1997

SURVIVAL AND HABITAT USE OF GREATER SANDHILL CRANE COLTS ON MODOC NATIONAL WILDLIFE REFUGE, CALIFORNIA

Kevin J. Desroberts
U.S. Fish and Wildlife Service

SURVIVAL AND HABITAT USE OF GREATER SANDHILL CRANE COLTS ON MODOC NATIONAL WILDLIFE REFUGE, CALIFORNIA

KEVIN J. DESROBERTS,[1] U.S. Fish and Wildlife Service, Modoc National Wildlife Refuge, P.O. Box 1610, Alturas, CA 96101, USA

Abstract: Radiotelemetry was used to monitor 13 (1990) and 14 (1992) greater sandhill crane (*Grus canadensis tabida*) colts on Modoc National Wildlife Refuge, California, to determine causes of mortality, brood habitat utilization, and effects of habitat management on colt survival. Colt survival rates were 0.36 (1990) and 0.54 (1992). Coyotes (*Canis latrans*) killed 3 colts and mink (*Mustela vison*) killed 4; 1 colt died because of a bacterial infection (*Staphylococcus aureous*). Broods used 6 different habitat types and 79% used more than 1 type. Irrigated meadows (74%), cultivated uplands (53%), and marsh (42%) were used by most broods. Habitat management practices included hay harvesting (15 July–30 August) and fall grazing (September–December) and did not directly cause mortality, but hay harvest may have increased vulnerability to predation.

PROC. NORTH AM. CRANE WORKSHOP 7:18-23

Key words: California, colts, habitat, mortality, predation, radiotelemetry, sandhill crane, survival.

Modoc National Wildlife Refuge (NWR), located near Alturas in northeast California, has historically been an important nesting and staging area for members of the Central Valley Population of greater sandhill cranes. The Central Valley Population was listed as a threatened species by the state of California in 1983 (Schlorff 1988).

Sandhill cranes begin arriving at Modoc NWR during mid- to late February. Most pairs establish nesting territories by mid-March and initiate nesting by mid-April. Crane use of the refuge has been monitored to some extent since the mid-1970's. From 1980 to present, special emphasis has been placed on crane habitat management, especially for the breeding population. Breeding pairs increased from 17 in 1976 to 36 in 1992 (Modoc NWR, unpubl. data).

A radiotelemetry study of greater sandhill crane colts was conducted on Modoc NWR during 1990 and 1992. Low nesting success (39%) caused by flooding in May 1991 produced too few colts to monitor (Modoc NWR, unpubl. data). The objectives of the study were (1) to determine causes of crane colt mortality, (2) to determine brood habitat utilization, and (3) to evaluate the effects of refuge management practices on colt survival.

Modoc NWR Manager E. C. Bloom procured funding and Assistant Manager D. Hardt developed the project proposal and acquired transmitters. E. C. Bloom, D. Hardt, R. L. Ryno, B. Storm, and A. Kahlen aided in capture, transmitter attachment, and monitoring of colts. Advice on various aspects of this project was graciously provided by C. D. Littlefield, G. L. Ivey, and M. Nagendran. The National Wildlife Health Center (NWHC), Madison, Wisconsin, performed 1 necropsy. E. C. Bloom, C. D. Littlefield, G. L. Ivey, M. Nagendran, and D. H. Johnson reviewed earlier drafts of this manuscript.

STUDY AREA

Modoc NWR (2,543 ha) is located at an elevation of 1,329 m in northeastern California. Climatic conditions consist of cold, wet winters and cool, dry summers. Annual precipitation averages 30.5 cm. The refuge contains irrigated meadows, a natural flood plain, marsh communities, riparian areas, grasslands, cultivated uplands, and uplands dominated by big sagebrush (*Artemisia tridentata*) and western juniper (*Juniperus occidentalis*).

Hay was removed from several wet meadow units during late July and early August during both years of research. Irrigation was terminated between 1 and 15 July to facilitate drying of meadows for haying to occur between 15 July through 30 August.

MATERIALS AND METHODS

I used a 60× spotting scope and 10×40 binoculars to locate cranes on territories during March and April. I conducted nest searches on foot in areas where cranes were observed on territory from April to June. I estimated the incubation stage of each nest using the flotation method (Westerskov 1950). Crane nests were monitored closely within a few days of the expected hatching date to determine precisely when colts hatched.

