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ABSTRACTS

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WINTER HABITAT SELECTION BY A REINTRODUCED POPULATION OF MIGRATORY WHOOPING CRANES: EMERGING PATTERNS AND IMPLICATIONS FOR THE FUTURE

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Abstract: In an effort to model the reintroduced eastern migratory population of whooping cranes (*Grus americana*) after the remaining wild whooping crane population, biologists selected the salt marshes of Chassahowitzka National Wildlife Refuge (NWR), Florida as the winter release site for ultra-light led juvenile cranes due to its similarities to Aransas NWR, Texas. Releases began in the fall of 2001, and the 3 subsequent winter seasons have afforded the opportunity to observe whether habitat selection by these whooping cranes would be influenced by the pre-selection of salt marsh. Intensive monitoring efforts each winter have revealed a dominant early-winter pattern. Young whooping cranes that return to Chassahowitzka NWR eventually abandon (1-10 days in birds observed to date) the salt marsh in favor of inland areas. A preponderance of birds utilizes private lands, with several birds wintering exclusively on cattle ranches. Forming and maintaining positive relationships with private landowners will remain an important objective for winter monitoring staff. Another, perhaps more pressing concern is the shifting land-use pattern in central Florida. The building boom threatens many of the ranches that the whooping cranes select. This is particularly problematic in light of the high level of site fidelity exhibited by older cranes.

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Key words: Chassahowitzka, Florida, *Grus americana*, habitat selection, reintroduction, whooping crane, winter.

THE WHOOPING CRANE IN MEXICO: PAST, PRESENT, AND FUTURE?

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Abstract: We reviewed ornithological, historic, anthropological, and archaeological records for evidence of whooping cranes (*Grus americana*) in Mexico. Records of whooping cranes in Mexico span 88 years (1863-1951) and cluster in 3 areas. Wintering records come from the northern highlands (Durango, and possibly Chihuahua), the central highlands (Guanajuato, Jalisco), and northeastern Tamaulipas, where the bird was also found in summer and might have bred. Later records (1970's and 1980's) of whooping cranes in the northern highlands are from individual birds released into the experimental migratory population that formerly migrated from Idaho to New Mexico, USA. Many of the wetlands used by whooping cranes remain and, though faced with a variety of threats, are conservation priority areas and some are already protected.

We suggest 3 scenarios by which whooping cranes might return to winter in Mexico. The first 2 involve dispersal by birds wintering at the Aransas National Wildlife Refuge, Texas, USA, by either population growth or ecosystem changes or degradation (e.g., climate change, reduced freshwater inflows) at the refuge. Finally, reintroduction of a migratory population might target part of Mexico as a wintering area. We encourage investigation of wetlands in Mexico, especially in northeastern Tamaulipas for their potential as future wintering areas.

Our preliminary survey of historic Spanish language publications covering the 1500's to early 1600's found clear references to cranes in which, for example, cranes are described feeding with geese in grain fields. Cranes are mentioned in accounts of the DeSoto and Coronado expeditions as well as the travels of Bishop Alonso de la Mota y Escobar. Unfortunately, these accounts do not adequately describe the birds for species identification. Only, the Florentine Codex by Fray Bernardino de Sahagun provides a description of the sandhill crane (*G. canadensis*) from near Mexico City at the time of Spanish conquest of the Aztecs. Continued searches of early Spanish language publications might yield more information of the historic distribution of cranes in Mexico.

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Key words: *Grus americana*, Mexico, whooping crane.

REPRODUCTIVE HEALTH OF THE FLORIDA FLOCK OF INTRODUCED WHOOPING CRANES

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Abstract: We examined the reproductive parameters of the introduced non-migratory flock of whooping cranes in Florida. Of 289 cranes introduced, 67 males and 65 females survived at least 3 years. The first behavioral pairs appeared in 1995, and eggs were first laid in 1999. In total, eggs were laid in 47 nests, 17 chicks hatched, and 4 young fledged by 2005. Severe drought conditions through 2001 were thought to be the reason for low reproductive nest success. In 2003 nesting conditions improved and 71% of nests with eggs, hatched chicks. During the next 2 years, with continued wet conditions, the proportion of pairs that laid eggs increased, but only 17% of those nests hatched. Embryos could not be seen in most of the decomposed eggs that were examined. In an effort to determine the cause for the low reproductive success of the flock, we examined the effects of behavioral pair formation, mortality, gonad size and histology, age, egg laying, hatching success, egg size, fertility, and egg microbial culture results on nesting success. When compared with the natural wild Aransas/Wood Buffalo flock, the productivity of birds reaching 8 years (100% egg laying, hatching, 60% fledging) was very low. When compared with the originating captive flock, however, evidence of fertility was similar. Productivity did however, increase in the captive flock beyond 8 years of age. At the time of this report, the reproductive birds in the Florida resident flock remain relatively young when compared with the captive flock. Therefore there may be improvement of reproductive success as the Florida flock ages.

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Key words: fertility, Florida, *Grus americana*, non-migratory, reproduction, whooping crane.

