1992

BEHAVIOR OF SANDHILL CRANES HARNESSED WITH DIFFERENT SATELLITE TRANSMITTERS

Glenn H. Olsen
U.S. Fish and Wildlife Service

David H. Ellis
U.S. Fish and Wildlife Service

Steven E. Landfried

Linda M. Miller
U.S. Fish and Wildlife Service

Susan S. Klugman
U.S. Fish and Wildlife Service

See next page for additional authors

Authors
Glenn H. Olsen, David H. Ellis, Steven E. Landfried, Linda M. Miller, Susan S. Klugman, and Charles H. Vermillion

BEHAVIOR OF SANDHILL CRANES HARNESSED WITH DIFFERENT SATELLITE TRANSMITTERS

GLENN H. OLSEN, U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD 20708
DAVID H. ELLIS, U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD 20708
STEVEN E. LANDFRIED, The Big House, Route 1, Highway 59 East, Evansville, WI 53536
LINDA J. MILLER,[1] U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD 20708
SUSAN S. KLUGMAN, U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD 20708
MARK R. FULLER, U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD 20708
CHARLES H. VERMILLION, NASA Goddard Space Flight Center, Earth Science Directorate, Greenbelt, MD 20771

Abstract: The effectiveness of various attachment methods and designs of platform transmitting terminals (PTT's) was tested on captive sandhill cranes (*Grus canadensis*) at the Patuxent Wildlife Research Center, Laurel, Maryland, during 1989–91. Combinations of attachment and transmitter designs included neoprene cord harness with batteries separate from the transmitter (2 harness designs), Teflon ribbon harness with batteries incorporated into the transmitter package (4 transmitter models), and a package attached directly to the bird with epoxy glue only. Physical effects seen on cranes wearing PTT's ranged from skin lacerations (caused by rubbing of harness material) to no observed effects (other than feather wear). The most successful harness material and design utilized a Teflon ribbon harness with the 4 ribbon ends from the transmitter forming a neck loop and a body loop joined at the sternum. Time spent by sandhill cranes performing most activities did not change after transmitter attachment using this harness method.

Key Words: behavior, crane behavior, *Grus canadensis*, platform transmitting terminal, radio telemetry, sandhill crane, satellite transmitter, transmitter attachment

PROC. NORTH AM. CRANE WORKSHOP 6:50-56

Bird banding and color marking have been research techniques for almost 100 years. These techniques have produced a wealth of knowledge about migration patterns, population dynamics, and location of breeding and wintering grounds for some species. Unfortunately, these techniques are not always appropriate for gathering information on species that are rare, in remote areas, or not routinely harvested. One or more of these conditions exist for many crane species. As a result, knowledge of migration routes and number, location, and duration of use of staging areas and stopover sites is incomplete or not available.

During the past 30 years, radio-tracking has developed as a means of providing detailed information about the life histories of some bird species. However, radio-telemetry has several disadvantages. It is labor intensive and identifies only a few locations for a comparatively high cost of time. Tracking migrating cranes using conventional telemetry, even when supported with aircraft, has proven to be difficult and expensive. Additionally, this activity can affect the bird's behavior and influence its migration route. International boundaries and other restrictions also limit or prevent monitoring transmitter-equipped cranes. Because of these limitations, an alternate technique for monitoring cranes over long distances is needed.

Platform transmitting terminals (PTT's) are special radio transmitters that can be located via the Argos satellite system (Harris et al. 1990). Some PTT's are now small enough to be carried by large birds. Tests of PTT's have been conducted on bald eagles (*Haliaeetus leucocephalus*), trumpeter swans (*Cygnus buccinator*), tundra swans (*C. columbianus*), southern giant petrels (*Macronectes giganteus*) (Strikwerda et al. 1986), and wandering albatrosses (*Diomedia exulans*) (Jouventin and Weimerskirch 1990).

Previously, cranes were radio-tracked with commercial transmitters attached as backpacks or on leg bands (Nesbitt 1976, Melvin and Temple 1987). One of our authors (Landfried) recognized the opportunities presented by the technology and the need to develop harnessing techniques on captive cranes. Before PTT's are attached to wild birds, basic information is needed about crane behavior in response to various attachment methods and transmitter designs. The objectives of our study were to use captive cranes at the Patuxent Wildlife Research Center in Laurel, Maryland, to test the effectiveness of various harness materials and harness configurations, to assess physical effects of the harness on the birds, and to identify crane behavior in response to attached PTT's.

