RAPTOR CONSERVATION AND MANAGEMENT

APPLICATIONS OF BIO-TELEMETRY STUDIES

FROM CEDAR CREEK NATURAL HISTORY AREA

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Introduction

Wildlife conservation and management need better understanding of the interactions among species and between species and their environment. There is a continuing need for criteria that can be used by land managers who manipulate raptor habitats.

The conservation of raptors presents unique problems because these birds are at the top of a food chain where they often exist in low densities. Suburbanization, industrialization, the use of pesticides, and persecution, have in many cases caused the elimination or reduction of local populations. Recent awareness of ecological concepts by professional biologists and the public is leading to programs that will enable raptors to be reintroduced into areas that may once again support a well-balanced environment. First, however, research must provide answers to questions concerning habitat use and preference, home range requirements, intraspecific and interspecific tolerances and the interaction among these factors. Then we will be able to predict how habitat changes will affect raptors. In many cases, bio-telemetry will play a key role in helping us understand these relationships.

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There is a permanent, automatic radio tracking system on the 6,000 acre (2428 ha) Cedar Creek Natural History Area in east central Minnesota (Cochran et al., 1965). Telemetry data from this system are already revealing how important different habitats are to different species, and how many individuals make use of an area.

Few marking methods produce the continuous, minute-to-minute data necessary for evaluating short-duration movements of wild birds that will accurately provide information on home range, intensity of habitat use, or spatial-temporal relationships between one raptor and another. To overcome this problem, radio transmitters were placed on several species of raptors and their movements followed by the Cedar Creek Automatic Radio Tracking System. The following examples will illustrate the usefulness of radio telemetry in providing information that a land manager can use in raptor management.

**Barred Owl Habitat Analysis**

Location data on 10 Barred Owls were taken every 15 minutes during darkness and every 30 minutes during daylight. More than 28,000 owl locations were sampled from some two million locations recorded over a period of 1,182 days (Nicholls, 1973). From these data, home range and habitat use were determined by the following methods.

The Cedar Creek area was divided into a grid system consisting of 2,080, 1.6-acre (0.65 hectare) squares. Squares were numbered from 1 to 2,080 for computer identification. 1.6-acre squares were convenient in terms of accuracy of the radio-tracking system and also permitted detailed classification of habitat types.

Habitats were classified into seven habitat types characteristic of Cedar Creek. Each square was assigned a habitat type which was determined by aerial photographs, vegetation maps, and field observations. A computer-drawn map was made of all locations for each owl and placed over a habitat map of Cedar Creek as a further means of insuring accuracy.

The habitat information for each square along with all locations occurring in each square for each Barred Owl were programmed for computer analysis (Sinniff, 1966). The results were presented as the number and percentage of owl locations occurring in each habitat type.

A determination of home range was necessary in evaluating habitat use. Home range boundaries were determined by drawing lines around the outermost 1.6 acre (0.65 hectares) squares with owl locations in them. The size of each owl's home range was determined by multiplying by 1.6 (acres) the number of squares within the boundary. The average home range of nine Barred Owls was 565 acres (231 ha). Home range size varied from 213 acres to 912 acres (86-369 ha).

After determining the acreage of each owl's home range, the total number of acres of each of the seven habitat types present within the home range was determined. Habitat preference was determined by comparing the observed number of radio fixes and the expected number of fixes that would have occurred if owls had entered the different habitat types by chance alone.

Data on the distribution of owl fixes with respect to different types of avail-
able habitat were tested for significance by chi-square methods of analysis. The conventional 0.05 percent or less probability level was used to indicate significance. The hypothesis for the chi-square test was stated as follows: If an owl entered different habitats by chance alone, the number of radio fixes in each habitat type will be proportional to availability.

The number of radio fixes in each habitat type was not proportional to availability. Thus, the hypothesis was rejected. Instead, Barred Owls showed definite and highly significant ($P < 0.05$) preference for or avoidance of different habitat types (Nicholls and Warner, 1972). The order of preference in decreasing intensity of use was oak woods, mixed hardwoods-conifers, white cedar swamps, oak-savannas, alder swamps, marshes, and open fields. There were no significant variations in this order with regard to sex, different individuals, phenological changes, changing seasonal weather conditions, time of day, night, or years.

Two of the seven habitats were preferred over the other five. They were the oak woods and the mixed hardwood-conifer habitats. The physical characteristics of these two habitats made conditions ideal for nesting, hiding during inactive daylight periods, and locating prey by sight and sound. These upland wooded areas were normally free of a dense understory. Very likely the lack of brush made it easy for owls to see, fly, and attack prey without hitting branches or leaves enroute and giving the intended prey victim warning of an impending attack.

The vertical use of the preferred oak woods and mixed-hardwood habitats varied with activity. In flying, the owls usually used air space which avoided dense vegetation such as that found in the overstory. Most flights occurred between four and twenty feet from the ground where understory vegetation was sparse. This was determined by the height at which owls hit mist nets ($N = 15$) and by direct observation ($N = 25$). Owls definitely used air space that had the least resistance for flying from one place to another.

