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REPRODUCTIVE BIOLOGY OF NORTHERN HAWK-OWLS IN DENALI NATIONAL PARK, ALASKA

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ABSTRACT — Two nesting pairs of the Northern Hawk-Owk (*Surnia ulula*) were studied in 1980 in Denali National Park, Alaska. Observations began during the incubation phase and ended when the young left the nest and could no longer be found. During this period information was gathered on food habits and breeding biology. Owls did not return to breed in the study area until 1984 when a pair layed eggs at a nest used in 1980. Failure to breed, at least in 1981, was apparently the result of a substantial decrease in the microtine population.

Surprising little is known about the status and biology of the Northern Hawk-Owl (*Surnia ulula*), particularly in North America. Walker (1974) claimed that hawk-owls have been reduced considerably in North America but offered no explanation to account for the reduction. Fyfe (1976) described it as rare to low in abundance in eastern Canada and low to moderate in abundance in central and western Canada. In Europe, Mikkola (1972) believed that hawk-owls had suffered a general population reduction in Finland, Norway, and Sweden, based on small recent invasions. Adequate raptor data are hard to obtain because of the generally low densities of raptors and their habit of nesting in remote and inaccessible places (Newton 1976). The fact that owls are secretive and nocturnal further compounds the problems of obtaining adequate data.

Bent (1938) summarized most early information available on the hawk-owl in North America, and Gabrielson and Lincoln (1959) summarized information on their breeding biology in Alaska. More recently Smith (1970) published information on various aspects of the reproductive habits of hawk-owls near Ottawa, Canada. Information on the hawk-owl in Europe is more extensive (Mikkola 1983).

Although no studies have provided detailed descriptions of hawk-owl breeding behavior, similarities in appearance and behavior between hawk-owls and the diurnal falconiforms are apparent. According to Sparks and Soper (1970), the hawk-owl is an ecological vicariate of a diurnal falcon or accipiter, and behaves like a falconid even though it is primarily a predator of small mammals. Harrison (1973) speculated that the hawk-owl may be filling a vacant diurnal niche.

Here I describe aspects of the breeding biology and behavior of Northern Hawk-Owls nesting in Alaska.

STUDY AREA AND METHODS

Two hawk-owl nests were studied; both were on the north slope of the Hines Creek drainage at about 670 m elevation in Denali National Park, Alaska. The 2 nests were west of park headquarters (R7W,T14S,S7 and R7W,T14S,S12) and 1.8 km apart. Both were within 100 m of the park road.

The nests were located in open needleleaf forest (Viereck et al. 1982) dominated by white spruce (*Picea glauca*). Aspen (*Populus tremuloides*) and balsam poplar (*Populus balsamifera*) occurred uncommonly. Ground cover consisted largely of willow (*Salix* spp.) in wet areas and dwarf birch (*Betula nana* and *B. glandulosa*) in dry areas. Labrador tea (*Ledum palustre*), blueberry (*Vaccinium vitisidaea*), and crowberry (*Empetrum nigrum*) also occurred. Sphagnum was thick in places. Annual rainfall at Denali Park headquarters averages about 37.5 cm, with summer rains and occasional summer snow accounting for most of the total. Daylength varies from 12 hrs in late March and September to 22 hrs. in late June.

Field Observations - Hawk-owls were observed for 137 hrs between 12 May and 5 July 1980. A 20-45x zoom lens spotting scope and 9x binoculars were used to observe all activities. Owls appeared to habituate to observer presence allowing observations to be made from a distance of

less than 60 m from the nest. To reach nests, trees were climbed directly or with the aid of an aluminum ladder. Additional observations of hawk-owls were made in 1977 and 1984. In 1977, a nest from which 5 young fledged was visited twice between 11 June and 2 July, and a different group of 5 fledglings was located on 27 June. In 1984, a pair of adults was observed between 24 March and 7 April near a nest used in 1980. Data from 1976 were from the park observation files.

Clutch sizes in 1980 were measured by climbing to the nest, while brood sizes were determined from the fact that all known eggs hatched and young fledged. In 1976 and 1977 the number of young fledged served as an index of both the minimum clutch sizes and brood sizes.

