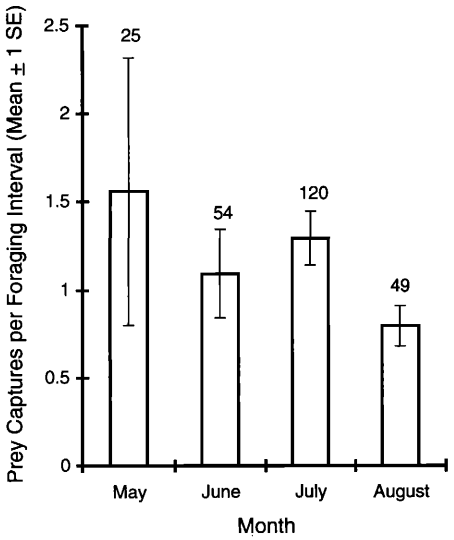

Figure 1. Monthly differences in the mean number of prey items captured by Mississippi Kites (*Ictinia mississippiensis*) during 2-min foraging intervals.

como las causas de este aumento, existen pocos estudios que puedan cuantificar esto. Las observaciones sobre el forrajeo de *Ictinia mississippiensis* en ambientes abiertos en Louisiana sugieren que esta especie es muy eficiente en su forrajeo en este habitat. *Ictinia mississipiensis* captura un promedio de 1.18 presas por cada 2 minutos de intervalo de forrajeo. Esta es una tasa exitosa mucho mayor que las anteriores en ambientes abiertos. Se hace necesaria la comparación de datos de forrajeo colectados en distintos habitats y localidades.

[Traducción de César Márquez]

ACKNOWLEDGMENTS

I am indebted to Dr. John C. Ogden and two anonymous reviewers for their comments and suggestions on an earlier draft of this manuscript and to the Louisiana Department of Wildlife and Fisheries for their assistance

LITERATURE CITED

CELY, J.E. 1987. American Swallow-tailed Kite uses Mississippi Kite nest. *J. Raptor Res.* 21:124.

GLINSKI, R.L. AND R.D. OHMART. 1983. Breeding ecology of the Mississippi Kite in Arizona. *Condor* 85:200–207.

JACKSON, A.S. 1945. Mississippi Kite. *Texas Game and Fish* 3:6–7.

LEVY, S.H. 1971. The Mississippi Kite in Arizona. *Condor* 73:476.

PARKER, J.W. 1977. Second record of the Mississippi Kite in Guatemala. *Auk* 94:168–169.

——— AND J.W. OGDEN. 1977. The recent history and status of the Mississippi Kite. *Am. Birds* 33:119–129.

SKINNER, R.W. 1962. Feeding habits of the Mississippi Kite. *Auk* 79:273–274.

SUTTON, G.M. 1939. The Mississippi Kite in spring. *Condor* 41:41–53.

WAYNE, A.T. 1906. A contribution to the ornithology of South Carolina, chiefly the coast region. *Auk* 23:56–68.

Received 12 October 1997; accepted 14 May 1998

J. Raptor Res. 32(3):247–250

EVALUATION OF NECK-MOUNTED RADIO TRANSMITTERS FOR USE WITH JUVENILE OSPREYS

LAUREN N. GILSON[1]

Raptor Research Center, Department of Biology, Boise State University, 1910 University Drive, Boise, ID 83725 U.S.A.

KEY WORDS: *Osprey*; Pandion haliaetus; *transmitters*; *necklace*; *retention.*

Transmitters on necklaces, originally used on game birds, resulted from a modification of neck-mounted markers developed in 1970 in response to selective predation on individuals with back-mounted markers (Pyrah 1970, Amstrup 1980). For larger birds, neck-mounted transmitters are used infrequently; backpack-style harnesses are preferred for their tenacity and durability in long-term research (Day et al. 1980, Marion and Shamis 1977, Young and Kochert 1987). For short-term research using short-lived radio transmitters, mounting methods must be highly reliable for the length of the study but need not be permanent. In a study of fledgling behavior, I mounted radio transmitters around the necks of Os-

[1] Present Address: P.O. Box 179 Wakkerstroom, 2480 South Africa.