We thank P. Goriup of the Nature Conservancy, J. French of Mariner Radar, P. Howie of Microwave Radar,

[1]Present address: Hawaii Research Group, Hawaii National Park, HI 96718

Table 1. Summary of tests of satellite platform transmitting terminals (PTT's) at Patuxent Wildlife Research Center, Laurel, Maryland, 1989–91.

Phase	Dates	PTT manufacturer	Number of PTT's tested	Attachment/ harness technique
I	Feb–Apr 1989	Mariner Radar	2	Neoprene cord
II	May 1989–Mar 1990	Mariner Radar	6	Teflon ribbon, crimped ferrule
III	Mar 1990–Nov 1991	Mariner Radar	4	Teflon ribbon, ribbon stitched under ferrule
		Telonics	6	Teflon ribbon, ribbon stitched under ferrule
		Microwave Telemetry	6	Teflon ribbon, ribbon stitched under ferrule
		Nippon Telephone and Telegram	1	Teflon ribbon, ribbon stitched under ferrule
		Nippon Telephone and Telegram	1	Epoxy glue

B. Burger of Telonics, and H. Higuchi of the Wild Bird Society of Japan for obtaining the PTT's used in these evaluations. We acknowledge supplemental funding for the project by the National Aeronautics and Space Administration. We also thank the caretakers at the Patuxent Wildlife Research Center for assistance in restraining the cranes for the procedures, especially M. J. Brockman for help in our initial trials. We received helpful reviews from D. G. Jorde, J. M. Nicolich, and G. R. Gee. We thank G. W. Pendleton for statistical consultation and A. W. Welch for typing this manuscript.

METHODS

One- and 2-year-old Florida sandhill cranes (*Grus canadensis pratensis*) (n = 6) and 2-year-old greater sandhill cranes (*G. canadensis tabida*) (n = 9) reared from eggs hatched at the Patuxent Wildlife Research Center were maintained in large, outdoor, chain-link enclosures (15 × 52 m or 34 × 55 m) without artificial light throughout the study. The birds, unable to fly due to previously performed tenotomies, were housed in the same pen during behavior experiments. Water and a pelleted commercial crane diet were provided *ad libitum*, and caretakers made daily visits to check the animals and their food and water supply. Animal care and facilities were in accordance with the principles of the Animal Welfare Act (P.L. 91-579, 94-279), as applied to birds by the U.S. Fish and Wildlife Service.

Cranes were equipped with a variety of PTT designs and backpack attachments. The birds were examined at frequent intervals to monitor the physical condition of each bird and the PTT. Cranes were examined weekly during the first month of testing and bimonthly if testing exceeded 1 month. Examinations during testing and after PTT's were removed included weighing birds and recording body circumference to determine changes in physical condition. Each PTT and harness was inspected for wear, and the underlying feathers and skin were inspected for injury.

Phase I

During the first phase (Table 1), we tested PTT's (Type 15S) from Mariner Radar (Lowestaft Ltd., Suffolk Rd., Lowestaft, Suffolk, NR32 5 DN, England; use of manufacturer's name does not imply government endorsement) that were sealed in a metal case and had an external battery pack. All PTT's supplied for tests were dummy units (facsimile copies in size, shape and weight, but without electronic components). Two PTT's were harnessed to Florida sandhill cranes with black neoprene cord (7 mm diameter, RS component 399-849). The harness consisted of a continuous loop secured with 1 knot tied in the cord ends and a crimped copper ferrule over the sternum. We tried 1 attachment with the batteries and PTT in the same loop of harness (Fig. 1) and another with batteries in a separate neck harness (Fig. 2).