1990

Crane colts were captured by hand from previously located nests and opportunistically in other territories. Most colts were located and captured within 24–48 hours after hatching. Each colt weighing >110 g was equipped with a

[1]Present address: Ruby Lake National Wildlife Refuge, HC 60, Box 860, Ruby Valley, NV 89833-9802, USA.

collar-mounted transmitter (SM1-H Mortality) weighing 5.5–6.0 g. Colts were recaptured after 4–5 weeks, the collar-mounted transmitter was removed, and a solar-powered leg-band transmitter (Solar Assisted H Module with Mortality) weighing 58–60 g was placed above the tibial-tarsal joint. A size 9, lock-on federal band was placed on the opposite leg. Both collar-mounted and solar-powered leg-band transmitters were identical to those described by Littlefield and Lindstedt (1992) and constructed by AVM Instrument Co., Livermore, Calif. (use of trade names does not imply endorsement by the U.S. Fish and Wildlife Service).

Crane colts with transmitters were monitored daily throughout the 70-day period prior to fledging and 3–5 times weekly from fledging to migration. Locations of colts, types of habitats occupied, and, when applicable, causes of mortality were recorded. Crane colts with transmitters that failed were located when possible and the transmitter removed. When mortality was suspected, but there was no transmitter signal, the area where the colt(s) was last seen was searched on foot and scanned with the receiver. If the colt(s) could not be found the parents were identified by territory presence and/or color mark identification and monitored until it was certain that the colt(s) was no longer present.

1992

Crane colts were again captured by hand from previously located nests and opportunistically in other territories. Due to problems associated with the 1990 transmitters, I used a PD-2T (Holohil Systems, Ltd., Ont., Canada) transmitter weighing 4 g in 1992. Transmitters were sutured onto the back of colts less than 28 days old. The down feathers were trimmed and transmitters were attached with Dermal 000 suture to the skin on the middle of the back with the antenna pointing down. Two suture tubes located on the transmitters allowed secure attachment and prevented transmitters from twisting. After 28 days each colt was recaptured, the sutures were cut, and the transmitter was reattached with duct tape to a plastic leg-band placed above the tibial-tarsal joint. When colts reached 50 days they were captured again and banded above the tibial-tarsal joint with a white color band (2.5 cm wide) and a red numbered band (9 cm wide) on 1 leg and a federal and 2 color bands (2.5 cm wide) on the opposite leg. All color bands were plastic, and each color sequence was unique for each colt. The transmitter was attached to the red numbered band with duct tape.

Crane colts were monitored daily throughout the 70-day period before fledging. Locations of colts, habitat types occupied, and, when applicable, causes of mortality were recorded. I monitored fledged colts with operating transmitters 3–5 times weekly until they migrated. Fledged colts lacking functional transmitters were identified by color band combination and monitored by visual observation until migration.

During 1990 and 1992, habitat use was recorded whenever colts were contacted by radio or observed. Sampling biases prevented statistical analysis of habitat use data. Instead, I calculated use based on the percentage of habitat types used by broods. The same variable was used for each habitat type regardless of how many times broods were observed in each type.

RESULTS

Crane Colt Fates in 1990

Transmitters were attached to 13 crane colts from 12 broods in 1990 (Table 1). Collar-mounted transmitters were attached to 8 colts ranging in age from 1 to 8 days; 7 disappeared before large enough for leg-band transmitters. Cause of mortality could be determined for only 2 of 7 colts with collar-mounted transmitters; transmitters failed and/or antennas detached on the other 5. One colt was apparently killed by a coyote when 2 days old. The transmitter had been removed and the colt was entirely consumed. The second colt died of starvation at 33 days because the neck collar had constricted the esophagus and halted the passage of food items.

In the 5 cases of transmitter failure, mortality was verified by conducting a ground search and monitoring the adults, who often stayed in the area where mortality occurred for 2–5 days. The absence of colts verified mortality occurred, but cause of death could not be determined. One malfunctioning collar-mounted transmitter was removed from a 25-day-old colt. This colt was never seen again and apparently died before fledging. Thus 6 of 7 (85%) colts marked (not including the colt that was starved by its neck collar) died during their first 5 weeks. Only 1 marked colt was known to have survived beyond 5 weeks; this colt and its sibling later fledged.

