J. Field Ornithol., 60(2):251-258

AN IMPROVED METHOD TO MONITOR NEST ATTENTIVENESS USING RADIO-TELEMETRY

DANIEL S. LICHT,[1] DANIEL G. MCAULEY,[2,3] AND JERRY R. LONGCORE[2]
U.S. Fish and Wildlife Service
Patuxent Wildlife Research Center
Laurel, Maryland 20708 USA

GREG F. SEPIK
Moosehorn National Wildlife Refuge
U.S. Fish and Wildlife Service
Box 1077
Calais, Maine 04619 USA

Abstract.—An improved method of automatically monitoring nest attentiveness was designed and tested using radio-equipped American Woodcock (*Scolopax minor*). Shielded coaxial cable (RG-58) was extended from a receiver and placed 30 cm above the nest, with a 3.8 cm section of the inner wire exposed. Presence, absence, and activity of birds within 10.1 ± 5.2 m (SD) of the nest were clearly indicated on a Rustrak recorder while extraneous signal interference was minimized.

MÉTODO MEJORADO PARA MONITOREAR ATENCIÓN AL NIDO UTILIZANDO RADIO-TELEMETRÍA

Resumen.—Se diseñó y se puso a pruebas un método mejorado de monitorear automaticamente la atención y cuidado a nidos, colocando un transmisor en un individuo de *Scolopax minor.* Un cable coaxial protegido (RG-58) fue extendido desde un recibidor y colocado a 30 cm sobre el nido, con una sección de 3.8 cm del interior del cable expuesto. La presencia, ausencia y actividad del ave dentro de un área de 10.1 m, 5.2 DE fue claramente indicado en una grabadora Rustrak. La interferencia de otros ruidos fue mínima.

Monitoring attentiveness of birds at the nest is useful for characterizing behavior. Direct observation of nesting birds has been used to study behavior (Mueller et al. 1982, Van Vessem and Draulans 1986), but this method is labor intensive. In areas of continuous daylight, movie cameras have been used to monitor activity (Cartar and Montgomerie 1987). Pressure-activated recorders have been described for use with burrow-nesting birds (Schramm 1983) and waterfowl (Cooper 1978) and heat-sensitive thermistors have been placed in artificial eggs in the nests of woodcock (Caldwell and Lindzey 1974). Several authors have reported using radio-telemetry (Gilmer et al. 1971, Harrington and Mech 1982, Kjos and Cochran 1970, Ringelman et al. 1982) to record animal activity, but the fluctuations of transmitter signals combined with extraneous interference often limit the interpretation of recorded activities (Kjos and Cochran 1970, Harrington and Mech 1982). We designed and tested a technique for automatically monitoring nest attentiveness of radio-equipped

[1] *Current address: U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center, P.O. Box 2096, Jamestown, North Dakota 58402 USA.*
[2] *Mailing address: U.S. Fish and Wildlife Service, Maine Research Station, Patuxent Wildlife Research Center, 242 Nutting Hall, University of Maine, Orono, Maine 04469 USA.*
[3] *Reprint requests should be addressed to McAuley.*

female woodcock. The system proved reliable for differentiating between an inactive bird on or near the nest, an active bird in close proximity of the nest, and a bird absent from the nest site.

METHODS

Our system differed from others (Harrington and Mech 1982, Ringelman et al. 1982) in that we did not use a multi-element antenna. We exposed 3.8 cm of the inner wire at the end of a coaxial cable and suspended it 30 cm above the nest to serve as the antenna (Fig. 1). When possible, we attached the wire to the woody vegetation above the nest using u-shaped staples or electrical tape. When no suitable vegetation was present a metal or wooden support was driven into the ground and the wire was suspended from it. We extended the cable from the nest to the antenna jack of an LA 12 receiver (AVM Instrument Co., LTD., Livermore, California[4]) that was connected to a Rustrak recorder (model 288) (Gulton Industries, Inc., Manchester, New Hampshire) designed for an input signal of 0–100 micro-amperes and with a paper speed of 30.5 cm (12 in.)/hour. The receiver and recorder were powered by a 12 v battery, placed in a reinforced box and setup ≥15 m from the nest. To exclude signal reception along the length of cable we used RG-58, 100% shielded, coaxial cable.

