A COMPARISON OF IDENTIFICATION TECHNIQUES FOR PREDATORS ON ARTIFICIAL NESTS

by Peter Leimgruber and Brij Kishor Gupta

Introduction

Nest predation is the major factor reducing the breeding success of passerine birds (Martin, 1991; Ricklefs, 1969). The identification of nest predators, however, is hampered by technical difficulties and has often not been very successful. Commonly used identification techniques range from rather coarse and speculative approaches, such as incidental observations (Yahner and Cypher, 1987; Yahner and Scott, 1988), conclusions based on the abundance of potential predators (Klett *et al.*, 1988; Stooras and Weege, 1987), and determination of tracks or bite marks on egg shells (Green *et al.*, 1987; Rearden, 1951), to more advanced techniques such as systematical observation of nests (Götmark and Åhlund, 1986; Salathé, 1987), haircatchers (Baker, 1980), trackboards (Angelstam, 1986; Wilcove, 1985), and trip cameras (Leimgruber *et al.*, 1994; Martin, 1987; Picman, 1987; Reitsma *et al.*, 1990). Little is known about how accurate identification techniques are. Nevertheless, major conclusions and management recommendations for the conservation of bird species have been based on predator identification studies such as the studies by Wilcove (1985) or Angelstam (1986)(Askins *et al.*, 1990; Terborgh, 1989). Presented in this paper are the results of a comparative study on the effectiveness and accuracy of three different identification techniques.

Methods

A 4 ha study plot was established at the Conservation and Research Center (CRC), a 1,200 ha research facility 2 km southeast of Front Royal, Virginia. The study plot was located in a 25 ha remnant of deciduous forest and consisted of a grid with 100 stations, each station 20 m apart and marked with red tape.

Between 17 July and 4 August 1991, three 4-day trials were conducted. During each trial, 30 nests were placed at randomly selected stations. Generalized ground nests were constructed within 5 m of the station by forming depressions in the ground or leaf litter close to a shrub, log or tree trunk. These nests were lined with leaves, moss, dry grass or other organic materials found in the vicinity of the nest. In each nest were placed two fresh northern bobwhite quail (*Colinus virginianus*) eggs. At the end of each 4-day trial the eggs were removed. To reduce the possible impact of human scent, the eggs and nest materials were handled with vinyl rubber gloves. During each trial, the 30 nests were evenly divided into three different categories, i.e. fluorescent pigment nests, trackboard nests and control nests.

Fluorescent pigment nests: Eggs and nest were powdered with fluorescent pigments. Predators that destroy the nests pick up these pigments and leave fluorescent tracks. A Raydetector III portable "Ultra Violet Light" was used to detect tracks.

Trackboard Nests: A thin layer (1 mm) of a mixture of petroleum jelly and clay powder was applied to a 3 mm thin board (32x32 mm) to preserve tracks of nest predators. Eggs and nests were placed on these trackboards (Angelstam, 1986; Schultz, 1991).

Camera systems: Cameras were used in the last trial in combination with trackboards (7 nests) and fluorescent pigments (8 nests). The camera systems operated with an infrared light beam and were activated by sudden changes in the "heat-profile" of the monitoring area (Rappole *et al.*, 1986). Nocturnal visitors could be photographed with the aid of an automatic flash. The cameras were also equipped with an automatic film advance and a databack that stamped Day-Hour-Minute on each exposure.

Results

A total of 84 (93.3%) nests were destroyed (i.e. at least one egg was removed or destroyed). There was no significant difference in the number of destroyed nests between trials (n-90, X^2=0.037, 2 df., P=0.9817). Although predation rates were lower for control nests than for fluorescent pigment or trackboard nests, this difference was not significant (n=90, X^2=0.265, 2 df., P=0.8756).

Predators were identified at 25 of the destroyed nests that were equipped with cameras, fluorescent pigments or trackboards. The most common nest predator was raccoon (*Procyon lotor*) (30%), followed by opossum (*Didelphis virginiana*) (5%), gray fox (*Urocinereus argenteus*) (3.33%), gray squirrel (*Sciurus carolinensis*) (1.67%), and black bear (*Ursus americana*) (1.67%). Nest predators remained unknown at 33 of the artificial nests that were equipped with cameras, fluorescent pigments or trackboards. There was a significant difference in the effectiveness between the three identification techniques. Based on their cell contribution to the chi-square value, cameras (86.6%) were the most effective, followed by fluorescent pigments (58.7%) and last by trackboards (20%). Cameras allowed the identification of nest predators when fluorescent pigments (1 nest) or trackboards (4 nests) failed. Trackboards were frequently found to have been removed and severely damaged so that no signs or tracks could be recognized.

