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TECHNIQUES FOR REARING AND RELEASING NONMIGRATORY CRANES: LESSONS FROM THE MISSISSIPPI SANDHILL CRANE PROGRAM

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TECHNIQUES FOR REARING AND RELEASING NONMIGRATORY CRANES: LESSONS FROM THE MISSISSIPPI SANDHILL CRANE PROGRAM

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Abstract: Captive-reared Mississippi sandhill cranes (*Grus canadensis pulla*) reared at the Patuxent Wildlife Research Center (Patuxent) have been released at the Mississippi Sandhill Crane National Wildlife Refuge (MSCNWR) since 1981. Of 131 birds released through December 1990, 103 were reared by foster parents. The remaining 28 were experimentally hand-reared in 1989 and 1990. After refining release procedures, parent-reared birds have integrated into the wild flock, many have survived, and some have bred. Releases of hand-reared cranes elsewhere in the 1970's were largely unsuccessful, at least in part due to the lack of a lengthy acclimation period. A new hand-rearing protocol holds promise in producing release-worthy birds. The technique employs some features first used in the 1960's (e.g., a costume for the human caretaker and model crane heads used to train chicks to feed). In the mid-1980's, the following features were added: (1) the costumed caretaker was given a visor and feathers, (2) a taxidermic crane head or a hand puppet was held or suspended from the ceiling for use in stimulating chicks to feed, (3) a taxidermic mount of a brooding crane supplied warmth, (4) a full-sized live crane was maintained in an adjacent pen and in visual contact with neonatal young to provide an imprinting model, and (5) a small group of adult (or subadult) cranes was penned adjacent to the outdoor chick pens to provide socialization models. Recent releases of Mississippi sandhill cranes hand-reared according to this protocol and released in Mississippi have had high first-year survival rates. The now-operational technique holds promise for producing large numbers of release-worthy birds.

Key Words: captive breeding, *Grus canadensis*, reintroduction, sandhill crane

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Reintroduction techniques for fledged cranes were described by Konrad (1976), Derrickson and Carpenter (1983), Horwich (1986, 1989), Horwich et al. (in press), Urbanek (1990), and Urbanek and Bookhout (1992) and are outlined below.

PAIRING OF CAPTIVE AND WILD CRANES

In Hokkaido, Japan, flightless male red-crowned cranes (*G. japonensis*) lured females into their enclosures (Konrad 1976). The resulting pairs produced chicks that fledged into the wild flock. Occasionally, captive cranes of other species have lured wild mates (Hyde 1957; G. W. Archibald, International Crane Foundation [ICF], pers. commun.).

A variation of this technique was tried twice with cross-fostered whooping cranes (*G. americana*) at Grays Lake National Wildlife Refuge (Grays Lake), Idaho (Drewien et al. 1989). Because adult male whooping

cranes in this experimental flock failed to return to the marsh with female mates, several attempts were made to capture and translocate adult females that had dispersed into neighboring states. When this also failed to produce viable pairs, 2 hand-reared females (1 each in 1981 and 1989) from Patuxent were introduced to the adult males. Both females were courted and although both pairs seemed to be forming lasting bonds, neither pair produced eggs and neither pair migrated together (Derrickson and Carpenter 1983, Drewien et al. 1989).

Another variation of pairing captive-reared and wild cranes occurred in northern China: chicks of the white-naped crane (*G. vipio*) and the red-crowned crane were hand-reared and fed long-term until they became semi-wild in the marshes at Zhalong (Jie et al. 1989). In subsequent years, these semi-domestic birds paired with wild mates and nested in the marshes near their natal area. Offspring resulting from these tame-wild matings were reportedly much more tolerant of human approach

and therefore better able to live in a human-dominated environment.

Either variation of this technique, although logistically difficult with a large number of birds, seems (at least from the experiments in Japan and China) to hold promise for forming small numbers of pairs.

ABRUPT RELEASES

The first sizable release of captive-reared cranes occurred in 1971, when 14 juvenile Florida sandhill cranes (*G. c. pratensis*) reared at Patuxent were transported to a site near Lake Okeechobee, Florida, and released without acclimation (Nesbitt 1979). None of these hand-reared birds integrated into the wild flock, and within a few months all had died of exposure, starvation, or accident. A single parent-reared crane released at Paynes Prairie, Florida, survived 3 years.

Following the experiment with hand-reared cranes in Florida, abrupt releases of parent-reared greater sandhill cranes (*G. c. tabida*) were attempted at Grays Lake in 1976 ($n = 1$) and 1980 ($n = 11$) (Drewien et al. 1982). Of 7 young that survived to migrate south, none reappeared at Grays Lake the following spring. These results, especially when compared with results from the gentle releases described next, further demonstrate the need for pre-release conditioning at the release site.