Because woodcock are tolerant of disturbance around their nest we were able to fasten the antenna wire without flushing the incubating bird. Because the wire can be positioned in <5 min, we recommend that it be done during a female's recess from the nest to minimize disturbance to the bird. To prevent mammalian predators from following the cable to the nest, the cable can be suspended above the ground.

We simulated activity near the nest to determine the effective distance at which our system received the signal and recorded it on the chart recorder. We placed single-staged radio-transmitters on supports at a height approximating that of a transmitter on a woodcock and placed them at different distances from the antenna. Transmitters weighed 4 g, had a power output of −33 to −37 dBm (Wildlife Materials, Inc., Carbondale, Illinois, 1986), and a 20.3 cm twisted strand, whip antenna.

We determined by trial and error in the field that with 3.8 cm of wire exposed and the tip of the antenna cable 0.3 m above the nest we could adequately monitor activity at the nest with a chart recorder. To test the limits of our system we varied the height of the cable and the length of the exposed inner wire and measured signal reception.

We exposed 3.8 cm of wire at the end of the antenna cable and moved the cable 0.3, 0.5, 1.0, 1.5, 2.0, and 2.5 m above the nest and measured the horizontal distance from the nest at which the system recorded a signal. We then fixed the wire 0.3 m above the nest and varied the length of the exposed wire from 1 cm to 10 cm (by 1 cm increments) and measured

[4] *Use of trade names does not constitute endorsement by the U.S. Government.*

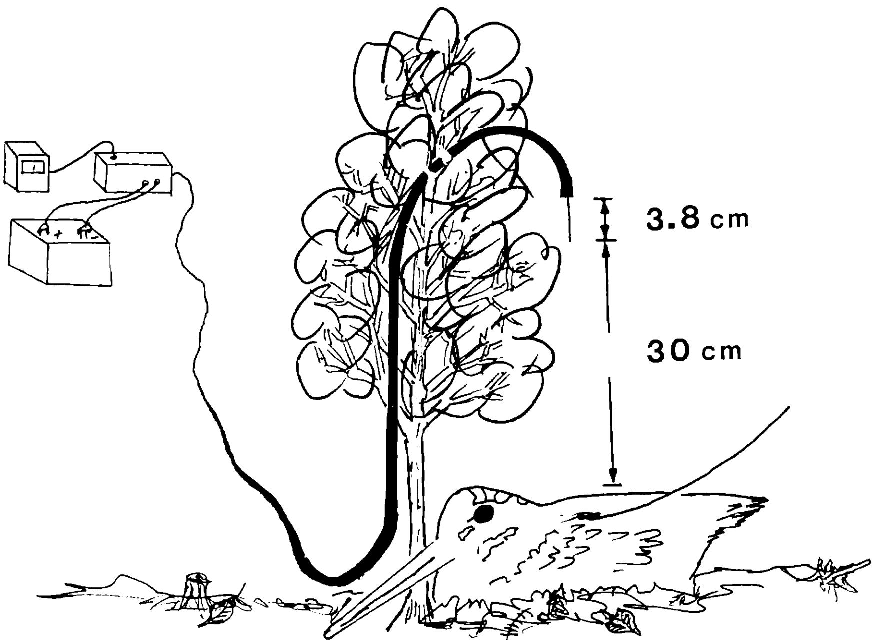

FIGURE 1. A length of 100% shielded coaxial cable extended from the receiving unit to the nest with the exposed inner wire serving as the antenna.

the horizontal distance at which the recorder was able to detect a signal from a stationary transmitter. We used linear regression to evaluate the relationship between variables. We monitored a stationary transmitter and a moving transmitter and measured the maximum distance at which a signal was recorded. We tested for differences using a *t*-test.

To further test our system a captive, radio-equipped woodcock was placed in a pen and monitored to compare actual behavior with activity recorded on the chart.

RESULTS AND DISCUSSION

For actual monitoring of nests we used antenna cables with 3.8 cm (1.5 in.) of the inner wire exposed. This length allowed us to monitor the nest as well as a limited area around the nest. For the heights tested, there was little correlation between height of antenna above ground and distance from the nest at which a signal was detected ($r^2 = 0.15$, df = 22, $P > 0.05$). However, the heights closest to the transmitter seemed to maximize reception of the signal when the bird was on the nest, thereby minimizing the loss of signal reception caused by frequency drift.

The horizontal distance at which a signal could be detected increased as the length of exposed wire increased ($r^2 = 0.61$, df = 38, $P < 0.05$).

