J. Field Ornithol., 60(2):171–177

SOLAR RADIO-TRANSMITTERS ON SNAIL KITES IN FLORIDA

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Abstract.—The effectiveness and safety of one- and two-stage solar radio-transmitters in tracking the movements and survival of adult and fledgling Snail Kites (*Rostrhamus sociabilis*) were evaluated between 1979 and 1983 in southern Florida. Transmitters were attached to birds with back-pack arrangements using teflon ribbon straps. Accessory plastic shields minimized feather coverage of the solar cells. Intact transmitters were seen on birds up to 47 mo after installation. Operating lives ranged from 8 to 21 mo for one-stage, and 10 to 14 mo for two-stage transmitters. Because survival of adult and nestling radio-marked kites was high, we conclude that our transmitter-attachment method had little effect on the birds.

EFECTO DE RADIO TRANSMISORES SOLARES EN *ROSTRHAMUS SOCIABILIS*

Resumen.—Desde el 1979–1983 se evaluó la efectividad y seguridad del uso de radio transmisores solares en adultos y juveniles de una población de *Rostrhamus sociabilis* al sur de Florida. Los transmisores se le colocaron en la parte dorsal de las aves (arreglo mochila) utilizándose cintas de teflón. Una cubierta de plástico se utilizó para evitar que las plumas cubrieran las celdas solares. La durabilidad operacional resultó ser de 8–21 meses para transmisores de una epata y de 10–14 para aquellos de dos. Transmisores intactos fueron observados en aves 47 meses despues de haber sido colocados. Dado el caso de que la supervivencia de adultos y juveniles con transmisores fue alta, se concluye que los aparatos y el método de colocarlos tienen muy poco efecto adverso en estas aves.

Solar-powered transmitters are often useful for studies of species, such as the Snail Kite (*Rostrhamus sociabilis*), that occupy open, well-lighted habitats. Solar-powered transmitters can provide more energy than battery-powered (e.g., mercury or lithium cell) transmitters of similar weight and size. Thus, solar-power is especially desirable for long-term, long-distance tracking studies in which transmitter weight is an important factor (Aucouturier et al. 1977, Church 1980, Patton et al. 1973).

The use of solar transmitters, however, often necessitates special at-

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tachment methods, because solar cells must remain fully exposed to sunlight to function efficiently (Herman 1981, Melvin et al. 1983, Strikwerda et al. 1986). For many avian species, conventional body-harness and tail-mount attachments result in the solar cells being covered by feathers. The attachment method used in this study of Snail Kites was a back-pack arrangement developed specifically to counter this problem. In this report we detail the attachment method, the performance of the transmitters, and their effects on the birds.

METHODS

Transmitter specifications and harness design.—Solar-powered transmitters in the 164 mHz range were obtained from Wildlife Materials Inc. (Carbondale, Illinois 62901; use of trade names does not imply endorsement by the U.S. Government). We used 19 one-stage transmitters (model SPB-150-3X) with rechargeable Nicad batteries: outside dimensions of 4 × 1.7 × 1.5 cm; 12–13 g; four 1 × 1 cm solar cells in series; 2.0 volt battery with 50 milli-amp-hour capacity; a recharge rate of ½ per 8 h; 25–35 ms pulse width; 80–100 pulses per min; -27 to -22 dBm power output; and 28 cm whip antenna. Also, we used 4 two-stage, capacitor-assisted solar transmitters (model SPCB-1250 3X): outside dimensions of 4.5 × 2.3 × 1.1 cm; 14–16 g; eight 1 × 1 cm solar cells in series; 4 volts; 10–15 ms pulse width; 200–300 pulses per min; −9 to −6 dBm output; and 28 cm whip antenna.

Each transmitter was fitted with two 23 × 0.64 cm braided teflon ribbons (Bally Ribbon Mills, Bally, Pennsylvania 19503). Teflon was chosen for durability and flexibility with minimal elasticity. One teflon ribbon was passed through an attachment tube at each end of the transmitter. Once the mid-points of the ribbons were centered in the tubes, the two ribbons were glued (5-min epoxy) in place, yielding 4 straps, each approximately 11 cm long.

