RAPTOR RESEARCH

CONTENTS

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NEST SITE SELECTION AND PRODUCTIVITY OF GREAT HORNED OWLS IN CENTRAL MINNESOTA

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Abstract

Thirty-three active nests (16 artificial, 17 natural) of the Great Horned Owl (*Bubo virginianus*) were found in central Minnesota in 1977. Sixteen of the 17 natural nests were originally built by the Red-tailed Hawk (*Buteo jamaicensis*). Average nest height was 14 m; 42% of the nests were in northern pin oak (*Quercus ellipsoidalis*); 79 percent in edge areas, 21 percent in woodlot interiors. Nests averaged 0.59 km from the closest human dwelling and 0.58 km from the closest graded road. Nest density in a thoroughly searched area was 0.21 per km². Utilization of artificial nest platforms was 52 percent.

The first incubating owl was seen on 20 February; the latest clutch was laid during the first week in April. Five of 7 clutches contained two eggs; 10 of 19 successful nests contained two nestlings. Forty-two percent of initial nesting attempts failed. Successful nests produced 1.8 young per nest. Artificial nests were less successful than natural nests, probably because of more human activity at artificial nest sites. An unusual distraction display involving an adult owl is described.

Introduction

The Great Horned Owl (*Bubo virginianus*) has adapted to a variety of habitats throughout most of North, Central, and South America (Bent 1938). In the rather extensively farmed rural areas of central Minnesota, it is a common inhabitant of woodlots and forested riverbottoms, often sharing these areas with another common raptor, the Red-tailed Hawk (*Buteo jamaicensis*). Because of their close association, I had an excellent opportunity, in conjunction with a study of the Red-tailed Hawk, to collect data on Great Horned Owls.

Methods and Materials

Nests were located in February, March, April, and May 1977 by systematically searching wooded areas for Red-tailed Hawk nests and when rechecking raptor nests located in previous years. A nest was classified as active when an owl was observed sitting atop the nest, apparently incubating, on at least two occasions during the nesting cycle. To create as little disturbance as possible at nests, observations were made, when possible, from a distance. To avoid the chilling of eggs and/or young, nest trees were generally not climbed during February, March, and early April. Nest heights were determined with an optical measuring device called a Relaskop. Nestlings were banded prior to fledging. Observations were by 10 by 50x binoculars and a 15-60x spotting scope. Nest locations were plotted on aerial photo maps (1:24,000), from which distances were calculated.

The Study Area

Thirty-three Great Horned Owl nests were found in central Minnesota in 1977: 15, 8,

1

5, and 5 nests, respectively, in Benton, Morrison, Sherburne, and Stearns counties. Habitat varied within the study area, but woodlots are typically dominated by pin oak (*Quercus ellipsoidalis*)/red oak (*Quercus borealis*), trembling aspen (*Populus tremuloides*), or sugar maple (*Acer saccharum*)/basswood (*Tilia americana*). Tree species in low-lying areas and riverbottoms include tamarack (*Larix laricina*), American elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), black willow (*Salix nigra*), and others. Some nests in Morrison County were in stands of jack pine (*Pinus Banksiana*) and large-toothed aspen (*Populus grandidentata*). Terrain in all counties is generally flat to moderately rolling. Although the study area is a transition zone containing sugar maple/basswood climax forest, oak savanna, and tall grass prairie, agricultural and lumbering practices have greatly changed the original appearance of the area.

Results and Discussion

Nest Site Selection. Sixteen of the 33 nests utilized by Great Horned Owls were manmade nest platforms. I erected 14 of them in 1976. Two were erected by other individuals prior to 1976. Of the 17 natural nests, one was a small leaf-and-twig structure probably built by squirrels (*Sciurus spp.*), and 16 were old Red-tailed Hawk nests. In 1976, 12 of the 16 red-tail-built nests were used by redtails, one was used by Great Horned Owls, and one was inactive. The remaining two nests were probably also used by redtails as they were still in excellent repair when I discovered them in 1977.

Fourteen nests were found in pin oak, 4 in bur oak (*Quercus macrocarpa*), 2 each in jack pine, white pine (*Pinus Strobus*), American elm, and trembling aspen, and one in red oak, basswood, tamarack, green ash, large-toothed aspen, cottonwood (*Populus deltoides*), and black willow.

Nest heights averaged 14.0 m and ranged from 5.5 m (the squirrel nest, in a pin oak) to 22.6 m (an artificial nest in a white pine). Artificial nests averaged 14.1 m in height (range: 10.1 m to 22.6 m). Natural nests averaged 13.9 m (range: 5.5 m to 19.2 m).

Twenty-six (79%) nests were in woodlot edges (arbitrarily defined as within 15 m of the outer boundary) or in scattered trees in open locations, such as in fencerows or pastures; 7 nests (21%) were in the interior of wooded areas. Of the natural nests, 82 percent (14) were classified as edge nests, and 18 percent (3) were classified as interior nests. Of the artificial nests, 75 percent (12) were edge nests, and 25 percent (4) were interior nests.

Nests were often quite close to areas of human activity. Active nests averaged 0.59 km from the nearest occupied human dwelling (range: 0.16 km to 2.4 km), and 0.58 km from the closest improved (at least periodically graded) road (range: 0.16 km to 2.6 km).

Placement and Success of Artificial Nests. Fifty artificial nests were erected in the study area in 1976: 25 in January, February, and March, and 25 in July and August. The procedure that I used to construct them is outlined in an earlier paper (Bohm 1977). My primary objective was to determine how readily they would be accepted by raptors, redtails in particular. In 1976, redtails nested on two of the platforms that were available to them (the first 25); none was used by owls. According to Baumgartner (1938), nest selection by Great Horned Owls occurs in late fall, several months prior to actual nesting. The fact that owls used none of the nests that were erected in January, February, and March seems to substantiate this.

In the 1977 nesting season, there were 50 artificial nests available. Because nests were often placed relatively close to each other, in clusters or groups, I estimated that the 50

nests represented 28 probable territories, i.e., areas that would likely support only one breeding pair of raptors of the same species. One of these territories was eliminated when a woodlot was logged in the fall of 1976. Nests in 14 (52%) of the remaining 27 areas were used in 1977 by Great Horned Owls. The only nest used by redtails in 1977 was one of these same 14. I believe a significantly higher utilization rate could have been attained if only one or two nests had been placed in a potential territory. Several nests were also purposely placed in areas that did not seem to be particularly favorable locations for raptor nests; none of these was utilized. Several artificial nests were selected when placed in woodlots that seemed to be suitable for raptors but that did not contain any natural nests.

Nest Density. Nests were often widely scattered throughout the study area. However, in a 28.5 km^2 area that was thoroughly searched, I believe all active nests were located. Six were found, representing 0.21 nests per km^2. I found no redtail nests. In the previous nesting season, 1976, I found 3 active Great Horned Owl nests and 3 redtail nests within the same area. In the more heavily wooded areas of central Minnesota, the density of nesting owls is perhaps higher. In Wisconsin, Orians and Kuhlman (1956) found that the Great Horned Owl population ranged from 0.05 to 0.08 pairs per km^2 (1953–1955). Hagar (1957), in New York, found 0.09 pairs per km^2, and Smith (1969), in Utah, found 0.14 pairs per km^2. On the basis of hooting censuses, Baumgartner (1939) estimated 0.39 to 1.16 pairs per km^2 near Lawrence, Kansas.

Productivity. I considered a nest to be successful if at least one nestling survived to approximately four weeks of age. At this age, most young Great Horned Owls have a fair chance of survival if forced from the nest. Premature departure may in fact be a fairly common phenomenon, for many of the nests used by owls are already in poor condition at the beginning of the nesting season. In a Wisconsin study, Orians and Kuhlman (1956) found that all the owlets that prematurely left their nests eventually survived. Similar results were found by Errington (1932). I found this to be true also. In two instances I found owlets that had prematurely left their nests. On one occasion, after an extremely windy night, I discovered two owlets on the ground near the base of their nest tree. They both seemed to be in good condition, even after a 16 m tumble. They were apparently being fed by an adult, as several small chunks of flesh were on the ground between them. In another area, about a week later, I found an owlet at the base of a large tree, approximately 150 m from the original nest tree. Again, it was apparently being fed by at least one adult, as it was surrounded by parts from several Redwings (*Agelaius phoeniceus*). In both of these instances the owlets appeared to be 3 to 4 weeks old when I found them; I located them again approximately two weeks later, and they appeared to be doing well.

Nesting Success. Forty-two percent (14 of 33) of the initial nesting attempts were unsuccessful. Failure rates in other studies have been 36 percent (4 of 11) in Montana (Seidensticker and Reynolds 1971), and 31 percent (4 of 13), 5 percent (1 of 17), and 27 percent (3 of 11) in Wisconsin in 1953, 1954, and 1955, respectively (Orians and Kuhlman 1956). The 19 successful nests (58%) produced 35 young, or 1.8 per nest. Successful nests in other investigations produced 1.7 owls (Hagar 1957), 1.8 (Seidensticker and Reynolds 1971), and 1.6, 2.0, and 1.8, in 1953, 1954, and 1955, respectively (Orians and Kuhlman 1956).