Phase II

We tested a Mariner Radar PTT redesigned with the battery in the same package as the other components, rather than in a separate harness and used a harness of different material. A strip of 5-mm-thick neoprene foam rubber pad was glued to the bottom of the PTT. The center of the strip was shaved thinner in an electric grinder with a stone wheel, thus forming a saddle to hold

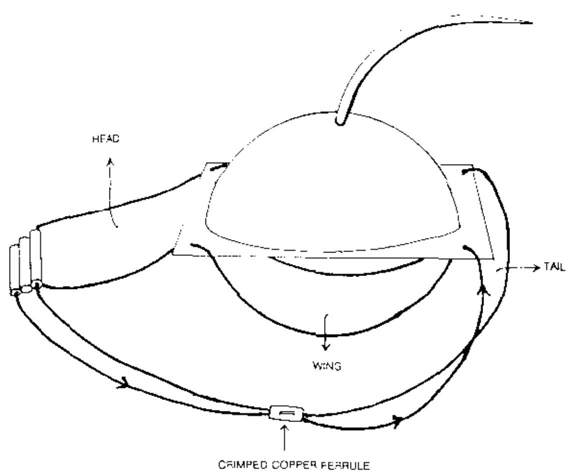

Fig. 1. Harness design for Mariner Radar PTT incorporating external battery package in the PTT harness.

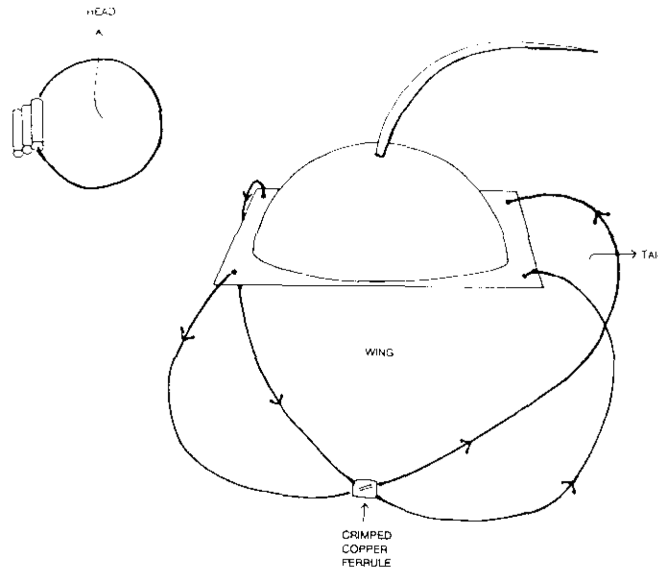

Fig. 2. Harness design for Mariner Radar PTT with a separate battery harness.

the PTT in place over the vertebral column and to relieve pressure on protruding spinous processes of vertebrae. Harnesses were 1.4-cm-wide Teflon ribbon (Bally Ribbon Mills, 23 N. 7th Street, Bally, PA 19503). This material and the attachment method were used with 2 other PTT models (see Phase III) that incorporated batteries and other components in 1 housing. Strands of ribbon from each anterior corner of the PTT were joined in front of the neck (neck loop), and strands from each posterior corner were placed behind the wings and joined below the abdomen. The lengths were adjusted to join on the sternum so that the PTT was centered on the midline of the back, between the wings (Snyder et al. 1989), and loose enough for a 15-mm rod to be inserted between the PTT and the back. The harness strands were fed through a brass or copper ferrule sternally, and each harness end was tied in an overhand knot. The combination of ferrule and knots secured the harness in place under the sternum. On some units, 2-0 nylon suture was stitched through the ribbons under the copper ferrule for more secure attachment (Fig. 3). Oil of cloves was applied to the edges of the neoprene pad and knots in the Teflon ribbon to discourage cranes from picking at these sites.

Phase III

We tested additional PTT's (either dummies provided by various manufacturers or our replicas of the manufacturer's dummies) to determine the long-term effects of the harnessing. Six Telonics PTT's (932 E. Impala Ave., Mesa, AZ 85204-6699), 4 Mariner Radar PTT's, 6 Microwave Telemetry, Inc., PTT's (6214 Satanwood Road, Columbia, MD 21044), and 2 Nippon Telephone and Telegram (NTT) PTT's (Toyocom Equipment Co. Ltd., 20-4 Nishi-Shimbashi 3-Chrome, Minato-ku, Tokyo, 105 Japan) were harnessed to Florida and greater sandhill cranes by using the materials and techniques described in Phase II, the only exception being the NTT units. All transmitters were dummies (non-operational) except 1 Telonics PTT and 1 Microwave Telemetry PTT that were fully operational. One NTT unit was attached to the feathers along the back with epoxy glue rather than attached with a harness. Because the NTT units had no attachment sites for a harness, we constructed a holder for the PTT from Teflon ribbon (Fig. 4). Otherwise, the harness configuration for the second NTT unit was the same as for the other PTT's. Longevity of PTT attachment on the cranes was tested for a maximum of 1 year (considered a reasonable PTT functional life) before removal.

