: 19 June, Green Lake Co, WI – Unknown
    - 6-09: 24 June, Juneau Co, WI – Unknown, possible collision (molt)
    - 7-12: 5 July, Juneau Co, WI – Unknown
    - 22-13: 10 September, Juneau Co, WI – predation (molt)
    - W3-15: 21 September, Juneau Co, WI – disease (pneumonia caused by *Aspergillus fumigatus*)
    - 16-15: 6 October, Juneau Co, WI – Predation

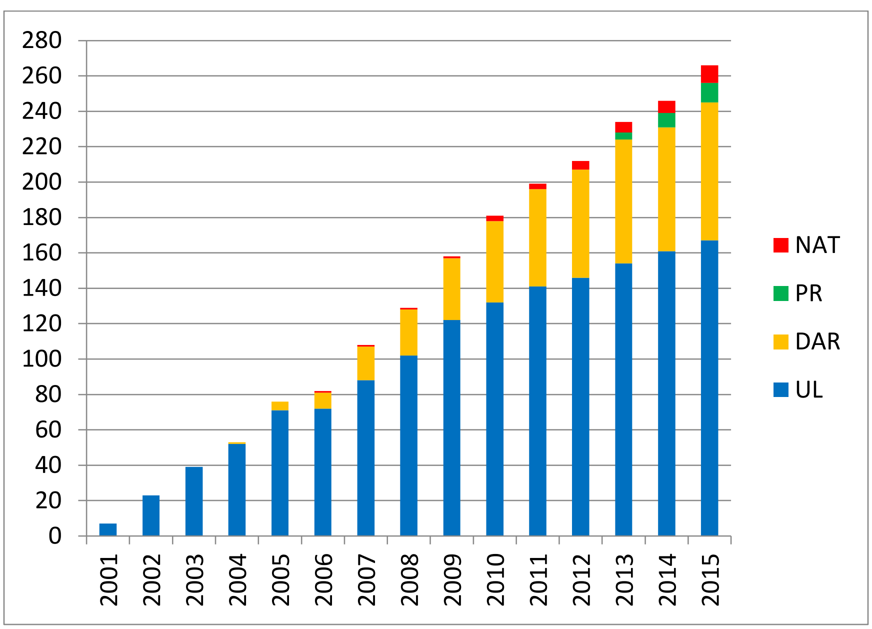


Figure 3. Cumulative number of cranes added to EMP: 266 (includes 2015 UL Cohort)

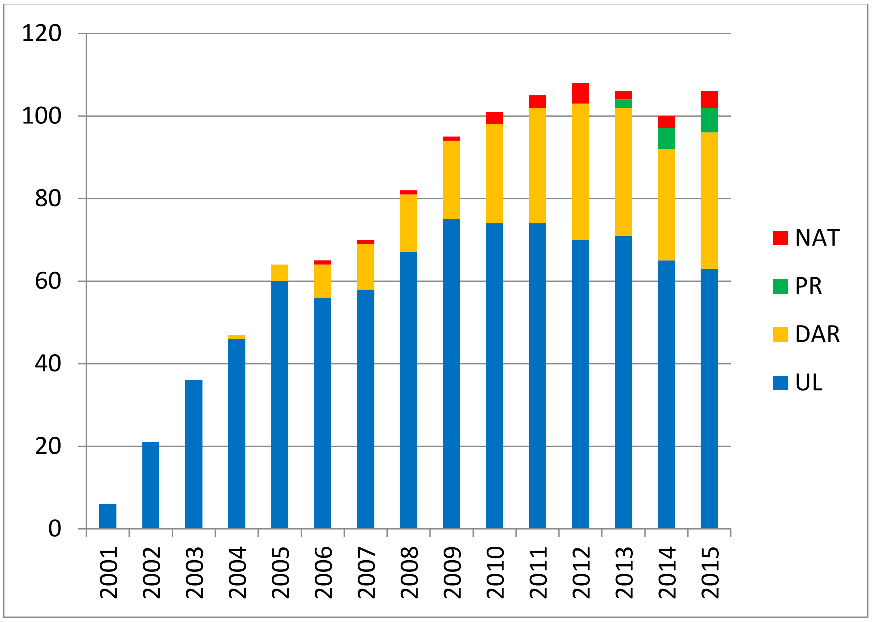


Figure 4. Population size at end of the year: 100 birds (52 males, 46 females, 2 unknown) as of 31 December 2015 (includes 2015 UL Cohort)

Reproduction

- Thirty-seven nests were initiated by 27 pairs (32 at Necedah NWR, 5 off refuge). Eight of the 10 renests were part of the forced renesting experiment conducted by the USFWS to try to mitigate the effects of blackflies on the breeding success of Whooping Cranes. All pairs whose eggs were taken for the experiment did renest and successfully hatch chicks, though only one of the renest chicks survived to fledging. In total, 24 chicks hatched and 3 fledged. Two wild-hatched chicks (W10-15 and W18-15) successfully migrated with their parents and are currently on wintering grounds.
- In addition to these Whooping Crane pairings, male 16-11 paired and nested with a Sandhill Crane, both the first successful nest at Horicon NWR and the first Whoophill in the EMP. This chick was removed from the wild and placed in captivity (see above, "Captures and Banding" section).
    - To date in the EMP there have been a total of 197 nests (161 first nests, 36 renests) leading to 64 chicks hatched in the wild and 10 fledged chicks (Tables 1 and 2). Currently, four of these survive in the wild.