SURVIVAL, MOVEMENTS, SOCIAL STRUCTURE, AND REPRODUCTIVE BEHAVIOR DURING DEVELOPMENT OF A POPULATION OF REINTRODUCED, MIGRATORY WHOOPING CRANES

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Abstract: An effort to reintroduce a migratory population of whooping cranes (*Grus americana*) into eastern North America began in 2001. During 2001-2004, 53 juveniles were released. All chicks were hatched at Patuxent Wildlife Research Center, Maryland, and transferred to Necedah National Wildlife Refuge (NWR), Wisconsin. Chicks were costume/isolation-reared and, with few exceptions, trained to follow ultralight aircraft, which led them to Chassahowitzka NWR, Central Gulf Coast of Florida. All individuals successfully returned to Central Wisconsin during their first spring migration except for the following: 5 individuals that were unable to navigate around Lake Michigan after taking an easterly migration route that terminated in Lower Michigan, and 1 female that did not return to Central Wisconsin until her second spring migration. A spring wandering period, in which yearlings typically explored and settled for several weeks in areas outside Central Wisconsin, followed spring migration. This temporary dispersal was more pronounced in females. Males summered in the core reintroduction area, while females not associated with males were more dispersed. In addition to the Michigan group noted, distant movements included 3 yearling females that summered in South Dakota, 1 female that summered as a yearling in Minnesota and then as a 2-year-old in Michigan, and 3 yearling males that staged in Minnesota in autumn. Many whooping cranes associated with sandhill cranes (*G. canadensis*).

Many older whooping cranes returned to the Chassahowitzka pensite in subsequent fall migrations and then moved inland to winter in freshwater Florida habitats. The 2004-2005 winter was characterized by much greater dispersal than previous winters, with 14 of 34 returning birds wintering in South Carolina, North Carolina, or Tennessee. There were 12 mortalities during 2001-2005. These were associated with predation (7), gunshot (2), powerline strike (1), trauma of unknown source (1), and capture myopathy (1, euthanized). Mortalities due to predation resulted from bobcats (*Lynx rufus*) in southeastern U.S. (5), an undetermined predator in Wisconsin (1), and predation in Wisconsin of an adult that was roosting on land because of a fractured tarsus. A protective protocol was effective in reducing potential predation by bobcats at the Chassahowitzka release site after the first winter. During spring 2005, 7 breeding pairs were apparent on or near Necedah NWR. At least 5 of these pairs built nests, and 2 pairs each laid 1 egg. The young, inexperienced pairs did not adequately attend their nests, and neither egg survived. Four other potential pairs were also evident by summer 2005, and prospects were good for increased future reproductive activity.

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Key words: *Grus americana*, reintroduction, reproduction, survival, whooping crane.

MISSISSIPPI SANDHILL CRANE CONSERVATION UPDATE, 2003-2005

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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 2003 to 2005, 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, 1842 hectares were burned annually, with 38% during the growing season. To restore open savanna, 506 hectares of woody vegetation were removed using mechanical methods. To bolster the population, we released 17-25 captive-reared juveniles annually. To protect cranes, nests and young, U.S. Department of Agriculture Wildlife Services conducted predator trapping under an Interagency Agreement, resulting in the removal of 15 large predators per year. Crane and habitat monitoring assessed life history parameters including radio-tracking, visual observations, and an annual nest census. Recently, however, a reduction and turnover in refuge biological staff resulted in reduced monitoring capabilities to radio-track cranes. The number of radio-triangulated locations in 2005 was less than a third and that projected for 2006 is 10% of that recorded during 1997 to 2002. We captured 19 AHY (after hatch year) cranes to band or change out worn or nonfunctional radio-transmitters using 4 different methods with nooses accounting for 80% of the captures. Leading known causes of crane mortality were predation (61%) and trauma (27%). An average of 27 nests was produced from 21 pairs annually during the 3 years. Recruitment remained extremely low with less than 3 young fledged per year. The early winter population was 110-125 cranes. Although Hurricane Katrina did not directly result in more than a loss of 5-7 cranes, 2 of the dead were breeding females that accounted for 40% of the fledged young since 1997. Current research needs focus on increasing recruitment and include assessment of causes of nest vulnerability and failure, increasing effectiveness of traditional predator trapping to protect nests and chicks, supplementary non-lethal predator management, and differences in chick food availability between successful and unsuccessful nest territories.

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Key words: endangered species, *Grus canadensis pulla*, Mississippi, Mississippi sandhill crane, reintroduction techniques.

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FACTORS INFLUENCING GREATER SANDHILL CRANE NEST SUCCESS AT MALHEUR NATIONAL WILDLIFE REFUGE, OREGON[1]

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Abstract: We used logistic regression to model the effects of weather, habitat, and management variables on Greater Sandhill Crane (*Grus canadensis tabida*) nest success at Malheur National Wildlife Refuge in southeast Oregon. We monitored 506 nests over 9 breeding seasons. Mean apparent nest success was 72% ± 4% and varied from 51 to 87%. Nest success was lower one year after a field was burned and declined with nest initiation date. Nest success was higher during warmer springs, in deeper water, and in years with moderate precipitation. Haying, livestock grazing, and predator control did not influence nest success. We suggest the short-term consequence of burning on nest success is outweighed by its long term importance and that water level management is the most important tool for managing crane nest success. Finally, studies of brood ecology are needed to develop a more complete picture of crane nesting ecology.

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Key words: breeding ecology, *Grus canadensis tabida*, land management, Oregon, predator control, sandhill crane, weather.

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[1] See Ivey, G. L., and B. D. Dugger. 2008. Factors influencing nest success of greater sandhill cranes at Malheur National Wildlife Refuge, Oregon. Waterbirds 31:52-61.

IS THE ANNUAL MARCH SURVEY OF THE MIDCONTINENTAL SANDHILL CRANE POPULATION APPROPRIATELY TIMED TO RELIABLY ESTIMATE POPULATION SIZE?