Because of the high mortality rate, a new sample was required for the attachment of the solar-powered transmitters. In addition to the surviving colt, transmitters were placed on 5 other colts, ranging in age from 32 to 45 days. The age of colts that had hatched from located nests was determined from hatching dates. Size and weight were used to estimate age of colts that had hatched from unknown nests.

Two colts from the new sample died before fledging. One colt died at 55 days and was located about 24 hours after mortality had occurred. The carcass was severely emaciated (1,200 g) and the right foot was distended. NWHC necropsy

Table 1. Suspected fates of radiotagged greater sandhill crane colts, Modoc NWR, California, 1990 and 1992.

Colt no.	Age (days) Transmitter attachment	Age (days) At death	Suspected fate
90-01	1	21	Unknown
90-02	2	19	Unknown
90-03	2	2	Coyote predation
90-04	1		Fledged
90-05	1	11	Unknown
90-06	6		Unknown[a]
90-07	7	33	Starvation
90-08	2	28	Unknown
90-09	32		Fledged
90-10	42	55	Infection[b]
90-11	45		Fledged
90-12	45		Fledged
90-13	35	62	Coyote predation
92-01	NA	<8	Unknown
92-02	4		Unknown[c]
92-03	8		Unknown[c]
92-04	23	41	Mink predation
92-05	23	75	Mink predation
92-06	25		Fledged
92-07	25		Fledged
92-08	28		Fledged
92-09	28		Fledged
92-10	27	69	Coyote predation
92-11	35	50	Mink predation
92-12	35		Fledged
92-13	35	60	Mink predation
92-14	35		Fledged
92-15	35		Fledged

[a] Transmitter removed at 25 days because of failure.
[b] *Staphylococcus* infection.
[c] Transmitter detached.

found that a bacterial infection (*Staphylococcus aureous*) was present in the right foot and 1 digit was dislocated; the emaciation was secondary to the infection. The second colt was killed by a coyote when 65 days old. The carcass was found in very dense cattail (*Typha* sp.) and rushes (*Juncus* sp.) 1.5 m tall in 18 cm of water. The vegetation surrounding the carcass was matted. No scat was found, but the carcass condition was typical of coyote predation.

Crane Colt Fates in 1992

Most crane pairs nested about 2 weeks earlier than normal due to mild spring conditions in 1992. Early hatching dates and the late transmitter arrival prevented their attachment to day-old colts. Three of the broods (6 colts) were monitored visually from hatching to capture. One colt was lost during its first week to an unknown cause, but is included in the results. Transmitters were attached to 14 crane colts from 9 broods ranging in age from 4 to 35 days (Table 1), but most colts (86%) were between 22 and 35 days old. Transmitters became detached from 2 colts and their fate was not determined. Seven of 13 (54%) monitored colts survived to fledging.

Four colts were killed by mink. Two colts (41 and 60 days old) killed by mink were found in dens. One den was located within 5 m of the Pit River, the other within 40 m of a canal. The third colt (50 days old) was found in a dry slough in an irrigated meadow that had been recently drained to permit hay harvest. The colt had been dead for 2 days and most flesh had been removed from the carcass. Mink scat was present at several locations in the slough within 1 m of the carcass. It appeared that a mink had killed the colt in the meadow and dragged it into the slough. The fourth colt was 75 days old and had fledged at least 6 days before being preyed upon. The colt was located within 12 hours following predation, and a mink was observed leaving the carcass. This colt was found within 50 m of the area where its sibling had been previously killed by a mink.

One colt was 69 days old when killed by a coyote. The primaries were almost completely developed and the colt probably would have fledged within 2-3 days. The carcass was located within 30 m of a pond in an irrigated pasture on adjacent private land. The carcass condition was typical of coyote predation.