Fifty percent of the artificial platforms that were utilized were successful; 65% of the natural nests were successful (table 1). The high rate of failure of artificial platforms

Table 1. Nesting Success in Artificial and Natural Nests.

Nest type	Number	Successful	Unsuccessful	Total young	Young per nesting attempt	Young per successful nest
Artificial	16	8	8	14	0.9	1.8
Natural	17	11	6	21	1.2	1.9

may be explained in part because they were often erected in locations where they were quite accessible. My activity around the nests may have attracted additional human attention. Also, two of three late nesting attempts were on artificial platforms. These attempts, perhaps renesting attempts, were particularly unsuccessful; all failed. I checked the latest of these on 10 May 1977 and found two owlets, both with their eyes still closed. Assuming them to be no older than one week, and using a 28-day incubation period (Bent 1938), I estimated that the clutch was laid during the first week of April. I found that most owls began incubating by the end of the first week in March; the earliest incubating owl that I saw was on 20 February.

The success rates of edge nests (58%) and interior nests (57%) were similar (table 2). This finding surprised me somewhat since I had thought that owls using the more conspicuous edge nests would be more vulnerable to human-related disturbances. (I believe that this aspect of Great Horned Owl productivity, comparing nest success to nest location, warrants further investigation.)

Nest Failures. Causes of nest failures were impossible to determine in most cases. It appeared, however, that at least three were caused by human interference. A fourth nest, which was being used by owls in February was being used by redtails in April. It was not known whether interaction occurred between the hawks and owls, or whether the hawks appropriated the nest after the attempt by the owls had already failed. A similar situation occurred in Montana (Seidensticker and Reynolds 1971). Raccoons (*Procyon lotor*) may have been responsible for some nest failures. On several occasions I saw them sleeping on leafy nests high in the treetops, most often on sunny days in April and early May. The crow (*Corvus brachyrhynchos*) may also be responsible for some nest failures. At one nest I saw nearly a dozen of them mob an incubating owl and chase it from its nest. This particular nest, however, eventually proved to be successful.

Clutch Size. The clutch size was known in seven nests in 1977; five nests contained two eggs, and two nests contained single eggs. Although I found 10 owl nests in 1976, I did not know their clutch sizes. However, I did know the number of nestlings per successful nest for both years (table 3). In 1977, 10 of 19 successful nests contained two owlets. The frequency of three-owlet nests was noticeably lower than in the 1976, when half the nests that I examined contained three nestlings. It would be interesting to know how weather conditions affect productivity. The winter of 1976–1977 was particularly severe in central Minnesota. Daily temperatures averaged 4.7 degrees C below normal (mean –13.7 degrees C, range –36.6 degrees C to 5.6 degrees C) in December and 6.2 degrees C below normal in January (mean –16.5 degrees C, range –41.7 degrees C to 1.1 degrees C) (U.S. Weather Bureau, St. Cloud, MN). Extreme conditions of this sort certainly place an increased energy demand upon organisms and are perhaps reflected in reproductive productivity. Food availability during the nesting cycle would, of course, also affect productivity. Hagar (1957) and Smith (1969) speculated that winter weather

conditions may have affected productivity changes in Great Horned Owl populations in New York and Utah, respectively.

Behavior. While we were banding nestlings, we observed some rather unusual behavior. At one nest, just as I was preparing to climb to the nest, another individual and I were surprised to see an adult Great Horned Owl land on the ground perhaps 30 m from us. The owl proceeded to shuffle about among the dry leaves, holding its wings out and away from its body, with the underside toward us, in a manner similar to the threat display posture used by young redtails. At no time did it turn the backs of its wings toward us, as nestling Great Horned Owls characteristically do when threatened. This

Table 2. Nesting Success in Edge and Interior Locations.

Nest type	Number	Natural suc/unsuc		Artificial suc/unsuc		Young produced	Young per nesling attempt	Young per successful nest
Edge	26	9	5	6	6	28	1.1	2.0
Interior	7	2	1	2	2	7	1.0	1.8

Table 3. Numbers of Nestlings per Successful Nest.

Year	1	2	Nestlings per successful nest 3
1976	2	3	5
1977	6	10	3

display lasted nearly a minute and was accompanied by bill snapping. The owl then flew into the woods, only to return and land on the ground again. This time the display lasted only 10–15 seconds before the owl flew back into the woods. When I climbed to the nest, both adults flew from tree to tree and hooted intermittently but came no closer than about 40 m. Errington (1932) saw a similar display by an adult owl in which the owl flapped about on the ground as though it were injured.

Adult behavior at any nest is unpredictable. On a large artificial platform containing a pair of three-week-old young, the adult sat tight until the climber thumped on the bottom of the nest with his fist. Other adults flushed when a climber was partially up the tree. No climber was actually struck by an owl. Behavior of this sort was perhaps discouraged in many cases by the presence of one or two other persons at the nest site. However, even with several people in the vicinities of nests, adult owls often became quite excited as the climber neared the nest. Several uttered an amazing variety of calls, perhaps best described as a mixture of hoots, barks, and whistles.

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BACTERIAL ISOLATES FROM THE PHARYNX AND CLOACA OF THE PEREGRINE FALCON (*FALCO PEREGRINUS*) AND GYRFALCON (*F. RUSTICOLUS*) (BACTERIA FROM FALCONS)

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Abstract

Swabs taken from the pharynx and cloaca of Peregrine Falcons (*Falco peregrinus*) and Gyrfalcons (*Falco rusticolus*) yielded many species of bacteria, including *E. coli, Proteus* sp., *Staphylococcus aureus, Pasteurella anatipestifer,* and *Pseudomonas aeruginosa.* Some of these organisms may be significant in the context of raptor disease.

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6

Introduction

The determination of normal bacterial floral populations in the gastrointestinal tracts of wild raptors has received little attention. Such knowledge would help in the recognition of potential pathogens in these birds. Field studies involving the Peregrine Falcon and the Gyrfalcon by one of the authors (WB) presented an opportunity to sample the bacterial flora of these threatened falcons, since nestling and adult birds were being handled for banding purposes.

During the fall of 1972 pharyngeal swabs were taken from seven wild Peregrine Falcons trapped on their southward migration. For comparative purposes, pharyngeal swabs were also taken from seven captive peregrines. In the spring of 1973 pharyngeal and cloacal swabs were taken from 25 nestling Peregrine Falcons and 13 young Gyrfalcons from Greenland eyries.

Samples were transported from the field to the laboratory in thioglycolate medium (1972) and Stuart's improved transport medium (1973) which were packed in ice. Subsequent laboratory culture, isolation, and identification followed standard microbiological techniques for aerobic bacteria.

Discussion

A large number of organisms, of many different species, was isolated from the pharynx and cloaca of both *F. peregrinus* and *F. rusticolus*. Since this study was intended primarily as a survey, it would be wrong to attempt too detailed an interpretation of the findings, especially on a quantitative basis, but certain points should be made.

Many of the organisms isolated are well recognized as part of the bacterial flora of raptors. Examples are *E. coli* and *Proteus* spp., both of which have been reported in previous surveys (Cooper 1973). *Staphylococcus aureus* is a potential pathogen of birds of prey, where it often results in infections of the feet ("bumblefoot"). Its isolation from the pharynx of captive peregrines but not from free-living birds of either species is of considerable interest. In a previous paper Cooper and Needham (1976) postulated that captive raptors might acquire their staphylococci from human sources, and the findings in the present study could support this postulation. *S. epidermidis*, however, was isolated from both free-living and captive birds.

One of the most significant isolates in this survey was probably *Pasteurella anatipestifer*, which is a known pathogen of waterfowl. As may be seen in Table 1, four out of seven free-living peregrines yielded this organism. All seven were trapped on the eastern coast of the United States while on passage south in October, and it is possible that the *P. anatipestifer* was acquired from diseased waterfowl.

Table 1. Isolates from Wild Trapped Peregrines 1972

Organisms	Number of birds (total of 7)
Staphylococcus epidermidis	5
Klebsiella pneumoniae	4
Escherichia coli	4
Pasteurella anatipestifer	4
Streptococcus sp.	3
Enterobacter sp.	3
Pseudomonas aeruginosa	2
Bacillus sp.	1

Table 2. Isolates from Captive Peregrines 1972

Organisms	Number of birds (total of 7)
Streptococcus sp.	5
Bacillus sp.	4
Escherichia coli	4
Enterobacter sp.	3
Klebsiella pneumoniae	2
Staphylococcus aureus	2
Staphylococcus epidermidis	2
Pseudomonas alcaligenes	1
Achromobacter anitratus	1
Neisseria pharyngitis	1
Neisseria catarrhalis	1
Proteus mirabilis	1

Table 3. Isolates from Nestling Peregrines 1973

Organisms	Number of pharyngeal isolates (total of 25)	Number of cloacal isolates (total of 25)
Streptococcus sp.	12	13
Escherichia coli	7	10
Staphylococcus epidermidis	6	6
Enterobacter cloacae	2	2
Proteus mirabilis	1	2
Corynebacterium xerosis	1	0
Proteus rettgeri	0	1

Table 4. Isolates from Gyrfalcons 1973

Organisms	Number of pharyngeal isolates (total of 13)	Number of cloacal isolates (total of 13)
Escherichia coli	6	5
Steptococcus sp.	5	5
Staphylococcus epidermidis	5	0
Haemophilus aphrophilus	1	5
Proteus mirabilis	0	3
Proteus vulgaris	0	1
Actinobacillus sp.	1	0

Pseudomonas aeruginosa is ubiquitous in nature and can occur as part of the intestinal flora of both mammals and birds (Bailey and Scott 1970). However, it can also cause disease in raptors, especially if wounds become infected, and it is noteworthy that therapy of such cases is frequently difficult.