Table 1. Nest initiation dates, number of nests, number chicks hatched, and number of chicks fledged 2005-2015

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
First Nest Initiation	16-Apr	5-6-Apr	03-Apr	07-Apr	02-Apr	<1 Apr	3-4-Apr	<26-Mar	15-Apr	07-Apr	1-3-Apr	
# First Nests	2	5	4	11	12	12	20	22	21	25	27	161
# Renests	0	1	1	0	5	5	2	7	2	3	10	36
Total Nests	2	6	5	11	17	17	22	29	23	28	37	197
# Hatched	0	2	0	0	2	7	4	9	3	13	24	64
# Fledged	0	1	0	0	2	0	2	1	1	1	3	11

Table 2. Pairs that have successfully fledged chicks with years of fledging

Dam	Sire	Year(s)		
11_02	17_02	2006		
2_04	9_03	2010	2013	2015
12_02	19_04	2010	2012	2014
13_03	9_05	2012		
17_07	10_09	2015		
25_09	2_04	2015		

RESEARCH & SCIENCE TEAM

Sarah J. Converse, USGS Patuxent Wildlife Research Center
Bradley N. Strobel, Necedah National Wildlife Refuge

INTRODUCTION

Prepared by Sarah J Converse, USGS Patuxent Wildlife Research Center

The WCEP Research and Science Team (RST) is a venue for scientists from Partner organizations and from outside the Partnership to collaborate on identifying high priority uncertainties, advancing efforts to address these uncertainties, and providing peer feedback on research proposals and products. The 2015 RST annual report highlights major areas of RST focus in 2015.

We also report on the WCEP Science Reboot. In March 2015, we held the Reboot at the International Crane Foundation. In this meeting, we brought together experts from inside and outside WCEP, with the goal of revising and prioritizing hypotheses about the causes of reproductive failure in this population. Given all that we have learned in the past several years, 2015 seemed to be an opportune time to revisit the vision for how research and science efforts can contribute to solving the major challenge of this reintroduction effort.

With the upcoming changes planned in the reintroduction effort – namely the decision to terminate ultralight-led migrations and to focus more intensely on increasing the amount of contact young birds have with adult birds – there will be many new opportunities to address priority uncertainties. In the next few years, we will have the opportunity to address major questions about Whooping Crane reintroduction, and answers to these questions will be critical to the future of any Whooping Crane reintroduction effort.

WCEP SCIENCE REBOOT

Prepared by Sarah J. Converse, USGS Patuxent Wildlife Research Center

In March 2015, the WCEP Research and Science Team organized a meeting of experts to identify hypotheses for nest failure, and associated management approaches conditional on each hypothesis. In August, a subset of the experts participated in an elicitation process to develop predictions about how management actions would perform, conditional on hypotheses, for nest survival and chick survival. We used value of information methods to calculate improvement in management outcomes expected from resolving uncertainty.

In the short term (3-year time scale), results indicate that valuable hypotheses to resolve to improve nest survival include the black fly, genetic structure, and costume rearing hypotheses. For chick survival, the predator, lack of experience, and genetic structure hypotheses are most valuable to resolve. In the longer term (10-year time scale), valuable hypotheses to resolve to improve nest survival include the genetic structure and black fly hypotheses. For chick survival, the genetic structure and predator hypotheses are most valuable to resolve.

These results indicate that ongoing testing of the costume rearing hypothesis is warranted (this is the goal of the parent-rearing project), as is continued investigation of environmental factors affecting nest survival (e.g., the predator hypothesis for chick mortality, which is being investigated by Brad Strobel). In the long term, however, testing the genetic structure hypothesis also appears to be warranted. The RST has continued to advocate for testing the captive selection hypothesis, which hypothesizes that captive genetic selection has resulted in heritable, non-adaptive changes in animals released to the Eastern

Migratory Population. In 2014-2015, the RST reviewed a proposal for release of wild-sourced individuals into the population, which was developed with the goal of testing this hypothesis. The International Whooping Crane Recovery Team has now become involved in this effort through their ongoing recovery planning effort.

BREEDING ECOLOGY AND MANAGEMENT RESEARCH ON NECEDAH NWR

Prepared by Bradley N. Strobel, Wildlife Biologist, Necedah National Wildlife Refuge, 11385 Headquarters Road, Necedah WI 54646

Forced Renesting

In 2014, we implemented the first year of a 3-year program of forced-renesting to assess the method's ability to increase the reproduction of Whooping Cranes in the EMP. The project was funded with a U.S. Fish & Wildlife Service Cooperative Recovery Initiative grant. Our objectives were to (1) determine if egg salvage-induced nest failure can increase the population's renesting propensity, (2) quantify and compare the reproductive success (i.e., hatch rate, fledging rate) of forced renests, natural renests, and first nests of Whooping Cranes and (3) evaluate the financial costs and the biological benefits to the population of the forced-renesting management action to inform future decisions about if and how the strategy should be implemented on an operational basis.