Automatic film advance and an internal clock built into the camera allowed us to identify species that showed up at nests after they had been destroyed by a previous predator (n=11). These 'second' visitors included raccoon, opossum, striped skunk (*Mephitis mephitis*), and gray squirrel.

Discussion

Nest predation rates were very high in our study plot. This may be explained by the high density of artificial nests and the location of the study plot within a forest fragment (Wilcove, 1985). However, all species identified at artificial nests in this study were previously reported to be nest predators (Martin, 1987; Wilcove, 1985).

Previously fluorescent pigments were used for tracking of small mammals (Duplanter *et al.*, 1984; Lemen *et al.*, 1985) and to describe physical contact interactions among mammals (Dickman, 1988). MacDonald and McShea (pers.comm.) successfully used fluorescent pigments for the identification of nest predators. However, the major drawback of this inexpensive technique is that rain washes off the pigments. Also, identification is often restricted to medium-sized predators and the detection of small predators is extremely difficult. However, this technique was more effective and accurate than the trackboards in our experiments.

Trackboards with different coatings were commonly used in next predation studies (Angelstam, 1986; Schultz, 1991; Wilcove, 1985), but only the European studies that used grease-based coatings were successful (Angelstam, 1986; Schultz, 1991). Angelstam (1986) and Schultz (1991) identified 75% and 93% of the nest predators. This difference in effectiveness may be explained by the absence of raccoons at the European study sites. Raccoons destroyed or removed many trackboards in our study. However, Angelstam (1986), as well as Schultz (1991), did not identify many small rodents. As for the fluorescent pigment techniques, identification was restricted to medium-sized predators.

Camera systems were the most effective and accurate technique. These systems allowed the identification of predators that were not detected with other techniques. Small predators like gray squirrels did not leave clear tracks in fluorescent pigments or on trackboards. Large predators like black bears did not touch fluorescent pigments or trackboards with their paws but still destroyed nests.

Only recently has the phenomena of 'second' visitors at artificial nests been described in a study that used the same camera techniques for predator identification (Leimgruber *et al.*, 1994). Only cameras with a databack can provide data on the sequence of different predator species at nests. Fluorescent pigments and trackboards are selective and may bias the results towards medium-sized predators such as raccoons or opossums, especially if these species appear as 'second' visitors after the destruction of the nest by a small predator.

We did not find significant evidence that identification techniques had an impact on the number of destroyed nests. However, with camera systems we obtained a series of pictures of raccoons that played extensively with trackboards. On one picture a raccoon even licked the petroleum jelly and clay powder mixture. We suspect that olfactorial-oriented nest predators may be attracted to trackboards.

Conclusions

Groups of predators described in previous studies with the help of fluorescent pigments or trackboards may not reflect the true diversity of this guild (Angelstam, 1986; Schultz, 1991; Wilcove, 1985). The role of medium-sized predators may have been overestimated and the role of small rodents, although frequently reported as nest predators (Boag *et al.*, 1983; Maxon and Oring, 1978; Reitsma *et al.*, 1990), may have been underestimated. Nest predation in forest habitats may not depend on a few important species, but on a diverse guild of predators that compensates population fluctuations of a single predator species (Leimgruber *et al.*, 1994; Reitsma *et al.*, 1990). Therefore, management recommendations based on a single or a few important predator species should be reviewed.

Number of artificial nests at which particular predator species were successfully identified with at least one of the identification techniques at the Conservation and Research Center, 1991

Predator Species	Nest predators identified by			Total
	Trackboard	Pigment	Camera	
Raccoon	4	11	8	8
Gray fox	1	1	1	2
Opossum		1	2	3
Gray squirrel			1	1
Black bear			1	1
Unidentified	25	17	2	33

**Cameras were always employed with one of the two other techniques. In some cases predators identified with cameras were also determined with the other techniques. Thus, the total number of nests that were robbed by a particular species does not equal the sum of individuals that were identified.*

References

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

Askins, R.A., Lynch, G.F. and R. Greenberg. 1990. **Population decline in migratory birds in eastern North America.** In: D.M. Power (Ed.) *Current Ornithology. Vol. 7*. Plenum Publ. Co. pp.1-57.

Baker, B.W. 1980. **Hair-catchers aid in identifying mammalian predators of ground-nesting birds.** *Wild. Soc. Bull.* 8:257-259.

