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CAPTURE OF SANDHILL CRANES USING ALPHA-CHLORALOSE

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ABSTRACT: From 1990–2001, we made 188 successful captures of 166 different greater sandhill cranes (*Grus canadensis tabida*) through experimental use of alpha-chloralose (AC). Most captures took place during September (72.3%; n=136), followed by August (14.9%; n=28), and October (12.8%; n=24). Territorial pairs were captured more successfully than family groups. Overall morbidity (6.4%) and mortality (4.3%) were lower than most other capture techniques for sandhill cranes. Exertional myopathy (EM) was the most common complication observed using AC (3.7%). Sedation level ($\chi_5{}^2$=25.9, P<0.01) and month of capture ($\chi_2{}^2$=12.3, P<0.01) were both associated with the presence of EM in cranes captured with AC. A logistic regression model suggests lighter sedation and the months of August and October are potential risk factors for EM in sandhill cranes captured with AC in Wisconsin (USA).

Key words: Alpha-chloralose, capture techniques, exertional myopathy, greater sandhill cranes, *Grus canadensis tabida,* morbidity, mortality.

INTRODUCTION

A variety of techniques have been utilized to capture wild cranes capable of flight, during all stages of the annual cycle: rocket-netting (Wheeler and Lewis, 1972; Ramakka, 1979; Tacha et al., 1982; Urbanek et al., 1991); walk-in trap (Logan and Chandler, 1987); night-lighting (Drewien and Clegg, 1992); helicopter to force flying cranes to alight to be captured by a ground crew (Ellis et al., 1998); feeding trough that conceals a human captor (Folk et al., 1999); clap trap and leg noose (Hereford et al., 2001); and alpha-chloralose (AC; Williams and Phillips, 1973; Nesbitt,1976, 1984; Farhadpour, 1983). Alpha-chloralose ($C_6H_{11}Cl_3O_6$) is a chloral derivative of glucose that has been used orally for the capture of many species (Balis and Munroe, 1964). The International Crane Foundation (ICF; Baraboo, Wisconsin, USA) has been experimentally capturing and banding social units (territorial pairs and family groups) of wild greater sandhill cranes (*Grus canadensis tabida*) with AC since 1990 to follow members of the social unit over time.

Cranes are susceptible to stress-related morbidity (i.e., a significant abnormality was observed after release) and mortality (Ellis et al., 1996), so any capture technique that reduces handling stress will presumably lower morbidity. Trapping methods that physically restrain cranes and those that immobilize cranes through chemicals differ markedly in the manner they stress captured birds as well as in their efficacy. Capturing cranes using AC requires no visible capture apparatus, allowing deployment in many places simultaneously without requiring extensive camouflaging (Bishop, 1991). With AC, however, birds can require up to 12–24 hr to recover, and they must be kept in a safe enclosure until recovery is complete. Even though birds are not handled or restrained in the enclosure and are generally calm until the time of release, stress-related injury does occur. Alpha-chloralose depresses the cortical centers of the brain (Balis and Munroe, 1964), and affects eyesight, so birds are less aware of disturbances around them. This would lower the overall stress the bird experiences from outside disturbance. Few mortalities in cranes due to overdose with AC have been reported (Williams and Phillips, 1973). Observations from our field studies, however, suggested exertional myopathy (EM) was a contributing factor to morbidity and mortality associated with immobilization of sandhill cranes using AC.

Birds captured using physical restraint

methods can generally be released shortly after processing (30–60 min). If a large group of birds is captured in one event using physical restraint, the amount of time a crane is in hand can be increased substantially. Increased handling time can elevate stress in birds (Duncan, 1974). Deploying traps of various designs among a large number of territories is also more difficult to accomplish than with chemical immobilization.