The role and significance of many of the bacteria isolated remain uncertain. It is probable that birds of prey have a degree of resistance to some bacteria and that the isolation of the organism is not, per se, indicative of pathogenicity. It is also likely that contaminated prey could be the source of the infection and that the bacterium would not, under normal circumstances, persist for any length of time in the raptor host. Despite great advances in our understanding of raptor pathology in the past ten years (Cooper 1978, Keymer 1972, Trainer 1969), much remains to be learned of the importance of many organisms, among them bacteria. Such information could prove useful in studies on free-living raptor populations where predator/prey pathogen relationships are as yet little understood.

Acknowledgments
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ANNOUNCEMENT

NOTICE OF SYMPOSIUM ON THE BALD EAGLE IN WASHINGTON

A symposium to review past research on the American Bald Eagle in Washington and to stimulate further investigation of this threatened species will be held June 14–15, 1980, at the City of Seattle Aquarium, co-sponsored by the National Wildlife Federation, Seattle Aquarium, Seattle Audubon Society, Seattle City Light, Seattle Woodland Park Zoological Gardens, The Nature Conservancy, U.S. Forest Service, U.S. Fish and Wildlife Service, and Washington Department of Game. Preregistration is recommended as limited space is available. Interested persons should forward $5 to cover registration fees to Washington Bald Eagle Symposium, c/o Jeremy Robertson, 2357 N.W. 70th, Seattle, WA 98117; phone (206) 789-6056; by May 31. A published copy of the symposium proceedings is included in registration fees.

SOME CONSIDERATIONS FOR FUTURE RAPTOR REHABILITATION

by
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Abstract

A female Wedge-tailed Eagle (*Aquila audax*) was released in a national park where myxomatosis had been introduced into the rabbit population. The release eventually failed because of the eagle's aggressiveness towards humans. The use of national parks and the need for conditioning rehabilitated raptors to fear humans are discussed.

Introduction

Techniques for rehabilitating raptors have been well documented; however, we know of no failures that have been discussed even though considerable information can be gained from their analysis. Many sources (e.g., Hamerstrom 1970) discuss release procedures, but, because the outcome of these releases are unknown, the methods used cannot be accurately assessed.

Discussed below are procedures used on a female Wedge-tailed Eagle (*Aquila audax*). Though they were not completely successful, they do suggest a number of considerations for future rehabilitation work.

Release Procedure

The eagle came from Melbourne Zoo; nothing was known about her previous history. In planning her release we decided to avoid any techniques related to falconry, if possible, because of their obvious drawbacks (tameness, aggression, dependence on man, expensiveness in terms of time and labour, etc.). A 5,500-hectare nature reserve near Canberra was chosen because previous experience with a number of species, including Wedge-tailed Eagles, had shown that releases in national parks and reserves, where progress could be monitored by park personnel, provided valuable data on the effectiveness of release procedures. After conferring with authorities we decided to release her immediately after myxomatosis was introduced into the park's plentiful rabbit population. This disease is harmless to eagles (Bull and Dickinson 1937), and we hoped that she would learn to hunt the many sick rabbits and gradually improve her skills as the population was reduced. It was fairly certain that adequate numbers of rabbits would remain even after the myxomatosis had run its course (e.g., Fullagar 1977). A resident ranger left her dead laboratory rats, to which she was accustomed, every second day.

Results

Two weeks after her release she was hunting rabbits, ignored all food put out for her, and appeared to be totally independent. Curiously, she settled within a large (4-ha) waterfowl enclosure surrounded by a 3-m-high fence.

Before her release this eagle was fearful of any approaches by man, especially strangers, and she would never eat in our presence. However, two months after her release she began to harry rangers who ventured into her hunting area. These attacks were low-

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angled swoops made at high speed with opened feet. Most people were able to drop to the ground quickly enough to avoid being struck, but one ranger was cut on the arm. As she would not come to food, she was trapped with the use of a noose carpet tied to a limb used as a perch. When returned to her pen, she again became fearful of humans.

Discussion

Use of National Parks. The release of the eagle where myxomatosis had been introduced was effective. From the aspect of an eagle's welfare, large national parks have several advantages over release sites in more remote areas. The bird's progress can be monitored by park personnel, and if something does go wrong, the no-shooting laws and sympathetic personnel in these parks give some guarantee that no harm will come to a released raptor. There are often large food supplies in these parks which can keep a released raptor resident. The disadvantages of some remote areas are that more persecution (e.g., shooting or poisoning) of raptors often takes place, and, if a bird does not fear humans, it may drift away from a remote area toward settlement particularly if food supplies are inadequate. This eagle chose a fenced compound to settle in. We have had a number of rehabilitated raptors, apparently accustomed to man-made structures, travel distances up to 800 km from their release points to built-up areas.

Loss of fear of humans. The degree of fear of humans in captivity is often an irrelevant and totally inadequate criterion for predicting how fearful of humans a raptor will be after release. Restraining a raptor can compound or amplify a fearful or stressful situation (McElroy 1972, Stevens n.d.) and semi-wild raptors being tame hacked can very abruptly lose their fear of man after they are first flown free. This eagle's aggressive behavior superficially resembled that of an "imprinted" raptor (e.g., McElroy 1972); however, some wild-caught raptors that have been trained for falconry or kept in zoos for long periods before their release exhibit similar behavior (pers. obs.).

There are probably a number of released raptors that die each year because they have lost their fear of man. A Whistling Kite (*Haliastur sphenurus*) was shot in Melbourne by wildlife authorities because it had attacked a number of people, injuring one. A number of raptors, apparently escaped captives, have been sent to us after being secured while diving at people or after landing on urban roofs.

Instilling a Fear of Man. Raptor ethologists, rehabilitators, and falconers could explore behavioral mechanisms, in particular those involved in imprinting, adult-fledgling relationships, "play," territoriality, social interactions, and learning, which may reveal methods of eliminating aggression toward humans in raptors before their release. A more fruitful approach might involve the exploration of methods to systematically teach tame or hand-raised raptors to fear humans, on the assumption that aggressive behaviors will disappear as a result. This could also help overcome the main drawback that results from all tame hack methods—the tameness of the raptor.

Much has been written in falconry works about methods of systematically eliminating innate fear in raptors, but very little has been written on how to instill fear. Most raptors probably have a basic innate fear of humans (Brown 1955), which is amplified by the birds' learning and experience. Methods of taming or "manning" (Stevens n.d.) involve learning not to fear man, and these methods (perhaps coincidentally) very closely resemble some c₁ the techniques that behavior therapists use to cure phobias in humans, e.g., flooding and systematic desensitization (Eysenk 1977). The use of similar forms of operant or classical conditioning, as outlined by Ferster et al. (1975), should provide

means to systematically teach raptors to fear people. When we were trying to trap the female eagle, she ceased launching attacks at us. Consequently, we began walking toward her to flush her to the tree containing the noose carpet. This offensive behavior on our part, contrasted with the defensive or fleeing behavior she elicited from most humans she attacked, appeared to make her fearful of us, and by the second day she would fly if we approached any closer than 150 m. However, these fears did not generalize, and she continued her attacks on other park personnel who ventured into her territory during the two days we were trying to trap her. Perhaps a variety of individuals chasing her and a consistent, offensive response from all humans would have produced more generalization and reinforcement of any fear of humans. The systematic use of pyrotechnics, air rifles, or firearms could aid in this type of conditioning if used after the bird has settled into an area as this eagle had.

Summary
    Careful consideration is necessary before any raptors are released, particularly if they have been hand raised or are of unknown origin. "Ability to hunt" should not be the sole criterion for release. There may be a risk to humans and, even if the release site is remote, to the birds themselves as well as potential repercussions for future rehabilitation work.
    Though it is preferable to prevent imprinting, rehabilitators often receive imprinted raptors. We release no eagles known to be imprinted, even into remote areas.
    The teaching of raptors, and some other animals, to fear man would seem to be an important area of research that could also be applied to wild endangered raptors at risk from persecution. It is desirable for a raptor to fly when humans approach to within shooting range; very few rehabilitated, hand-raised raptors are fearful enough to do so.

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SPRING HAWK MIGRATION IN EASTERN MEXICO

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Abstract

Hawk migration was witnessed along the eastern coast of Mexico for 23 days from 6 April to 6 May 1978 north of Veracruz. More than 262,000 hawks of 17 species were recorded, mainly *Buteo platypterus* (77%), *Buteo swainsoni* (6.4%), *Cathartes aura* (9.8%), and *Ictinia misisippiensis* (4.7%). A large proportion of the migrants may have passed in March and early April and a few after 6 May. Daily numbers of most species quickly decreased after 27 April. The importance of this flyway was evident from the 13,600 *Pelecanus erythrorhinchos* counted and from the several million other migrant birds seen.

