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SURVIVAL OF JUVENILE GREATER SANDHILL CRANES AT MALHEUR NATIONAL WILDLIFE REFUGE, OREGON

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Abstract: Greater sandhill crane *(Grus canadensis tabida)* recruitment rates in southeast Oregon have generally been low since the mid-1970s. To identify causative factors for low chick survival, transmitters were placed on 21 flightless young in 1983 and 18 in 1984. Of the chicks monitored in 1983, contact was lost with 4, 13 were lost to predators, 1 died of parasitic pneumonia,1 drowned and 2 fledged. In 1984, 8 chicks were monitored, 4 were lost to predators, 1 drowned, and 3 died from unknown causes. Of 10 transmitters which malfunctioned, 8 were on chicks known to have died. Predation was determined to be the major mortality factor on Malheur NWR, with coyotes *(Canis latrans)* being the most serious predator.

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This 2-year study was initiated in May 1983 to identify the factors causing high mortality rates of unfledged greater sandhill cranes on Malheur National Wildlife Refuge (NWR), Harney County, Oregon. Recruitment rates in southeast Oregon have been low since the mid-1970s, resulting in a decline in the number of nesting pairs on the refuge (Littlefield & Thompson 1987). This was the first attempt to monitor cranes from shortly after hatching until individuals either died or fledged.

The study was a cooperative effort between Oregon Department of Fish and Wildlife and the U.S. Fish and Wildlife Service. Numerous employees from these two organizations helped organize and participated in the study. In particular, we would like to thank Gerald Farstvedt and James Lemos (ODFW) who spent considerable time and effort in obtaining funds and transmitters, and who also helped in the field. U.S. Fish and Wildlife Service personnel involved in the study included Jon Anderson, Brad Ehlers, Ellen Kelley, Gary Ivey, David Paullin and William and Marcia Radke. Also involved were several people from Malheur Field Station. Most important were Gaylin and Roland Holloway who helped capture and monitor chicks. Without the help and support of these people, the study would not have been possible.

STUDY AREA

Malheur NWR is located in the northestern portion of the Great Basin at a relatively high elevation (1240 m). Precipitation occurs mainly from November through January, but May and June have greater monthly totals. Summers are generally dry with maximum temperatures seldom exceeding 35°C, while winters are cold with below 0° C temperatures for several weeks in most years. For a description of the refuge see Littlefield (1976) and Littlefield and Thompson (1987).

MATERIALS AND METHODS

Greater sandhill crane chicks younger than 30 days were fitted with hermetically sealed Telemetry Systems, Inc. CRZ-N transmitters. Transmitters (164 MHz) were placed around the neck with a 0.63 cm wide elastic collar. Elastic collars had a 3:1 stretch ratio. Transmitters were painted to match crane chick plumage; the white elastic was dyed in very strong hot tea mixed with 3 tablespoons of instant coffee granules. when elastic resembled the color of young cranes it was removed from the solution, dried, and attached to the trans-

mitters with super glue.

Upon equipping a chick, a small amount of super glue was placed on each side of the transmitter and attached to the down feathers on the lower neck. This prevented the transmitter from sliding to the neck's ventral surface until chicks had attained sufficient height to avoid impediment of movements. Usually within 1 week transmitters had shifted to the ventral neck region. Transmitter package weight was about 6g. After 30 days, or when chicks had attained sufficient height, a Telemetry Systems, Inc. RS50-2TM-3X-S (45-65 g) solar-powered transmitter attached to a plastic leg band (Insulfab Plastics, Inc.) was placed above the tibial-tarsal joint. Transmitter attachment was identical to that described by Melvin et al. (1983)

Nests were found between 15 April and 20 May 1983, and 21 April and 14 June 1984. Nests were examined at the expected time of hatching, and if chicks were present, transmitters were attached. Older chicks were equipped after being found from an auto or by searching on foot. Ground searching was conducted when a crane pair performed "broody" behavior.

Chick monitoring was accomplished from an auto or on foot, using a Yagi hand-held antenna and Telonics TR-1 receiver. Chicks were monitored every 1 to 3 days in 1983 and 1 to 5 days in 1984. Transmitters were equipped with mortality sensors and when signals became constant, a ground search was initiated to find the chick, chick remains, or transmitter. In 1984, considerable time and effort were spent searching for 10 chicks after their transmitters malfunctioned. Dead chicks which were recovered were sent to the National Wildlife Health Laboratory (NWHL), Madison, Wisconsin for necropsy.

Transmitters were placed on 21 chicks beteen 24 May and 8 August 1983, and 18 chicks between 14 May and 27 June 1984. Most chicks were equipped shortly after hatching but 10 of 39 were not equipped until they were 14 days or older.