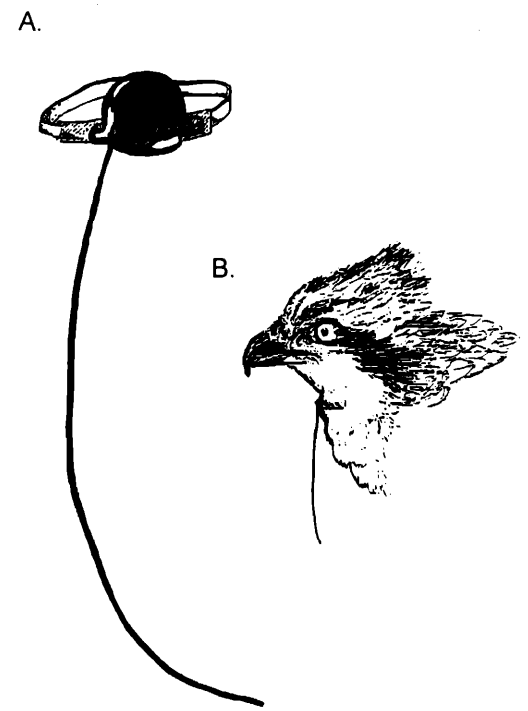

Figure 1. Rubber band style transmitter mount. A) Front view. B) As worn by fledglings.

preys *(Pandion haliaetus)* using standard rubber bands which have been used with Ospreys (C.P. Schaadt pers. comm.) as well as with raptors manned for falconry, and crimped nylon-wound elastic mounts designed and tested in this study. I describe and review the merits and drawbacks of each.

METHODS

In June–August 1993, I attached eight modified necklace-style transmitters (ATS Model 2032: 5.6–5.9 g, 90 d battery life) to nestling Ospreys of age 35–45 d at Cascade Reservoir, Valley County, ID. I stitched the radio to a 3 × 4 cm patch of 100% nylon pack cloth rolled into a sleeve and sewn around a size 34 rubber band (0.4 cm width, 12.5–13 cm unstretched circumference; herein referred to as RB, Fig. 1). In July–August 1994, I attached 16 pendant-style transmitters (Merlin Systems: 7.4–7.7 g, 90 d battery life) to Osprey nestlings at Cascade Reservoir. I hung the unit around an Osprey's neck on an adjustable loop of nylon-wrapped elastic (Stretchrite Round Cord Elastic, Rhode Island Textile Company; herein referred to as NWE, Fig. 2). The necklace consisted of two elastic segments with looped ends rejoined by cotton thread, fed through a 1.5 cm segment of metal tubing (Archer Butt Connector, No. 64-3036) and crimped to size.

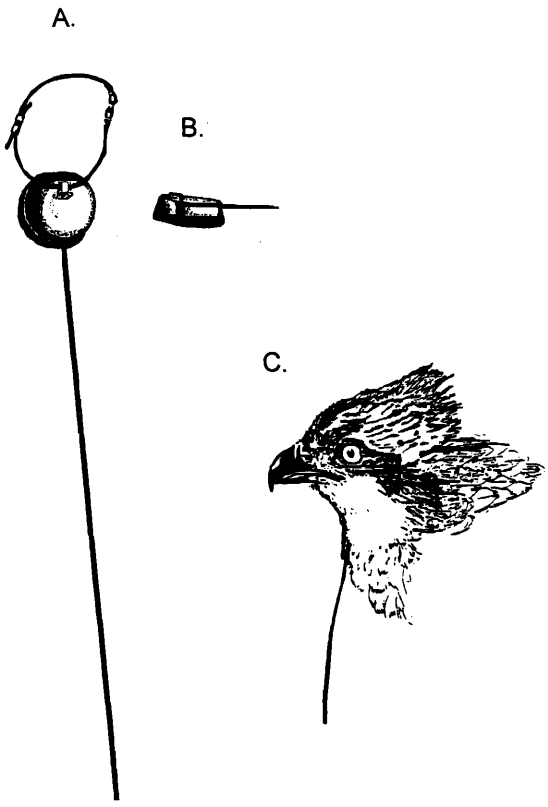

Figure 2. Nylon-wound elastic style transmitter mount. A) Rear view. B) Side view. C) As worn by fledglings (mounting bracket and antenna toward the Osprey's breast).