Some behavioral features of migrants are described. The need for further survey work is emphasized.

Introduction

I know of no accurate and extensive records of migrating North American birds of prey south of the United States border.[*] A huge migration was noted in early autumn 1976 about 15 km north-northwest of Veracruz (Thiollay 1977). This migration was studied in spring 1978, but most of the time was devoted to the ecology of resident raptors with observation of migrants as a sideline.

Methods

I tried to quantify the hawk migration from 6 April to 6 May 1978 along 20 km of the road leading east-west at a right angle from the coast, from just north of Palma Sola to the valley of Plan de Las Hayas. This unpaved road crossed first the narrow coastal plain, then hills and plateaus to an altitude of about 800 m on the eastern edge of the Sierra Madre Oriental, which rises well over 1,000 m (the Orizaba Peak, just southwest of our area, is 5,563 m above sea level). Steep slopes and canyons in this ridge provide a variety of thermals and updrafts readily used by hawks.

The weather was calm, hot, and clear during 23 of the 31 days spent there although it was sometimes cloudy on the mountains in late afternoon, with light to moderate south wind (optimal conditions for migration). By contrast, the remaining 8 days were cold, with strong north winds and low, dark clouds, but little rain. However, hawks did not stop their migratory movements for more than a few hours.

Three well-trained persons with 10 x 40 binoculars were always involved in searching carefully for migrants. According to the behavior of the migrants (see below), the same procedure was followed every day. During the morning, we waited along the road on the slopes above the coastal plain until the first kettles were detected. We then tried to remain all day in close contact with the flight line, often moving up and down the road within the 20-km section suitable for observation. Thus, the three persons were always together at a place believed to be under the main migrant flow. This was necessary for

accurate counts of large multispecies flocks, but we never knew whether other birds were passing elsewhere, i.e., more than 2 km on either side of our post. The possibility of undetected migrants elsewhere is why our results represent only minimum figures.

Most of the groups were detected at a great distance before they crossed the road, and thus they could be followed for a long time. Their specific composition was first assessed as they circled. Then the total number of individuals was counted when the flock was gliding on a long line. Lastly, the birds were again counted and identified when passing overhead. Only very few distant groups, which we could not reach in time, were estimated. More than 90 percent of the birds seen were actually counted to the nearest 5 or 10 individuals, rarely to the nearest 100 (in the case of huge, dense flocks).

As the temperature increased, most birds flew over the mountain west of the valley Plan de Las Hayas, where the road did not cross. They were then impossible to see. This happened sometimes as early as 2:00 or 3:00 p.m., so a large part of the daily migration was out of sight. On the 8 days when migratory conditions seemed to be best, watching was unsatisfactory because the flight could not be seen. Hence, no attempt was made to study the migration.

Resident raptors in the open habitats of the Palma Sola area included the Turkey Vulture (*Cathartes aura*), Black Vulture (*Coragyps atratus*), White-tailed Kite (*Elanus leucurus*), Common Black Hawk (*Buteogallus anthracinus*), Gray Hawk (*Buteo nitidus*), Roadside Hawk (*Buteo magnirostris*), Short-tailed Hawk (*Buteo brachyurus*), White-tailed Hawk (*Buteo albicaudatus*), Laughing Falcon (*Herpetotheres cachinnans*), Bat Falcon (*Falco rufigularis*), and Aplomado Falcon (*Falco femoralis*). Since local Turkey Vultures were nearly always low-flying, lone birds, they were easily differentiated from the high, northward-flying, migrant flocks. However, local Black Vultures often flew high in groups, even joining migrant raptors for some distance. They were identified as migrants only after we followed them a long time, and many of them, although behaving like migrants, were uncounted if we had doubts about them.

The few local wintering birds which remained at that time were distinguished from migrants by their behavior. They were mainly the American Kestrel (*Falco sparverius*) although the Marsh Hawk (*Circus cyaneus*) and the Sharp-shinned Hawk (*Accipiter striatus*) were also seen. Birds of migrant species seen hunting, roosting, or flying southward were not counted.

Results

The number of birds actually recorded is given in table 1. If we attempt a rough estimate of the migration which probably occurred during each of the 8 unstudied days (taking the mean number of birds counted on the days just before and just after), we reach a monthly total of about 350,000 hawks, not including the unknown number of birds possibly missed on other days.

The period covered was only a part of the spring hawk migration, which may last from February to the end of May. From the curve of daily numbers recorded, no single species migration period has been completely covered.

Turkey Vulture (*Cathartes aura*). The migration of Turkey Vultures seemed to reach its peak during April, with a daily mean of more than 1,500 birds, although the number decreased rapidly. Flights may begin early in the season since a group of 140 migrants was recorded in Texas one year on 26 January (Schumacher Donohue 1978).

Black Vulture (*Coragyps atratus*). The small number of Black Vultures identified as migrants (with a mean of 22 per day during the first three weeks) declined sharply at the end of April. Similar movements have been recorded in Panama (Heintzelman 1975) and Texas as early as 3 March (Schumacher Donohue 1978).

Osprey (*Pandion haliaetus*). Four hundred Ospreys were recorded, an encouraging number in light of the slowly recovering North American population, especially since this may be a small part of the latter. Ospreys migrate over a wide front in Mexico (Friedman et al. 1950), some winter north of Veracruz (Bent 1961), and the first migrants reach Texas at the end of February. Osprey populations, however, are evidently sparse in western North America (Snow 1974).

Swallow-tailed Kite (*Elanoides forficatus*). The absence of the Swallow-tailed Kite (only two recorded in spring and one in autumn) is surprising because, from its southeastern distribution, one would expect the U.S. population to migrate along the Mexican coast.

Everglade Kite (*Rostrhamus sociabilis*). Although apparently not true migrants, some individual Everglade Kites may wander long distances along the coastal lagoons. Wetmore (1943) also noticed a migrating (?) bird on 1 April in Veracruz.

Mississippi Kite (*Ictinia misisippiensis*). Flocks of the Mississippi Kite were probably missed because they often traveled outside the main flow of migrants. The migration began in the first days of April, reached a maximum in the second half of that month, and continued past 6 May. This corresponds to the extreme dates (28 March and 24 May) given for Texas in 1977 (Schumacher Donohue 1978). The peak recorded in 1978 was far below the 5,130 individuals counted on 5 September 1976 (Thiollay 1977a).

Marsh Hawk (*Circus cyaneus*). A fair proportion of migrant Marsh Hawks may have passed during March (first ones on 7 March in Texas according to Schumacher Donohue 1977), with their number declining in April. None was seen in May.

Sharp-shinned Hawk (*Accipiter striatus*). The daily mean numbers of the migrant Sharp-shinned Hawks were 119 in the first half of April, 33 in the second half, and 5 in the first week of May. In 1977, the true migration began on 25 March in Texas where 220 birds were still counted on 24 and 25 April.

Cooper's Hawk (*Accipiter cooperii*) and Red-shouldered Hawk (*Buteo lineatus*). It is interesting to point out the few Cooper's Hawks and Red-shouldered Hawks that were identified since they belong to rather rare wintering species south of Veracruz.

Broad-winged Hawk (*Buteo platypterus*). The Broad-winged Hawk is by far the most abundant migratory hawk in eastern Mexico. The 202,000 birds counted are but a part of the total North American population, which may amount to more than one million (see huge autumn 1977 migration in Texas [Schumacher Donohue 1978]). The flights gradually decreased throughout the period studied and probably peaked before our arrival. Broad-winged Hawks have been reported on 6 and 9 arch (1975, 1976) with the peak numbers (up to 100,000 a day) from 26 March to 2 April (Kennedy 1977, Schumacher Donohue 1978). Some flocks of migrants have also been recorded along the west coast of Mexico (Friedman et al. (1950) and at the southern tip of Florida (Heintzelman 1975), so this may not be the only migration route followed by the North American Broad-wing population.

Swainson's Hawk (*Buteo swainsoni*). The eastern coast of Mexico is likely to be on the edge of the regular flyway of Swainson's Hawk whose breeding distribution is more western. Flights remained about the same through April, decidedly decreasing from 28

April onward. Kennedy (1977) reported 100 migrants north of the Mexican border as early as 27 March. After 6 May, few additional birds are to be expected.

Red-tailed Hawk (*Buteo jamaicensis*). Surprisingly few Red-tailed Hawks were seen although the North American population is supposed to winter occasionally as far south as Guatemala (Land 1970).

American Kestrel (*Falco sparverius*). The small American Kestrel migrates over a much wider front than the soaring birds and is thus proportionately underrepresented in the counts. It decreased quickly during April (respectively 617, 23 and 11 per day during the first, second, and third decades), and none was seen in May.

Pigeon Hawk (*Falco columbarius*). Migrants are possibly more numerous in March. The latest was recorded on 5 May 1977 in Texas (Schumacher Donohue 1978).

Prairie Falcon (*Falco mexicanus*). The only individual identified (April 7) indicates that this species rarely winters south of Veracruz (Friedman et al. 1950).

Peregrine Falcon (*Falco peregrinus*). The daily mean number of migrant Peregrine Falcons steadily remained around 2 all during the observations. Canadian populations are probably involved. In Texas, Schumacher Donohue (1978) records similar late arrivals.

