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## MORBIDITY AND MORTALITY OF CAPTIVE WHOOPING CRANES AT THE INTERNATIONAL CRANE FOUNDATION 1976-2008

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Tracking the incidence of morbidity and mortality in captive animal collections helps inform husbandry and preventive medicine programs aimed at improving population health and viability. Carpenter and Derrickson (1982) and Olsen et al. (1997) published summary reports of captive whooping crane (*Grus americana*) mortality that served to identify key problem areas for the primary breeding flock and potential reintroduction programs involving this endangered species. We expanded on this approach and conducted an initial evaluation of morbidity and mortality factors for whooping cranes at the International Crane Foundation (ICF). The purpose of our study was to identify overrepresented factors and investigate management alternatives to prevent or minimize disease occurrence and mortality, and make recommendations for more effective use of veterinary resources in the future.

The medical records of 92 cranes (43 males, 46 females, 3 unknown) were examined for causes of morbidity and mortality from their time of arrival at ICF. Subjects departed the flock due to transfer to other institutions or death. The first brood stock arrived in 1989 from the Patuxent Wildlife Research Center, Laurel, Maryland, in 3 shipments totaling 22 cranes. From 1990 to 1996, 49 whooping crane eggs collected from wild nests in Wood Buffalo National Park (WBNP), Alberta, Canada, were sent to ICF for captive rearing of hatched chicks. The remainder of the records pertained to individuals accessioned since 1976 that were transferred from other institutions or hatched and retained at ICF for the purpose of captive breeding. Records for all groups were reviewed through 2008. The records of all chicks transferred for reintroduction were not included due to their short time in captivity.

Causes of morbidity and mortality were tabulated by body system, age, and gender. All morbidity and mortality events were noted to occur in 1 of 4 age classes: juvenile (<1 year old), sub-adult ( $\geq 1$  year to <4 years), adult ( $\geq 4$  years to <25 years), and geriatric ( $\geq 25$  years). An instance of morbidity was defined as any medical condition

requiring treatment, any condition diagnosed by a veterinarian, or any medical issue suitably severe in extent to warrant mention in the medical records. Instances of morbidity were categorized by the primary body system or location affected, including: beak, cardiac, endocrine, gastrointestinal, hematologic, immunologic, integumentary, musculoskeletal, neurologic, ocular, oral, reproductive, and respiratory. Behavioral morbidity was also included to account for cases where maladaptive behavior led to the need for treatment in the absence of an underlying etiology (e.g., some instances of feather picking). Where defined by laboratory analysis, a specific etiology was recorded. Repeat occurrences of the same condition in a particular bird were noted to be chronic problems, but only tabulated once per age class. Different conditions within the same body system or location were tabulated separately in each age class. Gastrointestinal morbidity was further classified as subclinical or clinical, due to routine monitoring for endoparasites and bacterial diseases of potential pathological and zoonotic concern. Each occurrence of parasitism or positive bacterial culture from routine sampling was tabulated separately.

Mortality events were ascribed to 1 of 10 categories: cardiac, gastrointestinal, iatrogenic, infectious disease, musculoskeletal, neurologic, renal, respiratory, trauma, and unknown. Causes of mortality were classified as primary and secondary where applicable.

The greatest number of morbidity events involved the gastrointestinal, musculoskeletal, and integumentary systems (Table 1). Gastrointestinal morbidity was primarily subclinical and consisted of positive fecal parasite tests from bi-annual screening or isolation of *Salmonella* sp. or *Campylobacter* sp. from routine fecal cultures. Clinical gastrointestinal disease was primarily limited to cloacal prolapses and metal foreign body ingestion in chicks.

Over 62% of musculoskeletal morbidity events occurred in chicks, predominantly among those hatched from WBNP eggs. Juvenile females were diagnosed with nearly twice as many musculoskeletal problems as males

**Table 1. Incidence of morbidity by body system among age classes of captive whooping cranes at ICF, 1976-2008.**

Body system	Juvenile ( <i>n</i> = 62)	Subadult ( <i>n</i> = 35)	Adult ( <i>n</i> = 41)	Geriatric ( <i>n</i> = 7)	All
Beak	1	3	10	1	15
Behavioral	1	1	2	1	6
Cardiac	0	0	3	0	3
Endocrine	0	0	1	0	1
Gastrointestinal	82	24	114	9	229
Subclinical disease					
Fecal parasite +	37	20	97	9	163
Salmonella sp. +	5	3	2	0	10
Campylobacter sp. +	23	1	12	0	36
Clinical disease	17	0	3	0	20
Hematologic	0	1	0	0	1
Immunologic	2	0	1	0	3
Integumentary	27	24	83	5	138
Musculoskeletal	95	6	36	5	142
Neurologic	0	0	1	1	2
Ocular	1	0	2	1	4
Oral	4	9	31	2	46
Reproductive	0	0	5	0	5
Respiratory	11	1	4	1	17
Total events	224	69	293	26	612