I noted plumage differences that enabled me to recognize sexes of adults at both nests following observations of copulation, prey exchange, and egg-laying. Males had grayish-brown or blackish-brown barring while in females barring was a lighter chestnut-brown. In the male, the border between the upper breast and foreneck was demarcated by a contrasting blackish band, while the transition in the female was less distinct. The differences were more apparent in one pair than in the other and, according to Mikkola (1983), these kinds of differences can be attributable to age.

Food Habits. Information on food habits was obtained from the analysis of 387 pellets, by direct observation of prey brought to young, and from discarded prey remains. Analysis of pellets provided over 95% of cricetid, 100% of soricid, and about 10% of sciurid and avian prey data. All remaining data was obtained by observation of prey delivery and the location of discarded remains. Pellets were collected beginning on 16 May and it was assumed that all pellets were cast during the 1980 breeding season. Microtines were identified to species on the basis of dentition (Bee and Hall 1956; Hall and Kelson 1959), and a collection of dentition was sent to the University of Alaska for verification. When dentition was lacking or badly fragmented, prey remains were placed in higher taxonomic categories.

Most pellets were collected at scattered and often previously unsearched locations. Since the date when they were cast could not be determined accurately, trends in food habits were determined by direct observations of prey brought to young and by discarded prey remains.

Numerical abundance of prey from pellets was determined by counting pairs of small mammal jaws and by examining skeletons of larger mammals and birds. The biomass contribution of each species was calculated by multiplying numbers of individuals found by mean prey wt. Average prey wts were determined from specimens in the University of Alaska Museum (Appendix 1).

RESULTS AND DISCUSSION

Food Habits. A total of 651 prey remains was recovered from the 2 nests, including at least 4 species of birds and at least 8 species of mammals (Table 1). Mammalian prey comprised over 94% of the combined total biomass, with birds contributing the remainder. Diets of both pairs of owls were similar qualitatively, but differed quantitatively, especially in relative use of *Clethrionomys rutilus.* Pellets from the 2 nests averaged 1.53 and 1.72 prey items, respectively, for an overall average of 1.61 prey items/pellet (range 1 to 4) at both nests. Mikkola (1972) found an average of 1.7 prey items/pellet in Finland.

Microtine voles, particularly *C. rutilus* and *Microtus* sp., were the most important prey of hawk-owls, contributing at least 70% of the total prey biomass. Mikkola (1972) found that voles, particularly *Clethrionomys* sp. and *Microtus* sp. were extremely important in the diet of hawk-owls in Finland, Norway, and Russia, contributing 94.8, 98.3, and 97.7% respectively, of the total prey items. *Clethrionomys* sp. was numerically most important in all countries except Finland, where *Microtus* sp. was most prevalent. Although infrequently represented in European studies, the Water Vole (*Arvicola terrestris*) comprised 99.4% of the prey taken by 2 pairs of hawk-owls nesting on Ulkokrunni Island, Finland in 1977 (Pulliainen 1978). Thus, use of microtines by hawk-owls in this study is comparable to other areas.

The Varying Hare *(Lepus americanus)* and Red Squirrel *(Tamiasciurus hudsonicus)* comprised over 20% of the total prey biomass, a surprisingly large percentage considering that the biomass contributions of sciurids and leporids have not been quantified previously, although hawk-owls are known to prey on them. Dixon (1938) claimed that the Great Horned Owl *(Bubo virginianus)* and hawk-owls were important predators of Varying Hares in Denali National Park. Henderson (1919) observed hawk-owls carrying remains of Varying Hare, but concluded that they probably had been scavenged.

On 27 May the wing of an adult Willow Ptarmigan *(Lagopus lagopus)* was found near a pile of hawk-owl pellets. Flesh remaining on the wing was extremely dessicated, indicating that the ptarmigan had not been captured recently. Ptarmigan, and other grouse, apparently are not important prey items during the breeding season (Table 1), although they are reportedly taken during winter (Fisher 1893). Birds, especially *L. lagopus,* were taken 30 times more frequently during winter than summer in Finland (Mikkola 1972). During the time hawk-owls are confined to the vicinity of their nests, the Gray Jay *(Perisoreus canadensis)* is probably

Table 1. Relative frequency of occurrence and relative biomass of prey in the diet of 2 pairs of Northern Hawk-Owls in Denali National Park, Alaska. Total number of prey items=651; total prey biomass=20.641 kg.

