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## ABSTRACTS

Following are abstracts of oral and poster presentations given at North American Crane Workshop 13 but which were not published in these Proceedings.

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## AGE-SPECIFIC SURVIVAL OF GREATER SANDHILL CRANE COLTS IN NEVADA

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**Abstract:** We estimated daily survival rates and fledging success and evaluated factors influencing survival of greater sandhill crane (*Grus canadensis tabida*) chicks (i.e., colts) in northeastern Nevada. We monitored 101 colts during 2009-2010. We found survival was lower on Ruby Lake National Wildlife Refuge compared to private or state-owned lands. Colts located on the Refuge had essentially no prospect of fledging ( $1 \pm 6\%$  in 2009,  $<1 \pm 3\%$  in 2010), whereas colts located on private and state lands had higher and more variable probability of fledging ( $25 \pm 13\%$  in 2009,  $15 \pm 9\%$  in 2010). Daily survival rates were lowest early in development and increased with age of colts. We did not detect an effect of weather or habitat use on survival. Our results support previous findings of predation as the primary cause of pre-fledging mortality in cranes. Our findings are inconsistent with sibling competition as a major source of mortality but support extrinsic factors as important determinants of survival. Our results suggest that management of predator populations may influence fledging of cranes in northeast Nevada.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:111**

**Key words:** chick survival, fledging success, *Grus canadensis*, Nevada, sandhill crane.

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## WHOOPIING CRANE DISTRIBUTION AND HABITAT USE: PAST, PRESENT, AND FUTURE?

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**Abstract:** Accurate determination of the historic range for a species can be important to the success of the species conservation and reintroduction efforts. The remnant wild population of the endangered whooping crane (*Grus americana*) historically had a wide distribution but is now limited to a small portion of that range. What can past and present whooping crane distributions tell us about the future? In addition to historic data compiled by R. P. Allen in 1952, we obtained 76 supplementary records and used geographic information systems to re-assess historic distribution and habitats of whooping cranes in their former breeding and wintering ranges. We extended the breeding, summering, and wintering ranges into several new areas. Whooping cranes historically were found in 9 biomes and many ecoregions, extending from the tundra and boreal forests of northwestern Canada to the Gulf Coast and xeric shrublands of interior Mexico. Based on crane life history, landscape, and wetland features of historic locations, we identified 4 features common to breeding and wintering areas: 1) high densities of wetlands or large wetland complexes; 2) shallow, open wetland systems with emergent vegetation; 3) subtle to rolling topography that provides an interspersed wetland and low meadow or prairie habitats with relatively sparse cover of trees and shrubs; and 4) high productivity due to hydrological pulsing, periodic inflow of nutrients, or periodic disturbances. The new insights from this assessment, combined with site-specific studies of current habitat use by whooping cranes, should better inform future evaluations and selection of reintroduction sites.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:111**

**Key words:** distribution, *Grus americana*, habitat, historic range, whooping crane.

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## **BEHAVIORAL MOVEMENTS OF ARANSAS-WOOD BUFFALO WHOOPING CRANES: ANOMALIES OR INDICATIONS OF WAYS TO FURTHER ENHANCE SPECIES RECOVERY**

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**Abstract:** Aransas-Wood Buffalo whooping cranes (*Grus americana*) usually summer and nest in and around Wood Buffalo National Park, winter at or near Aransas National Wildlife Refuge, and migrate between these sites during spring and fall each year. Since 2010 the Whooping Crane Tracking Partnership has monitored movements of 57 individual whooping cranes marked with transmitters that collect multiple GPS locations per day. The Whooping Crane Tracking Project and advancements in technology have provided an unprecedented opportunity to study this imperiled species in ways that to date have not been possible. Among other things, we have observed many behavioral movements that are well documented in the literature, but other movements have rarely or never been observed or reported. We have been able to document birds that summered in Saskatchewan, western Alberta, and eastern British Columbia, and even birds that spent weeks hundreds of km north of Wood Buffalo National Park. We have also observed migration paths that were well outside the range of the typical migration corridor and have documented birds wintering over 160 km, inland and along the Gulf Coast, from the Aransas National Wildlife Refuge. Here we present some behavioral movements observed to date that may provide additional insight into the recovery of the species.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:112**

**Key words:** Aransas, *Grus americana*, movements, tracking, whooping crane, Wood Buffalo.

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## INFLUENCES ON NEST SUCCESS IN A REINTRODUCED POPULATION OF WHOOPING CRANES

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**Abstract:** Historical nesting areas of extirpated whooping cranes (*Grus americana*) included wetlands in divergent taiga, tallgrass prairie, and Gulf coast biomes. The wild migratory population breeds in taiga while, since 2001, the Whooping Crane Eastern Partnership has worked to reintroduce an Eastern Migratory Population (EMP) in the tallgrass biome. Compared with previous reintroductions, most aspects of the EMP reintroduction have been successful. Adult survival is high, and pairing, foraging, migratory, and copulatory behaviors appear normal. Reproductive rates, however, are unsustainable. Multiple hypotheses including attacks by blood-feeding black flies (*Simulium* spp.), slow maturation of breeding birds, inappropriate energy-storage patterns, mal-adaptations to wild situations, inappropriate habitat use, and predation all potentially explain low nest success and are not mutually exclusive. Abundance of avian-feeding black fly species was related to nest failure, but the relevant species were found in high numbers only in the Necedah area. In 2012, when black fly populations were suppressed, nest success increased to 45% although only 2 of 9 chicks fledged, further suggesting that multiple biological constraints were involved. In 2013, a second control year in which black fly populations were not suppressed, nest success was again low. Conservation actions include maintaining the core population near Necedah along with other potential actions such as facilitating dispersion to new habitats that have different wetland productivity levels, black fly populations, and predator communities. How birds use the varied landscapes they inhabit can help guide reintroduction efforts as the reintroduced birds respond to varied situations for the first time in more than a century.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:113**

**Key words:** black flies, Eastern Migratory Population, *Grus americana*, nesting, whooping crane.

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## DETERMINING DIET COMPOSITION AND INGESTION RATE OF CRANES THROUGH FIELD MEASUREMENT

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**Abstract:** Determining diet composition and ingestion rates of food helps elucidate how a species utilizes its habitat. Yet determining diet and food intake rates can be difficult. With endangered species, foraging individuals cannot be sacrificed. Feces can often be hard to find in wetland species, and stable isotopes cannot completely overcome biases from differential digestion. Utilizing field measurements to determine diet composition and ingestion rates is an under-utilized technique and requires further assessment. We used vegetation community, food acquisition behavior (glean, probe, stab—associated with stalking, and jab), and food manipulation time to predict diet composition. At least 17 unique food items were identified in the diet of reintroduced whooping cranes (*Grus americana*) foraging in Wisconsin during summer. Our model was then tested with data independent of model creation and was over 90% correct. Ingestion rates were experimentally determined by baiting birds with a known number of food items. A regression, where the counted number of food items removed from the bait pile was used to predict the number of food items observed being consumed, explained over 80% of the variance. To increase knowledge on diet composition, our model provides a foundation and should be applied to broader habitats (e.g., Texas Gulf coast or Wood Buffalo National Park). These data may also be potentially predicted with accelerometers in 3 planes of motion and by precise locations superimposed on habitat maps so that diet information may be estimated remotely.

### PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:114

**Key words:** diet, food intake, *Grus americana*, ingestion rates, model, whooping crane.

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## HABITAT USE AND MOVEMENT PATTERNS OF WHOOPING CRANES IN THE OIL SANDS MINING REGION

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**Abstract:** Aransas-Wood Buffalo whooping cranes (*Grus americana*) migrate through the oil sands region of North America twice annually. Other migratory waterbirds, e.g., ducks, frequently land on oil sands tailings ponds and are oiled. Whooping cranes are speculated to be threatened by oil sands during migration, but it is unknown if mining activities pose a risk. We characterized movement patterns and habitat use of whooping cranes in the oil sands region using data from 49 individually marked cranes which made 146 individual migrations to or from the breeding grounds. Of these, 48 migrations were by juveniles and 98 were by adults or subadults. A considerable proportion (41%) of marked cranes flew over the oil sands region at least once between spring 2010 and fall 2012 and a large proportion (63%) of these landed at least once during migration at a stopover location in the oil sands region. The duration of stopovers was short, in most cases either 1 or 2 nights. Stopover and flight locations were recorded in close proximity to tailings ponds during spring migration (2.51 km and 0.96 km, respectively) but were considerably farther from tailings ponds during fall migration (26.29 km and 24.75 km, respectively). Results from this study will be used to guide land use decisions and management actions to mitigate potential threats from oil sands mining to whooping cranes.

### PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:115

**Key words:** Aransas-Wood Buffalo, *Grus americana*, migration, mining, oil sands, stopover, whooping crane.

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## **CAPTURE AND DEPLOYING GPS PTTs ON ARANSAS-WOOD BUFFALO WHOOPING CRANES: LESSONS LEARNED WITH NEW TECHNIQUES AND TECHNOLOGIES**

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**Abstract:** Research conducted by the Whooping Crane Tracking Partnership requires capture and marking of Aransas-Wood Buffalo whooping cranes (*Grus americana*) at their breeding and wintering grounds. Capture of pre-fledging whooping cranes at Wood Buffalo National Park had been successfully conducted by E. Kuyt. We emulated their methods with similar safety and efficiency. Adult whooping cranes from this population had never before been captured on the wintering grounds. In the first 2 winters (2009-2011) we captured 3 cranes. Starting in 2012, we developed a new methodology to effectively capture birds on the wintering grounds. This modified leg noose includes a remote trigger device and a retraction mechanism that cinches the noose and allows for variable resistance as the bird advances or retreats. During the ensuing 3 winters we successfully captured >30 birds with this technique. Overall, Platform Transmitter Terminals (PTTs) equipped with GPS receivers were attached to 31 pre-fledging whooping cranes in and around Wood Buffalo National Park and 26 birds (24 after hatch year, 2 hatch year) were marked on the wintering grounds in Texas through 2013. As of 1 January 2014, marked birds have provided >100,000 Doppler locations and >80,000 GPS locations. In inspection and preliminary use of data, we found communications between transmitters and satellites can be corrupted resulting in invalid locations. We developed algorithms that flag obvious and potential errors based upon several filters. Using this automated method, we found that approximately 1% of GPS locations are likely erroneous and should be removed before more detailed analyses are conducted.

### **PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:116**

**Key words:** Aransas-Wood Buffalo, capture, GPS, *Grus americana*, leg noose, PTT, remote trigger, Tracking Partnership, whooping crane.

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## CAN HORMONE METABOLITES PREDICT THE TIMING OF REPRODUCTIVE BEHAVIORS IN THE CAPTIVE WHOOPING CRANE?

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**Abstract:** Cranes are known for their elaborate courtship behaviors. Whooping crane (*Grus americana*) reproductive behaviors are well documented, both in their native habitat and in captivity. However, little is known about the influence of hormones on these behaviors. Reproductive behavior is shown to be strongly influenced by reproductive hormones in a variety of species, so in this study we attempted to understand the relationship between hormone concentrations and reproductive behaviors observed in the whooping crane. In understanding this relationship we could better interpret how captive management practices affect cranes. Our study assessed reproductive output in 7 captive whooping crane pairs through non-invasive hormone monitoring and behavioral observations. We found that reproductively-active females produced higher estradiol concentrations and displayed more reproductive behaviors than females that failed to reproduce. Initial observations also revealed higher proportions of reproductive behaviors following detection of elevated reproductive hormone metabolites with a lag time of approximately 7 days. This pattern was especially strong directly before an egg-laying event. We explored this relationship further using mixed models and model selection in order to obtain statistical estimates of the lag time between hormone elevation and increased levels of reproductive behaviors. Understanding this relationship will not only increase our knowledge of reproductive biology within this species but could create another monitoring tool for crane hormones and behaviors.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:117**

**Key words:** *Grus americana*, hormones, reproductive behaviors, whooping crane.

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## BREEDING DISTRIBUTION OF SANDHILL CRANES IN RUSSIA

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**Abstract:** Breeding distribution of the Mid-continent Population (MCP) of sandhill cranes (*Grus canadensis*) in Russia is poorly understood. Most published information has described the species breeding range in Russia being limited mostly to the Chukotka Autonomous Region and part of the Kamchatka Peninsula. We describe the historical and current breeding distribution of sandhill cranes in Russia with a primary focus on the 1,000-km range expansion in northern Yakutia over the past 60 years. We identify the current western limits of crane breeding in Russia based on results from our investigations. We also identify the Anadyr Lowlands, Chaun Depression, and Kolyma Region as the most important centers of sandhill crane breeding in Russia based upon settling patterns of a random sample of 133 PTT-tagged cranes tagged on the principal spring staging areas of the MCP in North America. Densities of sandhill cranes from across their breeding range in Russia are compared based on results from ground and aerial surveys. Possible factors contributing to the major range expansion of sandhill cranes in Russia starting in the mid-20th century include climate change and population growth.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:117**

**Key words:** Breeding distribution, *Grus canadensis*, MCP, Mid-continent Population, PTT, Russia, sandhill crane.

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## **A REVIEW OF PARENT-REARING WHOOPING CRANES AT PATUXENT WILDLIFE RESEARCH CENTER, 1988-2003.**

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**Abstract:** Seventy-four whooping crane (*Grus americana*) juveniles were reared by captive whooping crane parents between 1988 and 2003 at Patuxent Wildlife Research Center. Fifty-two chicks (70%) survived to 1 October of their hatch year. Chicks were raised by their own parents or by foster parents using 4 different adoption methods to foster eggs or chicks. Eleven pairs raised chicks with rates of success for each pair varying from 0 to 100%. Forty-six parent-reared whooping cranes were released in central Florida as part of an attempt to establish a non-migratory flock and 6 were kept in captivity. Parent-rearing increased Patuxent's capacity to rear chicks for release.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:118**

**Key words:** *Grus americana*, parent-rearing, Patuxent, whooping cranes.

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## **PREDICTING OUTCOMES OF REINTRODUCTION STRATEGIES IN A DECISION-ANALYTIC SETTING**

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**Abstract:** Thoughtful long-term planning of reintroductions to the Eastern Migratory Population of whooping cranes (*Grus americana*) is critical given the high-stakes nature of the reintroduction: it is an important element of the species' recovery plan but is costly in terms of money, time, and use of captive-bred propagules. As part of a 5-year planning process embarked upon by the Whooping Crane Eastern Partnership (WCEP), we took a decision-analytic approach to reintroduction planning. The authors served as analysts and facilitators for the WCEP Guidance Team, which has responsibility for the reintroduction. Through this process, decision objectives and alternatives were identified, and models were developed to predict objective outcomes under various alternatives. The most complex of these models predicted probability of population persistence based on a Bayesian Population Viability Analysis (BPVA). The BPVA was parameterized with empirical estimates from a Bayesian multi-state mark-recapture model, and with expert opinion. Expert opinion was necessary to allow for prediction of unobserved demographic processes, such as breeding success at novel release sites, which are key to evaluating alternative strategies. The BPVA also integrated model-based uncertainty, reflecting uncertainty about the cause of widespread nest failure in this population. The predictions made in the BPVA were integrated into the decision-analytic process, and decisions on a 5-year strategy will be forthcoming. However, it is important to see decision analysis in this case not as a process with a defined beginning and end, but as an ongoing process to support adaptation in the management of this population as uncertainties are resolved over time.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:118**

**Key words:** Bayesian Population Viability Analysis, BPVA, Eastern Migratory Population, *Grus americana*, reintroduction, WCEP, whooping crane, Whooping Crane Eastern Partnership.

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## MOVEMENT STRATEGIES OF SUBADULT INDIVIDUALS ON WINTER HABITAT INFLUENCE WINTER RANGE EXPANSION OF A MIGRATORY BIRD

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**Abstract:** Habitat qualities encountered on wintering grounds by migratory birds have carry-over effects on population dynamics in the breeding season and may influence future winter range expansion. Furthermore, subadult individuals of many long-distance migratory birds often wander farther distances on wintering grounds than paired birds that defend winter territories, suggesting various habitat qualities are encountered by these individuals each winter. We developed a preliminary model for the endangered whooping crane (*Grus americana*) to investigate how 2 different movement strategies utilized by subadult individuals on the winter areas along the Texas coast over a 5-year period may influence future range expansion and population dynamics. The first strategy incorporated the known life-history characteristics of subadults spending most time on the winter grounds in close proximity to their parents' territory; whereas we added a habitat quality parameter in strategy 2 to mimic their tendency to visit habitats known for plentiful food supply. Birds utilizing strategy 1 remained in close proximity to their parents' territory each year and encountered low to average habitat qualities, and birds of strategy 2 traveled farther distances and associated with higher quality habitats. Our model is the first attempt at predicting subadult *G. americana* movement behavior on the winter range and explores the implications on future range expansion between 2 different movement strategies—site fidelity and habitat quality. Future development of this model will incorporate a trade-off parameter between the 2 strategies to better resemble subadult movement and allow for more accurate predictions of *G. americana* winter range expansion and carry-over effects.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:119**

**Key words:** *Grus americana*, habitat quality, movement strategy, site fidelity, subadults, whooping crane, winter range expansion.