The Barred Owl does not hunt on the wing but waits on a perch from which it detects its prey by sight and sound. It then quietly drops on its prey and kills it with talons and beak. Most hunting perches were within 20 feet (6.1 m) of the ground. We watched Barred Owls attack mice from perches three times. On numerous other occasions, we saw owls on hunting perches above small access roads that transected woodlots.

During daylight, Barred Owls spent much time roosting in dense foliage between 20 and 50 feet (6.1-15.2 m) from the ground. If windy, they perched on a branch next to and on the leeward side of the tree trunk. Hollow oak trees were used for nesting. Nests ($N = 4$) were between 12 and 30 feet (3.7-9.1 m) from the ground. Many dead or dying trees provided numerous homes for prey species such as mice and squirrels. The oak woods and mixed hardwood-conifer habitats had all the requirements for survival of the Barred Owl, so it was not surprising that these habitats were used more intensively than the others that had less than ideal conditions for survival.

The open field habitat was the least used. This habitat lacked cover for concealment, nesting cavities, and hunting perches. Prey species were present but
Figure 1. Barred Owl 709 intensively used a mixed hardwood and conifer habitat as indicated by the numerous plus marks west of Cedar Bog Lake. The lowland White Cedar habitat surrounding the upland island was not intensively used. An aerial view of the same area is illustrated in Figure 2.

probably not utilized to any great extent because of the unfavorable physical structure of the habitat.

The following examples will show how habitat preference was expressed in ways other than by the chi-square test. Figure 1 illustrates how a Barred Owl intensively used a mixed hardwood-conifer habitat. It shows a 10-day computer map of the movements of a Barred Owl from April 9 to April 19, 1966 based on 480 fixes. The numerous fixes to the west of Cedar Bog Lake outlined an almost circular mixed hardwood-conifer island that was completely surrounded by a lowland white cedar swamp. Figure 2 is an aerial photograph of the same area showing the intensively used island to the upper left of the lake surrounded by the cedar swamp that received little use. Other owls using the same area in different years showed the same preference. Computer maps showed quite clearly that owls often moved back and forth between such upland islands.
Figure 2. Aerial view of Cedar Bog Lake showing the circular mixed hardwood and conifer island adjacent to the lake, which was completely outlined with fixes, as seen in Figure 1.

Figure 3 is a 45-day computer map for another Barred Owl from August 24 to September 20, 1965 based upon 1,055 fixes. White areas on maps are wooded and shaded areas are open fields or marshes. Each black plus mark denotes one or more radio fixes. In the wooded areas the plus marks are so numerous that they are fused together. The wooded areas are almost completely outlined with radio fixes while the open fields and marsh along Cedar Creek have few. Lines between plus marks indicate movement between successive locations. The lines crossing the open areas show that the owl frequently flew back and forth between different woodlots within the home range. Figure 4 is an aerial view of the same area as seen in Figures 3 and 5. By comparing the use or lack of use of areas A, B, C, D, E, F and G, one is able to see the differing intensity of use of the various habitats. Figure 5 is a 258 acre (104 ha) home range of the same Barred Owl for a 65-day period between July 15 and September 20, 1965. Each square is 1.6 acres (0.65 ha) in size and numbers in squares indicate the total number of fixes falling within each square. Light areas on map indicate open fields or marshes. Note how little use was made of these areas compared to the intensively used deciduous woods. Little use was also made of the white cedar swamp.
Figure 3. A computer-drawn map of locations and movements of Barred Owl 703. Compare areas A, B, C, D, E, F and G in Figures 4 and 5 to see how the owl used various habitats.

*Interspecific and Intraspecific Spatial and Temporal Relationships*

Continuous automatic monitoring of several raptors at the same time showed that the preferred habitat of the Barred Owl was also important to other raptors.

A family of Barred Owls and an adult Broad-winged Hawk used an oak woods habitat similar to that illustrated in Figure 5. One adult and one juvenile owl were radio-tracked from June 28 to September 7 and July 30, 1972, respectively. The hawk was tracked from July 2-6, 1972. The points plotted in Figure 6 represent locations of these three birds from July 2-6. The young owl left the nest cavity on June 29, but could not fly far. It moved about by walking, climbing, and by short glide-flights. The adult owl utilized the area indicated with the points connected by lines. The hawk used the same area, but the same-day locations were spatially separated. Tolerance between the two species while near each other may in part be due to nocturnal versus diurnal activity periods and
Figure 4. Aerial view of most of Barred Owl 703’s home range as seen in Figure 5.

differences in resource use.

Figure 7 illustrates the area used by the owl family from July 10-30, 1972. The boundaries were obtained by connecting peripheral locations plotted at particular times each day. The young owl, upon gaining better flying ability, greatly expanded its use of the area. The adult bird primarily used the oak woods and mixed hardwood-conifer habitats.