RESULTS

Transmitter-equipped Sandhill Crane Chicks-1983

Twenty-one greater sandhill crane chicks were equipped in 1983 (Table 1). Unfortunately, transmitters were not obtained until 21 May, 1 week after the hatching peak. Contact was lost with 4 chicks, 13 were known lost to predators, 1 died of parasitic pneumonia, 1 drowned and 2 fledged. Two chicks with which contact was lost (chicks 153 and 173) were known to have died before fledging. Therefore, total mortality of chicks was 89.5%. Mammalian predators accounted for 64.7% of the 17 chicks, while great horned owls (*Bubo virginianus*) were suspected of taking at least 2 (10.8%). Thirteen chicks were equipped within 4 days after hatching. Two chicks were captured within 1 week of fledging, while 6 were tagged when 14 to 30 days old. The average survival period for the 13 chicks instrumented shortly after hatching was 19.3 days (r=1-54). Five chicks captured when 14 to 56 days old survived an average of 15.8 days (r=5-30). One chick equipped on 8 August fledged 12 August. The history of each 1983 transmitter-equipped chick is presented in Appendix A.

Transmitter-equipped Greater Sandhill Cranes-1984

Eighteen unfledged crane chicks were transmitter-equipped in 1984 (Table 2). Transmitters arrived in ample time for the hatching, but many nests which were being monitored were destroyed by predators. Additional problems developed in 1984; 10 transmitters malfunctioned shortly after being placed on chicks, and the transmission range was usually between 10 and 15 m in 1984, compared to 220 and 440 m in 1983. These problems resulted in repeated disturbance of family groups and often delayed periods between monitoring. Fates of 8 chicks were determined. Four were lost to coyotes, 1 drowned, and 3 died from unknown causes. Of the 10 transmitters which malfunctioned, 8 chicks were known to have died. Therefore, total mortality was at least 88.9%.

Twelve chicks were equipped within 4 days after hatching, while 3 were 1 week old, 1 ca. 2 weeks old, and 2 ca. 4 weeks old. Recently hatched chicks survived an average of 8.8 days (r=1-14). Chicks which were ca. 7 days old survived 8 days (r=2-14 days), and the 2 which were ca. 4 weeks survived 7.5 days (r=2-12). No equipped chicks were known to have fledged. The history of the 18 chicks is presented in Appendix A.

DISCUSSION AND CONCLUSION

Although transmitter malfunctions in 1984 resulted in only a few chicks being monitored for their entire lives, the study was successful in determining major factors involved in chick mortality.

From information collected in 1983, and limited information in 1984, predation was determined to be the major chick mortality factor. Of 25 chicks whose fates wsre determined, 68.0% were lost to predators. Predation was particularly high for chicks less than 4 weeks old. So few chicks survived past their first 4 weeks, it was impossible to ascertain if other potential mortality factors, such as early meadow mowing, disease, starvation, accidents or brood strife were contributing to chick losses.

Coyotes were suspected in most predation losses, destroying 13 chicks (52.0%), 9 of the 17 chicks in 1983 and 4 of 8 in 1984. Great horned owls are abundant on Malheur NWR, and were known to have preyed on 2 young cranes and possibly another. A raccoon (*Procyon lotor*) was implicated in 1 loss, although raccoons are common on the refuge and in some years may contribute significantly to crane chick mortality.

Since studies were initiated on the refuge in 1966, 2 instances of predation by mink (*Mustela vison*) were detected. Presently, minks are uncommon on Malheur and it is doubtful the species has contributed to many losses. Golden eagles (*Aquila chrysaetos*) have killed and consumed at least 3 adult sandhill cranes in recent years, and certainly the species has the potential for capturing young cranes. During this study no chicks were known lost to eagles.

One chick has provided information on a mortality factor which could be prevalent in the local crane population and perhaps other populations as well. Gapeworms (*Syngamus* spp.) were first reported from sandhill cranes in Florida (Forrester et al. 1974), but were found in small numbers. The death of Chick 43 was the first record we are aware of for a sandhill crane death resulting from an infestation of gapeworms.

Since 1966, many chicks have been heard making "gurgling" noises (Littlefield pers. observ.). It was assumed respiratory "gurgling" was because of Aspergillus fumigatus, which had previously been reported from cranes on Malheur NWR in the early 1960s (E. Boeker unpubl. ms.). However, symptoms for aspergillosis are not accompanied by "gurgling" (Davis et al. 1971). Rapidly growing gapeworms obstruct the lumen of the trachea, resulting in suffocation. The inability to breathe causes a bird to gape which is an early symptom of infection. Affected birds also emit short, whistling sounds (Davis et al. 1971) . These whistling sounds can be described as "gurgling," indicating young cranes heard in the past may have been infected by the parasite.

Upon reexamination of the necropsy report from a chick which had apparently died of aspergillosis in 1961, an unidentified nematode engorged with blood was found in the trachea. Another chick which died after being captured in 1961 also had several unidentified nematodes engorged with blood in the trachae (E. Dickinson pers. comm. to R. Erickson). It is likely these unidentified nematodes were gapeworms.