During April and May 2015, Whooping Cranes initiated 21 first-nests and 10 second-nests on the Necedah NWR, and 27 first-nests population wide, including areas outside of Necedah NWR (Figure 1). On 16 April 2015, we collected 15 eggs from 8 nests, and transferred them to the International Crane Foundation, and subsequently to the USGS Patuxent Wildlife Research Center in Maryland. Of the 8 nests subjected to forced renesting, 100% of these pairs renested. We monitored black fly abundance periodically throughout the summer using artificial nests but detected far fewer black flies than during similar efforts in 2014 (Figure 1). This may have contributed to the higher than usual apparent nest survival rates for control nests in the EMP (control nests were those 21-8 = 13 nests on Necedah NWR that were not subjected to forced renesting; Table 1).

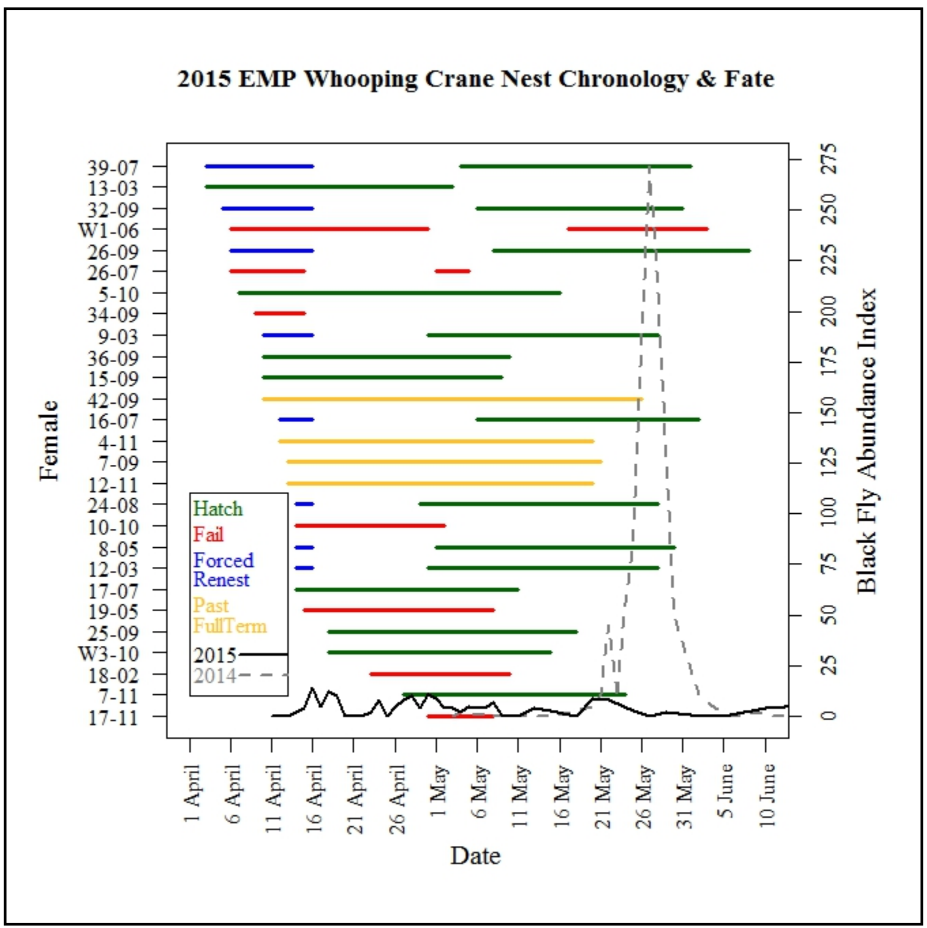


Figure 1. Whooping Crane nest chronology and fates during the spring of 2015 on the Necedah NWR. Colored bars indicate the period of activity for each Whooping Crane nest. Green bars indicate successfully hatched nests, red bars indicate failed nesting attempts and blue bars indicate nests subjected to forced-renesting. The black line shows the black fly abundance index measure as the total number of *Simulium annulus* and

Simulium johannseni captured using sweep net samples of artificial nests with Sandhill Crane brood mounts. The dashed grey line indicates the black fly abundance index from 2014.