(61 events vs. 32). The most common diagnoses were developmental in nature and included toe, wing, and limb abnormalities, but trauma-related musculoskeletal injuries were also common. Musculoskeletal problems were also common in adults, most often due to soft tissue injury.

Trauma-associated morbidity of the integument was most common among subadult and adult whooping cranes. Conditions included carpal abrasions, avulsed nails, broken feathers, and other abrasions. Adults also exhibited several cases of dermatitis or feather loss and/or poor feather condition.

For adults, problems involving the oral cavity were common, but most were cases of transient mucosal or tongue plaques of unknown etiology. Males experienced more beak morbidity than females (9 events vs. 1), consisting mostly of fractures from striking fencing materials during territorial defense. We recorded 24 instances of morbidity in geriatric males (*n* = 4) and 2 in females (*n* = 3), often involving the integument (feather loss, poor feather condition, and/or breakage) and musculoskeletal system (soft-tissue injuries, degenerative joint disease).

The incidence of mortality by primary cause is presented in Table 2. Musculoskeletal problems were the leading cause of death in the population, followed by respiratory problems, traumatic injury and iatrogenic

(usually handling related) causes. Chick deaths were often associated with fractures. Adult deaths due to respiratory conditions commonly followed aspiration events. The subadult and geriatric samples were too small to identify trends in causes of mortality.

The results of this study are consistent with past reviews of whooping crane health concerns at other captive centers (Olsen et al. 1997), except for the low incidence of clinical infectious diseases.

Subclinical gastrointestinal parasitism is the most frequently noted medical concern in the captive whooping crane population at ICF. Some cranes were diagnosed with the same parasite on multiple occasions despite apparently effective short-term treatment. Renewed attention to the timing and use of annual pen rotation and aggressive treatment of fecal positive cranes has succeeded in keeping worm burdens and environmental contamination below the threshold for clinical disease or pathology.

Musculoskeletal and integumentary injuries and resulting mortality are prime risks for this population. Excluding chicks, these problems are most often related to trauma due to the captive environment and/or capture. Management should continue to focus on preventing injuries through improved pen design, careful pairing of birds, and using the safest capture and handling techniques

**Table 2. Primary causes of mortality among age classes of captive whooping cranes at ICF, 1976-2008.**

Cause of death	Juvenile	Subadult	Adult	Geriatric	All
Cardiac	0	0	0	0	0
Gastrointestinal	1	0	0	0	1
Iatrogenic	2	2	0	0	4
Infectious disease	0	0	1	0	1
Musculoskeletal	6	1	2	0	9
Neurologic	0	0	0	0	0
Renal	1	0	0	1	2
Respiratory	1	1	3	0	5
Trauma	2	0	2	0	4
Unknown	0	0	1	0	1
Total events	13	4	9	1	27

available for the individual situation (Hartup et al. 2001).

Musculoskeletal problems in chicks are the most common cause of morbidity and mortality. Cases among chicks hatched from WBNP eggs may be overrepresented as they were some of the first whooping crane chicks reared at ICF and possibly the result of suboptimal management for the species. Even with changes in nutrition and exercise regimes, hand-reared chicks still frequently experience developmental musculoskeletal problems at a much greater frequency than parent-reared chicks (Kelley and Hartup 2008). Further work needs to be done to determine what aspects of parent-rearing promote proper musculoskeletal development.

The results of this study confirmed no record of a disease outbreak and the relative lack of mortality due to primary infectious diseases in the ICF captive whooping crane flock. The most common maladies appear to be artifacts of captivity, involving either self-induced traumatic injuries or accidental trauma from physical manipulation by caretakers, with many cases followed by a myriad of complications during or following surgical intervention. Future management should focus on husbandry practices that will reduce these problems.

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identifications of bacteria and parasites diagnosed from the ICF captive whooping crane flock can be obtained from B. Hartup. This material was presented at the 2007 Whooping Crane Health Advisory Team workshop in Baraboo, Wisconsin.

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**Key words:** captivity, *Grus americana*, morbidity, mortality, whooping cranes.