Behavioral Observations

From 17 May to 6 June 1989, behavioral responses of Florida sandhill cranes, 3 with and 3 without (controls) redesigned dummy Mariner Radar PTT's and the teflon ribbon harnesses, were recorded. From 12 February to 23 March 1990, 3 Florida sandhill cranes were observed for 2 weeks prior to harnessing and for 4 weeks after having been harnessed with dummy Mariner Radar PTT's.

After attachment, cranes were allowed 48 hours to

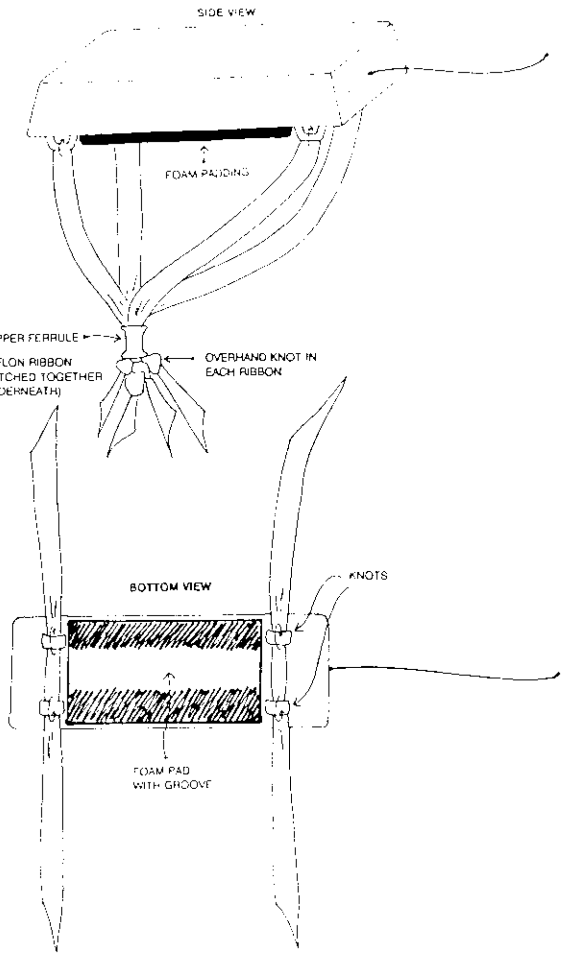

Fig. 3. Teflon ribbon, securing knots, and nylon sutures under copper ferrule to harness PTT's to cranes.

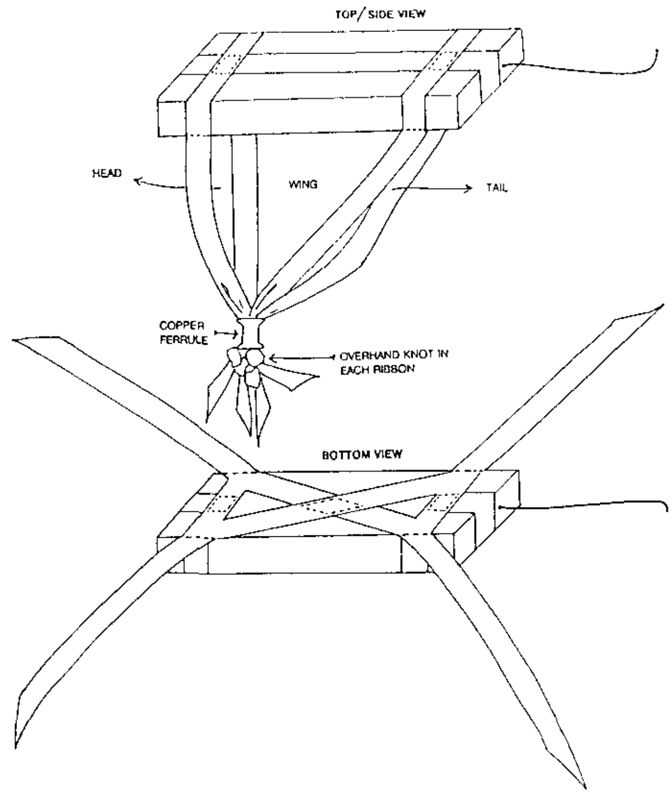

Fig. 4. Harness design with teflon ribbon to mount NTT PTT's.