Comparing Breeding Ecology and Reproductive Success of Sandhill Cranes and Whooping Cranes

We located 27 Whooping Crane first nests and 35 Sandhill Crane nests on Necedah NWR or the adjacent federally-owned lands. Excluding nests that were part of the forced-renesting management strategy, the apparent nest success of Whooping Cranes was 38%, slightly less than the 51% apparent nest success of Sandhill Cranes (Table 1). Most of the Whooping Crane nest failures were of unknown causes (Table 2). Sandhill Crane nest failures did not appear to be caused by a single factor disproportionately. Whooping Crane nest initiation dates were often obtained through direct observations of radio-marked adults. Sandhill Cranes were not radio-marked and therefore, nest initiation dates were estimated by floating eggs in warm water and referencing the float angle and shell exposed according to Fisher and Swengel (1991). The first Whooping Crane nest was initiated on April 3, 2015, and the first Sandhill Crane nest was initiated on April 9, 2015. Nesting chronology of Whooping Cranes and Sandhill Cranes appeared similar in 2015 (Figure 2).

From 11 April – 22 May, we recorded nesting behavior with trail cameras placed at 19 Whooping Crane nests and 27 Sandhill Crane nests. We monitored nests until either eggs hatched or nests were abandoned. We are currently completing the data collection by identifying behaviors (incubating, away from nest, manipulating nest platform, etc.) from diurnal photos. Due to the relatively large number of nests observed, data collection and analysis is ongoing. However, preliminary results from a discriminant function analyses on the behaviors of incubating cranes during the 2014 and 2015 seasons showed that the failed Whooping Crane nests were associated with higher rates of "bill flicking" and "head rubbing" than all other nests (i.e., successful Whooping Cranes, failed Sandhill Cranes and successful Sandhill Cranes).

Table 1. Apparent survival rates of sandhill and whoopng crane nests on Necedah National Wildlfie Refuge in 2014 and 2015.

		Assumed Initial Nests (no FRs)				Renests (FRs and Others)			
Year	Species	# Nests	# Successful	ANS	# Chicks	# Nests	# Successful	ANS	# Chicks
2014	SACR	16	9	56%	4	-	-	-	-
2014	WHCR	17[a]	5	29%	9	3[b]	0	0%	0
2015	SACR	35	18	51%	25	-	-	-	-
2015	WHCR	13[c]	5	38%	9	10[d]	8[e]	80%	12

a - 20 total initial nest, 3 nests were forced to fail
b - 2 forced renests
c - 21 total initial nests, 8 nests were forced to fail
d - 8 forced renests
e - all were forced renests

Table 1. Fates of crane nests monitored on Necedah NWR April-June 2015.

	Whooping Crane			Sandhill Crane		
FATE	N	% Total	% Relevant[a]	N	% Total	% Relevant[a]
Abandonment	2	6.7%	9.1%	0	0.0%	0.0%
Inviable	1[b]	3.2%	4.3%	1	2.9%	4.5%
Predation (Mammal)	2	6.7%	9.1%	2	5.7%	9.1%
Predation (Unknown)	0	0.0%	0.0%	1	2.9%	4.5%
Failure (Unkown cause)	4	13.3%	18.2%	1	2.9%	4.5%
Hatch	14	46.7%	63.6%	17	48.6%	77.3%
Human Caused Failure	8	26.7%	-	2	5.7%	-
Unknown Fate	0	0.0%	-	11	31.4%	-
TOTAL	**30**			**35**		

[a] - excludes nests of unknown fate or fates affected by research or monitoring activities, but includes the fates of "forced renests".

[b] - past term incubation, eggs collected to terminate nest

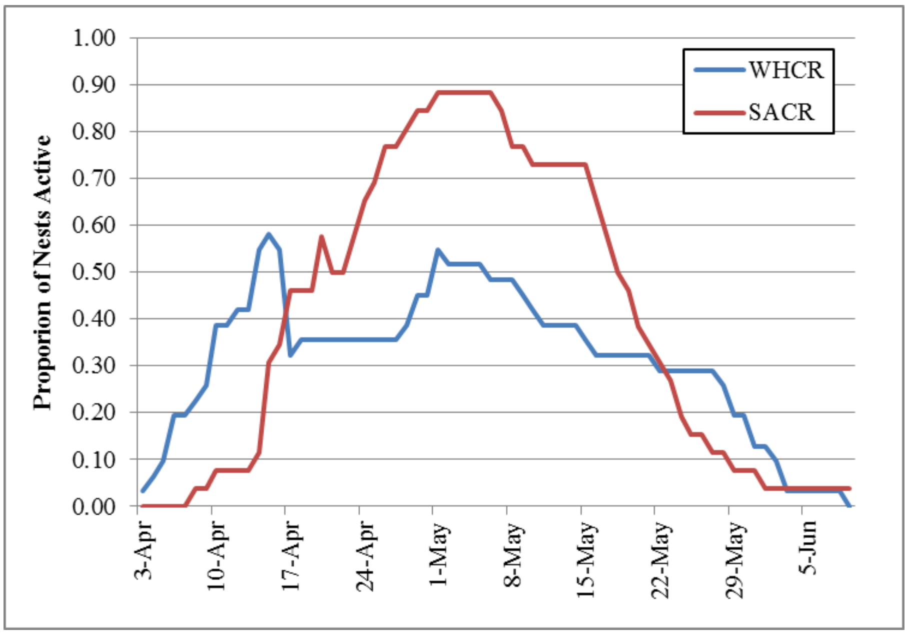


Figure 2. Whooping Crane and Sandhill Crane nesting chronology during the spring of 2015 on the Necedah NWR. Proportion of total nests active by date. The sharp drop in the proortion of Whooping Crane nests in mid-April was caused by the implementation of the forced renesting action.