Table 1. Migrants counted in spring

	APRIL										
	6	7	9	11	12	14	15	16	17	19	20
Cathartes aura	2,928	2,079	158	2,543	3,192	1,008	1,810	228	592	134	272
Coragyps atratus	50	21	49	36	28	11	38	1	5	8	6
Pandion haliaetus	93	20	27	24	28	17	10	34	18	22	23
Elanoides forficatus											
Rostrhamus sociabilis				2							
Ictinia misisippiensis	10	9	131	550	791	197	322	129	968	250	665
Circus cyaneus	31	20	52	17	16	4	6	4	7		1
Accipiter striatus	333	45	65	73	64	104	43	80	263	51	45
Accipiter cooperi	29	3	2	1	1	2	1		2		
Buteo lineatus	1	1	2	1	1		2		1	2	3
Buteo platypterus	42,988	28.100	20,320	4,765	8,176	11,630	6,858	32,850	16,830	5,847	1,685
Buteo swainsoni	3,762	1,628	162	120	862	1,402	3,554	570	576	136	174
Buteo jamaicensis	3	3									
Falco sparverius	1,402	313	137	76	49	143	63	84	167	54	27
Falco columbarius	4	1		1							1
Falco periarinus	8	2	1		2		1		2		1
TOTAL	51,642	32,246	21,106	8,209	13,210	14,518	12,708	33,980	19,431	6,504	2,903

Non-raptor soaring species

   Mixed with hawks were 762 *Anhinga,* 50 *Phalacrocorax,* 15 *Plegadis,* and 10 *Mycteria.* They were much less numerous than in September 1976 (Thiollay 1977a). The White Pelican (*Pelecanus erythrorhynchos*) deserves a special mention: There were 13,588 counted in 23 days (19,000 estimated for 31 days). This figure is only a part of the whole population since the species winters in the southern United States and along both coasts of Mexico (AOU checklist 1957, Peterson and Chalif 1973), and neither the beginning nor the end of the passage has been seen.

Behavior of migrants

   Since this work was intended to determine the magnitude of the migration, all my time was devoted to a thorough search and census of the migrants, and no detailed study of their behavior could be done.

   Migration began rather late in the morning. Large flocks rarely appeared before 12:00 noon, never before 11:00 a.m., and sometimes after 1:00 p.m. Only some groups of

west of Palma Sola, northern Veracruz (Mexico).

| | | | | | | MAY | | | | | TOTAL |
| | | | | | | | | | | | Counted during 23 observation days |
23	24	26	27	29	30	1	2	4	5	6	
385	3,418	1,067	3,642	681	341	62	62	292	325	51	25,820
5	31	4	8	4				8	4		333
4	21	3	7	3	4	2			2	1	380
			1						1		2
10		1					1				14
56	1,238	1,547	2,371	442	219	52	10	55	1,853	142	12,432
2	2		2	2							170
15	11	8	56	41	14	6	1		16	3	1,396
			2			1					45
1	1	1	3	5	1				2		29
1,618	1,970	302	4,984	1,230	3,670	898	68	129	1,429	450	202,147
57	1,135	161	1,779	95	76	34	7	77	68	24	16,684
											6
9	6	3	26	8	1						2,597
											7
2	2	8	2	2	2		3	3	2		48
2,159	7,835	3,105	12,881	2,514	4,328	1,055	152	564	3,702	671	262,110

Vultures or *Buteo,* which had spent the night in the surrounding hills, started between 8:00 and 10:00 a.m. Flights were dependent on weather conditions and usually lasted 2 to 6 hours. In the beginning of the afternoon *Buteo* formed the bulk of the migrants, but in the last two hours small hawks *(Falco, Accipiter)* increased markedly, often along with *Ictinia* and *Cathartes* whose large flocks frequently appeared very late (around 5:00 p.m.).

Birds showed their usual migration pattern, soaring to get height, then gliding on long distances and soaring again. Their flyway, however, shifted all day between the coast and the mountains, even without detectable change in local weather conditions. Thus with sunny weather and a south wind the early migrants were seen above the eastern hills. Then they crossed the Palma Sola–Plan de las Hayas road more and more west-ward, and after 3:00 p.m. they sometimes flew well above the distant mountains. Fortu-nately this tendency was reversed with north wind and clouds on the high range, and in the afternoon birds drifted toward the coastal plain above which they migrated even when fog covered the hills.

A commonly observed behavior was a reluctance to fly under the dark clouds even if conditions remained favorable. When clouds began to build up over the mountains, the birds tended to fly around them.

Buteo and *Cathartes* are strongly gregarious, associating with any other species. *Ic-tinia* shows intra- but less interspecific attraction and often forms dense monospecific flocks. *Pandion, Circus, Accipiter,* and *Falco* travel individually even when they are within a short distance of one another or temporarily join other species. Flocks rising quickly attract other birds, especially those flying low, which often turn up to 90° from their primary direction to join them and take advantage of the best thermals.

Each species has its own flight characteristics: Only soaring and gliding for *Cathartes,* occasional flapping for *Buteo,* strong wing beats and long glides for *Ictinia,* mainly rap-id, flapping flight for *Falco* and *Accipiter,* etc. As a result, their speeds are different. Mississippi Kites are the fastest of all, flying so quickly that some of their flocks can be overlooked if one is not searching constantly.

Roosting behavior was also very different from one species to another. At the end of the afternoon kestrels went down anywhere, perching on isolated trees. Broad-winged and Swainson's Hawks concentrated over remote wooded slopes, soaring for a while be-fore going down and scattering themselves over a large area. Turkey Vultures appeared shortly before sunset in long lines of several hundred birds gliding slowly, lower and lower, to roost in deep valleys *(barrancas),* sometimes more than 20 birds on the same tree. The flocks of Mississippi Kites often went down very late, perching immediately on 2 or 3 large trees.

As usual, very few of these birds were ever seen hunting, even before departing. In the morning most of them stayed on their roosting sites until 9:00 or 10:00 a.m. If up-drafts were not good enough, they began to fly low over the slopes and valleys to search for a suitable updraft, sometimes many kilometers from their roost, and then they went up quickly and disappeared.

Discussion

Three to four hundred thousand hawks (77% Broad-winged) migrated in April along the northeastern coast of Mexico. It is five times what can be seen in a whole autumn in the best lookouts of North America (Heintzelman 1975, W. S. Clark, pers. comm.) ex-

cept in Texas, and more than anywhere in Europe (Thiollay 1977b). The importance of this flyway is emphasized by the huge and continuous migration of passerines and others, involving often half a million birds a day.

Since the central part of Mexico is a high plateau with elevations of around 2,000 m edged on both sides by high ranges, it is easy to understand why soaring birds concentrate on the coastal slopes of this relief, to enter the United States in Texas. But we have seen that the flight lines could change over a wide front according to the weather and are difficult to fully control because of the few roads crossing these mountains. Moreover, we do not know the magnitude of possible central or western flyways.

Counting migrants is the easiest way to evaluate breeding populations of very large areas. Most if not all the world populations of species such as *Buteo platypterus, B. swainsoni* or *Ictinia misisippiensis* cross the Isthmus of Tehuantepec twice yearly. This bridge is the only locality north of Panama suitable to initiate a complete migratory survey. However, a numerous and well-trained team is necessary to control during 3 months some 100 km of hilly country over which hawks are often flying very high.

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*Ed. Note: N. G. Smith has been working on raptor migration in Panama for some years. See *Smithsonian Institute Report 7,* Winter 1974.

Figure 1. Study area showing presumed and known routes of spring migration.

COMMENTS ON THE RECOGNITION OF OFFSPRING BY RAPTORS

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Stinson (1976) presents anecdotes which suggest that Ospreys (*Pandion haliaetus*) may be able to recognize their own fledged young, and he contrasts his observations with those of Postulpalsky and Holt (1975), which suggest that Bald Eagles (*Haliaeetus leucocephalus*) may not recognize their own unfledged young. Although it is possible to argue that recognition, or lack thereof, has not been clearly demonstrated in either paper, let us assume that it has.

There is no adaptive rationale for the recognition of unfledged young in altricial species in which there is any distance between nests, because there is no natural way for a strange young to get from one nest to another. Once the young are on the wing, however, it would be adaptive for parents to recognize their own young, particularly in Ospreys, which often nest relatively near to other pairs and which exhibit little territorial behavior.

Territorial defense, nest-building, courtship, egg production, incubation, and the rearing of young constitute a considerable energy drain on the parents, increase their susceptibility to injury and disease and, by decreasing chances for individual survival, constitute a loss in genetic fitness to the adult. This loss in fitness is compensated for by the genes of the adult which have been passed to its young, resulting usually in a net gain. If adults feed unrelated young, there is a loss in fitness, so adults should recognize their own offspring. As long as the young are in the nest, recognition of the nest is sufficient. Once the young have fledged, individual recognition of the young increases the fitness of the adult if there is any chance that unrelated young will be fed. In species which defend large territories, and in which the young remain well within the territory, individual recognition of the young may be unnecessary.