The relationship between length of exposed inner wire and distance at which a signal could be detected is described by the regression:

$$y = 0.130 + 2.005x - 0.088x^2$$

where, y equals the distance (m) from antenna and x equals the length (cm) of exposed wire.

The range of detection for moving transmitters was greater than that of stationary transmitters ($t = 2.845$, df = 19, $P < 0.01$). When 3.8 cm of the inner wire was exposed and suspended 30 cm above the nest, a stationary transmitter could be detected at a mean distance of 7.1 ± 3.5 m (SD) ($n = 20$) from the nest, whereas moving transmitters could be detected at a mean distance of 10.1 ± 5.2 m (SD) ($n = 20$). The reason for the disparity is that a moving transmitter has a greater probability of its antenna being positioned to project a maximal signal toward the receiver. For the woodcock and other ground-nesting species, it might be more appropriate to use the distances determined with the moving transmitter because woodcock are often active near the nest when not incubating (pers. obs.). The estimate for the stationary transmitter may be more appropriate for perching and tree-nesting species, e.g. raptors, that may remain relatively motionless near the nest for long periods.

Many variables influence signal strength of multi-element antenna systems, such as proximity of transmitter to the ground, vegetation between the transmitter and receiving system and the length of the antenna cable. After using our system to monitor a stationary transmitter for 60 h we concluded that background interference (noise) was negligible. No signal changes were noted on the chart recorder other than gradual shifts of signal strength caused by frequency drift. We used this system during two field seasons under varying meteorological conditions ranging from snow to rain and fog and temperatures ranging from −6.6–27 C with no discernable loss of signal. Simultaneous observation of our system and a system using a seven-element Yagi antenna (positioned 100 m from nest and elevated 3 m) suggested that our system minimized extraneous signal interference more effectively (Fig. 2, Period B).

Visual observations of the captive woodcock indicated that our recording system was detecting most of the activity of the bird. In some instances, minor activity (slight movements during preening, ruffling of feathers) when the bird was near the exposed end of the antenna cable (<1 m) did not cause a sufficient modulation in signal strength to be recognized on the chart as activity. All other activities, such as walking and probing were recorded as activity by our system. We believe that any abrupt signal changes and modulations on chart records of nesting females using our system were caused by the bird's activity and not by extraneous interference.

Signal reception did not seem to be affected by the length of the coaxial cable. We initially tested the system using 50 m of coaxial cable and in the field we used up to 35 m of cable between the nest and receiver system with no detectable loss of signal. For species that may not tolerate activity

