Journal of Herpetology, Vol. 28, No. 4, pp. 514–516, 1994

Do Flag Markers Attract Turtle Nest Predators?

TRACEY D. TUBERVILLE AND VINCENT J. BURKE, *Savannah River Ecology Laboratory, University of Georgia, Drawer E, Aiken, South Carolina 29802, USA.*

Studies that monitor the fate of turtle nests often require a system that allows identification of individual nests. In many studies of turtle nests, plastic flagging is used for this purpose (J. Congdon, pers. comm.; Fowler, 1979). Because of their conspicuous nature, flags may affect visitation rates to nest sites by predators. Previous studies on potential effects of flags have focused primarily on predators of ground-nesting birds (Baker, 1978; Yahner and Wright, 1985). These studies suggested that avian predators, such as crows, do associate some types of nest markers with nest sites. However, no evidence was found that suggested mammalian predators were attracted to nest markers (Baker, 1978, 1980). Some researchers have avoided use of nest markers due to concern that markers might attract predators to bird nesting sites (Angelstam, 1986; Yahner and Cypher, 1987). However, we know of no studies that have investigated the effect of flagging on predators of turtle nests.

We examined the potential attractive and repulsive effects of plastic flagging material on turtle nest predators at Ellenton Bay, a 10 ha Carolina bay (marsh-type habitat) on the Savannah River Site in west-central South Carolina. Turtles species nesting at Ellenton Bay include *Kinosternon subrubrum, Sternotherus odoratus, Pseudemys floridana, Trachemys scripta, Chelydra serpentina,* and *Deirochelys reticularia* (Gibbons, 1970). Potential mammalian nest predators known to occur at Ellenton Bay include striped skunks (*Mephitis mephitis*), gray foxes (*Urocyon cinereoargenteus*), and raccoons (*Procyon lotor*). Qualitative observations (e.g., scat and tracks at depredated nests) indicate that raccoons are the predominant above-ground nest predators.

Turtle nests at Ellenton Bay were located by following transmitter-equipped turtles to nest sites. During the 1993 nesting season (April–July), one *S. odoratus*, four *C. serpentina*, eight *T. scripta*, 16 *P. floridana*, and 53 *K. subrubrum* nests were marked with two wire stake flags placed ≈50 cm from the nest on opposite sides. Nests were checked weekly for evidence of predation. Sixty-seven of the 82 monitored nests were destroyed during the study. Terrestrial predation was verified for 40 of the 67 destroyed nests. Flags were constructed of 6.35 cm × 9.0 cm fluorescent pink plastic mounted on 90 cm wire stakes (Forestry Suppliers, Inc., Jackson, MS, Pink Glo #33516). We considered the potential effects of flagging on nest predators to include: (1) no effect, (2) reduced visitation due to repulsion, (3) increased visitation due to attraction, and (4) increased visitation due to association of flagging with turtle nests, in that predators have previously located flagged nests containing eggs.

Three methods were employed to test for possible effects of flagging on mammalian predators. All methods were tested in areas where natural turtle nests were marked with two wire stake flags.

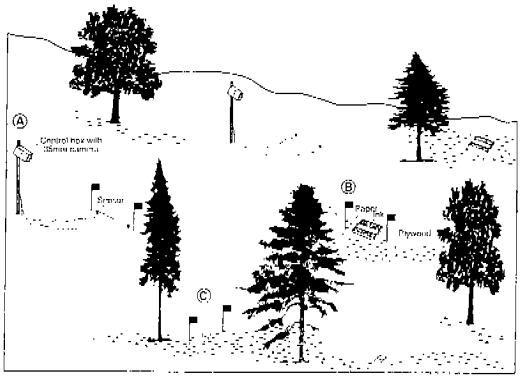

FIG. 1. Three experimental methods were used to compare predator visitation rates between flagged and unflagged sites: (A) flash-equipped 35 mm camera monitors set 20 m apart; (B) trackboards set 15 m apart; (C) bait stations set 10–15 m apart.

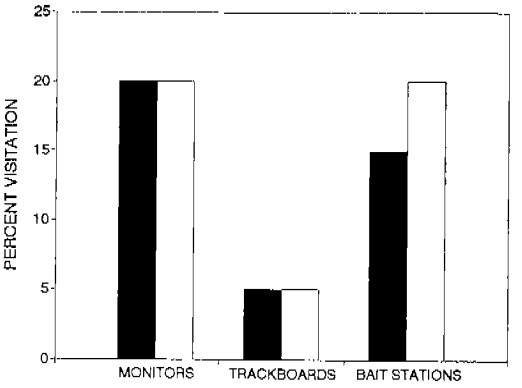

FIG. 2. Percentage of flagged and unflagged monitors, trackboards, and bait stations (N = 20) visited by potential turtle nest predators. Solid bars indicate flagged sites, empty bars represent unflagged sites.