Exertional myopathy (EM; Williams and Thorne, 1996), also known as capture myopathy, is a non-infectious disease characterized by skeletal and cardiac muscle necrosis and severe metabolic disturbance following extreme exertion, struggle, or stress. While the occurrence of EM has been most extensively documented in ungulates, cases from several avian taxa are known (Williams and Thorne, 1996). Exertional myopathy associated with the capture of free-ranging avian species has been reported in greater flamingoes (*Phoenicopterus ruber roeus*) and lesser flamingoes (*P. minor*; Young, 1967), sandhill cranes (*G. canadensis tabida*; Windingstad et al., 1983 and *G. canadensis pulla*; Carpenter et al., 1991), whooping cranes (*G. americana*; Drewien et al., 1997), lesser snow geese (*Chen caerulescens*) and Ross' geese (*C. rossii*; Wobeser, 1981), wild turkeys (*Meleagris gallopavo*; Spraker et al., 1987), California gulls (*Larus californicus*; Williams and Thorne, 1996), and black-bellied whistling ducks (*Dendrocygna autumnalis*; Finley and Jeske, 1998). There are also reports of EM in captive avian species including East African crowned cranes (*Balearica regulorum gibbericeps*; Brannian et al., 1981), emus (*Dromaius novaehollandiae*; Tully et al., 1996), white storks (*Ciconia ciconia*; Heldstab and Ruedi, 1980), and red-necked ostriches (*Struthio camelus*; Ostrowski and Ancrenaz, 1995). Williams and Thorne (1996) suggested, given the right conditions, any avian species has the potential to develop EM.

Objectives of this study were to summarize use of AC by ICF for immobilizing greater sandhill cranes in Wisconsin and compare this method with other crane capture methods. In addition, we investigated potential risk factors for EM in cranes immobilized with AC.

MATERIALS AND METHODS

This study occurred from 1990–2001, near Briggsville, Wisconsin (43°36′N, 89°36′W). This site was chosen for its high population density of breeding sandhill cranes, and it contains a mixture of agriculture and wetland systems with limited residential, industrial, or commercial development. All captures occurred from August to October to sample complete social groups (territorial pairs or family groups) without disturbing the incubation period or family groups with flightless young.

We captured cranes through the experimental use of AC (Fisher Scientific Company, Fair Lawn, New Jersey, USA). Our methods were similar to those described by Bishop (1991). Initially, a social group was baited using 140 cc (½ cup) of plain, whole kernel corn for each individual. This process conditioned the social group to eat corn regularly.

Before a capture attempt was made, each social group was observed at a bait site for up to 1 hr after arrival. Once the social group consistently arrived at the bait site directly from the night roost for approximately three consecutive days and stayed at the site for at least 1 hr after eating the corn, AC was applied to the corn and a capture attempt was made.

For each capture, AC was evenly distributed on the corn (Bishop, 1991), which was placed at the bait site just prior to sunrise. Birds were observed continuously until they were in hand or the attempt was aborted. Nontarget animals, including other cranes, were discouraged from accessing the bait site once it was provisioned with treated corn while trying to avoid disturbing the focal social group. After the capture attempt was completed, the remaining treated bait was removed and fresh corn was placed at the bait site.

Each immobilized crane was hooded and wrapped (Fig. 1) to minimize movement while transported (Bishop, 1991). Once at the holding pen, each crane was banded, measured, and weighed. Blood samples were collected from birds captured between 1996–2001. Once handling was complete, hoods and wraps of the sedated cranes were removed; then passive physical therapy was done by manipulating the wings and legs to stimulate circulation (Langenberg, pers. comm.). Finally, birds were placed in a darkened holding pen (2.5 m×2.5

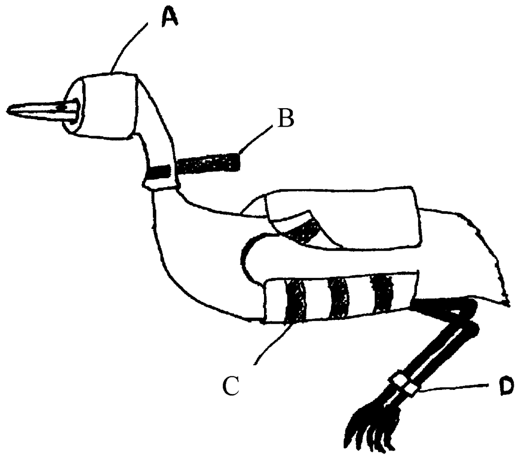

FIGURE 1. Illustration of a properly hooded and wrapped sandhill crane. The hood (A) is made of a light breathable material with a rigid plastic ring inserted between layers of the outside material to keep it from touching the eyes of the bird. A Velcro strap (B) adjusts to the thickness of the crane's neck. The body wrap (C) is made of heavy material (e.g., denim) with Velcro strips at the edges to lessen wing and body movements. The legs are taped (D) to reduce kicking while the bird is handled.

m×1.5 m, made of four wooden corner posts wrapped with tennis netting for walls, a separate wooden door with tennis netting, and a plastic tarp for the roof) for recovery.