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## PEOPLE OF A FEATHER FLOCK TOGETHER: A GLOBAL INITIATIVE TO ADDRESS CRANE AND POWER LINE INTERACTIONS

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**Abstract:** *The Cranes: Status Survey and Conservation Action Plan* of the IUCN/SSC Crane Specialist Group (1996) identified overhead power lines as a significant global threat to many crane species worldwide. The demand for electricity from growing economies and efforts to alleviate poverty through rural electrification are likely to increase in most of the developing world. Most of the sites where power line collisions occur are remote and communications among individuals have been very limited. To our knowledge, South Africa is the only crane range state with a comprehensive national program to deal with the threat of power line collisions (the Eskom-Endangered Wildlife Trust (EWT) Strategic Partnership). Coordination is critical at this stage, in order to share lessons, develop capacity, pool resources, and accelerate collective learning towards finding innovative solutions to mitigate this impact on threatened crane populations. In order to initiate this international collaboration, key role players participated in a workshop in Yueyang, China, in December 2012 aimed at stimulating discussion and promoting the coordination of efforts. Key outcomes of this workshop included: 1) a briefing document detailing the baseline information on global impact of power line collisions, the identification of hotspots and the process to be followed to address the impacts in these areas, and a comprehensive list of research and mitigation needs, and 2) the establishment of a global Cranes and Power Lines Working Group comprised of regional subject matter experts working in partnership to address this threat through the sharing of expertise and acting as an informed stakeholder group.

### PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:120

**Key words:** cranes, Cranes and Power Lines Working Group, mitigation, power lines, South Africa.

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## EVALUATION OF LONGEVITY AND WEAR OF COLORED PLASTIC LEG-BANDS DEPLOYED ON SANDHILL CRANES IN WISCONSIN

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**Abstract:** We investigated durability and retention of colored plastic leg bands deployed on sandhill cranes (*Grus canadensis*) by the International Crane Foundation since 1991. Overall, band retention was high (>90%) across 20 years of observation. A logistic regression model showed that 4 variables (band height, sex of bird, year of band deployment, and radio presence/absence) significantly affected long-term band retention. Short bands (2.5 cm) were 4.5 times more likely to fall off than tall bands (7.5 cm). Males were 2.3 times as likely to lose short bands as females, although females showed more wear on recovered tall bands over time. Low-quality plastic likely increased band loss in 1996-97. The largest factor affecting short band retention was the attachment of a radio transmitter which increased the weight and wear on plastic thickness. Short bands with radios attached were 4.0 times as likely to be lost as short bands without radios. Attaching a radio to a short band decreased its average and maximum lifespan by 5 years compared to short bands without radios attached. We provide 3 recommendations to maintain, or possibly increase, lifespan of short bands on sandhill cranes: 1) introduce bands made of solid plastic in 2 halves that snap together around a crane's leg rather than wrap around it, 2) mount leg-band transmitters on tall bands, or 3) use backpack harness-mounted transmitters instead of leg-mounted transmitters. These recommendations can significantly increase band retention, thereby reducing band loss, in a marked population of a long-lived avian species.

### PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:120

**Key words:** band longevity, *Grus canadensis*, plastic leg-bands, sandhill crane.

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## SURVIVAL OF THE ROCKY MOUNTAIN SANDHILL CRANE

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**Abstract:** The sandhill crane (*Grus canadensis*) is one of the longest lived of game bird species. Species with its life history tend to have relatively constant adult survival rates over time, mitigating environmental stresses by reducing reproductive effort. Given its low natural mortality rate, crane populations are not robust to large harvest rates, even if compensatory mortality is applicable. We evaluated survival of Rocky Mountain Population sandhill cranes during 1969-1992, based on a mark-resight/recovery program. This included time periods before and after initiation of sport harvest. Most cranes were banded as juveniles, on the breeding grounds, and the resighting period was centered in the winter. Therefore we estimated survival of the first 6 months, and then annual survival thereafter. We modeled crane survival as a function of age, body condition, and pre- or post-sport harvest. We also modeled relative vulnerability of cranes to hunting vs. non-hunting sources of mortality. Survival estimates were adjusted for loss of field-readable marks over time. Juvenile survival for the first 6 months was dependent on body condition, and on whether hunting occurred. Hunting also reduced survival from age 0.5 to 1.5 years, but had no effect on survival for age >1.5 years. Up to age 4.5, cranes were more vulnerable to non-hunting sources of mortality, relative to cranes age >4.5 years. The apparent lack of hunting impact on adult crane survival is based on data only until 1992. A new banding program for cranes could test whether harvest is more additive with current harvest levels.

### PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:121

**Key words:** *Grus canadensis*, hunting mortality, Rocky Mountain Population, sandhill crane, survival.

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## THE USE OF SATELLITE TELEMETRY TO EVALUATE MIGRATION CHRONOLOGY AND DISTRIBUTION OF EASTERN POPULATION SANDHILL CRANES

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**Abstract:** The Eastern Population (EP) of sandhill cranes (*Grus canadensis tabida*) is rapidly expanding in size and geographic range. Limited information exists regarding the geographic extent or migration chronology for EP cranes. To address these information needs, we trapped and deployed Platform Transmitting Terminals (PTTs) on 33 sandhill cranes from 2009 through 2011 to assess movements throughout the year. Tagged cranes settled in summer areas of Minnesota (10%), Wisconsin (34%), Michigan (28%), and Ontario, Canada (21%). Cranes departed for initial fall staging stopover sites by early October through Wisconsin, Michigan, Illinois, Indiana, Ohio, Kentucky, and Tennessee before reaching their winter terminus. We identified staging and transient stopovers; Jasper-Pulaski FWA, Indiana, and Hiwassee Wildlife Refuge, Tennessee, were used as stopover sites most frequently during migration. Cranes arrived at their winter terminus by mid-December in Indiana (28%), Kentucky (10%), Tennessee (69%), Georgia (10%), and Florida (31%). Cranes departed on spring migration by February and travelled on routes similar to those used during fall migration to their respective summer areas. Seventy-nine percent of marked cranes ( $n = 23$ ) returned to their initial summer area after a second spring migration. The estimated difference among mean center of the previous year's summer area was 0.53 km. The information we collected on EP sandhill crane movements provides insight into distribution and migration chronology that will aid in assessment of the current U.S. Fish and Wildlife Service Cooperative Fall Abundance Survey and can aid state and federal managers in identifying and protecting key staging and winter areas.

### PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:121

**Key words:** Eastern Population, *Grus canadensis tabida*, migration, movements, PTT, sandhill crane.

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## NATIONAL WHOOPING CRANE ENVIRONMENTAL EDUCATION PROGRAM

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**Abstract:** The International Crane Foundation and Hamline University's Center for Global Environmental Education have formed a partnership to develop a 4-part national whooping crane (*Grus americana*) environmental education program involving interactive multimedia tools. This work started in Texas through a partnership with Texas A&M University-Corpus Christi's Harte Research Institute. The first module, *Estuaries in the Balance: The Texas Coastal Bend*, focused on how estuaries work and the vital importance of the quantity and timing of freshwater inflows in sustaining high-quality habitat for wintering whooping cranes, as well as on sustaining important fisheries and industries for local economies. Target audiences are students and teachers in grades 4-8, families, and the general public. The curriculum is multi-disciplinary and adheres to state academic standards in science and social studies. The program is available via the web and distributed to schools, zoos, national wildlife refuges, and through partnership with Texas Parks and Wildlife Department. Development is currently underway for the second multimedia module, *To the Brink and Back*. This program will engage users in an exploration through time of the whooping crane as a species and the crane's relationship with humans. It will bring to life the history of the species' decline and recovery within the context of the larger conservation movement, whooping crane conservation and reintroduction, the fate of other selected endangered and extinct species, and important legislation that has affected whooping cranes.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:122**

**Key words:** environmental education program, *Grus americana*, partnership, whooping crane.

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## THE ROLE OF POPULATIONS AND SUBSPECIES IN SANDHILL CRANE CONSERVATION AND MANAGEMENT

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**Abstract:** The scientific literature on sandhill cranes (*Grus canadensis*) is organized into 9 breeding populations (Cuban, Florida, Mississippi, Eastern Flyway, Mid-Continent, Rocky Mountain, Lower Colorado River, Central Valley, and Pacific Flyway) and 6 subspecies. Several populations are composed of multiple subspecies, with subspecies occurring in multiple populations, and some populations are further divided into subpopulations that may also include multiple subspecies. Populations with "flyway" nomenclatures are not necessarily restricted to the North American flyway specified. The organization of sandhill crane distribution was adopted when cranes were limited by loss of wetland habitat and overhunting, which caused distinct breeding populations separated by unoccupied areas. Using this approach, management actions were tailored to meet local and regional recovery goals with great success. Sandhill crane populations are now larger than they were only a few decades ago and their distribution continues to expand. However, as crane populations and crane research have grown, unoccupied areas between populations have become populated, and genetic analyses have suggested that revision of subspecific designations may be warranted. This can lead to substantial confusion when evaluating an author's intended scope of inference for a given study. In this presentation, we define and review support for the existing organization of populations, subpopulations, and subspecies. We then discuss the implications of recent genetic and citizen science analyses to the existing organization. We close with an open question of what costs and benefits to crane conservation and management might occur if population designations were redefined.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:122**