RESULTS

Ospreys shed or removed seven of nine RB mounts in 1993. I recovered five of these. On two units, the rubber bands were broken and the three others were intact. All recovered transmitters remained firmly attached to the pack cloth.

RB mounts were lost at an average of 35 d (range 21–44 d) after application. In 115 hr of observations, I saw only one juvenile Osprey pull at its transmitter. Its sibling also preened around the necklace, both on the second day after application. Transmitter positions occasionally shifted, indicating that the unit moved freely about the Osprey's neck.

Ospreys shed or removed eight of 16 NWE mounts in 1994. The elastic pulled out of the crimping on one unit, two separated at the break-away loops, the elastic was not recovered with four units, and the eighth unit was not recovered. NWE mounts failed at an average of 26 d (range 18–37 d). In 504 hr of observation, I observed no Osprey young pulling at their own or their nest mates'

transmitters. All shed or removed transmitters were lost 18–44 d after application. The two mounting styles differed significantly in mean length of retention (Wilcoxon Rank Sum Test, S = 73.5, Z = 1.97, $P = 0.04$; NWE $\bar{x}$ = 25.7 d, RB $\bar{x}$ = 34.8 d) but not in variance in retention ($F_{6,7} = 1.63$, $P = 0.53$; NWE s = 2.18, RB s = 2.98). The locations of transmitter losses were not random: 13 of 15 were recovered at or below nest or perch sites ($\chi^2 = 6.2$, $P = 0.016$).

Two Ospreys, one in each year, pulled the necklace material into their mouths. Whereas the 1993 Osprey fed normally despite transmitter position and shed the unit without incident at the reservoir shore two days later, the 1994 Osprey fed itself with difficulty. I trapped this fledgling at its natal nest and removed the transmitter. The elastic caused only minor abrasion of tissue at the corners of the mandibles. Necklaces did not obstruct feeding of any other juvenile Ospreys.

Transmitters that were retained through dispersal from the breeding area (one in 1993, four in 1994) were worn by Ospreys for an average of 34 d (range 28–43 d). Four shed units that were replaced and subsequently retained through dispersal provided an additional 6–18 d of information before the Ospreys dispersed.

DISCUSSION

The main benefits of necklace style transmitter mounts are their low cost, easy construction, rapid application in the field, and minimal physical impact to their recipients. I prepared both styles of necklace mounts ahead of time, then simply slipped them over the heads and worked them under the feathers in the field. This greatly reduced the length of disturbance and amount of stress incurred by juveniles during marking and measurement. Per unit, both styles required under 30 min to prepare, cost less than $1.00 to construct, and took only minutes to attach. However, I found drawbacks to both styles I tested.

RB mounts were faster to attach than NWE mounts, but could not be adjusted to fit snugly. Rubber bands should have outlasted the battery life of the transmitter and dropped off after the unit was defunct. However, the elasticity of rubber bands apparently enabled fledglings to pull the transmitters off without breaking the bands. Although this behavior was never observed in the field, seven of nine (one remounted) units were either shed prematurely or successfully removed, three with the rubber band unbroken.