adjust to the PTT before observations were recorded. The 48-hour period served to avoid or lessen bias from handling the birds and attaching the PTT's. Crane behavior was recorded with a lap-top computer (Toshiba Model T1100 plus) and software for behavioral scanning (Hensler et al. 1986). Time budget data were obtained with scan sampling (Altmann 1974) to record 12 activities (Table 2) during 2- to 4-week periods. Observation periods were 25–75 minutes each depending on the number of birds being monitored. Data were not gathered during precipitation or during obvious human disturbance (e.g., caretakers entering pen, low-flying aircraft).

For analysis, only behavioral activities that occurred with a mean frequency of >2 performances per observation period were used. Totals for less frequent activities were categorized as "other" to obtain useful statistical results. We used analysis of variance to compare time periods before and after PTT attachment. Analyses were conducted with Student's *t*-test (Steel and Torrie 1960). We compared 2-tailed values (rejection zone $P = 0.05$), expecting some behavior categories to differ before or after application of PTT's.

RESULTS AND DISCUSSION

Phase I

The initial Mariner PTT and harness designs caused skin irritation in the caudal area over the *latissimus dorsi* muscle. The irritation seemed to be caused by rubbing or chafing by the black neoprene harness material. The mount with separate harnesses for PTT and batteries (Fig. 2) caused a 2- × 10-mm skin laceration on the sternum where 1 of the neoprene cords was positioned. Both injuries were observed 4 weeks after the harnesses were attached. Furthermore, the separate battery harness bounced against the bird's lower neck when it ran or flapped its wings. To a lesser degree, bouncing of the

Table 2. Crane behavior categories used in evaluating the effects of platform transmitting terminals (PTT's), Patuxent Wildlife Research Center, Laurel, Maryland, May 1989 – March 1990.

Activity (abbreviation)	Included behavior[a]
Feed (F)	Eating food pellets from or below feed hopper
Drink (D)	Drinking or "playing" in water cup
Probe (P)	Probing or otherwise feeding away from feed hopper
Loaf (L)	Standing, sleeping, 1-leg stand, sitting
Recline (R)	Lying (sternum resting on substrate)
Walk (W)	Walking
Alert (A)	Head elevated, watching
Cower (C)	Head lowered, neck bowed, neck feathers erect
Groom back (B)	Grooming PTT area
Groom side (S)	Grooming harness area
Groom other (G)	Preening or grooming not near harness or transmitter areas
Other (O)	All other activities
Not Observed (N)	Crane not seen by observer (hidden by feed shed, vegetation, etc.)

[a] Behavior categories based on designations by Klugman and Fuller (1990).

battery pack was also noted for the combined harness design (Fig. 1).

Phase II

We observed 3 Florida sandhill cranes with PTT's for 16 days in May and June 1989. Simultaneously, we observed 3 pen mates who were unharnessed (controls). Grooming activity was seen only 16.6% of the time in the harnessed cranes as compared to 26.6% of the time for control cranes (Table 3). Other observed activities (probing, loafing, acting alert, and feeding) were seen more frequently in the cranes with PTT's. However, we found large differences among cranes within each group. These differences and the relatively small number of observations precluded statistical analysis. Because of differences among cranes encountered in this trial, we decided to use each bird as its own control and compare observations of cranes before and after harnessing in subsequent trials.

During February and March 1990, we observed 3 Florida sandhill cranes 2 weeks prior to Mariner PTT attachment and 4 weeks after attachment. Only walking behavior was found to vary significantly at the $\alpha = 0.05$ level, with cranes walking more after PTT attachment (Table 4). However, the test used cannot detect small differences. Even at the $\alpha = 0.10$ level, only the categories "grooming back" and "not observed" differ between before and after harnessing time periods. Of these 2 categories, only grooming over the back was of special concern. Remarkably, the frequency of this behavior declined from 3.4% before PTT attachment to 1.1% after attachment. In neither trial (May–June 1989 and February–March 1990), did we find any injuries to the cranes other than worn and occasional broken feathers caused by the Teflon ribbon harness material or the redesigned Mariner PTT.