These parasites would be readily available to sandhill cranes as the intermediate host is the earthworm, a common food source for cranes on Malheur NWR. Gapeworms may be an important mortality source for greater sandhill cranes on the refuge. In addition, gapeworms may predispose crane chicks to predation. Unfortunately, chick 124 was mostly consumed by turkey vultures (*Cathartes aura*) before it was located, resulting in an inconclusive necropsy. Symptoms were somewhat similar to those of chick 43, therefore chick 124 could have died from this parasite.

In 1984, some information was collected on crane chicks in relation to water management. Water deficiences on portions of the refuge resulted in considerable chick movement. Limited irrigation resulted in chicks concentrating in a small meadow where water overflowed from a canal. Three chicks were transmitter-equipped at this ca. 9 ha area, but none was known to have hatched in the immediate vicinity. Excessive movements often results in increased predation, and none of these chicks was known to have fledged. Chick 64 had moved ca. 1.6 km within 24 hours of being transmitter-equipped. Once water receded in the meadow, no additional crane use was noted.

In another area, a broken dike provided an abundance of water through the early crane brooding period. Chicks 24 and 34 were being monitored in this field. Chick 24 was in the southeast corner, and chick 34 in the east-central portion. Six coyotes were seen regularly in the drier northeast portion, but both chicks were separated from the coyotes by several deep channels. As water levels receded in the Blitzen River, water flowed rapidly from the field. Tracks indicated coyotes immediately moved into the newly accessible areas and both chicks disappeared within 48 hours.

To some extent, transmitters were believed responsible for some chick mortality. The 2 chicks which drowned were likely the result of transmitter weight. This mortality factor could have been reduced or avoided by (1) equipping chicks which have been produced only from large eggs and (2)

not placing transmitters on recently hatched chicks when temperatures exceeded 30° C.

Chick 164 weighed only 100 g when equipped, and had been hatched from the smallest egg (85.5 X 61.0 mm) located on Malheur NWR in 1984. The chick was found dead 10 m from the nest and had apparently drowned while attempting to swim to shore. Chick 53 was transmitter-equipped when temperatures exceeded 30°C. The chick was later located near the nest and had apparently left the site prematurely because of the excessive heat. Transmitter weight likely prevented the chick from reaching shallow water before tiring and subsequently drowning.

Malfunctions in 1984 prevented an evalution of transmitter influence on chick mortality, but in 1983 there was some indication transmitters caused increased mortality. Refuge mortality of unmonitored chicks in 1983 was 84.4%, compared with 89.5% for those monitored. Even though some chicks were lost because of transmitters, considerable information was obtained during the study, and this information has been useful in making decisions for the management of greater sandhill cranes on Malheur NWR.

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APPENDIX A. THE HISTORY OF MONITORED GREATER SANDHILL CRANE CHICKS ON MALHEUR NWR, OREGON (1983-1984).

1983

Chick 13 – Chick 13, with its sibling (chick 23), left the nest on 20 May 1983 . It was captured and equipped on 24 May (after hatching 19 May). By 25 May, the adults and chicks had crossed ca. 1. 2 km of big sagebrush (*Artemisia tridentata*) and black greasewood (*Sarcobatus vermiculatus*) uplands, and were eventually relocated adjacent to a marsh northwestly of the nest site. This family group was using an ecotone between the marsh and uplands for feeding. Coyotes also used the ecotone. On 26 May, the transmitter, with attached down feathers, was located beneath 7. 5 cm of water within 1 m of shore. Fresh coyote tracks were evident along the shore leading into water where the transmitter was located. There was no sign of the chick or chick remains. An active coyote den was within 0.4 km of the transmitter, and pups were regularly seen in the vicinity.

Chick 23 – Chick 23, the sibling of chick 13, was probably the oldest of the brood and likely hatched on 18 May. Its movements were identical to chick 13. Upon locating chick 13's transmitter, a weak signal was received from chick 23's transmitter, but it was not located until 27 May. Similar to chick 13, only the transmitter was found, in a greasewood flat ca. 0.4 km northeasterly of the area being used by the family group on 25 May. The transmitter was in the area where coyote pup activity had been most evident during the proceeding days. Tracks and scats near the transmitter indicated both chicks 13 and 23 were killed and consumed by coyotes, likely on 26 May.

Chick 33 – Chick 33 hatched on 23 May 1983 and was equipped on 24 May. Its sibling was found dead near the nest, having died at hatching or shortly thereafter. After leaving the nest site, the family group moved 0.4 km southeasterly into a moist meadow. On 27 May, the chick was in the same general area, but had moved onto an ecotone between meadow and a greasewood upland. Shortly afterward, the southern portion of Malheur NWR became flooded as the Blitzen River overflowed its banks. From 1 through 8 June no signals were received as water remained high in the pair's territory. Water receded by 9 June and the chick was seen on its former feeding meadow. Appar-

ently, the adults moved the chick to higher ground during the run-off period, likely southeastward of their original territory. Adults were heard calling from that area in early June. The chick's remains were located among sedges (*Carex* spp.) in the feeding meadow on 10 June. Gnawed bones and fresh blood were near the transmitter, indicating the chick was consumed by a mammalian predator. Unlike other transmitters found after a chick had been consumed, the collar had been chewed and the antenna bent. Three long bone ends and coagulated blood were located within 20 cm of the transmitter. The substrate was moist, covered with dense sedge, 2m from a hardstem bulrush (*Scirpus acutus*) stand. No tracks or scats were found near the chick's remains, but raccoon predation was suspected.