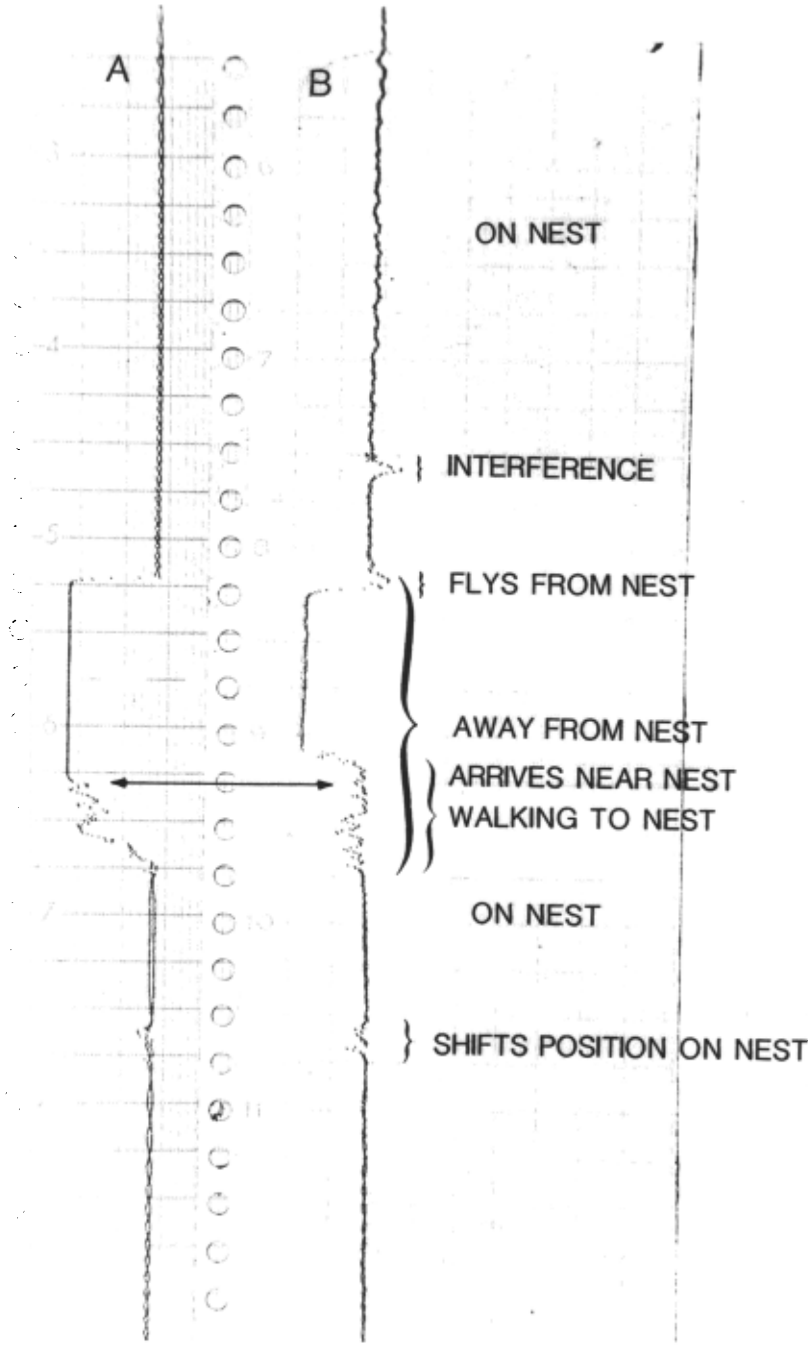

FIGURE 2. A simultaneous recording of simulated woodcock activity using our system (A), and a seven-element antenna placed 100 m from the nest (B).

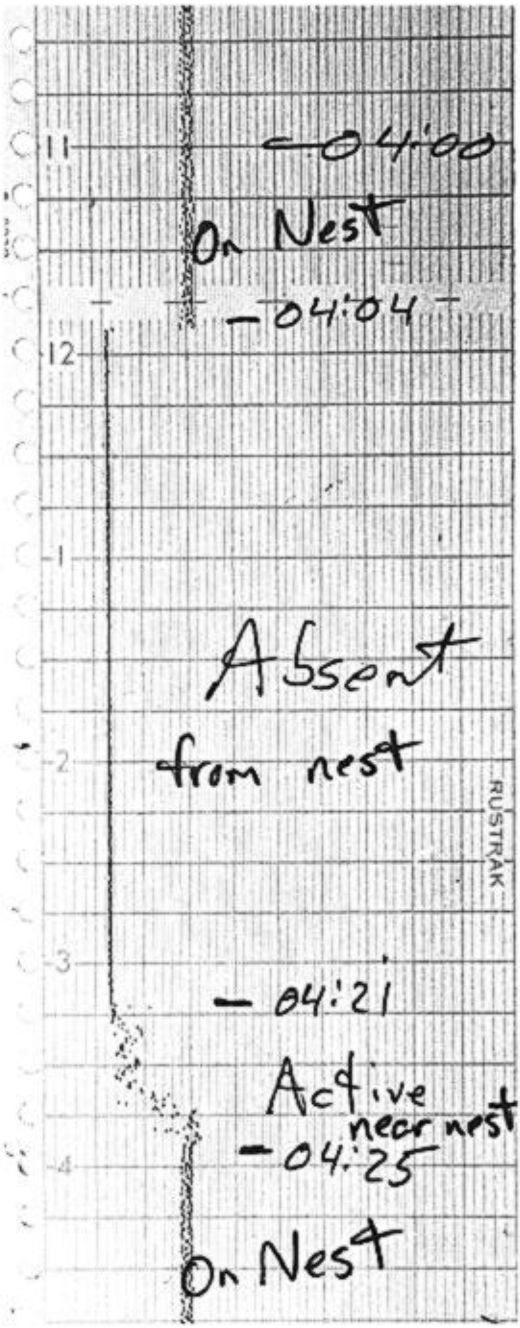

FIGURE 3. Actual recording of a woodcock on a nest, absent from the nest site, returning to the nest, and on the nest.

near their nests, longer lengths may be used, although researchers should experiment first.