SPECIES	% NUMBERS	% BIOMAS
Bird		
Tetraonidae		
Lagopus lagopus	0.15	2.60
L. lagopus or *Canachites canadensis*	0.31	0.39
Corvidae		
Perisoreus canadensis	0.92	2.09
Fringilidae		
Spizella arborea	0.31	0.07
Zonotrichia leucophrys	0.15	0.12
Small bird	0.92	0.64
Mammal		
Soricidae		
Sorex cinereus	1.39	0.18
Sorex hoyi	0.15	0.01
Leporidae		
Lepus americanus	0.92	9.43
Sciuridae		
Tamiasciurus hudsonicus	2.15	10.85
Cricetidae		
Clethrionomys rutilus	49.00	35.54
Microtus miurus	5.84	4.97
M. miurus or *Microtus pennsylvanicus*	5.53	4.71
Microtus oeconomus	19.82	18.13
Microtus sp.	5.22	4.45
Lemmus sibiricus	0.46	0.49
unidentified microtine	6.76	5.33
Total	**100.00**	**100.00**

a more important source of food than grouse (Table 1).

Trends in Predation. Hawk-owls exploited hares, squirrels, and birds in late May and continued to do so until observations ended on 5 July. Predation on these larger animals was related to the availability of large numbers of easily captured young.

Predation by hawk-owls on Varying Hares was restricted entirely to juvenile hares, taken between 31 May and 24 June. O'Farrell (1965) estimated that first litters of hares were born in late May and that the breeding season ended in late July near Fairbanks, Alaska.

Red Squirrels were taken by hawk-owls between 17 May and 2 July. Although owls preyed predominantly on juvenile squirrels, they also took adults. Since Red Squirrel populations do not fluctuate as widely as those of hares, Red Squirrels probably represent a more uniform food source from year to year than do hares.

Juvenile Gray Jays were taken by hawk-owls between 25 May and 19 June. Young Gray Jays are generally available as early as 15 April; thus they may have been taken more frequently prior to the beginning of observations. Most migrant birds arrived in late May or early June, and fledglings of migrant species generally appeared during the 2nd wk of July. Other than the nestlings and occasional adults of a few migrant, ground-nesting species,

Figure 1. Portion of the bog where male hawk-owl from nest A frequently hunted in 1980.

such as the American Tree Sparrow *(Spizella arborea)* and White-crowned Sparrow *(Zonotrichia leucophrys)*, owls did not regularly prey on migrant birds.

Hunting Habitat. Hawk-owls in Denali National Park frequently hunted in open areas with scattered trees. The male at nest A, for example, hunted a white spruce bog where 60% of 25 observed hunting strikes took place (Fig. 1). The bog, located at 0.60 km NW of the nest, was in an area of widely spaced, stunted white spruce < 4 m tall. The sparse open understory was composed of willow, labrador tea, and blueberry. Poor drainage promoted the growth of a thick sphagnum ground layer. The open understory and sphagnum substrate apparently enabled the male owl to hunt easily. The male at nest B was observed also to hunt an area with short white spruce and a ground cover of scattered shrubs and thick sphagnum.

Foraging Behavior. Hawk-owls captured prey by pouncing from an elevated perch (Table 2). Elevated perches were always spruce trees, and 92% (N=25) of the perches were at the top of a tree. When scanning for prey, owls leaned forward so that the body and tail were nearly horizontal, and the head was tilted downward, presenting a very kestrel-like silhouette. When prey was located the owl's head "snapped" into a fixed position and the body became rigid. When making a strike, owls launched into a gliding dive. If the strike distance was great (Table 2), owls flapped their wings a few times before beginning their descent. Roughtly 2/3 of the hunting strikes of male hawk-owls were successful (Table 2). When potential prey was not properly situated, hawk-owls leaned far forward while engaged in exaggerated tail pumping, a kestrel-like behavior. In extreme cases owls opened their wings and appeared as if to pounce, almost falling off the perch before regaining their balance. At other times owls glided to a lower perch and waited. On 3 July, for example, a male was perched atop a 6 m spruce when he apparently located prey below and immediately flew 3 m and perched at the top of a 2 m spruce. After 20 sec, he glided to a perch 0.60 m high and pounced onto a vole. Hovering by hawk-owls has been noted (C. Collins pers. obs.; Mikkola 1983), but was not observed in this study.