NWE cord had less stretch than rubber bands, permitting a tighter fit to each individual. However, nestlings scratched at their necks more often in 1994 than in 1993. I observed two Ospreys scratching at their necks 1 wk before both shed their transmitters: one separated at the loops and the other was missing its elastic. Preening resulted in two Ospreys being bridled by their necklaces, indicating that beak preening was not strong enough to break the mounts, but also that neither style fit sufficiently snugly. Were a talon to become hooked under the elastic, the downward force of an Osprey's leg was probably sufficient to pull the elastic out of the crimping or snap the threads at the break-away loops. I recovered no units on which the nylon cord was broken, in contrast to three of nine broken RB mounts. Transmitter removals in 1994 may thus have been attributable to scratching or preening in response to irritation, possibly caused by the crimped metal tubing. The recovery of most shed units below platforms or trees supports the notion that transmitter loss was associated with a behavior that is performed while perched.

All methods of transmitter mountings vary in physical impact to their bearers and in retention. Many studies that have employed neck-mounted transmitters or visual markers have encountered loss of markers, injury to the bearer, or death by starvation or predation (Hawkins and Simpson 1985, Small and Rusch 1985, Marks and Marks 1987, MacInnes and Dunn 1987, Pekins 1987, Sorenson 1989, Ely 1990, Samuels et al. 1990), thus leading most researchers to avoid neck mounts. However, Marcström et al. (1989) found significantly higher survival of pheasants with neck-mounts than with backpacks. Necklace mounts require a minimum of skill and time to attach in the field and cannot damage developing wing and tail feathers of young birds.

Tail mounts have been used effectively with many adult raptors including Ospreys (Kenward 1985a, Hagan and Walters 1990, Phelps 1993) but have resulted in damaged or loss of the retrices to which they were attached (Samuels and Fuller 1994). Backpacks are widely recommended and widely used for raptor studies, yet improperly fitted backpacks have entangled feet (Nicholls and Warner 1968) and can damage growing body feathers of young birds (Kenward 1985b). Backpacks also sometimes affect behavior which can result in selective predation on their bearers (Small and Rusch 1985, Marcström et al. 1989). Although backpacks are more costly and require more time and skill to attach properly, the benefits of greater retention and reduced impact on behavior may outweigh the costs. Kenward (1985b) recommended tail mounts as best for raptors "... unless the retrices of young birds are not yet fully grown," which precludes their use with pre-fledging juveniles. He also recommended anklet mounts over backpacks for juveniles, but found the transmission range of anklet-mounted radios was more readily reduced by low or ground perching, as is often observed in young Ospreys in this population.

In addition to cost-effectiveness and rapid deployment in the field, I used neck-mounted transmitters to reduce the risks to juveniles of damage to developing wing and tail feathers, interference with normal development of flight and hunting skills, selective predation on already vulnerable juveniles, or possible electrocution of young Ospreys with tail or backpack mounts. In general, while the neck-mounted transmitters in this study did not appear to cause damage to their bearers, antennae may

have been annoying, as juvenile Ospreys were observed biting at antennae while feeding and shaking their heads to move the antennae out of the way. Whereas necklace-style transmitter mounts were easy to construct and apply in the field, their retention was generally low, and appeared to be obtrusive in several instances. Neither neck-mounting method proved sufficiently durable for use with juvenile Ospreys. Both styles were shed early in the post-fledging period, which lasts 30–35 d at this study area.

Four possible means of improving NWE mounts are: (1) use tubing with "teeth" that could effectively bite into the elastic to prevent it from pulling out, (2) securing the NWE inside of the tubing with a drop of cyanoacrylate glue at each end, (3) knotting the end of the NWE against the ends of the crimped tubing, or (4) stitching through the elastic rather than crimping it. I was unable to locate "toothed" tubing small enough to effectively crimp the 1/8" NWE cord. Although gluing and/or stitching through might damage the elastic itself, it may secure the mount better than crimping alone, extending the effectiveness while still remaining a temporary mounting method.

RESUMEN.—El uso de accesorios para sujetar radio-transmisores temporalmente son aconsejables para las necesidades de investigación en el corto plazo, sin embargo los transmisores deben ser retenidos durante la duración del estudio. Con el fin de valorar la eficiencia de transmisores de collar en las aves rapaces, evalúe la retención de dos diseños en individuos juveniles de *Pandion haliaetus*: una banda de caucho y un cordón elástico de nylon. Los transmisores montados con bandas de caucho fueron significativamente retenidos por mas tiempo que los de cordon elástico de nylon. Sinembargo ninguno de los dos fue retenido hasta el períódo requerido para ser recomendados para realizar investigaciones de campo.