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Abstract: The U.S. Fish and Wildlife Service relies on an annual aerial photo-corrected survey conducted on the fourth Tuesday of March each year in the Central Platte River Valley (CPRV) and North Platte River Valley (NPRV) of Nebraska to estimate size of the midcontinental population (MCP) of sandhill cranes (*Grus canadensis*) to help guide population management. Wide unaccounted for annual fluctuations in survey counts over the past 25 years have raised concerns that many cranes either have left the Platte before the survey, have not yet arrived, or over fly the Platte entirely in some years. As a result, crane managers in the Division of Migratory Bird Management of the U.S. Fish and Wildlife Service and states in the Central Flyway requested that we evaluate temporal patterns of use of the CPRV in spring, and estimate percentage of MCP cranes present on the survey date each year, and assess whether part of the population uses the CPRV and NPRV intermittently. To evaluate length and pattern of stay, we monitored a representative sample of radio-marked sandhill cranes (n = 179) from their arrival to departure from the CPRV in year(s) following capture and estimated percentages of the population present on each survey date over a 5-year period (2001-2005). To evaluate whether part of the population over flies the CPRV and NPRV in some years we monitored a representative sample of PTT-marked sandhill cranes (n = 70) on their spring migration from the wintering to breeding grounds in the year following their capture and marking (1998-2002). Results of the study will provide crane managers with improved insight into the temporal dynamics of use of the CPRV and NPRV by the MCP and help establish how reliably the annual March survey tracks population change.

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Key words: *Grus canadensis*, midcontinental population, Nebraska, Platte River, sandhill crane, spring migration, survey.

DISTRIBUTION AND DISPERSION PATTERNS OF SANDHILL CRANE FLOCKS IN THE PLATTE RIVER VALLEY

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Abstract: We evaluated sandhill crane (*Grus canadensis*) flock distribution and dispersion patterns along the Platte River Valley, Nebraska, in 2002-2003. The objectives were to: (a) determine the overall distribution and relationship between roosting and foraging flock numbers by bridge segments, (b) evaluate flocking characteristics in relation to abundance of cranes in different bridge segments and total abundance, and (c) correlate dispersion patterns and habitat use to period of migration, roost locations, and habitat types. Preliminary predictions included: foraging flock dispersions would be correlated with roost locations; greater numbers and larger flock sizes will be present in bridge segments with larger roosting flocks; flock sizes varied over time ($P < 0.01$) and varied by bridge segments ($P < 0.01$). Week of migration period negatively ($P < 0.001$) influenced flock size, while total number of cranes present in the area ($P < 0.001$) and bridge segment ($P < 0.01$) had significant positive relationships to flock size. Mean flock size by bridge segment was positively associated with total cranes in the area. Foraging flock size differed by habitat with low grassland supporting the largest (mean = 666.4), followed by corn (mean = 316), high grassland (301.8), wet meadow (214.4), and alfalfa (204.9).

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Key words: dispersion, distribution, *Grus canadensis*, Platte River Valley, sandhill crane.

A LANDSCAPE PERSPECTIVE OF WHOOPING CRANE MIGRATION THROUGH NEBRASKA: CONSERVATION AND MANAGEMENT IMPLICATIONS

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Abstract: Past and current discussions of conservation of whooping crane (*Grus americana*) stopover habitat in Nebraska have long been focused on the Platte River. We evaluated the distribution of whooping crane stopover sites in Nebraska in a broader context to (a) determine the distribution of whooping crane stopover sites on the Platte River relative to other landscapes and (b) use whooping migratory behavior data to systematically define and explain patterns of stopover clusters. The distribution of stopover clusters suggests rainwater basin wetlands and the Platte River may be used interchangeably by migrating whooping cranes. The Rainwater Basin and Platte River appear to be particularly significant for spring north migrating cranes as there appears to be a void of wetlands between Cheyenne Bottoms and Quivira National Wildlife Refuges in Kansas. We propose that whooping crane conservation and management actions in Nebraska must take a broader landscape perspective to include the Platte River plus the entire area required for whooping cranes to travel during a day. This perspective suggests that we focus conservation and management activities on a 320-km wide and approximately 240-km long area centered on the Central Valley of the Platte River. We present a strategy to focus conservation and management actions to maximize the availability of whooping crane stopover habitat in south-central Nebraska.

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Key words: *Grus americana*, migration, Nebraska, Platte River, Rainwater Basin, stopover habitat, whooping crane.

COMMON CRANE MANAGEMENT IN GERMANY-MONITORING, PROTECTION, AND SCIENTIFIC WORK

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Abstract: About 200,000 common cranes (*Grus grus*) from northern, middle, and northeastern parts of Europe are migrating on the West-European route. In the northeast part of Germany 160,000 cranes stop over simultaneously during migration. This number has increased since the early 1980´s by 3-fold. About 60 sites with from 200 to 50,000 cranes are systematically observed from August to December by local expert groups. The overnight roosts are in ponds, swamps, and lakes, actively flooded meadows, and brown coal mines as well as in shallow backwaters of the Baltic Sea. They have been used year after year. More than 80% of the roosts are protected. Pre-assembly stop-overs are located in small wetlands which the cranes use before finally entering the roost at late dusk. These areas also need to be protected. Daily movements are 8-15 km but reach a maximum of 25 km from the roost sites. To minimize damage to agriculture, "diversion feedings" or lure crops were established at 6 places in 2004, paid for by government and private organizations. Problems can be further reduced by combining these tactics with leaving stubble-fields, early new sowing, and actively harassing cranes before they land. Guiding nature tourists with posted information occurs at 17 sites. The sites are used by thousands of people and are often led by rangers. Special societies are founded at several larger resting sites with about 60 members (20-250) on average. Problems often arise, especially with hunters, farmers, and holiday makers. To keep the level of disturbances low, the nature conservation, agriculture, hunting, and tourism agencies need to cooperate and develop a local crane management plan that would consider the interests of all parties. Scientific work is done at several large roost areas by institutions and members of the German Crane Working Group. This includes the yearly monitoring of breeding and roosting areas and the ringing (banding) and radio-tracking programs.