Brood Habitat Utilization

Brood habitat used consisted of 6 types: (1) irrigated meadows consisting of a variety of rushes, sedges (*Carex* sp.), and grasses that were flood irrigated from 1 April through 15 July, hayed during August, and grazed during autumn (some units were grazed September-December); (2) agricultural fields consisting of cultivated uplands planted with winter wheat, barley, or winter rye; (3) irrigated pasture (refuge and private land) consisting of grasses and sedges which are subject to spring and/or summer cattle grazing; (4) marsh consisting of bulrush (*Scirpus* sp.), cattail (*Typha latifolia*), and rushes; (5) floodplain, consisting of willow (*Salix* sp.), reed canary grass (*Phalaris arundinacea*), bulrush, rushes and sedges; and (6) grassland consisting of western wheatgrass (*Agropyron smithii*), crested wheatgrass (*A. cristatum*), intermediate wheatgrass (*A. intermedium*), and Great Basin wild rye (*Elymus cinereus*).

During 1990, colts from 12 nest sites were monitored. Six nests were located in irrigated meadows and 4 in marsh

habitat; 2 nests were not located before hatching. All 6 broods that hatched in irrigated meadows used these areas as brood habitat. In addition, 1 brood also used irrigated pasture, 1 also used agricultural fields, and 1 also used marsh habitat. The 4 broods that hatched from marsh nest sites also used these areas as brood habitat. In addition, 1 also used floodplain, 1 also used grasslands, 1 also used agricultural fields, and 1 also used irrigated pasture. Two broods hatched in unknown habitat types; 1 used irrigated meadow and the second a combination of marsh, irrigated meadow, and agricultural fields as brood habitat.

During 1992, colts from 7 nest sites were monitored. Four nests were located in irrigated meadows and 1 in marsh habitat; 2 nests were not located before hatching. All broods that hatched at irrigated meadow nest sites used this habitat for brooding. In addition, 1 brood also used marsh and agricultural fields, 1 also used irrigated pasture, 1 also used agricultural fields, and 1 also used floodplain. The brood that hatched at the marsh nest site used marsh, irrigated meadow, agricultural fields, and grasslands. Two broods hatched in unknown habitat types: 1 used agricultural fields, floodplain, and marsh; the other used agricultural fields as brood habitat.

Habitat Management

During 1990, 4 broods (4 colts) were using irrigated meadow habitat before it was mowed. Most colts were 8–9 weeks old and highly mobile when hay harvesting began. Mowing machinery did not cause any direct mortality, but the colts were displaced. Displacement of 1 colt may have caused its death. Its parents moved the colt and its sibling about 800 m north into marsh habitat with dense stands of rushes and cattail. Within 48 hours the monitored colt (62 days old) was killed by a coyote. The dense vegetation may have limited visibility for the cranes and provided easy concealment for the coyote, increasing the colt's vulnerability.

During 1992, 3 broods (4 colts, 7–9 weeks old) used irrigated meadows and adjacent habitats before meadows were mowed. Temporary displacement occurred, but no mortality occurred during mowing, and all 3 broods continued to use the meadows after hay removal. Two colts were killed after hay harvest: 1 by a coyote and one by a mink. Both colts were killed in adjacent habitat that had also been used before haying of meadow habitat. Therefore, displacement did not appear to increase exposure to predation.

DISCUSSION

Crane Colt Survival

Capture of crane colts and attachment of transmitters caused temporary disturbance and stress to both colts and adult cranes. However, the adults and colts returned to areas they had used prior to disturbance within 4–12 hours. No colts were injured during capture and handling. With exception of the colt that starved, no other colts were known to have died as a result of transmitter attachment or disturbance.

However, causes of crane colt mortality in 1990 could not be determined in most instances because of transmitter problems during the first 5 weeks of the study. The close monitoring of adults only helped to determine when mortality occurred. In 1990, mortality rates appeared to be very high (86%) during the first 5 weeks (Table 1), which was similar to data reported by Littlefield and Lindstedt (1992). Colts which survived through this critical period subsequently had a survival rate of about 71%. Two colts were known to have been killed by a coyote, 1 died from a *Staphylococcus* infection, and 4 died of unknown causes. In contrast, during 1992 the mortality rate (46%) was lower and mortality primarily occurred when colts were between 41 and 75 days old (Table 1). Four colts were killed by mink, 1 by a coyote, and 1 died of an unknown cause.