**Key words:** *Grus canadensis*, populations, sandhill cranes, subpopulations, subspecies.

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## ANNUAL VARIATION OF YOUNG OF THE YEAR IN THE ROCKY MOUNTAIN POPULATION OF SANDHILL CRANES

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**Abstract:** The sandhill crane (*Grus canadensis*) has the lowest annual production of young of any harvested bird in North America. Within the Rocky Mountain Population (RMP), the percent of juveniles (<1 year old) has been observed to fluctuate considerably among years (3-12%). Recognizing the mechanisms that drive this variation is important for understanding population dynamics and making future harvest decisions. The 3-year average of the percent of juveniles during migration at the San Luis Valley, Colorado is one of the parameters used to calculate the allowable number of harvest permits for the RMP. Reliable predictions of the production of young would be helpful in understanding limitations of population growth, and evaluating the importance of the juvenile survey in an optimal harvest decision strategy. Following previous hypotheses of the influence of large-scale drought on RMP crane juvenile production, and given predictions of future climate trends, we evaluated whether climate variables (e.g., winter snow depth, freezing temperatures during brooding) and drought indices (e.g., Palmer Drought Severity Index, Palmer Drought Z Index) could explain observed annual variation. Data were collected from 1972 to 2013. We fit these data using a Bayesian beta linear regression model. We found the Palmer Drought Severity Index a good predictor of juvenile production. Drought indices below zero were correlated with below-average juvenile production. Drought indices may be useful to adjust the harvest formula so a conservative number of permits are issued when juvenile production is expected to be low.

### PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:123

**Key words:** annual variation, drought index, *Grus canadensis*, harvest, juvenile production, RMP, Rocky Mountain Population, sandhill crane.

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## AGE-SPECIFIC MIGRATORY AND FORAGING ECOLOGY OF EASTERN POPULATION GREATER SANDHILL CRANES

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**Abstract:** Migratory birds adapt behavior to exploit changes in food resources. Altering foraging behavior and migratory chronology are common adaptive strategies that are linked to food density and distribution during migration. In some species, hatch-year (HY) individuals do not complete structural growth prior to migration. Therefore, food density and distribution, nutritional requirements, and foraging experience can also affect foraging behavior. We studied these relationships in Eastern Population greater sandhill cranes (*Grus canadensis tabida*) at Manitoulin Island, Ontario, Canada, during autumn migration 2011 and 2012. Our goal was to elucidate how changes in food density and variation affect behavior. We collected observational data that included: 1) waste grain depletion, 2) number and age of cranes using focal fields (functional response), and 3) individual behavioral time budgets of after hatch-year (AHY) and HY cranes using focal fields (behavioral response). We also conducted an experiment in 2012 to test for a causal relationship between grain and behavioral response. We manipulated grain in 0.25-acre plots in a sub-sample of focal fields ( $n = 12$ ) to emulate natural grain depletion. Results from our negative binomial generalized linear mixed-effects analysis of the functional response dataset showed no evidence for differences between AHY and HY field use. Our modelling procedure provided support (63% AIC support) for positive additive effects on functional response from field area, distance to nearest roost wetland, time of day, total grain density at the 5-km scale, and relative grain density at the 5-km scale. Our results did not provide evidence for within-field grain density or variation effects on functional response. Total and relative grain effects on field use were more important at the 5-km scale (i.e., a community food effect) than we had anticipated. Results from our linear mixed-effects modelling of the behavioral response dataset collected in observational fields provided evidence for more efficient foraging by HY cranes. Our top model (32% AIC support) showed negative additive effects (decreased foraging efficiency) from month of observation, crane age, and total grain and positive additive effects (increased foraging efficiency) from proximity to nearest roost wetland and grain variation ( $0.358 \pm 0.19$ ). Though the difference ( $\pm 1$  SE) in foraging efficiency between age groups was relatively small ( $-0.01 \pm 0.006$ ), our findings did not support our prediction that HY cranes feed less efficiently on seasonally novel food sources (i.e., spend more time searching compared to feeding relative to adult conspecifics). Analysis of our experimental dataset provided additional support for positive additive effects on foraging efficiency from variation ( $1.134 \pm 0.36$ ). The inclusion of grain variation but not grain density in our top models accords with the inverse relationship that often exists between heterogeneity of food distribution and foraging efficiency.

### PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:124

**Key words:** autumn migration, Eastern Population, foraging, grain density, *Grus canadensis tabida*, Manitoulin Island, sandhill crane.

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## EVALUATION OF A VACUUM TECHNIQUE TO ESTIMATE ABUNDANCE OF AGRICULTURAL GRAIN

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**Abstract:** Estimation of waste grain density and distribution in harvested agricultural fields is needed to develop energetic carrying capacity models for non-breeding granivorous gamebirds. We aimed to evaluate the efficacy of the Penny et al. blower-vacuum method for sampling waste barley at our study site as part of a larger study of Eastern Population sandhill crane (*Grus canadensis*) foraging and migratory ecology. To determine if the Penny et al. vacuum technique adequately sampled waste barley, we developed an experiment that compared the efficacy of the vacuum technique to hand-picking. In 2011, we used our Stihl Model BG 65E Blower-Vac and modified it similar to Penny et al., and in 2012 we used the Penny et al. Stihl Model BG 85. We sampled grain during autumn and conducted 2 analyses to evaluate the devices, including: 1) we sampled points ( $n = 25$ ) in 3 different fields using the vacuum sampling device for 10 seconds, hand-picking, and digging 2 cm into the substrate to collect remaining seeds, and 2) we randomly placed known abundances of dyed barley seeds in sampling frames, and sampled for 10 seconds. In each of the 3 fields, we used 3 different seed densities that were 90, 50, and 10% of the maximum density recorded in fields at the study site ( $n = 12$  per field, 36 total). Hand-picking was more effective (mean seed recovery = 98%) than the vacuum technique in both years. We detected no substantial vacuum model, seed density, or field effect.

### PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:125

**Key words:** agricultural fields, Eastern Population, *Grus canadensis*, sandhill crane, vacuum sampling, waste grain density.

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## CHARACTERIZATION OF STOPOVER SITES USED BY WHOOPING CRANES AS DETERMINED FROM TELEMETRY-MARKED BIRDS

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**Abstract:** An essential component to conservation of Aransas-Wood Buffalo whooping Cranes (*Grus americana*) is identifying locations and characteristics of migration stopover sites, but this type of information is limited due to the rarity of whooping cranes and remoteness of their stops. Data from the Whooping Crane Tracking Partnership provides an unprecedented opportunity to locate stopover sites along the entire migratory corridor. Much of the information about these sites, however, cannot be remotely sensed and is available only from ground-based, time-sensitive measurements of habitat characteristics. In 2012 the Platte River Recovery Implementation Program (Program) and researchers from the U.S. Geological Survey and Crane Trust initiated a ground-based study spanning from northern Texas to North Dakota to evaluate habitats that over 30 telemetry-marked whooping cranes have used as stopover sites during their migration. Herein, we present the overall study approach, show images of the diversity of habitats visited, and summarize preliminary results from site evaluations. Over 200 stopover sites have been characterized to date, thereby greatly improving our understanding of sites selected by migrating whooping cranes. Stopover site evaluations depend largely on private landowners allowing access to their properties, and we are grateful for the access landowners have provided to the project during the past several migration seasons. The Program and other organizations will apply knowledge gained from this study to inform habitat management practices and conservation strategies along the central Platte River and throughout the migration corridor.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:126**

**Key words:** Aransas-Wood Buffalo, *Grus americana*, migration stopover, Tracking Partnership, whooping crane.

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## MESHING NEW INFORMATION FROM THE WHOOPING CRANE TRACKING PARTNERSHIP WITH SPECIES RECOVERY GOALS—NEXT STEPS

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**Abstract:** The International Whooping Crane Recovery Plan (2007) has established population goals and objectives for downlisting whooping cranes (*Grus americana*) from “endangered” to “threatened”. Delisting criteria have not been established as of yet. In addition to population goals and objectives, the plan outlines a number of recommended actions that need to be taken to move species recovery forward. We expect that data generated from the Whooping Crane Tracking Partnership will provide key metrics that will enhance our understanding of population demographics for the last remaining natural population of whooping cranes (i.e., the Aransas-Wood Buffalo population, AWBP). If ongoing whooping crane reintroduction projects are not able to establish additional, self-sustaining whooping crane populations, the AWBP will have to continue increasing both its overall range and population size in order for this species to reach current downlisting goals (i.e., alternative downlisting criteria 1B). Thus, information gleaned from the tracking partnership on AWBP demographics such age-specific mortality rates, causal mortality factors and habitat use throughout the species’ range will provide critical information to future recovery efforts. We examine preliminary data from the Whooping Crane Tracking Partnership and suggest near-term recovery actions and long-term planning efforts that will enhance species conservation efforts specific to the AWBP.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:127**

**Key words:** Aransas-Wood Buffalo population, downlisting, *Grus americana*, recovery, Tracking Partnership, whooping cranes.