GENTLE RELEASES OF PARENT-REARED CRANES

In gentle releases in Mississippi, cranes (usually juveniles) were brailed (i.e., rendered temporarily flightless by having a plastic strap bound around 1 wing; Ellis and Dein 1991) and confined in large pens at the release site for about 30 days. Thereafter, they were debrailed and allowed to come and go at will.

Since 1981, more than a dozen gentle releases have been made using parent-reared cranes from Patuxent. Survival rates have varied greatly. Only 9 of 21 (43%) greater sandhill cranes released at Grays Lake in summer 1984 survived to migrate (Bizeau et al. 1987). These birds were held on site for less than 1 week in a small net-topped pen before release. However, 15 of 27 (56%) Florida sandhill cranes released after a longer acclimation period survived their first winter in a nonmigratory situation (Nesbitt 1988). Higher survival rates (Table 1) have sometimes been achieved in Patuxent's extensive release program with Mississippi sandhill cranes; about 2/3 (41 of 66) of the birds released from 1981 through 1989 survived for at least 1 year (McMillen et al. 1987, Zwank and Wilson 1987, unpubl. data). Nearly all Mississippi birds surviving more than a few months have success-

fully integrated into the wild flock. Details of the rearing procedures for these cranes are presented later in this paper.

GENTLE RELEASES OF HAND-REARED CRANES

Various attempts have been made to increase post-release survival rates for hand-reared birds (Horwich 1986, 1989; Nagendran 1992; Archibald and Archibald, in press; Horwich et al., in press; Urbanek and Bookhout 1992, unpubl. data). These experiments included work at the ICF (with releases in Texas and Wisconsin), at Seney National Wildlife Refuge, Michigan, and at Patuxent (with releases in Mississippi and Florida). In all of these experiments, sandhill crane chicks were reared in relative isolation from unclothed humans. In the 1960's, silhouette heads (2 dimensional) were first used at Patuxent to train chicks to feed. A puppet head was first used in 1982 (Archibald and Archibald, in press). In 1985, Horwich (1986, 1989) combined the devices used in previous hand-rearing attempts and applied concepts from classical ethology (e.g., age-specific learning, sign stimuli, and imprinting) to introduce a small number of sandhill cranes into a migratory flock. His method included a mounted crane model in brooding posture with a heat source and crane maternal vocalizations, hand puppets for feeding, puppet heads with bills dangling in the food, and a feathered costume allowing a human caretaker to lead the chicks afield to learn natural foods, the features of their natal area, and to socialize with wild cranes. These devices and a mock attack by an unclothed human prevent imprinting and attachment to humans.

Today, chicks are fed using a terry cloth puppet (ICF and Michigan) or a taxidermic mount (Patuxent). In addition, some chicks are penned in visual and auditory (but not physical) contact with adult cranes.

Fledged birds released in Wisconsin, Michigan, and Mississippi have survived well, many birds have effectively socialized, and several have paired with wild cranes (Urbanek and Bookhout 1992, unpubl. data; G. W. Archibald, ICF, pers. commun.). Some juveniles released in northern latitudes have also completed fall and spring migrations unassisted, while others have required assistance to move them to staging areas after they failed to move south unaided (Urbanek and Bookhout 1992; Horwich et al., in press). Recent releases have largely solved the problems of integrating hand-reared sandhill cranes into wild flocks in time for migration (Urbanek and Bookhout 1992, pers. commun.). Although no conclusions can yet be drawn for less gregarious species, hand-rearing is now a proven technique for introducing sandhill cranes in both migratory and nonmigratory situations.

Table 1. Fate of hand-reared (HR) and foster parent-reared (PR) Mississippi sandhill cranes released in Mississippi.

Winter of release	No. cranes released ^a		No. surviving 6 months		No. surviving 1 year		No. breeding by 1991	
	HR	PR	HR (%)	PR (%)	HR (%)	PR (%)	HR	PR
1980-81	0	9		9 (100)		7 (78)		1
1981-82	0	5		0 (0)		0 (0)		0
1982-83	0	7		5 (71)		5 (71)		1
1983-84	0	4		4 (100)		4 (100)		2
1984-85	0	10		9 (90)		5 (50)		5
1985-86	0	7		6 (86)		3 (43)		1
1986-87	0	2		2 (100)		1 (50)		
1987-88	0	9		8 (89)		7 (78)		
1988-89	0	13		10 (77)		9 (69)		
1989-90	12	17	12 (100)	14 (82)	12 (100)	13 (76)		
1990-91	16	20	14 (88)	17 (85)	14 (88)	15 (75)		

^a Not included are 2 birds that died before they flew from their release pen and 3 birds with severe heart murmurs. We did include 1 overly tame bird and 4 birds that were captured injured, sick, or emaciated after release. For these last 5 birds, date of removal from the wild was treated as death date.