The young of ground-nesting birds were captured on the ground. On 22 June a male owl dropped from its perch atop a 5 m spruce and took a tree sparrow nestling from the nest. Twenty min later the male owl returned, descended to the same nest, and took the remaining nestling. I did not observe the manner in which owls captured fledglings or adult birds.

Hawk-owls may take arboreal prey in a different way. On 15 June, a perched male turned to face a tree about 7 m away and launched into a rapid glide directly toward a young Red Squirrel climbing the trunk. The owl flew directly toward the trunk, and hit a branch, but the squirrel moved out of range before contact was made.

Feeding Behavior. Hawk-owls generally "prepared" prey before feeding. Microtines were eviscerated prior to, or sometimes after, removal of the head. Prey items were eviscerated by a tear in the side, which opened the peritoneal cavity just anterior to the hindlegs. Owls pulled out and discarded the intestines and the stomach. The re-

Table 2: Hunting success, perch height, and strike distance of hawk-owls in Denali National Park, Alaska.

	No. of Observations	Mean Success (%)	Mean (M)	Range	S.D.
Hunting success					
male	28	68			
female[a]	5	20			
total	33	61			
Perch height (male)	25		5.41	0.61—10.61	2.61
Strike distance (male)	18		8.10	0.91—21.21	5.47

[a]80% of the female's strikes occurred while her tail feathers were molting.

mainder of the organs were eaten, and a few times the intestines were swallowed as they were pulled from the rodent. Large prey items were not eviscerated, at least not immediately, but the organs may have been discarded or consumed at a later time. Varying Hares, Red Squirrels, and Gray Jays often were partially plucked before they were eaten.

Except for very small prey, such as fledgling sparrows and young microtines, which were swallowed entire, hawk-owls always began feeding by removing and eating the head, including the relatively large heads of Red Squirrels. In the case of microtines, after the head was removed the remainder was usually swallowed intact. Prey larger than *Microtus* sp. were dismembered more completely and eaten in several pieces. Adult owls did not always completely consume large prey. At various perch sites I found the discarded tails and hindlegs of Red Squirrels, and the legs of Gray Jays. Owlets were observed swallowing the legs and tails of squirrels on occasion.

Food Caching. Hawk-owls cached excess food 47 times during observations. Food was cached more frequently after owlets left the nest than when they were in the nest. During incubation and brooding, when the female remained at the nest, the male conducted all caching and food retrieval. When brooding of the young was completed the female also cached and retrieved prey. The male was twice observed caching prey in a favorite hunting area about 0.60 km from the nest. Prey almost always was cached at least 3 m above the ground on spruce boughs or spruce brooms (caused by the rust *Chrysomyxa arctostaphylii*).

All sizes of prey were cached. Some large prey items were fed upon periodically for up to 24 hrs. Three rodents were retrieved and consumed 5 hr, 1 hr, and 15 min, respectively, after being cached.

Smith (1922) first observed food caching by a hawk-owl during the breeding season, and Collins (1976) and Ritchie (1978) described the food caching behavior of captive and wild hawk-owls, respectively.

Nest Trees. In addition to the 2 nests studied in 1980, single nests were found in 1977 and 1982. All nests were located inside the hollow tops of white spruce trunks 2 to 10 m above the ground (Table 3). In Europe, nests were usually 4 to 5 m above the ground (range 2 to 13) (Glutz von Blotzheim and Bauer 1980). All nest trees were dead, and in all cases nest cavities probably formed when the tops of diseased trees blew off, exposing the hollow upper trunk (Fig. 2). The nest cavities were characterized by sections of old trunk projecting 0.3 to 0.9 m above the nest. Owls entered the nest cavity over low points in this shell. Eggs were laid directly on decomposed sapwood.