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## HEALTH ASSESSMENT OF JUVENILE WHOOPING CRANES IN WOOD BUFFALO NATIONAL PARK

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**Abstract:** During 2010-2012, 31 (19 males, 12 females) pre-fledging, juvenile whooping cranes (*Grus americana*) were captured for satellite tagging and health assessment at Wood Buffalo National Park (WB), Canada. All WB birds were in good to excellent physical condition and exhibited normal responses to capture. The mean  $\pm$  SE body weight was  $4472 \pm 87$  g (range 3311-5200 g). Feather condition was generally good and no external parasites were observed. Morbidity associated with capture was noted in 4 individuals: 1 crane avulsed a toenail and 3 others sustained self-induced lacerations likely from kicking out at capture. Preliminary analysis of laboratory data revealed numerous differences in the hematology, clinical chemistry, trace element and serum protein electrophoresis values of WB versus captive-reared juvenile whooping cranes, likely due to increased exposure to potential antigens in WB birds over captive and dietary differences between the 2 populations. Prevalence of the protozoan parasite *Haemoproteus* sp. was similar between WB (10%) and captive (17%) juveniles. Four of 30 (13%) WB juveniles were seropositive for West Nile virus, and 11 of 28 (39%) were seropositive for Infectious Bursal Disease virus. All 26 WB juveniles tested were seronegative for Inclusion Body Disease of Cranes, and 31 juveniles were negative for Avian Influenza by RT-PCR of cloacal swabs. Moderate to heavy growths of *E. coli* were isolated from cultures of cloacal swabs of WB juveniles; none were positive for *Salmonella* sp. or *Campylobacter* sp. By comparison, *Campylobacter* sp. is commonly isolated from captive juveniles. This study provides baselines for many health parameters in wild whooping cranes.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:127**

**Key words:** *Grus americana*, health assessment, juveniles, whooping crane, Wood Buffalo National Park.

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## TERRITORY AVAILABILITY BEST EXPLAINS FIDELITY IN SANDHILL CRANES

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**Abstract:** We investigated dynamics of mate and site fidelity among color-banded sandhill cranes (*Grus canadensis*). Over 22 years, 81 permanent mate switches (70%) occurred in 115 pairs: 24 switches (31%) were divorces and the rest occurred following mate disappearance. The asynchronous migration, incompatibility, and better option hypotheses did not explain divorces in this population well. Productivity of divorced pairs prior to separation was lower than non-divorced pairs, but divorcing did not improve individual productivity and productivity of divorced pairs following separation was lower than non-divorced pairs. Following divorce or mate disappearance, territory retention was high (divorce = 100%, mate loss = 83%) while males and females did not differ in original territory retention. Long-term territory retention led to higher lifetime productivity and divorcing prolonged territory retention, especially for pair bonds that may have been unstable. Divorcing birds typically paired with experienced territory holders, although invasion into a pair bond by a non-territorial bird occurred. Post-divorce, relocating birds moved to adjacent territories with a vacancy rather than re-distribute to random territories. Because territories in this population are limited, an opening on a proximate territory offers a potential advantage: a bird can stay with a current mate and territory, even if reproductive history is poor, or it can seek a new but familiar mate on an adjacent territory to potentially improve productivity in an unknown future. Pairing with familiar birds may minimize the risk of losing a territory altogether. Divorces are best explained by a new “territory limited” hypothesis rather than existing hypotheses.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:128**

**Key words:** *Grus canadensis*, mate fidelity, sandhill cranes, site fidelity, territory.

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## MISSISSIPPI SANDHILL CRANE CONSERVATION UPDATE 2011-13

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**Abstract:** The Mississippi sandhill crane (*Grus canadensis pulla*) is an endangered non-migratory subspecies found on and near the Mississippi Sandhill Crane National Wildlife Refuge in southeastern Mississippi. From 2011 to 2013, conservation efforts for the recovery of this population included management activities such as protection and law enforcement, restocking, predator management, farming, prescribed burning, mechanical vegetation removal, hydrological restoration, pest plant management, and education. To maintain open savanna, we burned 4,060 hectares (10,033 acres), with 69% during the growing season. To restore open savanna, over 4,040 hectares (1,000 acres) of woody vegetation were removed using mechanical methods. To bolster the population, we released 42 captive-reared juveniles as part of 7 cohorts. To protect cranes, nests and young, contractors conducted 17,400 trap-nights, removing 93 large predators and 200 raccoons (*Procyon lotor*). Crane and habitat monitoring assessed life history parameters including radio-tracking, visual observations, and an annual nest census. We collected over 5,150 observation records including 1,760 radio-fixes. We discovered 18 after-hatch-year carcasses. Of 14 with known or suspected causes of death, 6 were due to predation, 2 to disease (including first cases of encephalitis), and 8 to trauma. During the 3-year period, there were 36, 30, and a record 39 nests resulting in 3, 2, and 5 fledglings, the latter including only the third set of twins recorded. The December 2012 population was approximately 120 cranes, up slightly from the previous total.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:128**

**Key words:** *Grus canadensis pulla*, management, Mississippi sandhill crane, monitoring.

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## MIGRATION ROUTES AND WINTERING AREAS OF PACIFIC FLYWAY LESSER SANDHILL CRANES

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**Abstract:** Some lesser sandhill cranes (*Grus canadensis canadensis*) breed in the Homer area of the Kenai Peninsula, Alaska, and those birds are part of the Pacific Flyway lesser sandhill crane population. We captured 10 of the Homer summer lesser sandhill cranes in 2008, using noose lines, and fitted each crane with a satellite transmitter to track their migration routes to and from their wintering areas. On their migration south, they traveled east to Prince William Sound before they turned southeast and flew along the Alaska coast and the Alaska panhandle before they proceeded inland to British Columbia. From there they traveled southeast to eastern Washington and Oregon before arriving about a month later in the Central Valley of California for the winter, a distance of 3,860 km (2,400 miles). They used 3 wintering areas in the Central Valley, including the Sacramento-San Joaquin Delta, the Merced Grasslands, and the San Joaquin River National Wildlife Refuge (NWR). Their spring migration route was similar to their fall migration; however, the return trip took twice as long. The most important site used for staging during migration was Columbia NWR, near Othello, Washington.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:129**

**Key words:** *Grus canadensis canadensis*, Kenai Peninsula, lesser sandhill crane, migration, Pacific Flyway, wintering areas.

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## A MODEL FOR MITIGATING LOSS OF CRANES FROM POWER LINE COLLISIONS

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**Abstract:** Mortality from power line collisions is a serious issue for cranes. We developed a geospatial model to facilitate mitigation of take of greater sandhill cranes (*Grus canadensis tabida*) from proposed power lines in the Sacramento-San Joaquin Delta Region of California that should result in no net take. The model uses our data on local night roost site population estimates and of distances that greater sandhill cranes are likely to fly within 6 km from their roosts to develop crane use probability polygons around night roosts. We estimated crane overflights for each polygon within the 6-km radius, transected by a proposed power line per day (assuming 4 daily overflights and that 25% birds fly out in the cardinal direction of the line from the roost site), multiplied by the number of days in the wintering period then divided by the proportion of the line crossing the crane use area within each polygon. We then calculated expected mortalities using mortality rates/overflight reported in the literature. After estimating annual losses, we proposed using the same model to estimate the number of cranes “saved” by marking, burying, or removing existing powerlines (considering the efficacy of line markers to reduce mortality; generally less than 80%) in the area to achieve full mitigation of expected losses. Such a model could be applied to mitigate new power lines in areas where collision risk is high for similar species such as swans and other large birds.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:129**

**Key words:** California, geospatial model, greater sandhill cranes, *Grus canadensis tabida*, mitigation, mortality, power line collisions.

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## SPACE USE OF WINTERING WHOOPING CRANES

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**Abstract:** Two hundred and fifty productive pairs or 1,000 individuals are the number of whooping cranes (*Grus americana*) of the Aransas-Wood Buffalo population needed for achieving recovery goals and subsequent downlisting to ‘threatened’ status. What is not known is how much habitat and/or area is required to support this goal. We can begin to understand the space needs of cranes by employing data collected by telemetry-marked bird locations at fixed intervals. Kernel density estimators are used to evaluate the seasonal ranges and potential territory sizes. We assess variation in seasonal range size with timing of arrival at the wintering grounds, age class, and habitat quality. Understanding how whooping cranes use space, both temporally and geographically, will increase our ability to identify area needed for cranes and aid in refining land conservation priorities to achieve recovery objectives.

### PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:130

**Key words:** Aransas-Wood Buffalo population, *Grus americana*, space use, whooping cranes.

## SOCIAL LEARNING OF MIGRATORY PERFORMANCE

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**Abstract:** Successful bird migration can depend on individual learning, social learning, and innate navigation programs. Using 8 years of data on migrating whooping cranes (*Grus americana*), we were able to partition genetic and socially learned aspects of migration. Specifically, we analyzed data from the Eastern Migratory Population wherein all birds were captive bred and artificially trained by ultralight aircraft on their first lifetime migration. For subsequent migrations, in which birds fly individually or in groups but without ultralight escort, we used deviations from a straight-line path between summer and winter ranges on the migratory route of individual birds as a proxy for migratory performance. We built a hierarchical linear mixed model to examine how much of those deviations at each observed location on the migratory route could be explained by individual age, age of the oldest individual(s) in a migratory social group, group size, and genetic relatedness on both individual and group levels. The age of the oldest individual(s) in a group improved migratory performance by ~5.5% per year of age, decreasing the average deviation from a straight-line path by ~4.2 km per year of age for each relocation event (posterior mode: -4.2 km, 95% highest posterior density interval [HPDI]: -1.1 to -7.2 km). We found no significant effects of individual migratory age, group size, or mean group genetic variance. Our results show that social learning enhances group navigation performance for long-distance migrants and that the benefits of experience accrue over many years.

### PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:130

**Key words:** *Grus americana*, migration, social learning, whooping crane.



## PARENT-REARING AND RELEASING WHOOPING CRANES IN WISCONSIN

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**Abstract:** Four whooping crane (*Grus americana*) chicks were successfully reared at USGS Patuxent Wildlife Research Center, Laurel, Maryland, and released on Necedah National Wildlife Refuge, Wisconsin, in 2013. The chicks were reared by whooping cranes that had successfully reared sandhill crane (*G. canadensis*) chicks, and were, therefore, rated as proven parents. All whooping crane chicks received periodic health examinations. Chicks were vaccinated for West Nile Virus and Eastern Equine Encephalitis. Chicks were hatched during an 8-day period in early June. After fledging in net-covered pens at Patuxent, they were shipped by aircraft to Necedah NWR, 19 September, and placed in temporary pens for 4-6 days before release. Two of the crane chicks successfully integrated and moved off refuge. One crane was located (27 November 2013) in central Kentucky on the wintering area of the pair of adult cranes that the chick was accompanying. The other chick was in northern Indiana along the Kankakee River, and then flew in 1 day to southeastern Tennessee near Hiwassee Wildlife Refuge. Two chicks died after release. One was killed 7 days post-release by a vehicle along one of the east-west roads that cross the refuge. The other chick was killed by a canid predator 2 weeks post-release while on the territory of the adult birds it was accompanying. The parent-rearing technique was successful in rearing and releasing whooping cranes into the targeted population. Two of the released birds formed bonds with wild adult pairs, and 2 of the released birds successfully migrated from central Wisconsin to known wintering areas of cranes.

### PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:131

**Key words:** *Grus americana*, Necedah NWR, parent-rearing, Patuxent, whooping crane, Wisconsin.

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## BEHAVIORAL COMPARISON OF COSTUME AND PARENT-REARED WHOOPING CRANE CHICKS

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**Abstract:** During June through August 2013, 4 whooping crane (*Grus americana*) chicks that were reared by adult parent whooping cranes for eventual release in Wisconsin were monitored and behaviors recorded. Also, during the same period, 11 whooping cranes were costume-reared by humans for eventual release in Louisiana. Behaviors were also monitored for this group. All behavioral observations were recorded as 5 minute focal observation periods. Times of observations were selected randomly between 0800 and 1500 hours primarily to avoid conflicts with other activities. No observations were possible overnight because of potential for disturbance. Results for whooping cranes will be compared to a similar study done in 2010. Behavioral activities were divided into 2 categories, posture or movements, such as standing, hock sitting, walking, running, and resting on sternum, and activity such as foraging, vigilant, non-vigilant, sleeping, drinking, grooming or preening. Thus a crane chick would be scored for both a posture and an activity, such as standing and foraging, or walking and vigilant. For most behaviors, there were no differences between parent-reared and costume-reared chicks, but differences were observed in the amount of time the 2 groups spent in vigilant behavior and in foraging.

### PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:131

**Key words:** behavioral comparison, costume-rearing, *Grus americana*, parent-rearing, whooping crane.

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## A TECHNIQUE FOR AGING CRANES

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**Abstract:** Wild birds are traditionally aged, using feather characteristics, as hatch year (HY), after hatch year (AHY), second year (SY), and after second year (ASY); often only HY and AHY. For wild birds, no accurate method of aging exists. This is especially important for long-lived bird species such as cranes. Having a method of accurately aging wild cranes will improve assessment of age-specific survival and fecundity and result in more accurate age distribution information. Bird banding studies give researchers and managers information that is age-specific if the age of the bird is known at banding. However, this information is often not known for AHY birds. For cranes, it is extremely difficult to catch and band full-flighted individuals. Pentosidine is a compound that results from the non-enzymatic glycosylation of collagen. Pentosidine is considered stable and irreversible. It is found in a variety of organs and tissues, including skin, and will accumulate slowly during the entire lifetime of an animal. Pentosidine has been tested as a chronological aging method in a number of bird species, and we have been developing this technique using known-age sandhill cranes (*Grus canadensis*) and whooping cranes (*G. americana*) to develop techniques for using pentosidine as an aging tool or biomarker for endangered Mississippi sandhill cranes (*G. c. pulla*) and whooping cranes in the wild.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:132**

**Key words:** aging technique, cranes, *Grus*, pentosidine.

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## MIGRATION ECOLOGY OF ARANSAS-WOOD BUFFALO WHOOPING CRANES

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**Abstract:** Aransas-Wood Buffalo whooping cranes (*Grus americana*), like many other migratory birds, make major moves between summer and wintering grounds twice each year. Birds in this population travel approximately 4,000 km through the Great Plains of North America. Using data from the Whooping Crane Tracking Partnership, we estimated some basic migration parameters from 57 individuals marked with transmitters that collected multiple GPS locations per day. Our preliminary results indicate that whooping cranes have a protracted migration period, wherein in some migrations, birds arrive at terminal areas (e.g., wintering grounds) before others leave initial locations (e.g., summering areas). Cranes used an average of 10 stopover sites during migration and the most common staging duration was 1 day (>60% of sites). Marked birds generally followed a migration corridor as determined from past sightings and staging within the corridor was more uniformly distributed than may have been apparent from sightings. We identified instances where birds used stopover sites from season-to-season, but this behavior was less common than use of novel sites. To date, we have documented 2 mortalities during migration. Basic data about the migration of this species coupled with other site-specific information will be used to further the conservation and management of this endangered population

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:132**

**Key words:** Aransas-Wood Buffalo, *Grus americana*, migration, Tracking Partnership, whooping crane.

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## THE SPATIAL AND TEMPORAL USE OF HABITATS BY A REINTRODUCED POPULATION OF WHOOPING CRANES IN LOUISIANA

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**Abstract:** Forty pen-reared juvenile whooping cranes (*Grus americana*), comprising 3 release cohorts, have been released at the White Lake Wetlands Conservation Area in Vermilion Parish, Louisiana, since 2011 as part of a recovery effort to establish a self-sustaining wild population. Paramount to the survival of the Louisiana crane population (LAWC) is identifying habitats used by these cranes and understanding how habitat use changes spatially and temporally. We used CropScape, a USDA landuse GIS raster, for the years 2011 and 2012 to classify habitat type for 27,797 GPS satellite telemetry location points for 40 cranes from April 2011 through October 2013. We used these data to investigate the independent and interactive effects of year, time of day, and season on individual and cohort habitat use across the Louisiana landscape. We identified 15 habitat types used by the LAWC across 3 years. The number of habitat types used by the cranes increased each year (9 in 2011, 10 in 2012, and 13 in 2013). Eighty-one percent of the total crane location points were located in 3 habitat types: herbaceous wetlands (41%), rice (21%), and crawfish (17%). This study contributes important ecological information relative to habitats used by a reintroduced crane population across space and time. This information has been absent in our current understanding of overall crane use of natural resources and it provides us with the ability for comparisons between reintroduced and wild cranes.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:133**

**Key words:** *Grus americana*, habitat use, Louisiana, whooping cranes.

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## BEHAVIOR ECOLOGY OF PEN-REARED, REINTRODUCED WHOOPING CRANES WITHIN THE LOUISIANA LANDSCAPE

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**Abstract:** Theoretically, whooping crane (*Grus americana*) behavior can be linked to long-term individual/population survival and fitness as individuals should behave in ways that maximize their success. Thus, understanding the behavioral ecology of the 40 pen-reared whooping cranes released in Louisiana is central to the successful establishment of a self-sustaining wild whooping crane population in Louisiana. We conducted time activity budgets on 4 whooping cranes (2 from L-10 cohort and 2 from L-11 cohort) between June 2012 and December 2012. Data were summarized from 12 observations, representing 9 hours of time activity. We will use these data to investigate: 1) crane behavior patterns relative to allocation of time by behavior type within and among cohorts and between individuals and flocks; 2) how these patterns change over space and time and compare to the wild population of whooping cranes; and 3) the correlation and characteristic of behavior by habitat type. Preliminary results show that overall, cranes spent more time (66%,  $n = 4$ ) foraging than other behaviors. Cranes spent 14% and 11% of their time in preening and alert activities, respectively ( $n = 4$ ). Cranes spent almost twice as much time loafing than walking (8% and 4%, respectively;  $n = 4$ ). Sleeping cranes comprised the least amount of crane diurnal activities (2%,  $n = 4$ ). This study provides novel quantitative information on behaviors exhibited by a pen-reared, reintroduced whooping crane population in the wild and provides a strong foundation for the effects of habitat quality, captive-rearing methods, disturbance rates and types, and other environmental factors on whooping crane behaviors.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:133**