We appreciate the essential contributions of the many animal caretakers, technicians, graduate students, and volunteers who have helped in either rearing or releasing cranes. R. C. Erickson, the founder of our program at Patuxent, and J. Valentine, the father of the Mississippi sandhill crane studies, were the prime movers in inspiring early releases in Mississippi. T. J. Logan played a major role in organizing systematic data gathering for release birds. C. Ellis and J. Dennis helped with clerical chores. S. Swengel, R. Horwich and R. P. Urbanek made useful suggestions on the manuscript.

REARING AND RELEASE METHODS

This section details Patuxent's rearing program for Mississippi sandhill cranes intended for release. Of the chicks that were hatched at Patuxent (1989–91), about 70% of those intended for release were alive and otherwise suitable at time of shipment to the refuge.

Hand-rearing

Birds in the hand-rearing program are held in audio-visual isolation from humans, but with exposure to conspecific crane chicks, mounted crane brooding models, stuffed crane head feeding models, a live adult or subadult crane (imprinting model) penned next door to neonates, and a group of adult cranes in outdoor community pens (socialization models). Caretakers are disguised by gray cotton costumes and are often further hidden behind

screens.

Chicks were exposed to the above listed stimuli according to the following schedule:

- | | |
|---------------------------|-----------|
| (1) Live Imprinting Model | |
| in adjacent pen | Day 0–20 |
| (2) Stuffed Brooder Model | Day 0–10 |
| (3) Feeding Model | |
| (puppet head) | Day 0–10 |
| (4) Live Socialization | |
| Model in outdoor pens | Day 0–75+ |

The caretaker's costume covers the wearer from head to knee, with a viewing port covered by camouflage netting to obscure the face. The costume prevents chicks from recognizing and becoming attached to individual caretakers. In addition to the costume, screens covered with cloth or carpet are used when a costumed caretaker teaches a chick to feed to further reduce the chances that they will imprint on costumed caretakers.

Caretakers normally lock chicks outdoors when they clean pens and exchange food and water. Otherwise, caretakers do all chores while costumed. All visitors enter the rearing area only in costume. Even the veterinarians are costumed while performing health checks and other tasks. When a chick is removed from the pen for examination, it is frequently hooded to allow caretakers or veterinarians to remove their hoods.

Care of Late Term Eggs.—A rigorous rearing protocol is imposed even prior to hatching. At Patuxent, the eggs of

endangered cranes are incubated by poultry, cranes, and artificial incubators. When eggs that are not incubated by cranes approach hatching (ca. 27 days of incubation), taped brood calls of sandhill cranes are played to the eggs at ca. 0800, 1100, 1400, and 1630 hours for 5–15 minutes.

Care of New Hatchlings.—After a Mississippi sandhill crane chick hatches, it undergoes the same medication regime whether it is intended for release or not (M. M. Wellington, A. Burke, ICF; and J. M. Nicolich, Patuxent; in prep.). It is weighed, examined by a veterinarian, given prophylactic antibiotic injections, and placed in its own separate pen (about 8 × 8 feet) with a carpet mat. A stuffed brooder model with partly spread wings is located directly under a heat lamp to allow the chick under the wing for brooding. A water jug is placed in the pen and the bill of the stuffed brooder model is placed in the water.

The taxidermic mount crane head (including about 32 cm of the neck and a posteriorly protruding wire handle) is suspended from a hook in the ceiling and dangles in a bowl filled with granulated chick food. After removing the head from the string, the caretaker manipulates it through the hole in the screen as though it were the head of a parent crane feeding its chick. The caretaker dips the bill in water, then in the food, and then holds the food-laden bill near the chick while purring or playing the tape recording of a brood call. Most chicks show great interest in the moving head and eagerly peck crumbs from the bill. Eventually they learn to peck into the food bowl where the head is probing. As soon as the chick learns to eat from the bowl, caretakers no longer enter the pen to manipulate the head; rather they stand outside the pen behind a screen and bob the head using the suspending string which terminates on the pen wall. The head is similarly used to lure the chick to the water jug to train the chick to drink. Chicks that are reluctant to approach the head are enticed to do so by wrapping red tape around the tip of the bill. Mississippi sandhill crane chicks normally respond well without the red tip.