Cranes were monitored every 3–4 hr after processing through the day of capture until sunset to determine sedation status (Table 1). Most cranes were released the next morning, approximately 24 hr after exposure to AC, while some cranes were released the evening of capture, approximately 12 hr after exposure, if they appeared fully recovered (i.e., alert, fully mobile). After release, cranes were monitored through visual observations or radiotelemetry. When first encountered after release, cranes were observed for signs of normal behavior (e.g., alertness, mobility, integration into flock, presence of mate or family group). Thereafter, the cranes were monitored intermittently until migration to determine the continued overall health of each bird.

A baseline dose (41.55 $mg_{AC}/kg_{bird\ weight}$ or 0.39 g_{AC}/cup_{corn}) was administered from 1990–1998. The dose was increased by 10% (47.26 $mg_{AC}/kg_{bird\ weight}$ or 0.43 g_{AC}/cup_{corn}) in 1999 and by 20% (50.12 $mg_{AC}/kg_{bird\ weight}$ or 0.48 g_{AC}/cup_{corn}) in 2000 and 2001. For most birds, sedation level was estimated using specific criteria (Table 1). Age (adult or hatch year juvenile [juvenile]) was determined through field markings (Lewis, 1979). Sex of each bird was determined through relative size (Nesbitt et al., 1992), behavior (Archibald, 1976), or through genetic analysis of blood samples (Griffiths et al., 1998).

Because effects of EM may take several hours to several weeks to become apparent (Williams and Thorne, 1996), monitoring of birds in the field after release was essential to confirm a return to normal activity. Behavior abnormalities monitored in the field included: inability to attain normal lift when attempting flight, inability to stand from a sternal or hock sitting position, and inability to recover from an awkward position (i.e., on back or side). If any of these signs were observed, the bird was taken to an identified veterinarian/licensed wildlife rehabilitator for diagnostic testing, treatment, and rehabilitation. Necropsies were performed within a day of recovery of dead birds. Cases of EM were diagnosed through observation of a combination of the following clinical signs or pathologic findings: ataxia, paresis, or paralysis; significant elevations in creatine kinase (CK), aspartate aminotransferase (AST), or lactate dehydrogenase (LDH) levels; or extensive cardiac and skeletal muscle necrosis.

Using all capture records (including recaptures), associations of complete social group

TABLE 1. Parameters used to estimate different levels of sedation observed in sandhill cranes immobilized with alpha-choralose

Critera	Light	Light-moderate	Moderate	Heavy-moderate	Heavy	Very heavy
Head up[a]	>75%	51–74%	50%	26–49%	<25%	<10%
Leg kicks[b]	≤10 min	15 min	30 min	45 min	≥60 min	≥60 min
Responds[c]	>75%	51–74%	50%	26–49%	<25%	<10%
Salivation[d]	no gurgling	once or twice	noticeable	constant	heavy	excessive

[a] Percent time the bird holds its head up.
[b] Interval between leg kicks.
[c] Percent of stimuli (tactile, visual, auditory) to which the bird responds.
[d] Estimated by audible gurgling during respiration.

capture success with dose, month of capture, or target number of birds to be captured were analyzed using chi-square (Sokal and Rohlf, 1995). Excluding recaptures (because prior exposure may alter the sedation level the recaptured bird achieves), associations of EM with dose, sedation level, age, sex, month of capture, and capture success were analyzed similarly. Significance was established at $P \leq 0.05$. A logistic regression analysis was then used to evaluate the potential predictive association of the variables with occurrence of EM (presence/absence) in each crane (Hosmer and Lemeshow, 1989). Sex was not used in the logistic regression analysis because sex determination was lacking for 17 juveniles. Interactions among variables were excluded from the logistic model due to potential difficulty in their biological interpretation. This analysis allowed for examination of an odds ratio (OR) for each variable, adjusting for effects of all other variables remaining in the model, after stepwise removal of nonsignificant factors ($P > 0.10$). Statistical analyses were conducted using EpiInfo v6.04 (Centers for Disease Control and Prevention, Atlanta, Georgia, USA, 1997) and Statview 5.0.1 (SAS Institute Inc., Cary, North Carolina, USA, 1998) software for microcomputers.