Parent-Rearing Experiment

Prepared by Glenn H. Olsen, USGS Patuxent Wildlife Research Center

At the start of 2015 there were 5 parent-reared Whooping Cranes in the Eastern Migratory Population. All 5 Whooping Cranes wintered in areas with other Whooping Cranes or with Sandhill Cranes and all 5 successfully returned to Wisconsin in the spring of 2015. One of these 5 birds has died since: bird 22-13 was molting on a small wetland on Necedah National Wildlife Refuge when it died, possibly due to depredation. Scavenged remains, including working VHF and PTT radios, were recovered on 16 September 2015 by Eva Szyszkoski and Glenn Olsen.

In 2015, 4 Whooping Crane chicks were assigned to the parent-rearing program at USGS Patuxent Wildlife Research Center; these chicks hatched beginning in June. None of the 4 chicks died, but one was removed from the release program when it developed cervical scoliosis, thought to be of genetic origin.

That bird is currently slated to be used as a role-model for costume-reared birds at Patuxent. The other 3 birds were moved from their parents' pens on 25 August and placed together in a large pen with a pond to encourage water-roosting behavior. These birds were shipped to Necedah NWR by Windway Corporation on 16 September, banded the next day, placed in temporary pens, and released to the wild 3-5 days later. One bird was killed by predators on 16 October 2015. One bird moved to Dubuque, Iowa where it was in a compromised situation close to humans and, with help from Anne Lacy and the International Crane Foundation, was moved to a known crane roost site on the Wisconsin River. The bird (20-15) has since migrated to Louisiana but is currently not with any cranes. The other surviving parent-reared bird (14-15) migrated, possibly accompanied by Whooping Cranes, to Wheeler NWR where it is with Whooping Cranes (Table 3).

Table 3. Current status of captive-bred and parent-reared Whooping Cranes in the Eastern Migratory Population, as of January 1, 2016.

WCEP #	Sex	Status	Current Disposition
20-13	F	Dead	Recovered 15 Oct. 2013, heavily scavenged, no mortality cause
21-13	F	Dead	Recovered 21 Oct. 2013, impact trauma (vehicle)
22-13	M	Dead	Recovered 16 Sept. 2015, molting, possible predation
24-13	M	Alive	Winter 2015-16, Knox and Davies Co. Indiana
19-14	F	Alive	Winter 2015-16, Knox Co. Indiana
20-14	F	Alive	Winter 2015-16, Jackson Co. Alabama
21-14	F	Dead	Recovered 8 Oct. 2014, blunt trauma
27-14	F	Alive	Winter 2015-16, Morgan Co. Alabama
14-15	F	Alive	Winter 2015-16, Morgan Co. Alabama
16-15	M	Dead	Recovered 6 Oct. 2015, suspected viral infection
20-15	M	Alive	Winter 2015-16, St. Martin Parish, Louisiana

ANALYSES OF MOVEMENT PATTERNS AND OVERWINTERING LOCATIONS OF THE EMP

Prepared by Claire Teitelbaum and Thomas Mueller, Goethe University

The long-term monitoring data collected by WCEP provides a unique opportunity to analyze the movement patterns of the entire Eastern Migratory Population of Whooping Cranes. Because this database contains lifelong information on movement of single individuals as well as the composition of groups of migrating birds, we have been able to describe and analyze the movement patterns of individuals and groups since the beginning of the reintroduction effort. During the summer, the population spends time in a fairly small area of central Wisconsin, concentrated within the protected areas used as release sites. One exception is juvenile birds, which wander as far as hundreds of kilometers from their release area. On average, the population migrates for 17-31 days in November and December and 10-27 days in March and April, with no detectable changes in the duration of migration over time. In contrast, since 2006, a large portion of the population has shifted its overwintering range north from the reintroduced wintering grounds in Florida. This shift has led to a winter distribution that is much larger than the summering area, spreading from central Florida to southern Illinois. Further, this shift in overwintering location was driven by changes in the behavior of individual Whooping Cranes over the course of their lifetimes, where some birds have even used a different site in each year of migration. These results highlight that some aspects of Whooping Crane migration behavior, particularly overwintering behavior, are very flexible, while others appear to be relatively fixed. In the future, we plan to use the long-term monitoring data to identify links between movements, social associations, and social relationships within the population.

INVESTIGATING REPRODUCTIVE BEHAVIORS IN THE EMP

Prepared by Misty McPhee, University of Wisconsin-Oshkosh

One of the current approaches to conservation of the EMP is forced renesting of birds at Necedah National Wildlife Refuge. The downside to this strategy is that if cranes are not able to shift their date of nest initiation, this could be a management strategy with no end in sight. Thus, my collaborator and I built an individual-based computer model that will let managers explore the impact of different management decisions and environmental conditions on the success of nesting, which is crucial to the success of Whooping Cranes in the wild. Preliminary results suggest that when the wild population has more than 80% early nesters, the population crashes with no forced renesting. By forcing half of the pairs to renest, the population is relatively stable but there is no natural shift to nesting late, which means that reintroduction and forced renesting will be needed in perpetuity.