Imprinting and Socialization Models.—For the first 10–20 days, chicks are penned next door to a live adult or subadult conspecific to facilitate proper imprinting. To prevent aggression, chicks are protected from this crane by a vinyl-coated, welded-wire barrier with a sheet of clear plexiglass along the bottom 60 cm. These barriers permit unlimited viewing of the imprinting model.

After day 10, chicks can be moved away from the imprinting model if necessary to accommodate younger birds. At 4 days, chicks gain access to an outdoor run where they have visual and audio contact with a group of conspecifics (socialization models) in an outdoor community pen.

Human Avoidance Conditioning.—Beginning around 20 days of age, release chicks are subjected to several bouts of human avoidance conditioning. After the chicks are locked in their outdoor pens, an uncostumed human runs through the corridor at the end of these pens while producing loud noises (e.g., banging pots, yelling). Another observer simultaneously plays a tape recording of a sandhill crane guard call. In addition, the imprinting models are locked outside during the attack and encouraged to guard call. Chicks that show little or no reaction are captured, jostled, and then released. After the chicks are formed into release cohorts in community pens, 1 or 2 mock attacks are staged wherein 1 or 2 uncostumed caretakers pursue the chicks for about 5 seconds.

Parent-rearing

The parent-rearing process involves the captive rearing of a chick by a pair of conspecific foster parent cranes or rarely a single crane. We used Florida sandhill crane foster parents to care for early Mississippi sandhill crane chicks and greater sandhill crane foster parents to care for late-season chicks. Some Mississippi sandhill cranes are also employed as foster parents. This process closely parallels the rearing of a chick in the wild. At appropriate times the chick learns to drink, forage, avoid humans and fear predators, and learns how to interact with other cranes. Cranes reared by their own species should imprint properly. Parent-rearing is less labor intensive than conventional hand-rearing, but requires extensive facilities to maintain breeding pairs and their replacements.

Because parent-reared chicks are raised in an environment in close contact with other cranes, they are more subject to certain hazards than are hand-reared chicks. They are exposed to foul weather, parasites, and are at a greater risk of predation than birds raised in buildings. Because they have much greater contact with uncostumed humans and motorized vehicles, they become acclimated to both.

Several factors are considered when choosing pairs to raise chicks. Not all captive cranes make good parents; some kill or neglect chicks. Before a pair is allowed to raise a genetically valuable or endangered crane, it is given at least 2 years of experience raising cranes of a common taxon. The parenting performance of each pair is closely monitored and evaluated. Preferred pairs are tolerant of routine disturbances. They do not redirect aggression to eggs or chicks or tread on chicks when disturbed. Good pairs are constantly attentive to their chicks, and both adults share in incubation and brooding. About 80% of the pairs that are evaluated eventually prove suitable to rear Mississippi sandhill crane chicks.

Cross-fostering, the parent-rearing of a chick by adults of another species, results in near-normal behavioral development; however, if a chick is not exposed to species specific imprinting cues, it may prefer its foster parent species when it is an adult (Mahan and Simmers 1992). Cross-fostering is never used for Mississippi sandhill crane chicks.

Careful planning is required to provide a suitable pair of foster parents on the projected hatch date. Normally, eggs of 2 or more potential parents are manipulated to ensure that a suitable pair is ready.

Five different methods of adoption have been used at Patuxent and are chosen in various circumstances. In the preferred method, a pair hatches an egg it has been incubating and raises the resulting chick. A second alternative is to introduce a piped egg in exchange for an egg that has been incubated at least 21 days, but preferably 28–30 days. This method is consistently used when a pair's incubation performance has been poor or is unknown.

The final 3 fostering methods involve introducing a small chick to surrogate parents. These methods are risky and are not used routinely. In 1 approach, a pair's chick is replaced by a similar-aged chick. This technique, used when the pair's first chick becomes sick or dies, allows for movement of an ill chick to an intensive care area while still making use of a valuable pair of foster parents. Because the success of this technique depends largely on the behavior of the chicks, only chicks that have had previous exposure to live cranes are used. In another method, a pair's egg is replaced with a young chick, usually under 4 days of age. Generally only experienced parents tolerate such an abrupt change. The final, and most extreme, adoption method has only been used a few times at Patuxent. Non-endangered chicks as old as 7 days have been introduced to pairs that were not then incubating eggs or rearing chicks. Both experienced and inexperienced pairs have adopted chicks in this way. Six of 7 adoption attempts (1989–91) using these 3 chick introduction methods were successful.