RESULTS

During the study, 166 different cranes were immobilized in 81 capture events. Including recaptures, 188 successful captures of sandhill cranes with AC were made. In 48 of 81 (59%) capture events, all members of the social group were obtained. Most birds were sampled during September (72.3%; $n=136$), followed by August (14.9%; $n=28$) and October (12.8%; $n=24$). No association between dose, month of capture, or target number of birds captured and capture success was found. Also, no association between sedation level and month of capture occurred.

Cranes were sampled on 51 different territories. Although not significant, territorial pairs tended to be more successfully captured, followed by family groups of four, and then family groups of three (Table 2). In cases where one adult was immobilized, the ratio of uncaptured male and female mates was equal.

Eighteen birds were captured twice: seven birds (39%) were more heavily sedated, three birds (17%) were sedated at a similar level, and eight birds (44%) were more lightly sedated than during their first capture. Two birds (both adults) were captured three times. One crane exhibited the same sedation level each time immobilized. The second crane exhibited the same sedation level when AC dose was constant (1997 and 1998) but was more lightly sedated during the third capture (2000) when AC dose was increased.

TABLE 2. Comparison of success in capturing sandhill crane social groups of different size using alpha-chloralose.

Social group	Number caught	Total	%
Pairs	1/2	10	31
	2/2	22	69
	Total	32	
Family of three	1/3	6	19
	2/3	10	31
	3/3	16	50
	Total	32	
Family of four	1/4	1	6
	2/4	1	6
	3/4	5	29
	4/4	10	59
	Total	17	

Of 188 captures, 12 (6.4%) resulted in morbidity; eight (4.3%) of these 12 birds died. Exertional myopathy was the cause of morbidity in seven birds. Three of these seven cases of EM, all adult males, died; the remaining four cranes were rehabilitated, re-released, and have survived to date. Five mortalities were likely due to factors other than EM. Although not included in the analysis (capture was not successful), one sedated adult female was flushed during a capture event, flew into an irrigation ditch, and drowned. Three male cranes died of undetermined causes, though EM was unlikely based on gross necropsy and histologic evaluation. Remains of a fifth crane, a male, were received with bands attached 2 mo after release; the cause of mortality was inconclusive due to decomposition of the carcass.

Sedation level ($\chi_5^2=25.9, P<0.01$) and month of capture ($\chi_2^2=12.3, P<0.01$) were

TABLE 3. Results of logistic regression model for the effects of variables on exeritonal myopathy in sandhill cranes from Wisconsin.

Variable	Coefficient	SE	OR[a]	95%CI[b]
Month				
August	2.72	1.31	15.2	1.2–197.4
October	2.43	1.22	11.4	1.1–123.3
Sedation level	1.16	0.44	3.2	1.3–7.5
Dose	1.67	0.54	2.5	0.8–7.2
Constant	−8.95	2.08	—	—

[a] Adjusted odds ratio.
[b] Confidence interval.

both associated with the presence of EM. Sex, age, and AC dose provided were not associated with EM. Odds ratios for variables from the logistic regression model were generally consistent with the chi-square results (Table 3), and suggest that sedation level and month of capture were potential risk factors for EM in sandhill cranes captured with AC. A decrease of one unit sedation score (e.g., moderate to light-moderate) increased the odds of EM occurrence by three times (i.e., the less sedated the bird, the higher the chance of succumbing to EM). In addition, the odds of EM occurring during capture in August and October, compared to September, was 15 and 11 times greater, respectively.

DISCUSSION

A high proportion of capture events was successful in obtaining all target cranes to build a marked population of known social status; AC was an effective capture technique.