The first method involved use of a flash-equipped, 35 mm camera that was triggered when an animal broke an electronic light beam between two sensors positioned 20 cm above the ground and 1.5 m apart. The recording of an animal on film permitted reliable identification of predators to species. Camera monitors were arranged in pairs, with one monitor placed 20 m from its counterpart. For each pair of monitors (Fig. 1), the sensors of one camera were unflagged, whereas those of the other monitor were marked with two wire stake flags identical to those positioned at turtle nests. Twenty replicate pairs of monitors were sampled, with each pair activated for a 24 h period. Visitation to flagged and unflagged monitors was determined by the presence of potential nest predators on film. Once a potential predator was documented for a given monitor, no further visitation was recorded. A disadvantage of using the cameras is their conspicuous nature (monitor height = 1.5 m), making it possible that predators are attracted to or repulsed by the equipment itself.

The second method employed trackboards (method modified from Angelstam, 1986), which were 60 cm × 60 cm pieces of 0.625 cm thick plywood. A relatively odorless mixture of petroleum jelly and blue ink was spread on the board's surface in a thin layer to form two 12.5 cm strips of ink adjacent to a center strip of waterproof paper (Fig. 1). Visitors to trackboard sites presumably step in the ink and leave a print on the paper as they cross the board.

Trackboards were placed in pairs (N = 20) and left out overnight. One board had a flag located at each end of the paper strip, and the other board, located at least 15 m away, was unflagged. No board was visible from the location of another board. Boards were checked the following morning, and all prints were identified. A disadvantage of using trackboards is that animals visiting the site may not step in the ink.

In the third method, flagged and unflagged bait stations (N = 20) were monitored for visitation by potential nest predators. Bait stations were set out in pairs, with each bait station consisting of two intact, raw chicken eggs placed on the ground. Each flagged bait station was separated from its unflagged counterpart by 10–15 m. No bait station was visible from its counterpart's location. Stations were checked after 24 h, and visitation was recorded if any eggs were broken or substantially moved (i.e., more than 50 cm). One drawback of bait stations is that a visitor cannot be identified reliably and therefore may not be a potential nest predator. Although each of the three methods had benefits and drawbacks, we believe the use of three methods reduced the probability of bias to an acceptable level.

The frequency of visitation to flagged and unflagged sites was analyzed by performing a 2-tailed Fisher's exact test on each method. Differences in visitation rates between flagged and unflagged sites were considered significant at alpha = 0.05. The likelihood that flags affect predator visitation rates was considered to increase relative to the number of methods that displayed significant differences. Therefore, a priori conditions for acceptance of the hypothesis that flags attract predators were: (a) all tests are not significant = reject hypothesis; (b) one method is significant = possible flag effect; (c) two methods are significant = probable flag effect; (d) all methods are significant = flag effect extremely likely.

For each method, the only potential turtle nest predators detected were raccoons. All three methods indicated that flagged and unflagged sites experienced similar visitation (Fig. 2) ($P = 1.0$ for each method). Only one method (bait stations) experienced unequal visitation, but the variation between flagged and unflagged sites was not substantial. Some variation in visitation rates was observed among the three different methods, with trackboards experiencing somewhat less visitation than the other two methods.

The results of this study suggest that wire stake flags do not attract or repel mammalian nest predators. Because the type of flag used in these tests was simultaneously used to mark actual turtle nests in the same area, the data also indicate that the nest pred-

ators at Ellenton Bay did not form an association between flags and the eggs they consumed. Our results suggest that observed predation rates of flagged turtle nests are probably similar to rates of predation of unflagged nests. The use of flagging presumably does not affect nest survivorship.

Acknowledgments.—We thank K. R. Smith and J. R. Bodie for field assistance. Constructive comments on the manuscript were provided by J. W. Gibbons and J. D. Congdon. Camera monitors were designed by Jim Godwin of the University of Georgia's Electronics Design and Maintenance Shop. Research and manuscript preparation were supported by contract DE-AC09-76SR00819 between the U.S. Department of Energy and the University of Georgia's Savannah River Ecology Laboratory.

LITERATURE CITED

ANGELSTAM, P. 1986. Predation on ground-nesting birds' nests in relation to predator densities and habitat edge. Oikos 47:365–373.

BAKER, B. W. 1978. Ecological factors affecting wild turkey nest predation on South Texas rangelands. Proc. Ann. Conf. Southeast. Assoc. Fish Wildl. Agencies 32:126–136.

———. 1980. Hair-catchers aid in identifying mammalian predators of ground-nesting birds. Wildl. Soc. Bull. 8:257–259.

FOWLER, L. E. 1979. Hatching success and nest predation in the green sea turtle, *Chelonia mydas*, at Tortuguero, Costa Rica. Ecology 60:946–955.

GIBBONS, J. W. 1970. Terrestrial activity and the population dynamics of aquatic turtles. Amer. Midl. Natur. 83:404–414.

YAHNER, R. H., AND B. L. CYPHER. 1987. Effects of nest location on depredation of artificial arboreal nests. J. Wildl. Manage. 51:178–181.

———, AND A. L. WRIGHT. 1985. Depredation on artificial ground nests: effects of edge and plot age. J. Wildl. Manage. 49:508–513.

Accepted: 24 July 1994.