Over the next year and a half, I will be on sabbatical and focusing all of my attention on the EMP. My overarching objective for this sabbatical work is to better understand why Whooping Cranes are abandoning their nests and experiencing such low reproductive success in the wild. To this end, I plan to focus my efforts on three different approaches to this problem. First, I will spend time in the field with Brad Strobel, several students, and others collecting basic population data on wild Whooping Cranes as well as their close relative, the Sandhill Crane (*G. canadensis*). Second, I will conduct experiments testing the hypothesis that cranes do not have appropriate predator response behaviors, resulting in unnecessarily flighty behavior and abandonment of the nest. I would also like to develop methods to test differences in brooding behavior between birds and whether or not these differences impact chick survival. These behavioral tests will be conducted in the field and hopefully with captive animals at the Patuxent Wildlife Research Center and/or the International Crane Foundation. Third, I will conduct an extensive literature review on the other 13 species of crane to characterize similarities and differences in their ecology, behavior, and habitats in the hopes of identifying factors that could explain the Whooping Crane's current situation.

SCIENCE IMPACT OF THE EASTERN MIGRATORY POPULATION REINTRODUCTION EFFORT

Prepared by Sarah J. Converse, USGS Patuxent Wildlife Research Center

The science output from the Eastern Migratory Population reintroduction effort has been growing substantially in recent years. To date, a total of 37 journal articles have been published, focused on topic areas including health, medicine, demography, behavior, and management. In addition, 17 published abstracts and 3 student theses have been produced.

The scientific impact of EMP-focused publications is also growing. Three of the published papers have more than 20 citations each (scholar.google.com, accessed 26 January 2016) including: Runge et al. 2011 (124 citations), Mueller et al. 2014 (27 citations), and Hartup et al. 2005 (22 citations).

Journal impact factors are a widely used tool to assess the visibility of publication outlets. The journal impact factors for selected outlets have generally been less than 2 (Table 4). Five papers have been published in journals with impact factors >2. One publication, Proceedings of the North American Crane Workshop, stands out in terms of number of publications; 12 papers have been published there. It is important to recognize that this journal is not indexed by major indexing services such as Web of Science, and this severely limits the reach of these publications. Greater emphasis on publishing in indexed and more widely-available journals would increase the science impact of this reintroduction effort.

In 2016, the RST hopes to work with the Communications and Outreach Team to increase the visibility of EMP-related science. An example is a proposed effort to feature particular research projects on the WCEP web page or social media posts, with the post including information and photos that would be of interest to and accessible by the general public as well as other researchers. There is also a need to make the list of WCEP science products more accessible via improved placement on the WCEP web page.

Table 4. Journal Impact Factors for journals in which Eastern Migratory Population research has been published, through February 2016.

Journal	Number of Articles	Journal Impact Factor[a]
Biological Conservation	1	3.762
Bird Conservation International	1	1.784
Ecological Applications	1	4.093
Ecology and Evolution	1	2.320
J American Mosquito Control Association	1	0.948
J Avian Medicine and Surgery	1	0.393
J Fish and Wildlife Management	2	0.757
J Ornithology	1	1.711
J Vector Ecology	1	1.172
J Wildlife Diseases	1	1.355
J Wildlife Management	2	1.726
J Zoo and Wildlife Medicine	1	0.424
North American Bird Bander	1	NI[b]
PloS ONE	1	3.234
Proc North American Crane Workshop	12	NI[b]
Science	1	33.611
Veterinary Radiology and Ultrasound	1	1.453
Veterinary Surgery	1	1.041
Waterbirds	1	0.637
Wildlife Biology	1	0.880
Wildlife Rehabilitation	1	NI[b]
Zoo Biology	2	0.831

[a]From ISI Web of Science 2014
[b]Non-Indexed

COMMUNICATIONS & OUTREACH TEAM

Davin Lopez, Wisconsin Department of Natural Resources
Lizzie Condon, International Crane Foundation

The WCEP Communications and Outreach Team (COT) is responsible for all external communications on behalf of WCEP. It is also the main group responsible for maintaining the WCEP Google Drive, the main repository for notes and documents generated by the various WCEP teams. The COT draws from the expertise of our members, many of whom have experience in public communications and media relations. On occasion we also pull in other employees of WCEP partners when we feel it is necessary to get additional perspective on press releases and other COT activities. Many partners in WCEP this year participated in external outreach efforts.

Communications this year followed similar patterns to previous years, although we issued fewer press releases than usual, mainly due to a lack of a second team co-chair. We have decided that this year (2016) we will make major changes to our communications, including writing a new communications plan with a new set of core messages to define how we want the public and key partners to perceive WCEP's work. This plan will also include a schedule for press releases, social media posts, and other major communications for WCEP.