Davies and Carrick (1962) were probably the first to suggest that individual recognition of young develops as the young become mobile. Extremes in the onset of individual recognition can be seen in (1) the Common Murre (*Uria aalge*) which lays its egg on a rock edge in extremely close proximity to those of neighbors, the eggs can roll a bit on slanting ledges, and the parents recognize their own eggs (Tschanz 1959); and (2) Barn Swallows (*Hirundo rustica*) and Tree Swallows (*Iridoprocne bicolor*), which do not recognize their own young until about the time of fledging (Burtt 1977).

It would be interesting to determine, experimentally, the age at which Ospreys and other raptors begin to recognize their own young, but I would argue against such a study. There have been more than a few studies on parental recognition of young in a variety of birds, and there is every reason to expect that the phenomenon occurs in almost all species. Further studies of the phenomenon should not be performed on species that are suffering from low or declining populations, which includes too many of our raptors.

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NESTING POPULATIONS OF RED-TAILED HAWKS AND GREAT HORNED OWLS IN CENTRAL OHIO

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Abstract

Nesting populations of Red-tailed Hawks (*Buteo jamaicensis*) and Great Horned Owls (*Bubo virginianus*) were studied from 1974 through 1976 on a 510-km² (197-sq.-mi.) area located in Delaware County, Ohio.

In 1976, 59 nesting pairs of Great Horned Owls, 6 non-nesting pairs, and 9 unpaired individuals were located, while 78 nesting pairs of Red-tailed Hawks, 7 non-nesting pairs, and 7 unpaired individuals were located. Density of Great Horned Owls was one nesting pair per 8.2 km² (3.16 sq. mi.) of usable habitat, and density of Red-tailed Hawks was one nesting pair per 6.2 km² (2.39 sq. mi.). The rate of nonbreeding for Great Horned Owls and Red-tailed Hawks was 15 percent and 12 percent, respectively. Productivity of Great Horned Owls averaged 2.0 eggs per observed clutch, 1.9 nestlings per hatched clutch, 1.7 fledglings per successful nest, and 1.2 young fledged per nesting attempt. Red-tailed Hawk productivity averaged 2.0 eggs per observed clutch, 2.12 nestlings per hatched clutch, 1.96 fledglings per successful nest, and 1.29 young fledged per nesting attempt. Nest failure rate for Great Horned Owls was 25 percent. Red-tailed Hawk nest failure rate was 34 percent, and nestling mortality was 19.7 percent. Causes of Red-tailed Hawk nest failures were largely undetermined although predation by Great Horned Owls was often suspected.

Introduction

Recent studies of Red-tailed Hawks (*Buteo jamaicensis*) and Great Horned Owls (*Bubo virginianus*) suggested that nesting densities of these raptors in Ohio were markedly lower than densities reported elsewhere (Shelton 1971, Cornman 1973, Misztal 1974). This study ranged from 1974 through 1976. Most of the information on population density and productivity of these birds, however, was obtained during the last year. Therefore, this report will focus on the results of that year.

Study Area and Methods

A 510-km² area was selected in Delaware County, Ohio (approximate coordinates, north latitude 40° 08′ and 40° 20′; west longitude 83° 10′ and 82° 96′; see figure 1). Topography in Delaware County is flat to gently rolling, and land is devoted largely to agriculture (67%) with small percentages of pasture (16%) and woodlots (9%). Three major drainages traverse the study area, two of which have reservoirs comprising a combined area of 17 km². Urban and residential development occupies approximately 8 percent of the county, where the city of Delaware covers approximately 26.4 km² of this land.

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Nesting Red-tailed Hawks (RTH) and Great Horned Owls (GHO) were located from foot surveys and road surveys during a period from early February through April. We considered a nest to be active if an adult raptor was observed on the nest or if signs of recent occupation were evident (i.e., eggs, eggshells, fresh nest lining, abundant white-wash, and fledglings). Individual or paired birds were listed as nonbreeding when repeated searches failed to reveal an active nest. Inasmuch as other investigators have reported high rates of abandonment of incubating raptors disturbed by climbers (Fitch et al. 1946, Luttich et al. 1971), we obtained clutch-size data without climbing by using a mirror and pole device (Parker 1972). It was necessary to climb only once to most nests, to determine hatching success and to weigh nestlings; this was usually done within three weeks after hatching. Age of nestlings was determined by comparing body weights of each nestling to known growth rates of five nestling RTHs and two GHOs measured on the study area in 1975 and 1976. Beyond this time, age was determined by the linear measurement of the 7th primary, and/or overall size and plumage development. Final reproductive outcome was determined by counting the four- to six-week-old nestlings from the ground with the aid of a mirror and pole device and binoculars.

Results and Discussion

Breeding chronology. Great Horned Owls: Of 53 nests occupied by GHOs in 1976, 31 (59%) were former RTH nests, 17 (32%) were tree hollows, and 5 (9%) were arboreal squirrel nests.

We visited 10 nests while hatching was in progress. Dates of first hatch ranged from 7 March to 21 March ($\overline{X}$: 13 March, 10 nests). In 16 other nests where nestling were aged by weight, hatch dates ranged from 15 February to 26 March ($\overline{X}$: 10 March). We used 34 days as an estimated incubation period (Austing and Holt 1966) and estimated laying occurred between 12 January and 21 February ($\overline{X}$: 5 February, 26 nests). No attempt was made to determine actual fledging dates, but newly fledged young were observed in the last week of March. Assuming the variable nestling period to average about 45 days (Hoffmeister and Setzer 1947), fledging dates ranged from the last week of March to the first week of May.

Red-tailed Hawks: Nest-building activities were observed on 27 January 1975 and on 4 February 1976. Both instances occurred on unseasonably warm, sunny days. Of 41 RTH territories active in 1975, 34 (83%) were reoccupied by RTHs in 1976. Pairs in the 34 reoccupied territories built new nests in 22 (65%) and reused former nest sites in 12 (35%) territories. Of the 29 nest sites in 1975 not reused by RTHs in 1976, 10 (34%) were occupied by GHOs, 9 (13%) were unused, and 10 (34%) had been destroyed, presumably by weather.

In 11 nests visited while hatching was in progress, date of first hatch in 1976 ranged from 11 April to 2 May ($\overline{X}$: 19 April). In 44 other nests where young were aged by weight, the hatch dates ranged from 9 April to 10 May ($\overline{X}$: 19 April). Our record of the first egg in a clutch hatching 34 days after it was first observed as a single egg agrees with the length of the incubation period observed by Hardy (1939). Assuming the incubation period to average 34 days, estimated laying dates at 55 nests ranged from 6 March to 6 April ($\overline{X}$: 16 March). Actual dates of fledging were generally not determined, but the nestling period averaged 42 days for nestlings weighed on a daily basis. If the nestling period is assumed to average 42 days, estimated fledging dates ranged from the last week of May through the last week of June.

Nesting Season Density. Great Horned Owl: In the study area in 1976, Great Horned

Owls numbered 59 nesting pairs, 6 non-nesting pairs, and 9 unpaired individuals, thus a total of 74 activity centers (figure 1). An owl density of one nesting pair per 8.2 km² was calculated for the 483.6 km² of usable habitat in the study area, excluding the land occupied by the city of Delaware. Great Horned Owls in our study area were distributed in considerably higher densities than those previously reported in Ohio (i.e., 82.9 and 171.7 km² per nesting pair reported by Cornman 1973 and Misztal 1974, respectively). Distances between the nearest adjacent owl nests average 2.0 km, with a minimum distance between active owl nests of 0.9 km. Nonbreeding in GHOs in the study area in 1976 was approximately 15 percent.

Red-tailed Hawk: The RTH population in 1976 consisted of 78 nesting pairs, 7 nonnesting pairs, and 7 unpaired individuals, yielding a total of 92 activity centers (figure 1). Red-tailed Hawk density on the usable habitat of the study area averaged one nesting pair per 6.2 km². Densities on selected 52-km² plots ranged from 10.4 km² per nesting pair in the sparsely wooded uplands to 3.4 km² per nesting pair along the heavily wooded river drainages. The average distribution of RTHs in the study area in 1976 was higher than those reported elsewhere in Ohio (i.e., 24.9, 43.0, and 50.0 km² per nesting pair reported by Cornman 1973, Misztal 1974, and Shelton 1971, respectively). Adjacent RTH nests were spaced an average distance of 1.5 km, with a minimum distance between active nests of 0.6 km. Nonbreeding in RTHs in the study area in 1976 was approximately 12 percent.

Productivity and Mortality. Great Horned Owl: Clutches in 19 Great Horned Owl nests ranged from 1 to 4 with a mean of 2.0, and broods in 32 nests ranged from 1 to 3 with a mean of 1.9 (table 1). We found that 8.8 percent of the eggs in 17 nests failed to hatch. Nestling mortality in 32 nests was approximately 13 percent. Great Horned Owl productivity in 42 nests where young were successfully fledged averaged 1.69 young per successful nest; but, when unsuccessful nesting attempts are included in the average, the net productivity is 1.27 young fledged per nesting attempt.

Of 56 Great Horned Owl nesting attempts with known outcome in 1976, 14 (25%) failed to fledge young. Many nest failures were believed to have occurred during incubation or shortly after the eggs hatched, judging from the lack of an accumulation of whitewash at the nest. Human disturbance was the probable cause of three nest failures, and predation by raccoons and wind damage each caused two nest failures.