A flat plastic plate 3 × 4 cm with rounded corners was cut from a gallon milk container to serve as a feather shield. The shield was covered on both sides with rip-stop nylon tape (with a flexible fringe of the tape about 0.3 cm wide surrounding the rigid plastic on all edges to reduce abrasion) and was stitched with nylon thread or 12 lb monofilament fishing line to the teflon straps from the anterior end of the transmitters. Five-min epoxy was spread over the ribbon and stitching where the shield was attached. Exact angles and positions of the strap attachments to the shield were determined by experimenting with captive Snail Kites. When positioned on top of the feathers just anterior to the transmitter, this shield prevented contour feathers from covering the solar cells (Fig. 1). The straps and shield weighed 3–5 g and the full transmitter-harness package weighed 14–21 g, about 4–5% of the 375–400 g body mass of the kites.

Installation.—We loosely bound the bird's feet together with rubber bands to partially immobilize them. The transmitter was placed mid-dorsally on the bird so that the anterior end was between the proximal ends of the humeri. A front strap ws extended over each scapula and

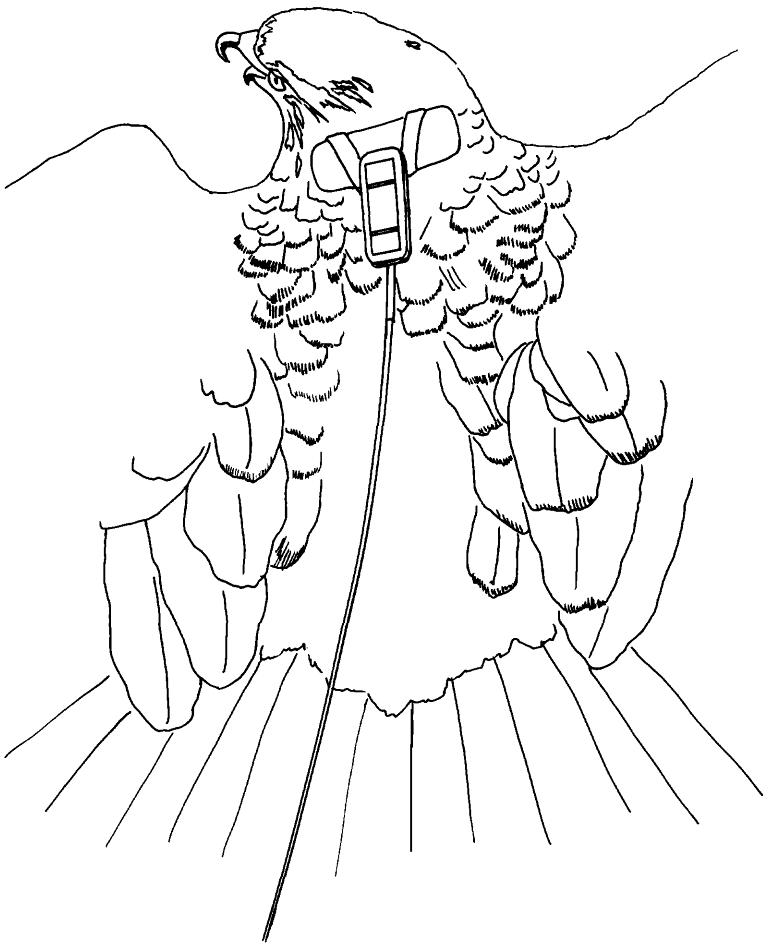

FIGURE 1. Solar-powered transmitter and feather shield in place on back of nestling Snail Kite.

forward around the neck, following the contour of the furcula to the sternum. The two front straps were then crossed about ⅓ of the way posterior along the sternum, forming a neck loop. The neck loop was positioned so that the straps did not constrict the neck and crop, yet were not so loose that they impinged laterally on the leading edges of the wings at their junction with the body. The straps from the posterior end of the transmitter were extended behind the junction of the trailing edges of the wings with the body, then down the sides in front of the thighs to the area about ⅓ of the way from the posterior end of the sternum. Next the neck and body loop junctions were held together, the straps kept flat and untwisted, while the common junction was worked under the body feathers. It was important to ensure that straps did not loop over large feathers in the axillar areas or over flexed legs. Transmitters often shifted during handling, and had to be repositioned before final attachment. We extended the wings and legs and allowed wing-flapping to ensure the harness was not impeding movements. On adults the straps were tightened to the extent that a 5–7 mm diameter rod (e.g., a pencil) slid easily between the body and the loops of the transmitter. A slightly looser fit was needed for nestlings to allow for continued muscular development.