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Key words: common cranes, Germany, *Grus grus*, management.

TEMPORAL DYNAMICS AND FLOCK CHARACTERISTICS OF SANDHILL CRANES IN THE PLATTE RIVER VALLEY, NEBRASKA

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Abstract: I gathered information on crane flocks in the Platte River Valley during spring staging of 2002-2004. The objective of this work was to evaluate hypotheses regarding flock size and formation using sandhill crane (*Grus canadensis*) flocks observed in the Platte River Valley. Specifically, I wanted to: (a) evaluate the effect of period of migration, geographical location, and habitat type on flock size, and (b) evaluate predictions regarding ecological theories of flock formation and behavior based on concentrated resources, accessibility, social facilitation, and potential predation response. Flock size overall was influenced negatively by period of migration ($P < 0.001$) and positively by geographical location ($P < 0.01$). Total crane abundance (55%) of flocks were located in corn fields, but flock sizes were larger and significantly different ($P < 0.001$) in low grasslands (mean = 666.4). There were no significant differences in flock size among other habitat categories (corn = 316, high grassland = 301.8, wet meadow = 214.4, and alfalfa = 204.9). The proportion of cranes foraging in a flock in corn fields decreased over time while it increased in flocks foraging in low grasslands. Proportion of cranes resting increased over time in corn fields while it decreased in low grasslands. There was a negative relationship between flock size and proportion of cranes foraging in a flock in corn fields but not in grasslands. The relationship between observed and predicted patterns (based on ecological flock formation theories) of crane flocks are evaluated and discussed.

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Key words: flock formation, *Grus canadensis*, habitat type, Nebraska, Platte River Valley, sandhill crane.

THE CUBAN SANDHILL CRANE AS UMBRELLA SPECIES: RELATIONSHIP WITH PLANT DIVERSITY IN THREATENED WHITE SAND SAVANNAHS

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Abstract: This project describes relationships between the Cuban sandhill crane (*Grus canadensis nesiotes*) distribution and habitat use and plant diversity in white sand savannahs, a threatened ecosystem in Cuba. Data are based on habitat use and selection of 10 radio-tagged sandhill cranes in the Los Indios Ecological reserve, Isle of Youth. We used Arcview and satellite imagery to map broad vegetation categories. Within the general Pine-Palm savannahs specific plant communities were characterized using species composition and dominant plant life forms. Habitat types most used by cranes for feeding and nesting were also those with highest plant species richness and diversity, particularly of shrubs. Habitat used by cranes also had a greater number and proportion of endemic plant species. Our results suggest that focusing conservation on areas used by Cuban sandhill cranes may serve to protect plant species diversity in the same areas and may help in protecting areas with significant levels of endemic plants.

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Key words: Cuba, Cuban sandhill crane, *Grus canadensis nesiotes*, habitat use, plant diversity, white sand savannahs.

SANDHILL CRANE WINTERING ECOLOGY IN THE SACRAMENTO-SAN JOAQUIN DELTA, CALIFORNIA

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Abstract: We studied wintering sandhill crane (*Grus canadensis*) ecology in 2002–2003 in the Sacramento-San Joaquin Delta of California, focusing on Staten Island, a corporate farm which was acquired by The Nature Conservancy and managed to promote sustainable agriculture that is beneficial to wildlife. Our purpose was to define habitat conservation needs for cranes, including the state-threatened greater subspecies (*G. c. tabida*). Research was conducted through intensive surveys by vehicle of crane foraging and roosting behavior. We estimated that about 1,500 greaters used Staten Island, which is a significant portion of the Central Valley Population of greater sandhill cranes and Staten Island supported 36% of all crane foraging use in the Delta region through the entire winter. Use of crops shifted in response to availability, with cranes showing highest preference for wheat. Corn, however, was the most important crop through the entire winter. Our estimates of winter home ranges of color-marked greaters averaged 1.7 $km^2 \pm 0.52$ SD ($n = 39$) while flight distances from roost sites to foraging areas averaged 1.4 km. In contrast, marked lesser sandhill cranes (*G. c. canadensis*) indicated much larger winter ranges (mean 18.6 $km^2 \pm 5.32$ SD; $n = 39$) and foraged much further from roost sites. Another relevant finding in our study was strong site fidelity of greaters. Some color-marked greater sandhill cranes are known to have used the same local wintering areas for at least 18 years, highlighting the importance of maintaining these traditional use areas. Other results demonstrate that crane welfare could be enhanced by provision of crane-compatible crops and roost sites in close proximity, implementing crane-friendly agricultural practices, and minimizing disturbance.

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Key words: agriculture, California, sandhill crane, wintering ecology.

HABITAT CHARACTERISTICS INFLUENCING SANDHILL CRANE NEST SITE SELECTION

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Abstract: The breeding population of greater Sandhill cranes (*Grus canadensis tabida*) in Wisconsin has greatly increased since the population was nearly extirpated in the mid-1930's (Henika 1936). The International Crane Foundation (ICF) has been studying these birds for over 10 years in an area with one of the highest density of breeding cranes in the Midwest; we have calculated a nesting density of over 5 pairs/km^2 (ICF unpublished data). Prior to this study, little was known about the habitat characteristics that may be influencing nest site selection.

We conducted nest surveys by helicopter during the last week of April of 2001-2003 in a 6500 ha study area in Marquette, Adams and Columbia counties in south central Wisconsin. Data from nest surveys in 2002 (n = 51) and 2003 (n = 63) were used to identify landscape and habitat characteristics that describe nest site selection in each wetland complex surveyed. Data was calculated for real nests and random points within each wetland at two levels; at the wetland level and the nest site level. At the wetland level we calculated landscape characteristics such as the number and type of habitat patches and amount of edge. For each nest point we calculated distance to each of the 13 habitat types. Nest and random points were compared to discern what variables best describe nest selection.