Red-Tailed Hawk: The clutch and brood sizes of RTHs ranged from 1 to 3 with a mean clutch size in 38 nests of 2.0, and a mean brood size in 57 nests of 2.12 (table 1). (Average brood size is larger than average clutch size because of the low hatching success (16.7%) of single-egg clutches). In 26 nests for which clutch size and successful hatching are known, 4 had one added egg each, a hatching failure rate of 7.3 percent. Nesting mortality rate in 56 nests was 19.7 percent, with loss of the entire brood accounting for 13 mortalities in 6 unsuccessful nests, and brood reductions accounting for 11 mortalities in 10 successful nests. The productivity in 50 successful nests averaged 1.96 young fledged per successful nest, but, when all nesting attempts are included, the net productivity averaged 1.29 per nesting attempt.

Because of low hatching success, single-egg clutches had a nesting success rate (16.7%) which was significantly (X^2, $P \leq 0.0001$) lower than that of 2-egg clutches (87.5%) or 3-egg clutches (86.7%). The final productivity of 2-egg and 3-egg clutches averaged 1.8 and 2.4 young fledged per successful nest, respectively. Brood reductions, occurring 10 times as frequently in broods of three (62%) as in broods of two (6%), suggest a higher

Table 1. Population and productivity statistics for Red-tailed Hawks and Great Horned Owls.

Red-tailed Hawk Studies

Researcher	Average density: km² per nesting pair	Average non-breeding rate %	Average clutch size	Average brood size	Average no. young fledged per nesting attempt	Average nest failure rate %	Hawk to owl nesting ratio
Kirkley and Springer 1980 (Ohio)	6.2	12	2.0	2.12	1.29	34	1.3:1
Cornman 1973 (Ohio)	24.9	8.4	—	—	1.5	16	5:1
Craighead and (Michigan)	19.2	30	2.0	—	0.9	—	—
Craighead 1956 (Wyoming)	2.6	17	2.3	—	1.4	—	3:1
Fitch et al. 1946 (California)	1.3	—	2.0	2.2	0.9	46	—
Gates 1972 (Wisconsin)	10.6	—	—	—	1.1	35	10:1
Hagar 1957 (New York)	8.0	35	—	1.9	1.1	41	1.5:1
Johnson 1975 (Montana)	8.0	12	2.53	2.53	1.57	40	—
Luttich et al. 1971 (New York)	7.0	20	2.0	1.9	—	26	—
McInvaille and Keith 1974 (Canada)	7.5	16	2.1	2.0	0.92	—	1.3:1
Misztal 1974 (Ohio)	43.0	—	—	—	—	—	—
Orians and Kuhlman 1956 (Wisconsin)	7.3	10	—	1.9	1.4	26	2.3:1
Seidensticker and Reynolds 1971 (Montana)	—	—	2.9	2.6	0.9	50	3:1
Shelton 1971 (Ohio)	50.0	—	—	—	—	—	—
Wiley 1975 (California)	3.2	4.5	2.53	2.19	1.64	26.4	—

Great Horned Owl Studies

Researcher	Average density: km² per nesting pair	Average non-breeding rate %	Average clutch size	Average brood size	Average no. young fledged per nesting attempt	Average nest failure rate %	Hawk to owl nesting ratio
Kirkley and Springer 1980 (Ohio)	8.2	15	2.0	1.9	1.27	25	
Baumgartner 1939 (Kansas)	1.3	—	—	—	—	—	
Boswell 1974 (Ohio)	—	—	2.0	1.45	1.18	36	
(Colorado)	—	—	2.66	1.85	1.69	8	
Cornman 1973 (Ohio)	82.9	—	—	—	—	—	
Craighead and (Michigan)	19.2	30	1.9	—	1.1	—	
Craighead 1956 (Wyoming)	7.8	0	2.2	—	2.0	—	
Hagar 1957 (New York)	12.2	27	—	1.8	1.5	11	
Houston 1975 (Canada)	5.2	(3–56)	—	—	—	6.5	
McInvaille and Keith 1974 (Canada)	22.0	(0–80)	2.37	2.2	1.8	—	
Misztal 1974 (Ohio)	171.7	—	—	—	—	—	
Orians and Kuhlman 1956 (Wisconsin)	14.5	30	—	1.82	1.46	16	
Seidensticker and Reynolds 1971 (Montana)	—	—	2.2	2.2	1.2	36	

degree of nestling competition in the larger broods. Fratricide may account for some of the brood reductions. In 1974, we observed from a blind a sibling fratricide sequence in which the largest of three RTH nestlings pecked both its nestmates to death. At one nest in 1976, we found evidence of sibling aggression where the smaller of two nestlings had parts of its head scarred and bare.

In 76 RTH nests with known outcome, 26 (34%) failed to fledge young. The causes of RTH nesting failures were often difficult to determine since the majority of the failures occurred during the incubation or early brood stages. Of the known causes of nest failure in 1976, human disturbance caused the desertion of three nests, wind and lightning each destroyed one nest, and predation by raccoons, crows, and GHOs (Springer and Kirkley 1978) accounted for the failures of one, two, and three nests, respectively.

Summary

Nesting populations of Red-tailed Hawks and Great Horned Owls were studied from 1974 to 1976 on a 510-km² area in Delaware County, Ohio. Population density and productivity of both raptors were similar to those values reported elsewhere in North America, but densities of these two raptors were considerably higher than those reported previously in Ohio.

In 1976, Great Horned Owls number 59 nesting pairs, 6 non-nesting pairs and 9 unpaired individuals, yielding an average density of 1 nesting pair per 8.2 km² of usable habitat and a nonbreeding rate of 15 percent. The estimated mean hatching date in 1976 was 10 March. Great Horned Owl productivity averaged 2.0 eggs per observed clutch, 1.9 nestlings per hatched clutch, 1.7 fledglings per successful nest, and 1.2 fledglings per nesting attempt. A hatching failure rate of 8.8 percent, a nestling mortality rate of 13 percent, and a nest failure rate of 25 percent were recorded for Great Horned Owls in 1976.

In 1976, Red-tailed Hawks numbered 78 nesting pairs, 7 non-nesting pairs, and 7 unpaired individuals, yielding an average density of one nesting pair per 6.2 km² and a nonbreeding rate of 12%. In 1976 the estimated mean hatching date was 19 April. Red-tailed Hawks produced an average of 2.0 eggs per observed clutch, 2.12 nestlings per hatched clutch, 1.96 fledglings per successful nest, and 1.29 fledglings per nesting attempt. A hatching failure rate of 7.3 percent, a nestling mortality rate of 19.7 percent, and a nest failure rate of 34 percent were also recorded for Red-tailed Hawks in 1976.

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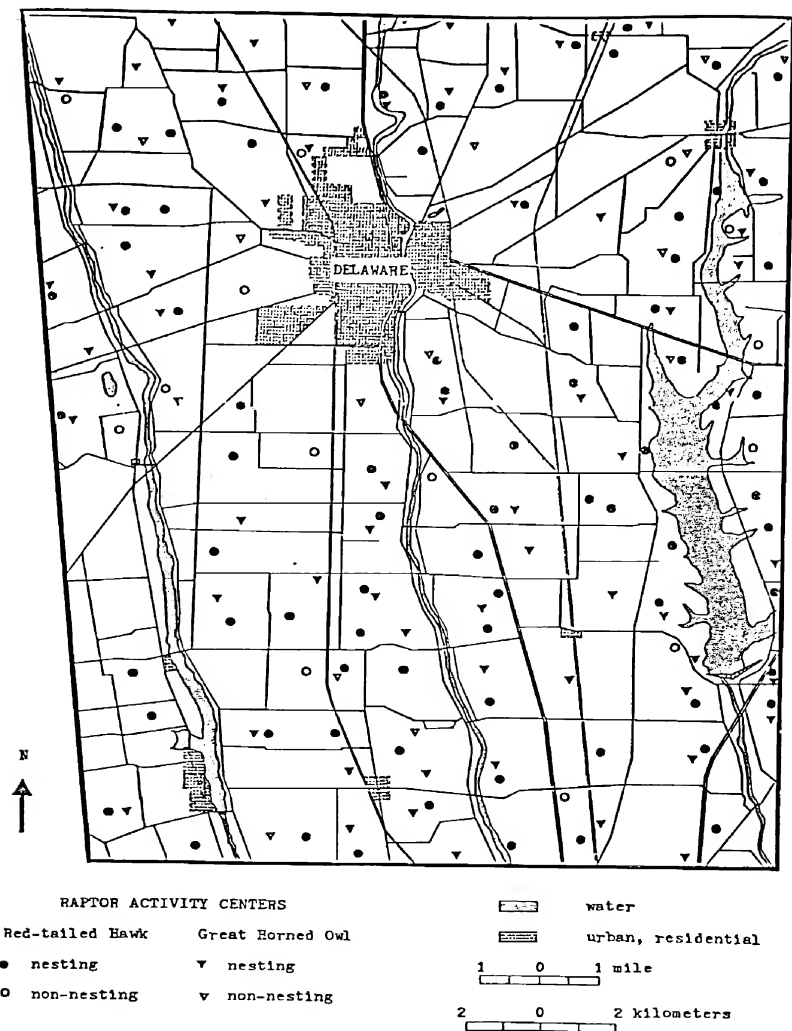
Figure 1. Distribution of Red-tailed Hawks and Great Horned Owls on the study area in 1976.