One possible reason pairs were more successfully captured than family groups is that when young are present, the adults tend to be more alert, causing them to ingest less treated corn. Often, adults allow the juvenile(s) to consume more of the corn at the bait pile. As there was no significant association between dose provided, month of capture, or target number of birds to be captured with capture success, there does not appear to be an extrinsic factor that would increase the probability of capturing an entire social group.

Mortality of cranes due to capture on breeding grounds, wintering grounds, and staging areas was variable. Capturing cranes on breeding grounds improves likelihood that each captured crane will be observed after release. If captured on wintering grounds or staging areas, cranes could leave the area without being observed, making follow-up observation and data concerning morbidity/mortality less reliable. Our study offered a high rate of post-capture observations (Table 4), so our estimate of mortality is less affected by seasonal migration. Though other techniques reported lower mortality/morbidity rates, most of these studies, except for the study with whooping cranes using a trough blind (Nesbitt, pers. comm.), did not note post-capture observations, so actual mortality rates may be higher.

Post-capture observation can alter mortality rates reported when capturing cranes. Had we not observed birds after release, rehabilitation would not have been possible, and therefore our mortality rate would have been higher. Our ability to rehabilitate some birds diagnosed with EM reduced our reported mortality rate to the second lowest rate found. The lower mortality reported in Farhadpour (1983) was from only one capture event where a large flock was drugged in a single attempt. No post-capture observation rate, however, was reported in this study.

Most other crane capture techniques are useful in catching individuals, not complete social groups. The only other tech-

TABLE 4. Summary of different techniques used in capturing cranes.

Citation	Species	Method	Stage of annual cycle[a]	Sample size	Morbidity[b]	Mortality[b]	Post-capture[b,c] observation?
This study	*Grus canadensis*	alpha-chloralose	B	188	6.4 (12)	4.3 (8)	98.4 (185)
Williams and Phillips (1973)	*Grus canadensis*	alpha-chloralose	W	266	not noted	14.7 (39)	not noted
Nesbitt (1976)	*Grus canadensis*	alpha-chloralose	W	104	not noted	5.8 (6)	not noted
Nesbitt (1984)	*Grus canadensis*	alpha-chloralose	B and W	617	not noted	4.9 (30)	63 (151)[d], 79 (19)[e]
Farhadpour (1987)	*Grus grus*	alpha-chloralose	W	60	not noted	2 (1)	not noted
Wheeler and Lewis (1972)	*Grus canadensis*	rocket nets	S	618	not noted	6.9 (43)	good (not quantified)
Williams and Phillips (1973)	*Grus canadensis*	rocket nets	W	41	not noted	10 (4)	not noted
Nesbitt (1976)	*Grus canadensis*	rocket nets	W	34	not noted	9 (3)	not noted
Ramakka (1979)	*Grus canadensis*	rocket nets	S	828	not noted	10.1 (84)	not noted
Tacha et al. (1981)	*Grus canadensis*	rocket nets	S	1456	not noted	14.8 (216)	low % observed
Urbanek et al. (1991)	*Grus canadensis*	rocket nets	B	186	1.1 (2)	0.5 (1)	97 (181)
Logan and Chandler (1985)	*Grus canadensis*	walk-in trap	W	11	0	0	91 (10)
Drewien and Clegg (1992)	*Grus canadensis*	night lighting	B	250	0.4 (1)	not noted	not noted
Drewien and Clegg (1992)	*Grus americana*	night lighting	B and W	19	not noted	not noted	not noted
Ellis et al. (1998)	*Grus canadensis*	helicopter	B	6	17 (1)	not noted	66.7 (4)
Folk et al. (1999)	*Grus americana*	trough blind	W	19	0	0	not noted

[a] B = breeding, W = wintering, S = staging.
[b] Percent in sample followed by number of birds affected in parentheses.
[c] Post-capture observation is defined as a crane observed at least once after release and was behaving normally.
[d] 151 of 240 normally sedated birds.
[e] 19 of 24 heavily sedated birds.

nique that is equally capable of capturing family groups on many territories, over a broad area, and within one field season is rocket-netting (Urbanek, pers. comm.). Though it was beyond our scope to evaluate trapping efficiency, rocket-netting and use of AC differ markedly in equipment needs and in labor deployment patterns. These considerations may influence which technique will be most effective.