Thirteen separate wetland complexes were identified, ranging in size from 280 ha (where 13 nests were found) to 1 ha (where 1 nest was found). Some of the nests within these complexes were clustered, with a few active nests only 10 m apart. The type and distance to the nearest upland (i. e. agriculture vs. forest) differed with each wetland complex, as the shape of each wetland (long and narrow, or round) varied along with the land use in the study area. The type and amount of habitat patches in each wetland also had an effect on the number and placement of crane nests. However, we have had difficulty showing quantitatively exactly which variables influence the nest site selection of these birds. Wetland size was consistently found to be the variable that influences nest selection the most, as the larger the wetland was, the more nests were found.

There are 3 major components to the ecology of sandhill cranes that has kept us from effectively detecting what variables best describe actual selection of sites for nesting by cranes – there is a strong social component (they are very territorial and influence each others' choice); they are long-lived and remain territorial for a long time so there is a time lag between changes in the landscape and how that is reflected in territory changes; and this area is most likely at carrying capacity, so both optimal and suboptimal nesting sites are probably occupied.

LITERATURE CITED

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Key words: breeding birds, eastern greater sandhill crane, *Grus canadensis tabida*, nest site selection, spatial scale, Wisconsin.

SELECTION CRITERIA FOR IMPORTANT SITES FOR WINTERING SANDHILL CRANES IN THE MEXICAN ALTIPLANO

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Abstract: Conservation of natural resources has increased worldwide, and Mexico shows the same tendency. Unfortunately, selection criteria for conservation areas and objectives do not always follow a methodology that will allow for optimum selection. In Mexico and other countries we have a series of priority sites proposed by experts in various biodiversity areas, based on knowledge of the existing biological resources of the site. This results in two situations: more attention and resources are given to certain areas, but no resources are invested in sites that could be of equal or greater importance than those currently proposed. This leads to knowledge gaps. Ducks Unlimited de Mexico, A.C., and other organizations have taken the task of identifying important sites for conservation of wetlands, proposing the application of selection criteria that allow for an impartial selection and the identification of sites that require greater attention for management and conservation. This will permit some sites to be selected for financial support. Twelve basic selection criteria have been identified, some independent of others, that allow for a quantitative value to be applied to the area for waterfowl. These criteria are likely also applicable to sandhill cranes (*Grus canadensis*). Number of wintering birds, duration of wetland, size, isolation, availability in terms of quantity, quality and distance to food, are the criteria for which most points are given, while area isolation and associated species and quality of water in wetlands are secondary factors considered.

PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 10:166

Key words: Altiplano, Mexico, wetlands, winter.

EXTRA-PAIR PATERNITY IN SANDHILL CRANES

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Abstract: Although cranes are known for "life-long" pair bonds, exceptions to this rule have been observed (i.e. divorcing pairs and individuals re-pairing following the death of a mate). With advancements in genetic techniques, another form of infidelity has been observed: extra-pair paternity (EPP; producing young with a bird while being socially paired to another mate) has been documented in many avian species. Is this true for cranes as well? Sandhill cranes (*Grus canadensis*) from a dense breeding population in south-central Wisconsin were tested for EPP using 6 microsatellite DNA markers. The frequency of EPP ranged between 4.4% (2 of 45 chicks) and 11% (5 of 45 chicks). The 2 confirmed extra-pair chicks were from different broods of one pair that has been socially bonded for a minimum 12-year period. The social male was rejected as the genetic father in both cases. The 3 other cases of EPP (twice the social male was rejected as the genetic parent, once the social female was rejected) may be authentic infidelity or mate replacement prior to sampling. The range of EPP for this population of sandhill cranes is similar to other species with similar mating systems. For the confirmed cases of EPP, the female was able to increase her individual reproductive success without losing her territory.

PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 10:167

Key words: extra-pair fertilization, *Grus canadensis*, microsatellites, monogamy, sandhill crane.

MATE FIDELITY IN A DENSE BREEDING POPULATION OF SANDHILL CRANES

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Abstract: The objective of this study was to investigate mate switches observed in a dense breeding population of banded Sandhill Cranes (*Grus canadensis*). Over a 14-year period, 50 of 70 breeding pairs switched mates (71%), with 45 pairs switching permanently (64%). Mean mate retention between years was 83%, with an average pair bond lasting 5.7 years (range 1-13 years). Most permanent switches occurred following the death or disappearance of a mate, and overall permanent divorce (19%; 13 of 70 pairs) and annual divorce rates (6%) were low. Territory retention following mate switches was high. Males and females did not differ in their ability to retain their original territory. Retaining their original territory after a mate switch, however, did not increase reproductive fitness for either sex. Previous reproductive success was not a significant cause of divorce, nor did an individual crane's reproductive success significantly increase following divorce. Five of the 13 divorced pairs (38%) fledged at least one chick to fall migration prior to divorcing. Also, 10 of 57 pairs that did not divorce went 5-8 years without fledging chicks without observation of divorce. There was evidence to suggest that sandhill cranes may choose to divorce in response to an opening on a nearby territory. Having a breeding territory may take precedence over reproductive success experienced by a pair. If a nearby territory becomes available, a breeding adult sandhill crane in this population may have to choose between staying with a current mate (possibly weighing reproductive history) and changing mates and perhaps territories to increase reproductive success.

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Key words: divorce, *Grus canadensis*, mate fidelity, mortality, reproductive success, sandhill crane.