Figure 7 also shows areas used by an adult Red-tailed Hawk and an adult Broad-winged Hawk between July 10-30. Their activity areas overlapped to a certain extent with each other and with those of the Barred Owls. The dated symbols for each bird represent selected locations at the same time of day. On the 13th, the Red-tailed Hawk was in the east-central part of its area while the Broad-winged Hawk was at its west-central border. The Barred Owls were in the center of their area. On the 17th, the Red-tailed Hawk was in the more northern end of its range. This was also the southern end of the Broad-winged Hawk’s range. At the same time, the Broad-winged Hawk was using the northwestern edge of its area. When the Broad-winged Hawk occupied the south side of its range on the 28th, the Red-tailed Hawk was in the south end of its area. Other
hawks and owls were also observed in the same area at the same time showing that even greater raptor densities were tolerated.

These examples show that certain species do coexist in the same area provided there is enough suitable habitat to space out individuals. This spacing would tend to reduce conflicts between species using the same area. These data do not reveal all the interactions among raptors, but further detailed study will lead to a better understanding of this phenomenon.

Two examples of a minute-to-minute analysis of locations indicated that some species may not tolerate each others’ presence at the same time and place. The possibility of interspecific avoidance is illustrated by a Great Horned Owl and a Barred Owl; both were “tracked” from December 10-30, 1971. The following
Figure 6. This map illustrates the simultaneous use of an area by three raptors. The locations and corresponding dates indicate that the adult owl and hawk use the same area, but at different times.

Examples illustrate when the owls were in overlapping areas of their ranges, and the occasions on which they came closest to each other during the twenty-day period. Figure 8 shows that on the 13th, when the Great Horned Owl moved into the area used by a Barred Owl, the Barred Owl flew east to a woodlot different from the one it had occupied during the previous two days. On the 14th, when the Great Horned Owl moved toward the western part of its range, the Barred Owl returned to the same woodlot it had used on the 12th. On the following day, December 15, the Great Horned Owl occupied an area farther west, while the Barred Owl flew to the same woods the Great Horned Owl had used two days earlier. The Barred Owl eventually flew north into an oak woodlot
adjacent to the one used by the Great Horned Owl on the 14th. Later, the Great Horned Owl returned to that woodlot and, within two hours, the Barred Owl flew east out of the overlap zone.

Whether or not the owls communicated their location to one another is unknown. However, another incident later in the month reinforces speculation that the Barred Owl may have been avoiding the Great Horned Owl. The Great Horned Owl moved into the overlap area and the Barred Owl moved away to the east. Later, when the Great Horned Owl had flown to the west, the Barred Owl moved north, still avoiding the overlap area.

The Great Horned Owl is larger and potentially dangerous to the Barred Owl, yet the Barred Owl might prove formidable should a conflict occur. Perhaps the coexistence of two owl species using the same area is possible only when adequate resources and space enable them to avoid each other.

Figure 7. Peripheral locations of two hawks and two owls were connected to estimate the range of these raptors during the same time period. There were areas of overlapping use but the dated symbols suggest that the birds maintained spatial separation.
Figure 8. The dated and time labeled symbols on this map trace the movements of two owls. Though the birds used some of the same areas, the spatial separation indicates that they avoid use of these overlap areas at the same time.

Discussion
Habitat preference and intensity of use were determined by statistical methods. Those habitats (oak woods and mixed hardwoods-conifers) apparently having all the requirements necessary for survival of the Barred Owl were the habitats most preferred. Determination of animal habitat preferences through the use of radio-telemetry will help the land manager in his planning. For example, to maintain a population of Barred Owls, one certainly would have to maintain a few densely wooded areas with some mature trees. Such areas are required by this species in order to complete its life cycle.

It is not enough to know what kinds of habitats are needed, but also how much. Through radio-telemetry, we have answered this question for Barred Owls by determining home range size. An average pair of Barred Owls requires 565 acres (231 ha) in which to live. Similar information is now being obtained for other raptors on the Cedar Creek Natural History Area.
Several organizations are establishing wildlife preserves, natural areas and educational nature centers. As lands are set aside for these projects, knowledge of habitat requirements is essential. In addition to natural occurrence of raptors in these areas, raptors are becoming available for introduction through rehabilitation programs and through efforts to trap and relocate those few individuals that interfere with man's activities (Fuller et al., 1974).

The diversity of species and number of individuals to be maintained on an area requires knowledge of more than just habitat preferences. The interrelationships of raptors must be considered in various management and conservation contexts. The type of spacing that we found at Cedar Creek allows for a higher population density than would be possible if each pair occupied an exclusive home range. Telemetry can thus provide a basis for determining the optimum number of raptors which can occupy a given area. This information should be part of every population management plan, so that the manager can minimize intra- and inter-specific conflicts and thus contribute to a more interesting and stable community.

Conclusions

The Cedar Creek Radio-Tracking Station provides needed home range and habitat-use data and intra- and inter-specific spatial-temporal information that can be used in conserving and managing wildlife species. The techniques developed here may be especially useful in determining and saving the habitats required by rare or endangered raptors in many parts of the world.

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Literature Cited