[Traducción de César Márquez]

LITERATURE CITED

AMSTRUP, S.C. 1980. A radio collar for game birds. *J. Wildl. Manage.* 44:214–217.

DAY, G.I., S.D. SCHEMNITZ AND R.D. TABER. 1980. Capturing and marking wild animals. Pages 61–88 *in* S.D. Schemnitz [ED.], Wildlife management techniques manual, 4th ed. Wildl. Soc., Inc., Washington, DC U.S.A.

ELY, C.R. 1990. Effects of neck bands on the behavior of wintering Greater White-fronted geese. *J. Field Ornithol.* 61:249–253.

HAGAN, J.M., III AND J.R. WALTERS. 1992. Foraging behavior, reproductive success, and colonial nesting in Ospreys. *Auk* 107:506–521.

HAWKINS, L.L. AND S.G. SIMPSON. 1985. Neckband a handicap in an aggressive encounter between Tundra Swans. *J. Field Ornithol.* 56:182–184.

KENWARD, R.E. 1985a. Radio transmitters tail-mounted on hawks. *Ornis Scand.* 9:220–223.

———. 1985b. Raptor radio-tracking and telemetry. *ICBP Tech. Publ.* 5:409–420.

MACINNES, C.D. AND E.H. DUNN. 1987. Effects of neck bands of Canada Geese nesting at the McConnell River. *J. Field Ornithol.* 59:239–246.

MARCSTRÖM, V., R.E. KENWARD AND M. KARLBOM. 1989. Survival of Ring-necked Pheasants with backpacks, necklaces, and leg bands. *J. Wildl. Manage.* 53:808–810.

MARION, W.R. AND J.D. SHAMIS. 1977. An annotated bibliography of bird marking techniques. *Bird-Banding* 48:42–61.

MARKS, S.J. AND V.S. MARKS. 1987. Influence of radio collars on survival of Sharp-tailed Grouse. *J. Wildl. Manage.* 51:468–471.

NICHOLLS, T.H. AND D.W. WARNER. 1968. A harness for attaching radio transmitters to large owls. *Bird Banding* 39:209–214.

PEKINS, P.J. 1987. Effects of poncho-mounted radios on Blue Grouse. *J. Field Ornithol.* 59:46–50.

PHELPS, J.M., III. 1993. Factors affecting foraging and productivity of Ospreys (*Pandion haliaetus)* at Cascade Reservoir, Idaho. M.S. thesis, Boise State Univ., Boise, ID U.S.A.

PYRAH, D. 1970. Poncho markers for game birds. *J. Wildl. Manage.* 34:466–467.

SAMUELS, M.D. AND M.R. FULLER. 1994. Wildlife radiotelemetry. Pages 370–416 *in* T.H. Bookhout [ED.], Research and management techniques for wildlife and habitats. Wildl. Soc., Bethesda, MD U.S.A.

———, D.H. RUSCH AND S.R. CRAVEN. 1990. Influence of neck bands on recovery and survival rates of Canada Geese. *J. Wildl. Manage.* 54:45–53.

SMALL, R.J. AND D.H. RUSCH. 1985. Backpacks versus ponchos: survival and movements of Ruffed Grouse. *Wildl. Soc. Bull.* 13:163–165.

SORENSON, M.D. 1989. Effects of neck collar radios on female Redheads. *J. Field Ornithol.* 60:523–528.

YOUNG, L.S. AND M.N. KOCHERT. 1987. Marking Techniques. Pages 125–156 *in* B.A. Giron Pendleton, B.A Millsap, K.W. Cline and D.M. Bird [EDS.], Raptor management techniques manual. Natl. Wildl. Fed., Washington, DC U.S.A.

Received 10 December 1996; accepted 9 May 1998