**Key words:** behavior, *Grus americana*, Louisiana, reintroduced, whooping crane.

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## CAPTURE OF SANDHILL CRANES USING ALPHA-CHLORALOSE

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**Abstract:** The International Crane Foundation has captured greater sandhill cranes (*Grus canadensis tabida*) in Wisconsin using oral delivery of alpha-chloralose (AC). The goals of this study were to assess the efficacy of modest changes implemented in 2002 with drug deployment (regimented baiting limited to early fall) and post-capture treatments (fluid administration) intended to reduce capture-associated morbidity and mortality, especially exertional myopathy (EM). We reviewed 317 captures made between 1990 and 2011. Capture efficacy (the proportion of capture attempts where all cranes in a targeted social group were successfully immobilized) improved from 59% to 72%; however, there was no statistically significant difference in sedation scores. The proportion of cranes that were diagnosed with EM decreased from 7/188 (3.7%) to 3/129 (2.3%), and the overall mortality observed among the captured cranes decreased from 9/188 (4.8%) to 4/129 (3.1%). Time in confinement (elapsed time between capture and release, including processing and recovery in a portable pen) was reduced by 3 to 4 hours in birds that received subcutaneous fluids compared to those that did not ( $F_{2,213} = 6.6$ ,  $P = 0.002$ ), but no preventive association was found between fluid administration and the development of EM. The findings of this follow-up study suggest that these management changes in bait deployment resulted in modest improvement in the efficacy of the field capture technique and were associated with decreased morbidity and mortality rates with little change in sedative effect. This method is associated with very low morbidity compared to alternative practices used to capture groups of cranes.

### PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:134

**Key words:** alpha-chloralose, capture, *Grus canadensis*, sandhill crane, Wisconsin.

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## A COMPREHENSIVE HABITAT TYPE DATASET FOR WHOOPING CRANE CONSERVATION PLANNING IN TEXAS, USA

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**Abstract:** Using land use and land cover data sets to develop species-specific habitat maps is challenging, especially if the species uses both upland and wetland areas. The last wild flock of whooping cranes (*Grus americana*) winters in a limited area along the northwestern Gulf coast in and around Aransas National Wildlife Refuge, Texas. While National Wetland Inventory data can provide a base map for estuarine coastal marsh and palustrine inland marsh extent, the adjacent upland and shallow subtidal vegetative cover are not represented. To adequately quantify potential habitat coverage and evaluate landscape patterns for conservation planning, we combined 3 databases (CHTD) to develop a preliminary habitat type dataset for whooping cranes. Using historical crane survey points from 2004-2010, we identified the habitat-type with each location, ranked the use, then created potential habitat type maps using the CHTD and calculated extent by rank. Use of habitat types at the micro level was not possible given the error within each of the databases used; however, the meso level provided valuable spatial coverage and amount of habitat available under current conditions. The mesohabitat type matrix was crosswalked to land cover classes in the Sea Level Affecting Marsh Model, and potential changes predicted for various sea-level rise scenarios. Overall, habitat types currently used by whooping cranes will decrease in the current wintering area. We identified the data gaps and information necessary to evaluate habitat quality at various spatial and temporal scales. Recommendations for improving the datasets as well as directions conservation strategies should take are also considered.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:135**

**Key words:** Aransas National Wildlife Refuge, CHTD, comprehensive habitat type dataset, *Grus americana*, Texas, whooping crane.

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## EGG PRODUCTION BY FIRST-TIME BREEDERS IN THE EASTERN MIGRATORY POPULATION OF WHOOPING CRANES

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**Abstract:** In 2001 a project to reintroduce a migratory population of whooping cranes (*Grus americana*) into central Wisconsin began. In 2005, the first pairs began breeding. From 2005 to 2013, first nesting attempts by 42 different pairs were documented. Of those nests, 38 (90%) were initiated by pairs in which the females had no prior nesting experience. Of the remaining 4 pairs, 3 females had 1 year of experience each and 1 had 3 years of experience. Age at first breeding for the majority of females was 3 or more years; however 2 different females each produced a single egg when they were only 2 years old, in 2011 and 2012, respectively. Both eggs were collected after full-term incubation (between 35 and 46 days). Infertility was suspected, but due to their deteriorated condition, it could not be confirmed. These 2 eggs represent the first documented record of whooping cranes less than 3 years of age producing eggs. Egg production by individuals in the Eastern Migratory Population was compared to the naturally occurring population of whooping cranes, and to the reintroduced nonmigratory whooping cranes in Florida. In both the wild and Florida populations, no 2-year old females were confirmed laying eggs. Minimum age at time of first egg production for whooping cranes at 2 major captive breeding centers was 4 years.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:135**

**Key words:** age, egg production, first-time breeders, *Grus americana*, Eastern Migratory Population, whooping crane.

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## NATAL DISPERSAL OF WHOOPING CRANES IN THE REINTRODUCED EASTERN MIGRATORY POPULATION: THE FIRST TEN YEARS

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**Abstract:** When managing a reintroduced population, it is important to quantify natural behavior, such as natal dispersal, to determine if the population is behaving “normally” compared to natural populations. In 2001 the Whooping Crane Eastern Partnership began raising and releasing costume-reared whooping cranes (*Grus americana*) into eastern North America in an effort to supplement the globally-endangered wild population. We measured natal dispersal distances for whooping cranes that dispersed from their release (i.e., “natal”) area to their first breeding territory or nesting location on and around the Necedah National Wildlife Refuge in central Wisconsin. Using a generalized linear model, we determined that natal dispersal distances (range: 0.6-72.6 km,  $n = 84$ ) were not predicted by sex, cohort, year of establishment, or age of the bird when it first became territorial. As more territories become occupied, there would be an extra cost to acquiring a territory farther from the natal area or displacing another territorial adult. However, the proportion of mature cranes that were territorial did not decrease over time. The reintroduced population is a decade old and most individuals have been costume-reared and released in the same general area. A lack of sex-biased natal dispersal has also been observed in the only remaining wild population of whooping cranes in central North America. Continued monitoring of this young, but maturing, reintroduced population will allow us to further determine if these trends are preliminary or truly represent results from a wild population.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:136**

**Key words:** *Grus americana*, natal dispersal, reintroduced population, whooping crane.

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## CHANGES IN WINTER DISTRIBUTION OF THE REINTRODUCED EASTERN MIGRATORY WHOOPING CRANE POPULATION

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**Abstract:** From 2001 to 2012, 196 costume-reared juvenile whooping cranes (*Grus americana*) were released in the eastern U.S. to reintroduce a migratory population of this endangered species. Techniques included leading juveniles from Wisconsin to wintering areas by ultralight aircraft (UL) or direct autumn release (DAR) in Wisconsin prior to their first autumn migration. With few exceptions, UL cranes released on the Florida Gulf Coast wintered in inland freshwater habitats in subsequent winters. The population wintered in 4 general regions: Florida/southern Georgia, coastal Carolina, the mid-South (primarily Tennessee and northern Alabama), and the North (Indiana, Illinois, and Kentucky). The UL releases resulted in concentration of the early population in Florida. Later DAR releases and short-stopping by UL birds increased numbers in the mid-South. Winter climate played a large role in wintering in the North. Drought resulted in changes in wintering locations, especially in Florida. Other factors influencing changes in distribution included habitat degradation and associations with other cranes, especially new mates and birds released by different techniques. Breeding pairs and direct autumn-released birds exhibited greater winter site fidelity than non-breeders or ultralight aircraft-led birds, but fidelity was low for all groups. Most prevalent causes of mortality were predation in Florida and gunshot farther north. Because most pairing occurred in central Wisconsin, the widespread winter distribution had no apparent negative effect on pair formation. There was no clear relationship between winter region and subsequent incubation success. The widespread winter distribution of the population poses no apparent risk to the outcome of the reintroduction.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:136**

**Key words:** direct autumn release, *Grus americana*, migratory population, reintroduction, ultralight aircraft, whooping crane, winter distribution changes.