Chick 43 – On 26 May 1983, chick 43 was captured and fitted with a transmitter along with its sibling chick 53. After leaving the nest site the family group moved ca. 50 m SSE where it remained through 31 May. By 1 June, the adults had moved the chick northeastward where they came in contact with a neighboring crane pair. Numerous unison calls were given by the 2 pairs, indicating a territorial dispute was in progress. By 4 June, the family group had moved to the eastern edge of their territory, feeding in a greasewood upland-meadow ecotone, but on 5 June the chick was in an irrigated meadow southerly of the upland. Minor movements continued through 8 June in the southern portion of their territory. The pair and chick moved to within 50 m of a well-traveled road on 9 June where they fed in a dense creeping wildrye (*Elymus triticoides*) stand through 16 June. On 17 June, the chick was found dead in 16 cm of water. Both adults were within 10 m indicating the chick had recently died. The carcass was collected and shipped to NWHL for necropsy. Diagnosis determined the chick had died from parasitic pneumonia and tracheitis. Over 20 gapeworms, both male and female, were located in the trachea and lungs. Chick 43 was the first record we are aware of for a sandhill crane death resulting from an infestation of this nematode.

Chick 53 – Chick 53 (sibling chick 43) hatched on 27 May and was transmitter-equipped shortly afterward. Temperatures were above normal on both 27 and 28 May. The chick was found dead on 28 May, ca. 2 m from the nest, apparently having drowned. Excessive heat likely caused the chick to leave the nest prematurely, and transmitter weight could have prevented the chick from reaching shallow water before tiring. The specimen was analyzed at NWHL and was reported as normal. However, the liver was shriveled and had a whitish coating over the surface, and the lungs and intestine had the consistancy of bloody pus. The peritoneal cavity was filled with yolk material which was normal for a chick this age. The final diagnosis from NWHL was--cause of death undetermined.

Chick 63 – On 31 May 1983, this chick was transmitter-equipped at the nest. It weighed 128 g and had hatched on 30 May. Shortly after leaving the nest the adults moved the chick into a creeping wildrye stand in a flooded meadow/greasewood ecotone. By 5 June, chick 63 had moved 0.25 km eastward. This eastward movement continued and on 28 June the family group was ca. 0.8 km ESE of the nest site. Movement into this area occurred after a neighboring pair had lost their 2 chicks chicks (chicks 73 and 83). That pair had abandoned its territory shortly after their chicks were lost, thus allowing the chick 63 family to move into the area. The family group returned to their own territory 29 June and remained there until contact was lost on 9 July.

Chick 73 – Chick 73, with its sibling, chick 83, was equipped on 31 May 1983. The chicks, together ca. 10 m from the nest, had hatched on 29 and 30 May. Chick 73 weighed 110 g when equipped and was apparently the younger of the brood. Flooding on 3 June stranded the family on a greasewood upland where it remained through 9 June. After water levels receded, the birds moved southward to adjoining uplands where they fed in a meadow upland ecotone. On 21 June, the group moved 0.4 km northward and on 24 June, 0.25 km southwesterly near an adjoining pair's territory. This was the last live contact. On 27 June, the carcass was found on a willow (*Salix* sp.) upland. The chick had been decapitated which is indicative of predation by a great horned owl. An owl pair nested within 0.4 km from where the remains were located. The NWHL diagnostic report showed massive traumatic tissue tearing lesions throughout thc thoracic cavity and the lungs were torn apart,

Chick 83 – Sibling to chick 73, chick 83 weighed 122 g when instrumented on 31 May. Unlike other pairs during the study, the adults kept the chicks relatively close together throughout the monitoring period, Movements within the territory were similar to chick 73. Chick 83 was found dead on 27 June ca, 2 m from chick 73; it had also been decapitated. Both chicks were apparently killed at the same time by a great horned owl. The NWHL diagnostic report showed the chick had multiple

trauma regions along the back, and the ribs were crushed. One lung was torn and puncture wounds were present through the skin. The gizzard contained unidentified seeds, indicating the chick was healthy at the time of death.

Chick 93 – Both chicks 93 and 103 (siblings) were captured on 1 June 1983. Chick 93 weighed 106 g and was captured 5 m from the nest swimming in 75 cm of water. Both adults were present, leading the young to a dry dike 15 m west. The 2 chicks appeared chilled and were quivering. These 2 chicks were not monitored on 2 June, but on 3 June the transmitters were found near a dike near the release site. Coyote tracks and scats were nearby; Chick 93's collar was intact and located with the attached transmitter in water 12.5 cm, westerly of the dike.