BEHAVIOR COMPARISONS FOR WHOOPING CRANES RAISED BY COSTUMED CAREGIVERS AND TRAINED FOR AN ULTRALIGHT-LED MIGRATION

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Abstract: The successful reintroduction program being run by the Whooping Crane Eastern Partnership using whooping cranes (*Grus americana*) trained to fly behind ultralight aircraft depends on a supply of these trained crane colts each year. The crane colts are hatched from eggs contributed by the various partners and trained to follow costume clad humans and ultralight aircraft at USGS Patuxent Wildlife Research Center, Laurel, Maryland, USA. After several seasons of raising small numbers of crane colts (7-14), we wanted to increase the number of birds being trained, but were restrained by limits in our facilities. By altering the established husbandry and training program to allow the use of a recently modified facility, we have increased the number of colts raised for this release program. However, we did not know whether the new facility and husbandry regime would significantly alter the behavior of the colts. Therefore, we have begun a two year study to determine if there are differences in the behavior of cranes raised by the two methods, and if any of the differences discovered relate directly to whooping crane survival and migration skills in the release program.

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Key words: behavior, costume-rearing, *Grus americana*, migration, training, ultralight aircraft, whooping crane.

EGG BREAKAGE BY CAPTIVE CRANES AT THE INTERNATIONAL CRANE FOUNDATION

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Abstract: Captive cranes can break eggs through deliberate destruction, clumsy parental behavior, or accidentally because of thin shells. We report on the frequency of egg breakage by pairs of captive cranes at the International Crane Foundation (ICF). Among the 15 species of cranes and 1 hybrid female, all except a grey-crowned crane (*Balearica regulorum*) have broken eggs at ICF. Some pairs broke 1/3 or more of their eggs despite efforts by aviculturists to retrieve them before breakage. We compared the proportion of broken eggs among 7 species where we have data from >5 individual females and more than 150 eggs per species. The total percentage of broken eggs varied by species with Siberian cranes (*Grus leucogeranus*) having the lowest rate (<1%) and whooping cranes (*G. americana*) having the highest (13%). Similarly, the proportion of egg-breaking pairs varied among these 7 species from a low 20% of Siberian cranes to 86% of sandhill (*G. canadensis*) and white-naped (*G. vipio*) cranes. Anecdotal and circumstantial evidence suggests that most egg breakage is by deliberate destruction. There is currently an ongoing effort to counteract or reform birds that deliberately destroy their eggs.

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Key words: captive, cranes, egg breakage.

INFECTIOUS BURSAL DISEASE IN WILD POPULATIONS OF TURKEYS AND SANDHILL CRANES: PRELIMINARY FINDINGS

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Abstract: Captive-reared whooping cranes (*Grus americana*) released into Florida for the resident reintroduction project experienced unusually high mortality and morbidity during the 1997-1998 and 2001-2002 release seasons (Spalding et al. 2008). Infectious bursal disease virus (IBDV) serotype 2 is currently under investigation as the factor that precipitated the mortality events. A small percentage of whooping cranes have been exposed to IBDV in the captive setting. However, many more are being exposed post-release, and prevalence of exposure seems to increase with age or length of time the birds are in the wild in Florida (Spalding et al. 2008). The goals of this study were to provide baseline data on the potential for exposure of whooping cranes to IBDV from other wildlife reservoirs, and to provide information needed to make informed decisions about protocols and management to ensure this virus does not impact the recovery of the endangered whooping crane.

First we investigated whether wild exposure was possible by monitoring specific pathogen free chickens on whooping crane release sites in central Florida during the 2003-2004 and 2004-2005 release seasons. We determined serum neutralizing antibody titers to IBDV serotype 2, and considered titer levels ≥1:32 indicative of exposure. Four of 8 sentinel chickens at a Lake County site and 2 of 7 sentinel chickens at a Polk County site became exposed to IBDV serotype 2.

Secondly we investigated what wild bird reservoirs may be involved in post-release exposure by analyzing 222 blood samples from wild turkeys (*Meleagris gallopavo*) and 41 blood samples from sandhill cranes (*G. canadensis*) in 9 counties in northern and central Florida and 2 counties in southern Georgia. Whooping cranes from the resident flock have been observed in all counties in Florida where blood samples were collected. Thirteen percent of wild turkeys were exposed to the virus (median = 1:3, range = 1:0 to 1:256). Seroprevalence (% samples at each site with titer level ≥ 1:32) ranged from 0% to 64%, with only one site having no detectable evidence of exposure. Ten percent of sandhill cranes captured were exposed to the virus (median = 1:8, range = 1:0 to 1:128). Therefore, there appears to be potential for whooping cranes, both resident and migratory, to come in contact with wild birds that have been exposed to this virus.

To gain further insight into prevalence of exposure and length of time the virus has been present in wild sandhill cranes of Florida, 108 archived serum samples collected in Alachua County (northern Florida) and Osceola County (central Florida) from May 1992 to March 1998 were tested for antibodies to IBDV serotype 2. Overall, 46% of samples had titer levels high enough to indicate exposure (median = 1:16, range = 1:0 to 1:1024). In Alachua County, 54% of birds were exposed (n = 55, median = 1:32, range = 1:2 to 1:1024). The earliest evidence of exposure came from samples collected on May 7, 1992. In Osceola County, 38% of birds were exposed (n = 53, median = 1:16, range = 1:0 to 1:256). The earliest evidence of exposure came from samples collected on October 1, 1992. Although we were unable to demonstrate that sandhill cranes in Florida were exposed to IBDV prior to the introduction of captive-reared cranes, we did determine that the virus has been present in wild birds of Florida for at least 16 years.