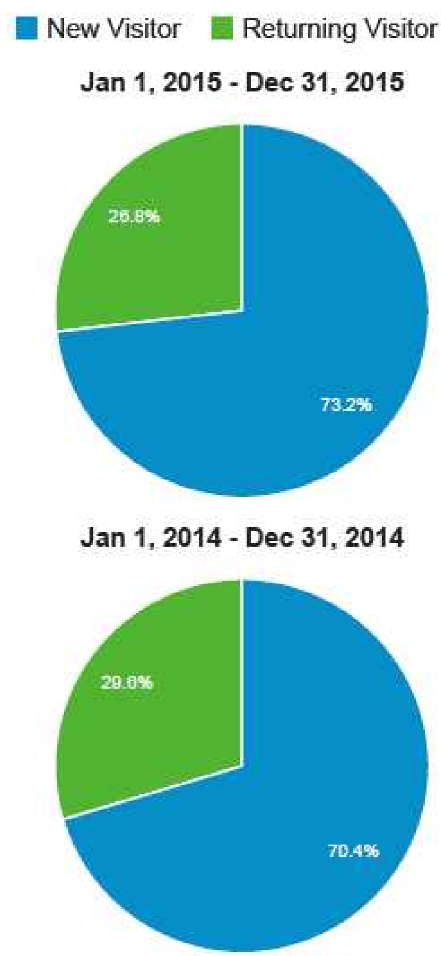
WCEP Website

www.bringbackthecranes.org had **18,443** unique visitors in 2015. This represents an increase of 33% from 2014 when the site had **13,869** visitors. When combined with founding-partner websites: http://www.operationmigration.org (140,454) and www.savingcranes.org (30,699), a total of 189,586 unique visitors were reached with WCEP specific information in 2015.

The number of "pageviews" also increased with **49,348 versus 37,804 (2014).** A "pageview" is defined as the total number of pages viewed. Repeated views of a single page are counted.

Our "sessions" total likewise saw an increase for 2015 with **24,904 vs 19,251** for the previous year. A "session" is the period time a user is actively engaged with multiple pages on a website.

Of the total number of unique visitors, we can see that the number of **new** visitors increased slightly over last year.



Where are they coming from?

Of the 24,904 sessions, search engines generated 9,356 visits, while referring websites and social media sites generated the majority of the balance.

The top two traffic-generating sites in each category are listed below.

Search Engine	**Sessions**
All	**9,356**
Top Two: Google **Yahoo**	**8,271** **497**
Referring Websites	
All	**7,307**
Top Two: operationmigration.org **4webmasters.org**	**1,592** **842**
Direct Traffic	**5,268**
Social Media	
All	**2,973**
Top Two: Facebook **Twitter**	**2,701** **138**

WCEP also continues to work on developing a new website that will use a WordPress platform. The WordPress platform is a much easier interface than the current HTML platform, which will enable multiple WCEP personnel to be able to update and add content. Currently only two people in WCEP have the required HTML technical skills to update the existing website. Ideally, this will allow WCEP to make the website much more dynamic than in years past. On the heels of the new website, WCEP also plans to launch a new Whooping Crane reporting site that will provide feedback and relatively up to date individual location information (following WCEP guidelines on the precision of location reporting).

WCEP Media Releases/Press statements

The COT issued the following press releases this year:

- First wild Whoopers hatching
- Whooping crane chicks getting ready for fall migration

We also issued the following statements and project updates:

- Project updates for January, February, March April, early May, late May, June, late July (2), September, and November
- WCEP statement about the USFWS vision document

Traditional Media Coverage

News articles that included "Whooping Crane" from states within the EMP range

AL.com

Alabama News Center

Alabama Public Radio
Associated Press
Audubon Magazine
Baltimore Sun
Baraboo News Republic
Clanton Advertiser
Daily Caller
Decatur Daily
Examiner.com
Gettin' Outdoors Radio Show (several live interviews)
Green County Daily World
Iowa Gazette
Knoxville News Sentinel
KWWL.com
LaCrosse Tribune
Madison Record
Milwaukee Journal Sentinel (several stories)
Mother Nature Network (several stories)
Rhett Turner & Greg Pope, Red Sky Productions
Tallahassee Democrat
The Clanton Advertiser
The Southern Illinoisan
Victoria Advocate
WALB TV, GA (several stories)
Washington Times
WEAU.com
WHNT News
Wisconsin Gazette
Wisconsin Public Radio
Wisconsin Public Radio News
WISN Milwaukee
wisn.com
WMTV
WTTV Chicago Tonight

Magazine articles focusing on the Eastern Migratory Population

Month	**Magazine**	**Article title**
Nov	Outdoor Alabama Magazine	It's time to Give a Whoop!
Jan	Alabama Wildlife Federation Magazine	Endangered Whooping Cranes
October	Ducks Unlimited Magazine	Hunters can help one of our rarest birds

WCEP partners conducted interviews with many radio and television media sources about Whooping Cranes and the EMP reintroduction project. These sources include Wisconsin Public Radio, Alabama

Public Radio, several country and pop radio stations in Alabama, AL.com, and local television stations in northern Alabama.