Chick 103 – Chick 103 weighed 112 g when captured. It had been on a bulrush mat ca. 6 m from shore. Size and activity indicated this was the oldest chick and had probably hatched on 20 May. The transmitter and collar were found on a dike near ths release site on 3 June ca. 0.75 m from the nearest water. The collar was stained with blood. Probably the same coyote captured both chicks shortly after transmitter attachment.

Chick 113 – Chick 113 was equipped while on a nest on 1 June 1983. It weighed 119 g and was extremely active. Also in the nest was a cracked egg being incubated by an adult. On 3 June, the chick was located on a dike ca. 30 m northwesterly of the nest site, accompanied by both adults. The transmitter, with attached collar, was located below willows 50 m east of the nest site on 4 June. Transmitter condition and nearby tracks indicated the chick had been consumed by a coyote.

Chick 123 – Chick 123 was captured on 1 June ca, 50 m from a well-traveled road, 2.4 km westerly of Malheur NWR Headquarters. The adults had apparently nested near Malheur Lake's southern shore, and were likely moving the chick to favorable feeding habitat further south. The chick was estimated to be 30 days old. The family group had moved south of the road and was feeding along a dike on 2 June. The signal was lost from 3 until 9 June. On 9 June, the chick was feeding in a meadow ca. 0.4 km SSE of the capture site. On 12 June, the transmitter was located on a dike 0.4 km southerly of the capture site. A coyote was present, feeding on the carcass. Chick feathers were scattered over a 1 m area. The transmitter had been removed with collar intact, similar to others where coyote predation was suspected. Not enough chick remains were available for necropsy.

Chick 133 – On 2 June 1983, chick 133 was captured and transmitter-equipped. It was estimated to be 3 weeks old and weighed 300 g. Both adults were in attendance. The chick had apparently hatched from a nest 0.8 km easterly of the capture site. By 3 June, the family had moved 0.4 km southwestward and was feeding at a meadow's edge adjacent to a greasewood upland. However, chick 133 had moved back near the capture site by 6 June. Contact was lost between 10 and 15 June, but was reestablished on 16 June ca. 0.5 km southerly of the capture site. This was the last contact.

Chick 143 – Chick 143 was chick 63's older sibling and had already left the nest when chick 63 was equipped and released. Both chicks were together 3 June, but shortly afterward the adults separated, each taking a chick. Throughout much of the monitoring period the adults kept the chicks separated, feeding in different areas usually 30 to 50 m apart. Chick 143 was seen on several occasions on a dike ca. 200 m easterly of the nest site in early July. The chick was active on 10 July, but no contact was made on 12 July. On 13 July, the chick's remains and transmitter were located east of the Blitzen River ca. o.8 km easterly of the nest site. The remains were on a greasewood-wildrye upland. There were 4 distinct feather piles as the predator apparently dragged the chick, stopping occasionally to feed. Bone chips and both legs were also present. The chick was apparently captured by a coyote and drug from the meadow, across the Blitzen River and road, to the upland, before being consumed.

Chick 153 – Chick 153 was 4 to 5 weeks old when captured on 7 June 1983. The transmitter malfunctioned 10 June, and it was recaptured 12 June and the transmitter replaced. The chick fed along a moist dike where habitat was limited. On 21 June the adults had moved the chick off the dike's southern end. Habitat there was also limited as deep water and dense Baltic rush (*Juncus balticus*) predominated. The family group had returned to the dike by 24 June. The group again left the dike and moved onto residental lawns at refuge headquarters on 26 June. The transmitter malfunctioned at this time and close observation indicated the antenna was not present (B. Ehlers pers. comm.). No signal was received on 27 June and the chick was not seen or heard again. B. Ehlers dispersed the chick from a refuge lawn on 26 June. About 2 to 3 hours later a great horned owl was perched in a tree ca. 15 m away and could have been responsible for the chicks disappearance.

Chick 163 – Chick 163 hatched on 27 May 1983,

but because of inaccessibility was not equipped until 15 June. When captured, the chick was ca. 100 m westerly of the nest site, being fed by both adults in an ecotone between moist meadow and a wildrye upland. The family group remained on or near the ecotone through 28 June, but by 29 June had begun to drift southward as water levels receded. They remained in the southern extremity of their territory until mid-July when they moved northwestward apparently searching for favorable feeding habitat. By 17 July, the meadow was mostly dry with only a few moist spots in the deeper depressions. Contact was not made on 19 July, and on 20 July the transmitter was located among chick feathers and bone fragments ca. 0.4 km easterly of the last contact point. The transmitter's condition was similar to others in which coyote predation was suspected, but no coyote tracks or scats were noted.