Preliminary findings from the archived sandhill crane samples suggest that there is an age effect on seroprevalence in the population. Sixty-three percent of adult samples (n = 41, median = 1:64, range = 1:4 to 1:1024), 56% of subadult samples (n =

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36, median = 1:32, range = 1:2 to 1:128), and 13% of juvenile samples (n = 31, median = 1:4, range = 1:0 to 1:64) had titer levels high enough to indicate exposure. These findings are consistent with chicks having a shorter exposure time and immature immune system. The presence of higher seroprevalence and higher titers in older birds suggests that there is constant re-exposure or that birds remain carriers of the virus.

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Spalding, M. G., H. S. Sellers, B. K. Hartup, and G. H. Olsen. 2008. A wasting syndrome in released whooping cranes in Florida associated with infections bursal disease virus titers. Proceedings of the North American Crane Workshop 10:176.

PROCEEDINGS OF THE NORTH AMERICAN CRANE WORKSHOP 10:171–172

Key words: disease, Florida, Georgia, *Grus americana*, *Grus canadensis*, infectious bursal disease virus, *Meleagris gallopavo*, sandhill crane, whooping crane, wild turkey.

SEROLOGICAL SURVEY FOR INFECTIOUS BURSAL DISEASE VIRUS EXPOSURE IN CAPTIVE CRANES

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Abstract: Between September 2001 and March 2002, unusually high morbidity and mortality was observed during releases of endangered, captive-reared whooping cranes (*Grus americana*) in central Florida. An ongoing epidemiological investigation has implicated infectious bursal disease virus (IBDV; Family Birnaviridae) as the likely etiological agent (Spalding et al. 2008). The source of this virus remains unknown. A previous serological survey showed positive antibody titers to IBDV serotype 2 were present in small numbers of juvenile and adult whooping cranes at the International Crane Foundation (ICF), Baraboo, Wisconsin and the Patuxent Wildlife Research Center, Laurel, Maryland between 1995 and 2003 (Hartup et al. 2004). The purpose of this study was to complete the serological survey of the ICF captive flock by testing the 14 other species of cranes at the facility (including 1 hybrid individual) for IBDV serotype 2 neutralizing antibodies.

We used 393 archived serum samples from annual physical examinations of 104 individuals conducted between 1998 and 2002. Eighteen of the samples were from hatch-year cranes; the remainder were acquired from cranes 1 to 39 yrs of age (mean = 14 yrs). Serum neutralization titers ≥ 32 were considered positive for IBDV exposure (Thayer and Beard 1998).

Twenty-three percent of the cranes tested were seropositive at least once during the study period (titer range 0 – 512). Seropositive individuals were identified from 10 of the 14 species tested (Table 1). One of the 18 hatch-year cranes tested was seropositive. Seropositive status varied across years within individuals with a complete serological history. There was a significant declining trend in annual flock seroprevalence during the study ($\chi^2 = 7.9$, $P < 0.01$); peak prevalence was 19.5% in 1998 and declined to a low of 1.2% in 2002 (Table 2). Fifty percent (12/24) of the seropositive individuals had a mate that was also seropositive at least once during the study period. There did not appear, however, to be any spatial clusters of seropositive pairs or individuals on the ICF grounds; the housing status of seropositive cranes mirrored the proportions of cranes housed on public display or in an off-exhibit breeding area.

This data suggests that exposure of captive cranes at ICF to IBDV serotype 2 occurred as early as 1998, was common among the species sampled and certain pairs of cranes, showed a diffuse distribution among the housing units, but may have been in decline flock-wide by the end of the survey. The propensity of low titer levels observed in most of the cranes was probably not associated with active infection. None of the cranes, including seropositive individuals, exhibited any of the clinical signs of wasting previously associated with IBDV-related disease in whooping cranes. The results of this study suggest there is potential risk for IBDV serotype 2 introduction with transfer of seropositive cranes to new exhibits or zoos, or habitat used for re-introduction. Screening cranes prior to transfer may be warranted.

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Key words: Birnaviridae, cranes, Gruidae, infectious bursal disease virus, neutralizing antibodies, serological survey.

Table 1. Species and numbers of individuals tested and seropositive for IBDV antibodies at ICF, 1998–2002.

Species		No. tested	No. positive
Black crowned crane	*Balearica pavonina*	3	1
Grey crowned crane	*Balearica regulorum*	3	2
Blue crane	*Anthropoides paradisea*	2	0
Demoiselle crane	*Anthropoides virgo*	2	0
Wattled crane	*Bugeranus carunculatus*	8	3
Sarus crane	*Grus antigone*	7	2
Sandhill crane	*G. canadensis pratensis*	14	4
Eurasian crane	*G. grus*	2	2
Red-crowned crane	*G. japonensis*	9	3
Siberian crane	*G. leucogeranus*	19	1
Hooded crane	*G. monacha*	8	3
Black-necked crane	*G. nigricollis*	7	0
Brolga	*G. rubicunda*	9	0
White-naped crane	*G. vipio*	10	3
Hybrid	*G. canadensis x G. japonensis*	1	0

Table 2. Annual flock mean titer and seroprevalence for IBDV antibodies in 14 crane species at ICF, 1998–2002.

Year	No. tested	Mean ± SE	No. positive	% positive
1998	77	25.6 ± 7.9	15	19.5
1999	80	13.5 ± 4.0	8	10
2000	78	17.3 ± 5.0	12	15.4
2001	77	11.5 ± 2.6	11	14.3
2002	81	3.2 ± 0.8	1	1.2

SAFETY OF WEST NILE VIRUS VACCINES IN SANDHILL CRANE CHICKS

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Abstract: West Nile virus arrived in North America in 1999 and has spread across the continent in the ensuing years. The virus has proven deadly to a variety of native avian species including sandhill cranes (*Grus canadensis*). In order to provide safe and efficacious protection for captive and released populations of whooping cranes (*G. americana*), we have conducted a series of four research projects. The last of these was a study of the effects of two different West Nile virus vaccines on young Florida sandhill crane (*G. c. pratensis*) chicks and subsequent challenge with the virus. We found that vaccinating crane chicks as early as day 7 post-hatch caused no adverse reactions or noticeable morbidity. We tested both a commercial equine vaccine West Nile – Innovator (Fort Dodge Laboratories, Fort Dodge, Iowa) and a new recombinant DNA vaccine (Centers for Disease Control). We had a 33% mortality in control chicks ($n = 6$) from West Nile virus infection, versus 0% mortality in two groups of vaccinated chicks ($n = 12$), indicating the two vaccines tested were not only safe but effective in preventing West Nile virus mortality.