Phase III

The NTT unit that was attached with epoxy glue detached after only 5 days, pulling out all the feathers to which it was glued. This method of attachment reportedly met with good preliminary results on captive cranes in Japan (H. Higuchi, pers. commun.). We found it unsuitable for cranes, and further testing of this method was not pursued.

Premature loss of 2 Microwave Telemetry PTT's at days 52 and 57 was due to a sharp edge on the PTT that cut the harness material. The manufacturer modified the package to eliminate the sharp edges.

Three other PTT's (1 each from Telonics, Mariner Radar, and Microwave Telemetry) were lost in <70 days. With these 3 PTT's there was no stitch or suture under the copper ferrule. The retention of the harness was totally dependent on the 4 knots in the sternal ends of the Teflon ribbons. We found that without the suture in the Teflon ribbon under the ferrule, if 1 knot opened a crane could pull the ribbon out of the ferrule.

Of the 5 remaining Telonics PTT's tested for harness longevity, all remained on sandhill cranes for 365 days. The range for the remaining 3 Mariner Radar PTT's tested was 158–365 days ($\bar{x}$ = 255 days). The range for the 3 Microwave Telemetry PTT's tested was 284–365 days ($\bar{x}$ = 338 days). The 1 NTT PTT tested with a harness remained on the crane 284 days before being removed. The method of attachment as ultimately developed appears to be adequate given the expected battery life for some PTT's of only 90 days (others are programmable to last 6+ months). All PTT's caused some broken feathers and many worn feathers directly under the PTT. However, worn and broken feathers were replaced by normal feathers usually within 6 months after loss or removal of the PTT.

Table 3. Behavior (time budgets) of Florida sandhill cranes without (control) and with Mariner Radar platform transmitting terminals and Teflon ribbon harnesses, May – June 1989, Patuxent Wildlife Research Center, Laurel, Maryland.

Crane no.	Date harnessed	Monitoring dates	Behavior categories (%)[a] G	P	W	L	A	F	N	O	No. of observations
1	17 May 89	22 May – 6 Jun	21.2	11.1	10.0	41.7	8.1	1.3	5.5	1.1	458
2	17 May 89	22 May – 6 Jun	12.0	15.9	8.3	33.0	7.6	4.6	17.7	1.1	458
3	22 May 89	25 May – 6 Jun	16.5	6.7	18.5	31.7	11.8	0	10.4	4.5	357
Harnessed Cranes (n = 3)		22 May – 6 Jun	16.6	11.6	11.8	35.7	9.0	2.1	11.2	2.0	1,273
Control Cranes (n = 3)		22 May – 6 Jun	26.1	7.0	11.3	30.0	3.1	0.4	17.6	3.4	612

[a] Percent of time behaviors were observed: G = all grooming activities, P = probe, W = walk, L = loaf, A = alert, F = feed, N = not observed, O = other.

CONCLUSIONS AND RECOMMENDATIONS

Our trials with captive sandhill cranes suggest that relatively heavy (e.g., 50 – 165 g) transmitters, such as those available for radio-tracking via satellite, can be attached to cranes in a backpack configuration. We padded the bottom of the transmitter with a centrally grooved piece of neoprene foam rubber to cushion and stabilize the PTT over the bird's back. Feather wear occurred under the pad and under the Teflon ribbon, but no skin irritation was observed. Most activities were not significantly different before or after attachment of the PTT's. Remarkably, preening of the PTT or harness areas was observed less often in harnessed cranes than in controls. Also, grooming of the side and back occurred less frequently after attachment than before attachment of the PTT in cranes where these behaviors were observed pre- and post-harnessing.

We recommend that the batteries and other components be included in 1 housing and that Teflon ribbon (1.4 cm wide) be used as the harness material. Rubber cord

Table 4. Behavior (time budgets) of Florida sandhill cranes without (control) and with Mariner Radar platform transmitting terminals and Teflon ribbon harnesses, February – March 1990, Patuxent Wildlife Research Center, Laurel, Maryland.