Mortality risk when using AC can be controlled (Bishop, 1991). Williams and Phillips (1973) reported 17 of the 39 dead birds from their study drowned after wandering into a pond or ingesting water while anesthetized. We controlled this factor by avoiding immobilization of cranes near open water and capturing fewer cranes simultaneously, a precaution emphasized in Bishop (1991).

Keeping the number of cranes captured in an event small allowed us to be attentive to each individual. With one exception, the largest number of cranes captured in our study was four. Urbanek et al. (1991) reported similar results with rocket nets.

Our ability to control the dose for free-roaming birds was affected by not only amount of drug applied to the corn, but also by behavior of the foraging birds. Higher doses used in this study did not necessarily result in higher sedation levels. Sedation levels, however, reflected the amount of drug ingested and was related to EM.

Seven cranes experienced clinical EM resulting in three deaths. Though several studies documented EM in cranes (Brannian et al., 1981; Windingstad et al., 1983; Carpenter et al., 1991; Drewien et al., 1997), its cause is still not completely understood. We found that cranes immobilized during the months of August and October were more at risk of developing EM than those captured during September. Alpha-chloralose may alter thermoregulation in birds (Balis and Munroe, 1964), and extremes in air temperature may increase the risk of heat (August) and cold (October) stress in sedated birds. Complications with heat stress have been observed with sarus cranes (*G. antigone*) in Vietnam (Barzen, unpubl. data).

In addition, cranes captured in August may be at risk because they are not yet conditioned to consume corn as a primary forage item during warm weather and corn has not yet been harvested. As a result, cranes may not consume enough treated corn to become heavily sedated. Cranes captured in October may be at risk because of seasonal behavioral changes. Territorial behavior decreases as autumn advances and sandhill cranes begin socializing in flocks prior to migration (Walkinshaw, 1973). A large synchronous harvest of many cornfields occurs in Wisconsin during October. Harvest dramatically increases the availability of waste corn in most areas. Hyperphagia by cranes, in preparation for fall migration, also occurs. This causes cranes to be less likely to defend bait within their territory. In October, for example, cranes would often forage at their bait site for a short time, which could cause them to not receive a full dose of AC before joining a flock in a cornfield. This habit would lower sedation scores, increasing the likelihood of EM. This situation may also put less wary birds (i.e., partially drugged) that could not be captured at greater risk of predation, attack from another crane, or of entering a dangerous area (e.g., an irrigation ditch).

To minimize mortality, birds in Wisconsin should be captured in September. In addition, to reduce the likelihood of EM, every attempt should be made to achieve heavier sedation. Observers should be sure the social group is on bait consistently and that birds are comfortable at the bait site for at least an hour after they arrive (as emphasized by Bishop, 1991). Because EM did not affected our recaptured cranes, even when immobilized at a lower sedation level, it is possible certain individual cranes differ in their susceptibility to EM and this may be predictable. For this reason, we avoided using AC to recapture cranes previously diagnosed with EM.

The method used to capture animals should be determined by the goals of the study. Our goal was to capture whole social groups of cranes from known breeding territories. This need was the main factor in our decision to experiment with AC. When specific cranes are being pursued, night lighting, trough blinds, helicopters, walk-in traps, and leg snares may be the most efficient method with the lowest mortality.

Given the wide variety of avian species reported to develop EM as a result of capture, considerable attention should be given to methods for reducing exertion and stress when capturing free-ranging birds. Spraker (1993) listed 16 factors that might help in prevention and treatment of EM in the field and suggested trapping techniques resulting in incidence of EM greater than or equal to 2% be reevaluated. Occurrence of EM was 3.7% (seven of 188 captures), but only 1.6% (three of 188) captures resulted in mortality from EM, due to intensive rehabilitation efforts. Rehabilitation of cranes with EM is possible and should be attempted to reduce capture-induced mortality. Additionally, because individuals affected by EM develop clinical signs hours, days, or weeks after capture, extended post-release monitoring is essential in assuring the accuracy of survival rates and the well being of the birds. This may be true for other techniques (e.g., rocket nets) as well.

Lastly, the use of AC in this study was experimental; use of this compound with free-ranging sandhill cranes requires authorization by the US Food and Drug Administration and consideration of potential drug withdrawal times in populations that may be hunted.

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