Nesting Chronology. In 1980, owls were seen near nest A on 17 April by park employees. On 18 April, a rodent was passed from one adult to another at a habitually used perch. In 1984, when nest B was first reoccupied, owls called near the nest tree on 24 March. On 27 March, one adult was perched at the nest cavity entrance and a microtine was exchanged nearby. According to Eckert (1974), hawk-owls begin breeding (presumably selecting nest sites) in mid-March, and sometimes as early as February. Henderson (1919) observed a pair "in

Table 3. Dimensions of 4 hawk-owl nests in Denali National Park, Alaska.

MEASUREMENT	NEST A (1980)	NEST B (1980)	NEST FOUND IN 1977	NEST FOUND IN 1982	MEAN	S.D.
Height of nest above ground (m)	7.82	9.91	5.08	2.51	6.33	3.22
Cavity depth (cm)	2.6	15.4	14.1	12.8	11.2	5.8
Cavity diameter (cm)	19.2 x 23.1	14.4 x 17.3	21.8 x 25.6	—	18.5 x 22.0	3.8 x 4.3
Tree diameter at breast height (cm)	47.7	40.0	47.3	35.9	42.7	5.8
Tree diameter at nest height (cm)	29.8	20.4	35.1	23.7	27.3	6.5
Tree height (m)	8.74	10.21	5.56	3.18	6.92	3.16

Figure 2. Hawk-owl nest tree (nest B) discovered in 1980.

the act of breeding" on 19 February in Alberta, Canada. Mikkola (1972) found that they began calling as early as 17 February in Finland, and after the beginning of March in Russia, with territories being established a "few weeks" before nesting began. The initiation of breeding apparently can begin as late as early May (Harrison 1973).

Assuming an incubation period of 28 d (Harrison 1973; Terres 1980), and back-dating from the date of egg-hatching, the mean date of clutch initiation in 1980 was calculated to be about 19 April (range 13 to 24 April). Elsewhere in Alaska nests containing eggs range from 16 April to 18 May (Gabrielson and Lincoln 1959). In Alberta and central to southern Canada, eggs normally were found between 30 March and 5 June, and in Labrador and Newfoundland between 9 May and 11 June (Eckert 1974). Extreme dates when eggs were found in Lapland and Finland range from 30 March to 23 June.

The mean date of hatching in 1980 was 17 May (11 May to 22 May). This estimate was based on the condition of the young at nest A. On 29 May the nest contained 4 downy, white young, all with their eyes closed. Spotted Owls and Short-eared Owls open their eyes at 8 to 9 and 7 to 8 d after hatching (Clark 1975; Forsman 1981). Assuming that hawk-owls open their eyes at about 7 to 9 d, and considering the different sizes of the young at the time the nest was examined, I estimated the oldest young to be about 1 wk old when I first examined the brood in late May.

Hawk-owls left the nest in early and mid-June (1 to 5 June and 11 to 15 June). If calculations of hatching dates were correct, the young left the nest when approximately 20 to 22 d old (Fig. 3).

Roles of Adults During Incubation. Incubation was performed entirely by the female, while the male did all the foraging. Mikkola (1972) also found that females did all incubation. The female at nest A remained on the nest except for short periods when she left to receive food, preen, cast, or defecate. When not foraging the male perched in the tops of nearby trees about 30 m from the nest.

Food was usually exchanged away from the nest. Generally the female did not respond immediately when the male arrived with food and he either cached the food or, more commonly, flew to the nest and perched at the cavity entrance. The male frequently flew to the nest entrance several times before the female left the nest and accepted food at a nearby perch.

Roles of Adults During the Nestling Period. The female at nest A brooded the young almost constantly for the first 10 d to 2 wks after eggs hatched. During this time, foraging was conducted entirely by the male. Until the young were about 2 wks old the female received all food at the nest. After the 2nd wk the female left the nest to receive food at nearby perches. Toward the end of the nestling period the female spent almost all of her time perched outside the nest. At this time the male visited the nest only to deliver prey and, when not foraging, usually perched at least 100 m from the female.

Roles of Adults During the Post-Nestling Period. During the first 10 d after the young left the nest females perched nearby constantly. When not foraging, males continued to perch about 100 m from females.