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## PAIR FORMATION IN THE REINTRODUCED EASTERN MIGRATORY WHOOPING CRANE POPULATION

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**Abstract:** During 2001-2013, we examined pair formation in the eastern migratory population (EMP) of endangered whooping cranes (*Grus americana*) reintroduced into central Wisconsin. Released cranes were costume-reared in captivity and either led by ultralight aircraft (UL) to winter areas in Florida or released directly in the core Wisconsin area in autumn (DAR). Of 183 members of the population, 141 (77%) formed 346 pair bonds of 1-4 types. The primary cause of failure to form breeding pairs was mortality. For females, the secondary cause was dispersal from the core reintroduction area and association with sandhill crane (*G. canadensis*) flocks. For males, the secondary cause was insufficient numbers of females with which to pair in the core area. Most pairs did not form within groups. Mean age of breeding pair formation was greater for males because of the unequal sex ratio in the core. Mortality was the primary cause of breeding pair dissolution; mate stealing by males was a secondary cause. Mean re-pairing time was likewise greater for males. The core area was critical to pair formation, where minimally 87% of breeding pairs formed. Formation was concentrated in the arrival period at the end of spring migration. Reintroduction techniques based on costume-rearing facilitated prolific pair formation and successfully established the critical base of the EMP. Size of initial release cohorts, adequate number of females to compensate for dispersal, and importance of a core release area with sufficient concentrated habitat are factors that should be considered in planning future reintroductions.

### PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:137

**Key words:** eastern migratory population, *Grus americana*, pair formation, reintroduction, whooping crane, Wisconsin.

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## A PRELIMINARY LOOK AT THE DEVELOPMENT AND TIMING OF CUES INFLUENCING PHILOPATRY IN CAPTIVE-BRED WHOOPING CRANES RELEASED USING THE MODIFIED DIRECT AUTUMN RELEASE METHOD

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**Abstract:** The philopatric traits which cranes exhibit have been a tool used in whooping crane (*Grus americana*) reintroduction projects. When a new core breeding area was selected in east-central Wisconsin, the Direct Autumn Release Project was modified to take advantage of existing facilities on the previous core breeding area at the Necedah National Wildlife Refuge (NWR) and to learn more about the development of philopatric cues. Whooping crane chicks were transferred from the existing facilities at Necedah to the new desired breeding grounds at the Horicon NWR when they were 82-107 days old. The chicks were released as a group near a known communal pre-migration roost of whooping or sandhill cranes (*G. canadensis*) in mid to late October. All other rearing and release protocols were consistent with those from 2005-2010. Juvenile whooping cranes were released on Horicon NWR in 2011 ( $n = 8$ ) and 2012 ( $n = 6$ ). Nine birds (4 males, 5 females) returned to Wisconsin on their first migration north. Eight of the 9 survived to the fall. Satellite transmitter information on the 3 females from the 2011 cohort provide the only consistent location information to inform us on philopatry; i.e., areas used, frequency of use, and how use may change throughout the year and from year to year. Only 1 of the females with satellite transmitters (33%) returned to either refuge the first year. Including all tracking data available increases the sample size to 8 birds. Three of 8 (37%) were documented exhibiting philopatric tendencies to Horicon. More information needs to be gathered once cranes released at Horicon begin setting up nesting territories potentially as early as spring 2014.

### PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:137

**Key words:** direct autumn release, *Grus americana*, philopatry, PTT, whooping crane, Wisconsin.

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## EGG FERTILITY RATE OF THE REINTRODUCED EASTERN MIGRATORY WHOOPING CRANE POPULATION 2005-2012

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**Abstract:** Early reproductive success is a key factor that determines the probability for a reintroduced population to establish, grow, and persist at carrying capacity. Current attempts at establishing the reintroduced Eastern Migratory Population (EMP) of whooping cranes (*Grus americana*) suffer from similar low productivity despite an annual increase in numbers of pairs that exhibit egg-laying behavior. We aimed to gain a better understanding of the reproductive health of the EMP by using egg fertility rates as a measure of reproductive success. We found the EMP is not following the same trend as the Florida Nonmigratory Population (FNP) but shows similar reproductive characteristics to the viable, self-sustaining Aransas Wood Buffalo Population (AWBP). We compared multiple reproductive characteristics and how experience affects these factors in breeding females between the self-sustaining AWBP and the failed, reintroduced FNP. We found the egg fertility rate of the FNP (1992-2007), EMP (2005-2013) and AWBP (1985-1996) were 48.7, 71.4, and 93.1%, respectively. The age at which males and females in the EMP first produce eggs and first exhibit fertility was younger than the FNP and AWBP. Fertility rates of inexperienced females increase with age, which indicates age affects fertility in this population. By 8 years of age, all EMP females exhibited fertility, similar to AWBP (98%,  $n = 28$ ) whereas, only 46% of FNP ( $n = 13$ ) females exhibited fertility. The onset of earlier reproduction compared to WBNP means younger birds are more likely to breed but less likely to exhibit fertility, thereby reducing overall fertility in the EMP.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:138**

**Key words:** Eastern Migratory Population, egg fertility, *Grus americana*, reproduction, whooping crane.

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## REMOTE CAMERAS AID CRANE BEHAVIOR STUDIES: WET MEADOW UTILIZATION BY SANDHILL CRANES ALONG THE PLATTE RIVER, NEBRASKA

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**Abstract:** The central Platte River in Nebraska supports over 500,000 migrating sandhill cranes (*Grus canadensis*) during spring. These birds use the area to rest, feed, and strengthen pair bonds. The few remaining intact wet meadow grasslands within the Platte River Valley offer sanctuary and vital resources to staging cranes. To better understand how wet meadows are used by cranes, we placed 10 remote cameras set to record motion and time-lapse images along sloughs and uplands within a variety of habitat management scenarios, including hayed, grazed, and burned pastures. Over 60,000 individual sandhill crane behaviors recorded between 7 March and 17 April 2013 were grouped into 6 behavioral categories. These instantaneous behaviors were analyzed at intervals ranging from 10 seconds to 5 minutes, and inferences were made based on time of day, habitat, and other variables. Further understanding of sandhill crane behavior may help researchers and land managers optimize use of native habitats by sandhill cranes.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:138**

**Key words:** behaviors, camera, *Grus canadensis*, Nebraska, Platte River, sandhill cranes, wet meadow.

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## RECOVERY AND MANAGEMENT IN A FIELD ENVIRONMENT OF A JUVENILE WHOOPING CRANE FOLLOWING SURGERY TO REPAIR A FRACTURED LEFT CORACOID

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**Abstract:** On 4 January 2012, while being handled to replace a satellite transmitter, a whooping crane (*Grus americana*) sustained an injury leaving her unable to fly. Rest and medication produced little improvement, so radiographs were obtained and a fractured left coracoid was diagnosed. Surgery to repair the fracture was determined to be the best course of action and was successfully completed on 27 January. The bird was returned to a smaller, dry section of the release pen and remained there for 2.5 days before being moved to a temporary pen at a separate location. Although she appeared less stressed, she remained unwilling to eat and had to be force-fed her medications. Due to continued stress and weight loss, she was returned to the release pen on 2 February. At this time her incision was healing well, but she required medication for several more weeks, and restraint for force feeding would no longer be a viable option. Observations indicated an immediate improvement in her behavior after being returned to the release pen. She began eating and foraging, interacting normally with the other cranes, and willingly took most doses of medication. Sixteen days following surgery she was observed taking a short flight inside the pen and on day 24 she was found in the marsh outside the pen, having flown over the fence to get outside the pen. Seven weeks after surgery, she and 2 other birds moved out of the marsh and settled in an agricultural setting where she still remained 2 years post-surgery.

**PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:139**

**Key words:** coracoid, field environment, fracture, *Grus americana*, surgery, whooping crane.

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## WHOOPING CRANES RETURN TO LOUISIANA: THE FIRST THREE YEARS

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**Abstract:** Despite being proposed as early as the 1970s, a reintroduction of whooping cranes (*Grus americana*) to Louisiana was not approved until 2010. After a 60-year absence from the state, 40 birds in 3 cohorts were released at the White Lake Wetlands Conservation Area (WLWCA) in Vermilion Parish on 3 March 2011, 27 December 2011, and 17 December 2012. All birds were hatched and costume/isolation reared at the Patuxent Wildlife Research Center in Laurel, Maryland, for 5.5-9 months before being transferred to a soft release pen at the WLWCA. Environmental conditions varied greatly across years and likely played a role in the survival, dispersal, and habitat choices made by each cohort. All birds eventually moved out of the WLWCA and dispersed widely, using 20 different Louisiana parishes and 3 neighboring states. Many settled in agriculture fields in the area of the historic Cajun Prairie while others used coastal marsh habitats. Survival of the first cohort was poor, with only 1 bird still surviving (10% survival) by mid-April 2013, but survival of the following 2 cohorts was significantly higher with over 70% of each cohort surviving at that time. Major causes of mortality were predation and illegal shooting; however, several additional birds disappeared and were presumed dead from unknown causes. Although the population in 2012 was small, young, and had an uneven sex ratio, 1 pair did form and built 2 nest platforms. The population in 2012 contained 23 individuals (9 males, 14 females) with an additional 10 birds to be transferred and released by the end of 2013.

### PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 13:140

**Key words:** *Grus americana*, Louisiana, reintroduction, White Lake Wetlands, whooping crane.

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