With the transmitter and harness adjusted, we stitched nylon fishing line once or twice through the junction of the neck loop, and separately through the body loop. Next the two loops were sewn together using several independent stitches and knots. A curved surgical suturing needle facilitated stitching close to the bird's body. Excess teflon ribbon was trimmed off close to the junction. A handkerchief was slipped under the junction to prevent fouling of feathers, and a coat of 5-min epoxy was applied to the ends of the straps over the knots. The entire harness-installation required about 20–30 min/bird. All radio-marked birds were also banded with U.S. Fish and Wildlife Service aluminum bands and individually-numbered PVC bands.

Field procedures.—Between April 1979 and June 1981 we marked 23 wild Snail Kites with solar-powered radio transmitters to obtain information on nestling survival and dispersal, and on seasonal movements of adults to and from Lake Okeechobee, Florida. Telemetered kites were tracked during April–December 1979, January–July and December 1981, January–August 1982, and March–June 1983. In 1980, we tracked kites in February, July, and August, and telemetry locations were reported from March–June by Rod Chandler and Paul W. Sykes, Jr.

All Snail Kites were radio-marked on Lake Okeechobee (Glades, Hendry, Okeechobee, and Palm Beach counties). We placed 13 one-stage transmitters on nestling kites from April–July 1979, and two in August 1980. In May and June 1981 we put four one-stage and four two-stage transmitters on adult kites. Adults were captured with noose carpets placed on perches used habitually for extracting snails.

Radio-marked birds were located from an airboat in all years, and by airplane in 1979 (n = 1), 1980 (n = 2), 1981 (n = 3), and 1982 (n = 6). In addition to Lake Okeechobee, we searched Conservation Areas 3A and 3B (Dade and Broward counties) from 1979 to 1983, Conservation Area 2B (Broward County) in 1979 and 1981, and lakes Kissimmee and Tohopekaliga (Osceola County) from 1981 to 1983. For a detailed description of the areas used by kites during the study period, see Beissinger and Takekawa (1983), Sykes (1983), Beissinger (1986), and Beissinger and Snyder (1987).

Kites were tracked using a TRX-24 receiver (Wildlife Materials, No. B1h). Folding three-element yagi antennas (Wildlife Materials, No. C7e) were used while tracking from an airboat. Rigid three-element yagi antennas (Wildlife Materials, No. C7d) mounted in tandem with a rightleft switchbox (AVM Instrument Co., Dublin, California 94566) were used while tracking from airplanes.

RESULTS AND DISCUSSION

Initial trials with captive Snail Kites fitted with solar transmitters without feather shields revealed that when birds were perched, feathers of the mantle and scapular areas prevented sufficient light from reaching the solar cells to allow the transmitters to function. However, the shield attachments kept feathers from covering the solar cells, allowing the transmitters to function at full capacity. Other studies have shown that recharging of Nicad batteries can occur from partly-covered solar cells that are wired in series, but that charging efficiency is reduced (Church 1980, Silvy et al. 1979).

In the field all but three kites were monitored from 8 to 16 mo after radio-marking. In all cases, the shield, harness, and transmitters remained in proper orientation, and no indications of detrimental feather wear were visible. Kites were observed carrying transmitters up to 47 mo after installation, indicating that the harness attachment can be used for long-term studies. If desired, a "weak link" could be inserted in the harness to allow the transmitter assembly to detach from the bird at a relatively early date (Karl and Clout 1987).