Crane	Period	Behavior categories (%)[a] A	B	D	F	G	L	N	O	P	S	W	No. of observations
Yellow	Without PTT	23.6	4.6	2.2	4.4	3.9	1.5	2.0	0.8	35.4	0.8	20.6	457
	With PTT	16.3	1.3	0.3	6.0	12.3	3.3	1.0	0	32.9	1.7	24.9	301
Green	Without PTT	22.3	4.2	2.2	3.5	3.5	0.4	2.6	1.1	36.5	1.3	22.3	457
	With PTT	17.3	1.3	0.7	2.7	7.6	6.0	1.0	0.3	35.5	0	27.6	301
Silver	Without PTT	30.4	1.3	0.4	2.0	4.2	2.6	5.7	0.7	32.6	2.4	17.7	457
	With PTT	13.0	0.7	1.0	0.7	4.0	5.7	2.3	0.3	49.8	0	22.6	301
All Cranes	Without PTT	25.5	3.4	1.6	3.3	3.9	1.5	3.4	0.9	34.9	1.5	20.2	1,371
	With PTT	15.5	1.1	0.7	3.1	8.0	5.0	1.4	0.2	39.4	0.6	25.0	903
P-Value[b]		0.101	0.077	0.588	0.591	0.236	0.171	0.078	0.130	0.283	0.262	0.032	

[a] Percent of time behaviors were observed: A = alert, B = grooming PTT area, D = drink, F = feed, G = groom areas other than in B or S, L = loaf, N = not observed, O = other, P = probe, S = groom harness area on side, W = walk.

[b] P-value comparison for all cranes without PTT's versus with PTT's.

should be avoided because it causes chafing of the skin. The Teflon ribbon ends should be stitched together where they meet on the sternum. On captive, non-flighted birds, the Teflon ribbon with copper or brass ferrule attachment method was secure. For wild, fully-flighted birds, we suggest crimping the ferrule to lie flat over the Teflon ribbon to hold the attachment and avoid interference with long-range migration or reproduction.

LITERATURE CITED

ALTMANN, J. 1974. Observational study of behavior: sampling methods. Behavior 49:227-265.

HARRIS, R. B., S. G. FANCY, D. C. DOUGLAS, G. W. GARNER, S. C. AMSTRUP, T. R. MCCABE, and L. F. PANK. 1990. Tracking wildlife by satellite: current systems and performance. U.S. Fish Wildl. Serv. Tech. Rep. 30. 52pp.

HENSLER, G. L., S. S. KLUGMAN, and M. R. FULLER. 1986. Portable micro-computers for field collection of animal behavior data. Wildl. Soc. Bull. 14:189-192.

JOUVENTIN, P., and H. WEIMERSKIRCH. 1990. Satellite tracking of wandering albatrosses. Nature 34:746-748.

KLUGMAN, S. S., and M. R. FULLER. 1990. Effects of implanted transmitters on captive Florida sandhill cranes. Wildl. Soc. Bull. 18:394-399.

MELVIN, S. M., and S. A. TEMPLE. 1987. Radio telemetry techniques for international crane studies. Pages 481-492 *in* G. W. Archibald and R. F. Pasquier, eds. Proc. 1983 int. crane workshop. Int. Crane Found., Baraboo, Wis.

NESBITT, S. A. 1976. Use of radio telemetry techniques on Florida sandhill cranes. Pages 299-303 *in* J. C. Lewis, ed. Proc 1975 int. crane workshop. Oklahoma State Univ. Publ. Printing, Stillwater.

SNYDER, N. F., S. R. BEISSINGER, and M. R. FULLER. 1989. Solar radio-transmitters on snail kites in Florida. J. Field Ornithol. 60:171-177.

STEEL, R. G. D., and J. H. TORRIE. 1960. Principles and procedures of statistics. McGraw-Hill Book Co., Inc., New York, N.Y. 481pp.

STRIKWERDA, T. E., M. R. FULLER, W. S. SEEGAR, P. W. HOWEY, AND H. D. BLACK. 1986. Bird-borne satellite transmitter and location program. Johns Hopkins APL Tech. Digest 7:203-208.