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Key words: DNA vaccine, *Grus americana*, *Grus canadensis*, Innovator, sandhill crane, vaccination, West Nile virus, whooping crane.

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A WASTING SYNDROME IN RELEASED WHOOPING CRANES IN FLORIDA ASSOCIATED WITH INFECTIOUS BURSAL DISEASE TITERS

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Abstract: Whooping cranes (*Grus americana*) have been reintroduced into central Florida beginning in 1993 until the present. Bobcat predation of otherwise healthy cranes in good nutritional condition was the most common cause of mortality. However, release cohorts in the years 1997-1998 (14/22 died) and 2001-2002 (14/27 died, 5/27 clinical illness) experienced unusually high morbidity and mortality. Positive serum neutralizing titers for infectious bursal disease virus (IBDV) were identified following the 2001 event, and an epidemiological study of released birds and the captive source flocks was initiated. Serotype 1 (Lukert and Variant A) tests were mostly negative. Serotype 2 testing resulted in many more positives. Polymerase chain reaction positive results for IBDV were obtained from two whooping cranes; one that died during the first epizootic in Florida in 1998, and one captive bird that died in 2003 at Patuxent Wildlife Research Center. The serotype remains unconfirmed at this time. Virus isolation has not been accomplished. The disease was characterized by chronic weight loss in young of the year birds that were actively foraging. Other observations included granulomatous oral lesions, bill bruising and fractures, anemia, abnormal submissive behavior, and infection with *Megabacteria* and *Eimeria*. Eight of 10 released cranes with titers > 1:128 had detectable evidence of illness. Older birds sharing the same habitat and food remained unaffected. Some sick birds were able to recover and become members of bonded pairs. The first seropositive case occurred in 1993. Seropositive birds are not randomly distributed by year indicating differential exposure or susceptibility. The prevalence of seropositive birds (titer > 1:32, $n = 256$, 1993 to 2003) increased from 7% of birds leaving captive centers to 33% of birds that had spent 2 weeks in Florida. Significantly more older birds, captured because they were clinically ill or to change transmitters, were seropositive (75%). Within the wild flock seroprevalence increased with age. In wild birds monitored frequently, fluctuation in titers indicated multiple re-exposures. The source of exposure, whether within the whooping crane flock, sandhill cranes, or another species, remains unknown.

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Key words: burnivirus, epidemiology, Florida, *Grus americana*, infectious bursal disease, whooping crane.

IS MAGNITUDE OF FAT STORAGE BY SPRING-STAGING SANDHILL CRANES DECLINING IN THE CENTRAL PLATTE RIVER VALLEY, NEBRASKA?

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Abstract: Proximate analyses of carcasses of sandhill cranes (*Grus canadensis*) collected in the Central Platte River Valley (CPRV), Nebraska, during spring 1999 indicated a marked decline in fat levels from springs 1978 and 1979. Concern that amounts of fat cranes stored by their spring departures from the CPRV may have further declined prompted this evaluation. For our assessment, we made use of morphological measurements (culmen post nares, tarsus, flattened wing chord) along with body mass on each of 810 sandhill cranes that were collected for proximate analysis or captured with rocket nets at widely distributed sites in the CPRV during 1978-1979 and 1998-2005. For these birds, we conducted a principal components analysis to develop a body size variable when testing the relationship between mass and date. We next evaluated whether masses at arrival and departure and rates of mass gain in sandhill cranes differed from previous (1978 and 1979) and current (1998-2005) studies and addressed the implications of our findings.

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Key words: fat storage, *Grus canadensis*, Nebraska, Platte River, sandhill crane.

A YEAR-LONG STUDY OF FOOD CONSUMPTION BY CAPTIVE WHOOPING CRANES AT THE INTERNATIONAL CRANE FOUNDATION

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Abstract: Throughout 2002, we recorded daily food consumption by 12 pairs of captive whooping cranes (*Grus americana*). For 7 pairs we recorded food consumption throughout the entire year while there were large continuous gaps in measurements of food consumption for 5 pairs that raised chicks that year. Birds received both a maintenance and breeder diet, and for both we converted food consumption to energy intake (Joules/g body mass) using the combined fall weights of female and male. We compared daily energy intake with 6 meteorological variables (involving temperature, wind speed and humidity), photoperiod (natural and artificial) and egg laying using multiple regression. We found mean daily energy intake averaged 411.4 $\pm$ 141.6 j/g body mass ($\pm$ SD, range: 20–1,202). Energy intake was lowest in June and July and highest in March (pre-laying), October and November (pre-migration and migration). In addition, we examined the signs of the coefficients for each environmental variable among all pairs (using sign tests). We found that daily energy intake was negatively correlated with daily mean temperature. Further, we found that daily energy intake was positively correlated with both daily minimum and daily maximum temperatures. These last 3 findings suggest that whooping cranes, like many other homeothermic animals, have a thermal neutral zone and that temperatures above and below the zone require energy expenditure to maintain regular body temperature.

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Key words: energy intake, food consumption, *Grus americana*, temperature, whooping crane.