Chick 173 – Chick 173 (ca. 4 weeks old) was captured with its sibling (chick 183) on 23 June 1983. Upon release the chick ran southwesterly into a dense hardstem bulrush stand. The transmitter malfunctioned before or during attachment, and the chick was not seen or heard after release. Efforts were unsuccessful in relocating the chick.

Chick 183 – Chick 183 was transmitter-equipped on 23 June. It was the smallest of the 2 chicks. After capture, the family moved southeasterly 0.4 km. By 30 June, the group had moved southeastward 0.4 km from the previous data point. On 14 July, chick 183 was recaptured and the transmitter was replaced with a leg-band transmitter. The adults and chick were located 0.8 km northerly and 0.4 km easterly of the last data point on 23 July. When approached, the chick was hiding among common cattail *(Typha latifolia)* but shortly afterward flew and joined the adults. On 25 July, the group was back on its nesting territory where it remained through 29 July. The adults and chick subsequently left the territory and moved NNW 4.8 km where they were located on 31 July. This northern movement continued until the group arrived at a grain field 11.2 km northerly of the nesting territory. They were still in this area in late September, along with 57 other greater sandhill cranes. Two data points were obtained from the wintering area, where chick 183 was seen on the Faith Ranch (ca. 16 km west of Modesto, Stanislaus Co., California) on 24 and 28 December 1983 (T. Pogson pers. comm.). The transmitter had malfunctioned and the chick was not seen subsequent to 28 December.

Chick 193 – Chick 193 was equipped 29 June 1983 when less than 1 week old. It weighed 155 g and had no sibling. The adults and chick remained within 10 to 50 m of a well-traveled road through early July. Most activity occurred within 0.4 km of the road. Feeding habitat remained in excellent condition well into July because of high water levels in Malheur Lake. Chick 193 was alive on the morning of 12 July, but that afternoon the transmitter was located in cattails and rushes 15 m from a newly mowed hay swath; some down feathers were attached and the transmitter was scraped and worn. Coyotes had been consistently seen for ca. 2 weeks in the area and coyote predation was believed responsible for the chick's demise.

Chick 203 – Chick 203 was near fledging when instrumented with a leg-band transmitter on 5 August 1983, ca. 8.0 km WNW of Diamond, Harney County, Oregon. The chick had first been seen on 4 August, but no adults were in attendance. Upon capture, the chick did not attempt to hide or flee. The chick was captured in a recently mowed meadow, and continued to feed alone in the same area through 9 August. On 19 August, chick 203 was found dead 10 m from the edge of a meadow being mowed. Canine tracks were evident around the carcass and a few feathers were missing but there was no evidence any portion of the bird had been consumed. The carcass was shipped to NWHL, where laboratory diagnosis revealed massive tissue tearing of the musculature, rib fractures and internal bleeding in the right thoracic area. There was a deep penetrating wound which may have been attributed to a canine tooth in the right pectoralis major. Massive hemorrhage and bruising of the breast muscles were evident. The lesions were consistant with a predatory mammal such as a coyote or dog. The bird weighed 2930 g and appeared healthy. Mouse fur, likely montane vole *(Microtis montanus)*, was found in the gizzard, which indicated the chick had recently fed. The area where the chick was located is well known for free-roaming dogs, but coyotes also frequent the area. It was suspected the chick was killed by a dog since it was not consumed.

Chick 213 – Chick 213 was captured and equipped with a leg-band transmitter on 9 August 1983 in a grain field. The chick was near fledging when captured. Through September, the adults and chick 213 remained in the vicinity of the capture site, and on 11 October migrated. It was located on the wintering area near Thornton, San Juaquin County, California on 22 October 1983 (T. Pogson pers. comm.). During the winter 58 data points accumulated. Chick 213 was relocated in Diamond Valley, Harney County, Oregon on 21

March 1984 where it remained until mid-April. On 27 April, it moved ca. 19 km SSW of Diamond Valley where it remained through mid-May, but was not seen again on Malheur NWR until autumn. On 27 and 28 September, it was seen ca. 11 km northward of Frenchglen, Harney County, Oregon, moving northward ca. 16 km on 3 October. Chick 213 left the refuge on 15 October and was resighted near Thornton on 28 October 1984. Somewhere between Malheur NWR and Thornton the transmitter was lost, but the color-band combination on the bird continued to provide a means for identification.

1984

Chick 14 – Chick 14 was captured and instrumented on 14 May 1984. High water from the Blitzen River covered much of the parent pair's territory from 16 through 30 May. On 27 May, the family moved ca. 0.25 km southwesterly to a sagebrush-covered slope where it remained for 1 day before moving back to the original capture site. The chick was killed shortly after returning. The transmitter was retrieved on 2 June among sagebrush west of the Blitzen River. Tracks indicated the chick had been killed by a coyote. As a result of high water most feeding was confined to a narrow ecotone between open water and rimrocks. The family was often seen feeding among sagebrush on a steep slope below the rimrock.