Newly hatched parent-reared chicks are given medical treatments according to a schedule similar to that of hand-reared chicks (M. M. Wellington, A. Burke, ICF; and J. M. Nicolich, Patuxent; in prep.). Fresh food and a fountain waterer are placed near the nest daily until the chick is mobile (2–3 days). At Patuxent, parent-reared chicks are handled days 0–4, 6, 9, 12, 15, 18, 21, 25, 32, 46, 53, 60, 67, and every 2 or 3 weeks thereafter. Chicks are observed daily for signs of injury, panting, and lethargy. In addition, they are periodically caught, examined, weighed, and given prophylactic treatment for parasites and other medications or treatments as needed. Fresh fecal samples are taken at

scheduled intervals and examined for parasites.

Natural foods provided by the parents supplement commercially prepared crumbles or pellets. After the first few days, the feed bowl and waterer are placed near the parents' feeder to familiarize the chicks with this location. Daily provision of chick feeders and waterers is discontinued when the chicks are large enough to reach those used by the adults.

Forming Release Cohorts and Releasing Colts

Until 1989, all Mississippi sandhill cranes intended for release were parent-reared. In 1989 we modified our elaborate costume rearing regime to prepare chicks for release. These birds appear as 1990 release birds in Table 1. In 1990 and 1991, 3 types of experimental release cohorts were used each year: 1 cohort consisted entirely of parent-reared birds, the second consisted of a mixture of hand-reared and parent-reared birds, and the third type consisted entirely of hand-reared birds.

Hand-reared Mississippi sandhill cranes are kept at the chick rearing facility until they are 55–60 days. At this age they are formed into temporary juvenile cohorts in netted community pens. Normally these cohorts are penned next door to a small group of parent-reared (i.e., wild-acting) adult conspecifics. Parent-reared chicks remain with their foster parents somewhat longer. Because most of the parent-rearing pens are without nets, the flight capability of parent-reared chicks is closely monitored after about 55 days. When they are capable of flight, the chicks are brailled until mid-October when they are removed from their foster parents' pen, debrailled and randomly assigned to a release cohort, and released in a net-covered community pen. Cohorts are then randomly (or restricted randomly) assigned to a release pen in Mississippi.

Hand-reared and parent-reared colts remain with their release cohorts until mid-November when they are brailled, crated, and shipped to the MSCNWR. After a month in 1 of 3 large release pens (ca. 2 ha each), the brails are removed and the birds are allowed to come and go at will. Food is provided in the release pens for 2–3 months. Wild cranes also take advantage of the food available in the release pens and serve as trainers for the release birds.

Monitoring Survival of Release Birds

Survival of parent-reared Mississippi sandhill cranes has been under study since 1981 (Zwank and Wilson 1987, unpubl. data). Radio telemetry and color banding are used extensively to monitor survival after release. Each bird released in 1990 and 1991 carried a transmitter which also

included a mortality sensor.

Some aspects of survival for all birds released through January 1991 are presented in Table 1. After experiencing poor success integrating release birds into the wild flock in 1981 and poor survival for the birds released in 1982, we adjusted cohort formation time and the pre-release acclimation period to about 1 month each. Following these changes, release birds readily integrated into the wild flock and survived well (survival to 1 year post-release was 65% for 52 birds released from December 1982 through January 1989).

We hoped that survival rates for hand-reared Mississippi sandhill cranes would approach those of parent-reared birds, but the rates experienced so far for hand-reared birds have been unexpectedly high. All (12) of the 1989 hand-reared birds released in January 1990 survive to the present (late 1991). Of the hand-reared birds from the following year (released in December 1990), 1 died prior to leaving the release pen; 14 of 16 (88%) chicks that actually flew from the release pen survived to 6 months.

Of 16 birds that have been alive at least 4 years after release (and are therefore of breeding age), 10 have participated in 26 breeding attempts (eggs observed). Of these, at least 15 attempts have resulted in fertile eggs, at least 9 of which led to hatching, and 6 chicks fledged. Of course, no hand-reared birds have been involved in these attempts: it will be 1 or more years before anything is known of the reproductive performance of reintroduced hand-reared Mississippi sandhill cranes.

CONCLUSIONS

Survival rates for parent-reared Mississippi sandhill cranes released as 6-month-old juveniles have risen to acceptable levels during the 11 years that releases have been conducted at the MSCNWR. Many of the birds surviving to breeding age have also bred. Hand-reared birds (28) have been released for only 2 years so our conclusions about their survival are at best tentative. However, 6-month survival rate pooled for both years was 96%, and 1-year survival was 93%. These data bode well for the continued use of hand-rearing as a reintroduction tool, especially for nonmigratory cranes.

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