WCEP Social Media Sites

WCEP has social media accounts on both Twitter and Facebook. We currently have around 700 Twitter followers and 1,500 Facebook followers. We post updates on Facebook, as well as articles related to other endangered species recovery efforts and linking to WCEP partner projects.

Social media sites provide WCEP with an additional tool to better reach new and existing audiences about the project and its partners.

Through increased usage and exposure, the number of "Likes" on the WCEP Facebook page grew from **1203** on 1 January 2015 to **1509** on 31 December 2015, representing a **25%** growth rate over the 12 months. Comparatively, in 2014 the page grew in size by 80%. During 2015 a total of 169 stories were shared/published on the WCEP Facebook Page (facebook.com/WhoopingCraneEasternPartnership). It is important to note the type of post that gets the most attention so that we can continue to provide this type of content and continue to build the WCEP Facebook audience. Last year's top two stories in terms of audience engagement were: The hybrid crane at Horicon and the start of the (final) ultralight-guided whooping Crane migration.

WCEP primarily uses Twitter to broadcast press releases and updates. During 2015, WCEP sent out 9 Tweets that garnered nearly 8,000 "impressions". An "impression" is defined as a Tweet that was delivered to an account, although not necessarily read. The main focus of Twitter for WCEP is to get news stories into the hands of like-minded conservation organizations and into newsrooms. Twitter is a free service that is very easy to use and takes little time to maintain, thus the COT deems it a worthwhile outreach tool.

Education and outreach programs and events

WCEP partners conducted many programs and outreach events designed to raise awareness about Whooping Cranes and the EMP reintroduction project. We continued to work with our core audience, as well as building our following with outreach events and materials designed to reach non-traditional audiences. Presentations about Whooping Cranes were given at schools, assisted living facilities, and other venues.

Birding and crane-specific festivals are an important part of WCEP outreach. This year WCEP partners tabled and presented at the Whooping Crane Festival in Port Aransas, Texas; the Whooping Crane Festival in Princeton, Wisconsin; the Sandhill Crane Festival in Lodi, California; International Migratory Bird Day in Florida; and the Festival of the Cranes in Decatur, Alabama.

Operation Migration's outreach efforts through its Field Journal and social media websites continued to reach a wide audience with frequent updates. Other outreach efforts included public tours at the International Crane Foundation, with specialized tours dedicated to Whooping Crane conservation efforts, and special tours at Patuxent Wildlife Research Center. Operation Migration also offered Whooping Crane viewing opportunities at White River Marsh State Wildlife Area and at flyovers along the ultralight migration route to Florida on behalf of WCEP. Visitors to the blind at White River numbered 225 people who got the opportunity to witness the young cranes up close in their pen, while roughly 2,000 people attended the flyover events.

This year we continued our relationship with Journey North, an educational website that reaches an audience of over 250,000 visitors per month. Journey North helps foster a personal connection to the Whooping Cranes in the EMP through providing in-depth information and updates about each individual Whooping Crane chick throughout its lifetime. WCEP links to these individual histories on the WCEP website. Operation Migration continues to fund the Whooping Crane component of Journey North, and provides them with updates during the fall and winter months to help keep the biography pages up to date. Journey North's Whooping Crane website pages were viewed almost 250,000 times. I addition to their website, regular updates are sent out via Facebook, Twitter, and email to roughly 64,000 subscribers.

COT members also participated in Wisconsin Department of Natural Resources (WDNR) "Ask the Experts" chat sessions. These chats are a text based online format designed to provide feedback and answers to the public. The WDNR held two chats in 2015 that were focused on Whooping Cranes. The first was in May, where we had 65 participants, 86 later views, and answered 77 questions. The second was in October, where there were 211 participants, 307 later views, and 1,370 questions answered.

Pledge campaign logo

The International Crane Foundation (ICF) spearheaded a new campaign called "Keeping Whooping Cranes Safe", which focuses on reducing human-caused mortality of Whooping Cranes across all wild populations. The first pilot community for this campaign is northern Alabama, an important wintering area for cranes in the Eastern Migratory Population. The campaign is centered on Wheeler National Wildlife Refuge in Decatur, Alabama, although many activities covered the entire state. As part of this campaign, ICF created a Whooping Crane mascot that attends outreach events; posted billboards; produced a 30 second radio and television public service announcement with a local spokesperson; conducted radio, television and newspaper interviews; worked with partners to increase K-12 and public outreach programs; tabled at gun shows and other local events; conducted workshops on Whooping Crane outreach for environmental educators and teachers; provided materials for hunter education classrooms; added ten new Whooping Crane education trunks to schools, museums and other outreach facilities; and helped grow the Festival of the Cranes at Wheeler NWR to over 3,000 participants. A local brewery also made a Whooping Crane beer with conservation messaging on the can. ICF started a pledge campaign that is not exclusive to Alabama, although it was advertised heavily in Alabama.

Whooping Crane Red Ale, made by Old Black Bear Brewing Company in Madison, Alabama.