Boag, D.A., Reebs, S.G. and M.A. Schroeder. 1983. **Egg loss among spruce grouse inhabiting** lodgepole pine forests. *Can. J. Zoo.* 62:1034-1037.

Dickman, C.R. 1988. **Detection of physical contact interactions among free-living mammals.** *J. Mamm.* 69:865-868.

Duplanter, J.M., Cassaing, J., Orsini, P. and H. Croset. 1984. **Utilisation de poudres fluorescentes pour l'analyse des depacements des petits rongeurs dans la nature.** *Mammalia* 48:293-298.

Gömark, F.M. and M. Åhlund. 1986. **Do field observers attract nest predators and influence nesting success of common eiders?** *J. Wildl. Manage.* 48:381-387.

Green, R.E., Hawell, J. and T.H. Johnson. 1987. **Identification of predators of wader eggs from egg remains.** *Bird Study* 34:87-91.

Klett, A.T., Shaffer, T.L. and D.H. Johnson. 1988. **Duck nest success in the prairie pothole region.** *J. Wildl. Manage.* 52:431-440.

Leimgruber, P., McShea, W.J. and J.H. Rappole. 1994. **Predation on artificial nests in large forest blocks.** *J. Wildl. Manage.* 58: 254-260.

Leman, C.A. and P.W. Freeman. 1985. **Tracking mammals with fluorescent pigments: a new technique.** *J. Mamm.* 66:134-136.

Martin, T.E. 1987. **Artificial nest experiments: effects of nest appearance and type of predator.** *Condor* 89:925-928.

Martin, T.E. 1991. **Breeding productivity considerations: what are the appropriate habitat features for management?** In: J. Hagan and D.J. Johnston (Eds.) *Conservation of neotropical migrants*. Smithsonian Inst., Washington, D.C. pp.455-473.

Maxon, S.J. and L.W. Oring. 1978. **Mice as a source of egg loss among ground-nesting birds.** *Auk* 95:582-584.

Picman, J. 1987. **An inexpensive camera setup for the study of egg predation at artificial nests.** *J. Field Ornithol.* 58:372-382.

Rappole, J.H., Navarro-Lopez, D., Tewes, M. and D. Everett. 1986. **Remote trip cameras as a means for surveying for nocturnal felids.** In: R.P. Brooks (Ed.) *Nocturnal mammals: techniques for study*. Pennsylvania State Univ. Sch. For. Resour, University Park. Pap. 48:157. pp.45-52.

Rearden, J.D. 1951. **Identification of waterfowl nest predators.** *J. Wildl. Manage.* 15:386-395.

Reitsma, L.R., Holmes, R.T. and T.W. Sherry. 1990. **Effects of removal of red squirrels, *Tamias hudsonicus*, and eastern chipmunk, *Tamias striatus*, on nest predation in a northern hardwood forest: an artificial nest experiment.** *Oikos* 57:375-380.

Ricklefs, R.E. 1969. **An analysis of nesting mortality in birds.** *Smithsonian Contr. Zool.* 9:1-48.

Salathé, t. 1987. **Crow predation on coot eggs: effects of investigator disturbance, nest cover and predator learning.** *Ardea* 75:221-229.

Schultz, G. 1991. **Untersuchungen zum Einfluß verschiedener Predatoren auf den Bruterfolg von bodenbrütenden Vögeln.** Thesis. Christian-Albrechts-Universität, Kiel, Germany. 97 pp.

Stooras, T. and P. Weege. 1987. **Nesting habitats and nest predation in sympatric populations of capercaille and black grouse.** *J. Wildl. Manage.* 51:167-172.

Terborgh, J. 1989. **Where Have All The Birds Gone?** Princeton Univ. Press, Princeton, N.J. 384 pp.

Wilcove, D.S. 1985. **Nest predation in forest tracts and the decline of migratory song birds.** *Ecology* 66:1211-1214.

Yahner. R.H. and B.L. Cypher. 1987. **Effects of nest location on depredation of artificial arboreal nests.** *J. Wildl. Mana.* 51:78-181.

Yahner, R.H. and D.P. Scott. 1988. **Effects of forest fragmentation on depredation of artificial nests.** *J. Wildl. Manage.* 52:158-161.

Authors' addresses: Peter Leimgruber, c/o Dept. of Zoology, University of Oklahoma, Norman, OK 73019, USA.; Brij Kishor Gupta, Manager, Agra Bear Rescue Facility, Wildlife S.O.S., 133, New Adarsh Nagar, Balkeshwar, Agra - 282004, India.