The increase in survival during 1992 may be attributed to the difference in age distribution of the colts monitored and small sample size. Thirty-eight percent of colts were monitored within 1–7 days following hatching in 1992, compared to 55% in 1990.

In the past, mink were not considered a significant predator of sandhill crane colts (Littlefield and Lindstedt 1992). The incidence of mink predation on Modoc NWR is comparable to recent documentation at Malheur NWR (Ivey and Scheuering 1997). Mink are very efficient and opportunistic predators. The importance of prey items varies with prey availability and season, with high use of specific prey items at certain times of the year (Linscombe et al. 1982). The high incidence of mink predation on crane colts during 1992 was probably influenced by the drought that prematurely dried irrigated meadows, marshes, and ponds. These conditions probably reduced many prey species normally taken by mink, which may have increased the predation rate on crane colts.

Coyotes have been documented in the past as a major predator of waterfowl and sandhill crane eggs and young (Littlefield and Lindstedt 1992; Modoc NWR, unpubl. data). Coyotes have been controlled on Modoc NWR since 1975 to increase waterfowl and crane production. In addition, the refuge is bordered by livestock and sheep ranches where predator control is annually practiced, usually by Animal Damage Control (U.S. Department of Agriculture) personnel. The low incidence of coyote predation on crane colts during this study may be attributed to these control efforts.

Brood Habitat Utilization

During 1990 and 1992, a total of 19 broods used 6 different habitat types. Fifteen broods (79%) used more than 1 type. Fourteen broods (74%) used irrigated meadows, 10 (53%) used cultivated uplands, 8 (42%) used marsh, 3 (16%) used irrigated pasture, 3 (16%) used floodplain, and 2 (11%) used grassland.

With an abundance of invertebrates and small vertebrates, wet meadows provide the best foraging habitat for crane colts (Schlorff 1988), and were most frequently used by pairs with young.

Severe drought conditions were prevalent during 1992, and water was insufficient to properly irrigate meadows and maintain marsh habitat on the refuge. Many areas dried prematurely. Some crane clutches originally laid in nests over water hatched on dry land. Drought conditions may have forced pairs to use other habitats of poorer quality to provide food for their young. Following hatching, pairs with broods often move their young into areas of suitable habitat with abundant invertebrate populations (Walkinshaw 1973). The impact of the 1992 drought was also apparent in the use of cultivated uplands. Seventy-one percent of the broods foraged in cultivated uplands during 1992 compared with 42% in 1990.

In most (91%) cases, cultivated uplands were used in addition to other habitat types and were primarily used from just before fledging until migration. Only 1 brood was observed foraging exclusively in cultivated uplands. Agricultural fields contained standing wheat, barley, and rye, which are very important to juvenile cranes from post-fledging to migration (Walkinshaw 1973, Littlefield 1986). On Modoc NWR, these fields are also used extensively by adult cranes during autumn migration.

Habitat Management

Refuge management practices had no known direct effect on the survival of crane colts using irrigated meadows during this study. Since meadows were mowed after most colts could escape mowing machinery, colts were able to move to adjacent habitat. Broods often returned to meadows following haying. However, drying meadows probably reduced food availability, and displacement of broods during haying probably increased vulnerability to predation, dependent upon colt age and the habitat type into which they moved.

RESEARCH AND MANAGEMENT IMPLICATIONS

Crane Colt Survival and Habitat Use

Capturing, attaching transmitters, banding, and, to a lesser extent, monitoring resulted in disturbance to both colts and adults. Colts were captured by hand and some had to be chased to be captured, but none were injured. The adults were disturbed but remained nearby while colts were handled. Colts promptly rejoined their parents when released. Handling caused temporary stress and displacement, but did not result in known mortality or cause permanent habitat abandonment.

Some adults with broods reacted negatively to me in my vehicle during monitoring; they would often sit down in an apparent attempt to hide. However, since I was present for only a few minutes at a time, these reactions did not appear to have significant impacts on colt survival or habitat use.