Chick 24 – On 19 May 1984 chick 24 was captured. Its male parent had been banded (599-01477) and color-marked on 16 April 1982. After being equipped, the chick was not relocated until 25 May, ca. 0.4 km northeasterly of the capture site and where it remained through early June. A neighboring pair, also with a transmitter-equipped chick, disappeared in early June resulting in chick 24's family moving onto their territory on 6 June. The area was completely flooded during this time, but on 10 June most water had drained from the field and chick 24 disappeared shortly thereafter. The adults were seen feeding ca. 3 km northwesterly of their territory on 11 June, but no chick was present. The transmitter malfunctioned on the day the chick was lost, so the causative factor was undetermined. Possibly, as the chick was killed, the transmitter was damaged.

Chick 34 – Chick 34 and its sibling chick 44 were equipped on 21 May 1984. The male parent had been banded (599-01309) and color-marked on 4 August 1983. This chick's transmitter failed after 26 May, but it it was located alive on 7 June on a small island adjacent to a dugout pond. Chick 34 was lost at approximately the same time as its neighbor, chick 24. Water levels dropped rapidly in the field after flows from the Blitzen River and tributaries receded. By 11 June, the island became connected with uplands. Fresh coyote tracks and scats were evident where the chick was last observed. There was little doubt that the chick was killed and consumed by a coyote. The adults were located on 11 June feeding on an upland ca. 0.8 km southwesterly of the brooding area. Neither adult gave any indication of broodiness.

Chick 44 – Chick 44, sibling to chick 34, was equipped with a transmitter on 21 May 1984. On 24 May, chick 44 was still in the nest vicinity, but had moved to an island northerly of the site on 28 May. The decomposed chick remains were located 7 June near a broad-fruited burreed (*Sparganium eurycarpum*) stand ca. 10 m northerly of a crane brooding platform. The remains were sent to NWHL, but the carcass was unsuitable for examination because of extensive post-mortem autolysis.

Chick 54 – On 22 May 1984, chick 54 was captured and fitted with a transmitter. Water had overflowed from a canal and provided excellent crane brooding habitat from mid-May through 10 June. Chick 54, along with 2 other broods, was captured in this area. Approximately 1 week old, the chick remained in the field through 23 May at which time its transmitter malfunctioned.

Chick 64 – After locating chick 54 on 23 May 1984, chick 64 was captured ca. 0.4 km southerly in the same field. After extensive searching, on 24 May, chick 64 was relocated ca. 1.6 km southeasterly of the capture site. The pair was feeding on a dry dike surrounded by dry meadows. The chick could not be relocated between 25 and 29 May, but on 30 May the family was located on a small wet area ca. 0.8 km SSE of the capture site. The transmitter was producing a weak signal and it malfunctioned shortly afterward. No adults were seen in the area after this date and apparently the chick died around 1 June.

Chick 74 – Chick 74 had recently hatched when it was equipped at a nest on 23 May 1984. On 24 May, the chick had left the nest when its sibling (chick 84) was equipped. On 26 May, a coyote was reluctant to leave as Littlefield approached the nest. The transmitter was located ca. 15 m from the nest and the chick had apparently been consumed by a coyote.

Chick 84 – Chick 84 was the sibling of chick 74 and was equipped with a transmitter on 24 May

1984. The chick was apparently removed by a coyote shortly after hatching. The transmitter was located under 25 cm of water, 3 m from the nest. A coyote was present near the site and had to be driven away.

Chick 94 – This was the third chick captured in the flooded field where chicks 54 and 64 were transmitter-equipped. Chick 94 was captured on 26 May 1984. The family group had been observed earlier ca. 0.4 km northwesterly of the site. Shortly after capture, the group moved back to their original site where the chick was located 28 May. The transmitter malfunctioned shortly afterward, but the pair was present on their territory on 30 May. The pair showed no "broody" behavior and had left the area in early June.

Chick 104 – Chick 104 was recently hatched when equipped on 27 May 1984 and was from the same pair which produced chick 113 in 1983. The transmitter malfunctioned shortly after placement, However, the pair was easily monitored until the chick was lost. By 30 May, the family had moved to a dry meadow easterly of the nest, where they remained until 5 June and then moved to a small wet area ca. 0.4 km northeasterly of the nesting site. On 11 June, the adults performed distraction behavior, but on 12 June the adults were no longer on their territory. The chick was apparently lost during the evening of 11 June or morning of 12 June. Coyotes were heard near the family on 11 June.

Chick 114 – Chick 114 was instrumented when still on the nest 31 May 1984. The pair was one of which had relocated after high water in Malheur Lake had inundated their original territory. Their habitat was limited to a narrow ecotone between a slough and sagebrush upland. Coyote tracks were evident throughout the ecotone, and the chick was evidently lost to coyotes before 9 June.