Manual monitoring of radio-equipped woodcock using hand-held antennas while the automatic recording system was simultaneously monitoring the bird showed that the automatic system monitored nest attentiveness as accurately as we could. On only 2 of 99 occasions did the observers notes disagree with activity recorded by the automatic unit, and in both instances the observer recorded that the bird was on the nest, while the automatic unit recorded that the bird was a short distance from the nest (<10.1 m) and active.

Our system allowed for clear delineation of three types of activity of a nesting female ([1] on the nest, [2] active near the nest, [3] absent from nest area). A female on the nest was recorded as a wide, straight line at a maximum-signal level caused by the pulsing characteristics of the transmitter signal (Fig. 3). Activity near the nest ($<10.1 \pm 5.2$ m) was recorded as a "sawtooth" line at a level between maximum signal and no signal, whereas the bird's absence from the nest site was recorded as a narrow, straight line at the no-signal level. The use of capacitors in line between the receiver and the recorder can be used to increase or decrease the width of the line, as desired.

CONCLUSIONS

Our system proved highly reliable for monitoring the attentiveness of woodcock at the nest and should be easily adaptable for most radio-equipped nesting birds. The technique also may prove useful in obtaining clear recordings of brood attentiveness of altricial birds (Cochran 1980: 511) and for other studies where recordings of presence or absence of radio-equipped animals are desired. When using our system for other species and different size transmitters, researchers can vary exposed wire length to obtain the desired level of coverage. For less tolerant species, antenna height and cable length may be increased to some extent although researchers should test the system first.

A major concern with any system is frequency drift of either the receiver or the transmitter. By placing the exposed end of the coaxial cable at a height where signal strength is greatest, the effect of frequency drift on recordings is minimized. Using receivers with a frequency stability of less than ± 1.0 KHz would minimize drift as would protecting the receivers from extreme temperature fluctuations. Also, transmitters can be improved to minimize drift but with added cost.

ACKNOWLEDGMENTS

We thank B. E. Benedict, R. A. Houston, R. C. Kuntz III, J. D. Sayre, R. T. Speer and K. N. Wood who monitored radio-marked woodcock on nests. M. A. Howe, M. C. Perry and M. R. Fuller made helpful comments on the manuscript.

LITERATURE CITED

CALDWELL, P. D., AND J. S. LINDZEY. 1974. The behavior of adult female woodcock in central Pennsylvania. Proc. Fifth Am. Woodcock Workshop. Univ. of Georgia, Athens. 13 pp.

CARTAR, R. V., AND R. D. MONTGOMERIE. 1987. Day-to-day variation in nest attentiveness of White-rumped Sandpipers. Condor 89:252–260.

COCHRAN, W. W. 1980. Wildlife telemetry. Pp. 507–520, *in* S. S. Schemnitz, ed. Wildlife Management Techniques Manual. Wildl. Soc.

COOPER, J. A. 1978. The history and breeding biology of the Canada Geese of Marshy Point, Manitoba. Wildl. Monogr. No. 61.

GILMER, D. S., V. B. KUECHLE, AND I. J. BALL, JR. 1971. A device for monitoring radio-marked animals. J. Wildl. Manage. 35:829–832.

HARRINGTON, F. H., AND L. D. MECH. 1982. Patterns of homesite attendance in two Minnesota wolf packs. Pp. 81–105, *in* F. H. Harrington and P. C. Paquet, eds. Wolves of the world. Noyes, Park Ridge, New Jersey.

KJOS, C. G., AND W. W. COCHRAN. 1970. Activity of migrant thrushes as determined by radio-telemetry. Wilson Bull. 82:225–226.

MUELLER, H. C., N. S. MUELLER, AND K. D. MEYER. 1982. Unusual nest attentiveness of an eastern phoebe. J. Field Ornithol. 53:421–422.

RINGELMAN, J. K., J. R. LONGCORE, AND R. B. OWEN. 1982. Nest and brood attentiveness in female black ducks. Condor 84:110–116.

SCHRAMM, M. 1983. Automatic recording of nest visits by burrow-nesting birds. J. Field Ornithol. 54:192–194.

VAN VESSEM, J., AND D. DRAULANS. 1986. Nest attendance by male and female gray herons. J. Field Ornithol. 57:34–41.

WILDLIFE MATERIALS, INC. 1986. Telemetry and capture equipment. Catalog 30. Carbondale, Illinois.

Received 19 May 1988; accepted 1 Oct. 1988.