Radio Transmitters

There were several problems with the collar-mounted radio transmitters in 1990. The elastic collar (2.54 cm in diameter) did not expand enough to allow passage of large food items. This was first noted when a collar was removed from a colt (25 days old) after the transmitter had failed. There were 2 red-winged blackbird (*Agelaius phoeniceus*) chicks and 1 frog (*Rana* sp.) in the colt's esophagus above the neck collar, and it probably would have starved had the collar not been removed. Another colt did starve as a result of collar restrictions similar to those described above. Though 4 colt disappearances were unexplained (Table 1), starvation due to the elastic collar could have been responsible for 1 of those deaths, the colt that disappeared when 28 days old. The other 3 colts disappeared before they were old enough to be starved by the collar.

The location of the antenna, ventrally on the colt, limited the signal range, especially in dense cover. In addition, antennas were in constant contact with vegetation, and 4 antennas broke off.

The solar powered leg-band mounted transmitters functioned satisfactorily. Attachment did not appear to cause discomfort or limit mobility. However, when 1 colt (55 days old) was recovered after dying from a *Staphylococcus* infection, it was apparent that the tibial-tarsal joint was swollen on the leg with the transmitter. Whether the swelling was caused by the infection or the transmitter is unknown, but it seems possible that the transmitter weight (60 g) might cause irritation to the tibial-tarsal joint.

Reception ranged from 1,600 to 3,200 m. However, cloudy days and cool nights decreased battery power, which subsequently reduced reception distance to as low as 800 m. When cranes returned as juveniles in 1991, 2 of 4 still had functional transmitters.

The transmitters used on small colts in 1992 were much improved. Transmitters sutured on the back of colts did not

cause any observed discomfort or mortality, and reception (800 m) was more than adequate. However, some of the sutures did become detached as a result of growth and poor knot tying. When transmitters were attached to leg bands with duct tape, they remained attached but did not inhibit movement, and the attachment location increased reception distance from 800 m to 1,200 m.

Habitat Management

During this study, irrigated meadows were the most used habitat type. In the past, irrigation of most meadows was terminated 1–15 July to permit hay harvest between 15 July and 30 August. The majority of crane nests hatch on Modoc NWR between mid-May and early June. Most colts were only 5 weeks old when irrigation was terminated and 7–8 weeks old when mowing began. Termination of irrigation likely resulted in a decline in populations of both invertebrates and vertebrates during a period when crane colts were most dependent on these food sources. In addition, removing vegetation before colts have fledged increases vulnerability to predation (Littlefield and Lindstedt 1992), especially by coyotes. Irrigation should be sustained at least through 1 August and hay mowing not permitted before 15 August. This delay will maintain important brood habitat and should allow the majority of colts to fledge prior to hay removal.

LITERATURE CITED

IVEY, G. L., and E. J. SCHEUERING. 1997. Mortality of radio-equipped sandhill crane colts at Malheur National Wildlife Refuge, Oregon. Proc. North Am. Crane Workshop 7:14-17.

LINSCOMBE, A., N. KINLER, and R. J. AULERICH. 1982. Mink (*Mustela vison*). Pages 634-635 *in* J.A. Chapman and G.A. Feldhamer, eds. The wild mammals of North America. Johns Hopkins Univ. Press, Baltimore, Md.

LITTLEFIELD, C. D. 1986. Autumn sandhill crane habitat in southeast Oregon. Wilson Bull. 98:131-137.

_____. 1989. Status of greater sandhill crane breeding populations in California, 1988. Unpubl. Rep., Wildl. Manage. Div., California Dep. Fish Game, Sacramento. 40pp.

_____, and S. M. LINDSTEDT. 1992. Survival of juvenile greater sandhill cranes at Malheur National Wildlife Refuge, Oregon. Pages 21–31 *in* D. A. Wood, ed. Proc. 1988 North Am. crane workshop. Florida Game Fresh Water Fish Comm. Nongame Wildl. Program Tech. Rep. 12.

SCHLORFF, R. W. 1988. Five-year status report–greater sandhill cranes. California Dep. Fish Game, Sacramento. 9pp.

WALKINSHAW, L.H. 1973. Cranes of the world. Winchester Press, New York, N.Y. 370pp.

WESTERSKOV, K. 1950. Methods for determining the age of game bird eggs. J. Wildl. Manage. 14:56-67.