Chick 124 – Chick 124 was ca. 4 weeks old when captured on 13 June 1984 in a dry area which provided little crane feeding habitat. The chick either died on the evening of 14 June or morning of 15 June. The chick's remains were located being consumed by turkey vultures. All internal organs except for one piece of intestine and all musculature were stripped from the carcass. The brain had also been removed. No diagnosis could be made by NWHL because the carcass was unsuitable. General appearance indicated the chick had died, with no indication the bird had been killed by a predator.

Chick 134 – On 14 June 1984, chick 134 was captured and equipped with a transmitter when ca. 4 weeks old. Unfortunately, the transmitter malfunctioned shortly after attachment and the chick was assumed lost because the capture site was only ca. 0.4 km from an active coyote den which contained 6 pups. However, on 27 June the chick was observed ca 0.4 km westerly of the capture site. The family was in the same location on 6 July, but disappeared shortly afterward. Examination of the area showed a well-traveled coyote trail where the chick was last seen.

Chick 144 – Chick 144 was ca. 4 days old when captured on 14 June 1984. It was in the same general area on 15 June, but by 19 June had moved 0.25 km northwesterly across a large body of water and willow grove to a meadow which contained several uplands. The transmitter malfunctioned on 20 June, and on 22 June the adults were located near the capture site feeding in a meadow-basin wildrye (*Elymus cinereus*) ecotone. The chick had apparently been killed or died.

Chick 154 – This 4 day old chick was captured on 14 June 1984 among a dense stand of Baltic rush. The chick's remains were found floating in 30 cm of water on 17 June, 10 m from the capture site. The NWHL found nothing significant upon necropsy. The internal organs were rather decomposed, but there was no internal infection. There was no indication of pneumonia and the stomach had food remnants present.

Chick 164 – This chick was transmitter-equipped in the nest on 18 June 1984. Its sibling hatched on 19 June. Upon reexamination on 19 June, chick 164 was found dead ca. 1 m from a dry meadow. The NWHL reported that the chick had likely drowned. The chick was an unusually small female. Its stomach contained egg membrane and shell fragments. Its sibling was also dead at the nests edge and sent to NWHL for necropsy. Its stomach was empty, but this chick was much larger, weighing 125 g. The yolk sac had not been totally resorbed. The NWHL could find nothing significant, and cause of death could not be determined.

Chick 174 – Chick 174 hatched on 22 June 1984 from a nest on a flooded island. At the time of capture on 26 June the chick had swam 0.25 km to dry land. Signals were received until 6 July,but the transmitter malfunctioned afterward and the chick was never relocated. The chick did not survive and the adults had abandoned the area by 23 July.

Chick 184 – Chick 184 was instrumented 27 June 1984. The transmitter malfunctioned shortly after placement and the chick was never relocated. On 28 June, the adult pair was present and did per-

form minor distraction displays. However, by 29 June, the adults had left the area. A pair was consistently seen through 5 July ca. 0.4 km easterly of the capture site, but it was not determined if this was the pair with chick 184.

Table 1. Suspected fates of 21 greater sandhill crane chicks transmitter-equipped in 1983.

Chick No.	Date Equipped	Date Lost	Suspected Fate
13	24 May	26 May	Coyote
23	24 May	26 May	Coyote
33	24 May	10 June	Raccoon
43	26 May	17 June	Disease
53	27 May	28 May	Drowned
63	31 May	9 July	Lost Contact
73	31 May	27 June	Great Horned Owl
83	31 May	27 June	Great Horned Owl
93	1 June	3 June	Coyote
103	1 June	3 June	Coyote
113	1 June	3 June	Coyote
123	1 June	12 June	Coyote
133	2 June	16 June	Lost Contact
143	3 June	13 July	Coyote
153	7 June	27 June	Lost Contact
163	15 June	20 July	Coyote
173	23 June	23 June	Lost Contact
183	23 une	28 Sept.	Fledged
193	29 June	12 July	Coyote
203	5 Aug.	10 Aug.	Canine
213	9 Aug.	11 Oct.	Fledged

Table 2. Suspected fates of 18 greater sandhill crane chicks transmitter-equipped in 1984.

Chick No.	Date Equipped	Date Lost	Suspected Fate
14	14 May	28 May	Coyote
24	19 May	10 June	[1]Lost Contact
34	21 May	7 June	[1]Lost Contact
44	21 May	28 May	[2]Died
54	22 May	23 May	Lost Contact
64	23 May	30 May	[1]Lost Contact
74	23 May	26 May	Coyote
84	24 May	25 May	Coyote
94	26 May	28 May	[1]Lost Contact
104	27 May	12 June	[1]Lost Contact
114	31 May	9 June	[1]Coyote
124	13 June	15 June	[2]Died
134	14 June	6 July	[1]Lost Contact
144	14 June	22 June	[1]Lost Contact
154	14 June	17 June	[2]Died
164	18 June	19 June	Drowned
174	22 June	6 July	[1]Lost Contact
184	27 June	28 June	Lost Contact

[1] Transmitter malfunctioned, but chick was known not to have survived.

[2] Carcass shipped to NWHL, but cause of death could not be determined.