All solar-powered transmitters functioned reliably for a minimum of 8 mo, with the exception of transmitters placed on two 1980 nestlings, which we suspect did not fledge successfully, and one placed on an adult, which may have dispersed or perished during the 1981 drought. Of the one-stage transmitters on kite nestlings in 1979, 12 were functioning well after 1 yr and another worked intermittently. At least seven were still working at 16 mo, but most birds were not relocated after this time. However, three were resighted in 1981 (21 mo after installation) when two had transmitters that were intermittent and weak; the third bird's transmitter had failed. Three birds from this group were resighted carrying nonfunctional transmitters 34, 45, and 47 mo after installation.

Seven of the eight adults radio-marked in 1981 were relocated in 1982. Three of the one-stage transmitters had minimum lifetimes of 8–13 mo. One of these transmitters became very weak at about 1 yr, and apparently the batteries no longer held a charge because the transmitter functioned only when the sun was shining. For the four birds carrying two-stage transmitters, the minimum transmitter life was 10–14 mo. One of these kites carried an intermittent transmitter at 1 yr and it failed at 14 mo.

We could not verify that any of our transmitters met the life expectancy of 2 yr anticipated by the manufacturer. Silvy et al. (1979), using transmitters of the same manufacturer and model and similar transmitters from another manufacturer, met life expectancy on all units and exceeded life expectancy with 70% of their transmitters. Their Nicad-powered units continued to transmit in light more than 4 yr after attachment. A gradual increase in Nicad battery resistance to the point of no-recharging is expected, but solar Nicad transmitters should continue to transmit in light until another component fails (Patton et al. 1973). Many of our units might have functioned 4–5 mo longer than our minimum recorded periods, but our field season did not allow us to determine this. However, we suspect that the heat and high humidity of the freshwater marsh habitats of southern Florida might have been the major factor contributing to relatively early transmitter failure. Whenever we observed kites with nonfunctioning transmitters, the transmitters appeared intact, with antennas in place, but we were unable to recover any transmitters to determine the exact causes of failure.

We usually received strong radio signals from the solar-powered transmitters. From an airboat, we detected the one-stage transmitters on perched birds from 0.8–1.6 km, and on flying birds from 1.6–3.2 km. We detected two-stage transmitters at distances of 1.6–2.2 km and 3.2–4.8 km from perched and flying birds, respectively. When we monitored solar-powered transmitters from aircraft, the range of the one-stage model was 8.0–11.2 km and the range of the two-stage model was 11.2–24 km. These ranges are similar at the lower limit and exceed the upper limit of ranges recorded for the same transmitters by Silvy et al. (1979) for upland birds.

The captive Snail Kites used for developing the harness attachment did not exhibit any behavioral abnormalities or physical effects from the transmitter-harness packages. Likewise, no behavioral effects were observed in wild kites that were radio-marked. Adults adjusted to flight with the backpack immediately. A female fitted with a one-stage unit was observed copulating in the normal manner and successfully raised young. At least two other radio-marked kites (one male, one sex unknown) also successfully raised broods.

Survival of radio-marked birds was excellent. Thirteen of 15 nestlings radio-marked in 1979 and 1980 survived more than a year beyond fledging. At least 7 of 8 adults radio-marked in 1981 survived to 1982, despite a severe drought that caused a major population decline (Beissinger 1984, Beissinger and Takekawa 1983). Our occasional sightings of birds with nonfunctioning transmitters 3–4 yr after radio-marking suggested that long-term survival of radio-marked birds might also have been reasonably good. These survival data gave no evidence that the transmitters were having detrimental effects on the birds.

ACKNOWLEDGMENTS

We thank Helen Snyder for assistance in all phases of this work. Bonnie Hink, Don Hampton, and Frank Belk assissted with aerial tracking, while Owen Ballow, Rod Chandler, Gary Falxa, Carolyn Glynn, David Jickling, Margaret Lansing, Margaret Reeves, Margaret Stein, and Paul Sykes assisted with surface studies. Daniel McAuley and Paul Sykes provided many useful suggestions for the manuscript. Financial support was provided by the U.S. Fish and Wildlife Service, National Wildlife Federation, National Audubon Society, Chapman Memorial Fund, and the University of Michigan. Beissinger was supported by a National Science Foundation Postdoctoral Fellowship and the National Zoological Park, and Fuller received support from W. S. Seegar and F. P. Ward during preparation of this paper.

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Received 28 Jan. 1988; accepted 24 Sep. 1988.