PRE-NESTING BEHAVIOR OF THE SWALLOW-TAILED KITE (*ELANOIDES FORFICATUS*), INCLUDING INTERFERENCE BY AN UNMATED MALE WITH A BREEDING PAIR

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Snyder (1974) has described the breeding biology of the Swallow-tailed Kite (*Elanoides forficatus*). My observations of their pre-nesting behavior, made while staying at the Archbold Biological Station at Lake Placid, Florida, confirm his on copulations, courtship feeding, and nest-building. I report two aspects of behavior, one, the activities of an unmated male and the other relating to courtship feeding, that have not been reported previously, or at least not described in detail as far as I am aware. My observations were made between 16 March and 1 April 1979 at Parker's Island, Highland County, Florida, a colony known to have been in existence for at least 25 years. Past nests, from local reports, were located in the tops of tall slash pines (*Pinus elliotii*) as were two of the three nests in 1979. A third nest was apparently located in a swamp (bayhead) located 1.1 km away. The colony consisted of seven individuals, three pairs and an unmated male. The two pairs in the pines nested close to one side of a road and did their courting and perching on bare trees on the other. This situation was favorable to making observations, and I did not use a blind. Determination of sex was possible during much of the first 90 to 120 min. of a day, when the females spent most of their time perching on the dead trees where they were subject to copulations and courtship feedings.

Activities of an Unmated Male

Intrusions of an unmated male (hereafter designated IM for intruding male) were largely upon pair A. Pair A completed a nest 10 days later than the other two pairs of the colony. The latter became relatively inactive once incubation began. The intrusions of IM involved conflicts with pair A and interference with copulation, courtship feeding, and nest building.

Copulations. IM interfered with copulation 14 times. On 18 March, when in flight, IM knocked male A (MA) from the back of female A (FA) twice in 13 min. But physical interference was not always needed. On 26 March MA mounted FA five times in succession, breaking away each time when IM circled within 5 m. The intruding male tried to copulate with FA four times. She never assumed her horizontal invitation pose, and all he was able to do was to alight on or brush over her back, momentarily.

Courtship Feedings. As with the copulations, interference took two forms, with IM either trying to prevent MA from feeding FA (N = 3) or to feed her himself (N = 11). On 27 March IM swooped and knocked MA away two times in succession when the latter was about to feed his mate. On the following day he knocked FA from her perch after she had received an anole (*Anolis carolinensis*) from MA. Although IM carried anoles to feed FA, she never assumed her horizontal invitation pose and never accepted prey

from him. On one occasion female B (FB), who had just left off incubating, accepted an anole from the unmated male.

Interference with Nest Building. The chief interference of IM was to perch within 2 to 4 m of the nest. On 28 March he twice swooped at FA when she came in carrying nest material, forcing her the first time to leave and the second time to drop the stick she was carrying.

Conflicts. IM persisted in remaining close to pair A for hours each day. MA was also persistent in trying to drive him away. The result was that much time was taken up with the two kites circling over the nest area. This conflict circling differed from the circling seen at times when the other members of the colony gathered, by the tighter circles, more flapping of wings, and dives as MA partly closed his wings to dive on IM. Many *per-weat* calls accompanied these conflicts. I never saw physical contact although I twice saw the kites come within centimeters of each other. These conflicts diverted MA's attention from his mate and nest-building. Evidence for this was suggested by observations on 28 March when IM was absent between 06:25 and 08:08. During this interval MA copulated five times and fed his mate anoles nine times, the most attention that he had paid to her on any single morning. As soon as IM returned at 08.08, the diving and circling began again. I never saw aerial maneuvers that I could interpret as courtship although the question of their being so is raised both by Brown and Amadon (1968) and by Snyder (1974).

Courtship Feeding and Displacement Activity

Of 84 observed transfers of prey from the males to the females of the three pairs, the prey was an anole 6–7 cm in length in 83 and an unidentified object in one. All the females flattened with wings slightly out in an invitation pose (Snyder 1974) on seeing their mates coming and accepted the offerings readily. Three quarters of the observations were made on pair A. Male A brought anoles to his mate four times on 19 April between 06:48 and 07:27. Then at 07:34, for the only time by any male, he brought a small frog. When he alighted by his mate, she made no move to take it. Male A flew off, circled, and tried to feed her 12 times in 34 min., carrying the frog the whole time and shifting it from bill to feet and back. On four of these attempts he held his wings up and partly open for periods of 15 to 60 sec. The wings-out maneuver appeared to reflect a conflict situation in which the male was uncertain whether to stay or to fly. Although FA always accepted anoles from MA, she would not, it seemed, accept a frog. The unmated male circled near the perching tree on three occasions carrying an anole. FA assumed no invitation pose and refused his offering the two times he alighted beside her. He then rested with wings partly out in what I considered, for both males, to be a displacement activity.

Discussion

I have found no previous accounts of interference by an unmated bird with pre-nesting Swallow-tailed Kites. Skutch (1965) speaks of as many as six additional birds at a nest but gives no explanation. I saw extra birds by nest A but could see from lines of flight that they were from the other pairs nesting in the same colony, one pair coming from as far as a kilometer away. There were never more than seven kites at Parker's Island and one of these, the unmated male, behaved differently from the others. Snyder (1974) speaks of a single extra kite but gives no further details.

A question is whether female Swallow-tailed Kites always demand anoles in courtship feeding. Snyder (1974), in the two courtship feedings he describes, noted an anole in one and a lizard in the other.

Although Swallow-tailed Kites are not considered a threatened species, they have been extirpated from most of their range within the United States (Bent 1937). The Parker's Island colony, consisting of 20 pairs in the 1950s (local report), had dwindled to three pairs by 1979. Any factors that may contribute to further decline would seem worthy of study. The persistent time- and energy-consuming intrusions of the unmated male must have been a handicap to the mated pair. Yet interpretations are difficult. Pines suitable for nesting appeared to be scarce, and pair A might have experienced delay even without the intruder. Although I left Florida on 1 April, subsequent observation by Fred E. Lohrer showed that pair A did succeed in establishing a nest.

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JUVENILE PRAIRIE CHICKEN PREDATION BY MARSH HAWK

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While Marsh Hawks (*Circus cyaneus*) are known to prey upon Prairie Grouse (Grange, Wisconsin Grouse Problems. Wisc. Cons. Dept., Madison, 1948), no published account could be located in the literature detailing an observed attack. During a study of the reproductive ecology of Greater Prairie Chickens (*Tympanuchus cupido pinnatus*) in northwest Minnesota near Crookston, I observed the predation of a 29-day-old chick by an adult female Marsh Hawk.

At 19:15 on 24 July 1975 I located a radio-tagged hen with a brood of 4 chicks feed-

31

ing in a hayed alfalfa field 15 cm tall. The hen and brood were 25 m from a 6-m-wide strip of small grain 40 cm tall. I remained in a mobile-receiving vehicle some 110 m from the brood and observed with binoculars. I gave a chick distress call to determine the exact location of the hen. When the radio signal became constant at 19:20 (indicating no movement), I observed the hawk which had apparently just landed about 5 m from the hen near the edge of the grain strip. The hawk preened until 19:22 when it flew away from the brood, over the grain strip, and landed 100 m away. At 19:27 the hawk returned, flying near to the ground, landed, and sat motionless at the edge of the grain strip near the crouched hen and brood. At 19:30 the hawk flew toward the brood, hovered briefly about 1 m off the ground and then dropped sharply, apparently attacking a chick. Immediately the hen flew at the hawk, and feathers were observed flying about from an apparent struggle on the ground. The radio signal indicated considerable activity for 1 or 2 minutes and then became constant as though the hen had been killed. At least 2 chicks then flushed and flew 100 m out into the alfalfa. At 19:34 the hawk took flight, carrying a chick, and once again the hen flew at the hawk, following it for 10–15 m, but no aerial contact was noted. The hawk flew 150 m and landed, probably to eat the chick.

It is probable that the strip of small grain provided ambush cover for the hawk. I had not seen it approach initially, and perhaps the hen had not either. The short cover of the hayfield likely enhanced detention of the brood by the hawk and made possible the subsequent predation.

ANNOUNCEMENTS

WANTED: RECORDINGS OF RAPTOR VOCALIZATIONS

We are in the process of developing and testing a technique for censusing diurnal and nocturnal raptors. The technique is based on responses to recorded raptor vocalizations. We are interested in access to recordings of all North American woodland hawks and owls for which the following information is available: Location and behavioral context within which the recording was made and, if possible, age and sex. We would be happy to respond to any inquiries and to establish correspondence with anyone who is involved in related work. Direct correspondence to: Dr. James A. Mosher, Appalachian Environmental Laboratory, University of Maryland, Frostburg State College Campus, Frostburg, Maryland 21532.

The Migratory Bird and Habitat Research Laboratory, U.S. Fish and Wildlife Service, has been asked to determine the population status of the Cooper's Hawk and the Golden Eagle in the eastern United States and to identify research and management needs. We would appreciate historic and current information about productivity, habitat use, and sources of mortality and disturbance. Please contact:

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