Ten to 11 d after leaving the nest, owlets moved

Figure 3. Owlets approximately 17 days after leaving the nest, 37 days old on 28 June.

further from nest trees, flying up to 30 m horizontally and frequently landing on the ground. When they landed on the ground near a potential perch, they usually would climb. At this time males began to perch nearer the young and even brought food directly to them on occasion. Males were observed to offer only small intact prey to the young, while females often fed owlets pieces of prey.

The female at nest A was first seen hunting about 2 wks after owlets left the nest and by 27 June, 3 days later, roles of the sexes had changed drastically. The female was now absent for periods of at least 5 h and, although presumably hunting part of the time, seldom brought food to the owlets. The male fed and guarded the young in the absence of the female, and owlets were left alone for varying lengths of time when the male foraged. On 5 July, the last day of observation, the male at nest A continued to perch near the young and provided almost all their food. The female at nest B was not observed hunting.

Clutch and Brood Size. Clutch and brood sizes of nests in this study (Table 4) were similar to those reported elsewhere. According to Bent (1938), hawk-owls lay between 3 to 9 eggs, usually 7. Mikkola (1972) recorded a mean clutch size of 6.31 (range 3 to 13), and a mode of 5 for 135 completed clutches in Europe.

Nest Success. Both nesting attempts in 1980 were successful, with no infertile eggs or nestling mortality. Hawk-owls also nested successfully in 1976 and 1977. Virtually no quantitative information is available on nest success or reasons for nest failure in hawk-owls.

Tail Molt. Mayr and Mayr (1954), and Collins (1961) summarized information on tail molt of several species of small owls, although tail molt of the hawk-owl has not been well described. Wheelwright (1863:8443) stated that "the old birds may be seen in deep moult, without tails, even before the young are flyers."

Only the female at nest A molted her tail during the nesting period. The pair at nest B dispersed before tail molt was initiated by either adult. Tail feathers of the female at nest A were first noticed

Table 4. Productivity of hawk-owls in Denali National Park, Alaska.

YEAR	NESTING ATTEMPTS	CLUTCH SIZES	BROOD SIZES	∓ FLEDGLINGS / SUCCESSFUL NEST
1976[a]	2	5,6	5,6	5.5 (2)
1977[a]	2	5,5	5,5	5.0 (2)
1980	2	4,5	4,5	4.5 (2)

[a]nesting attempts, clutch sizes, and brood sizes in 1976 and 1977 are represented by minimum numbers, based on family groups located.

missing on 24 June, and only the 2 central tail feathers remained on 26 June, indicating that the molt was centripetal; the innermost rectrices were last to molt. On 29 June all her rectrices were missing. By 12 July her new tail feathers appeared to be about 20.0 mm long, or about 12% of their total length (Eckert 1974).

Among smaller owls (those with wing lengths < 210 mm) the tail molt is simultaneous, while among larger owls (those with wing lengths of > 230 mm) it is usually gradual or irregular (Mayr and Mayr 1954). Wing lengths of male and female hawk-owls average 220.9 mm and 226.0 mm, respectively (Earhart and Johnson 1970). Simultaneous tail molt in the hawk-owl, then, would extend the upper limit of wing lengths of owls predicted by Mayr and Mayr to undergo simultaneous molt. Since the tail feathers of small owls usually are shed over a period of several days to several weeks, Forsman (1981) has suggested that the word "simultaneous" be used sparingly.

Nest Defense and Natural Enemies. Of the interspecific encounters witnessed, a male hawk-owl defended its nest most vigorously against a Northern Goshawk *(Accipiter gentilis)*. On 20 May the owl attempted to intercept a goshawk that was flying directly toward the nest tree. The goshawk was 200 m away, and flying rapidly about 35 m above the ground when the owl left its perch and flew toward it. The hawk-owl flew past the goshawk without striking it, and then banked and pursued the goshawk until the accipiter was about 40 m beyond the nest.

Other than the goshawk encounter, hawk-owls remained perched when other raptors flew into view. The Golden Eagle *(Aquila chrysaetos)*, for example, soared high over the nest at least once every 2 observation days, but hawk-owls only watched until the eagle disappeared from view. Other raptors elicited a more vigorous response. On 21 May, a perched male hawk-owl stiffened as a Red-tailed Hawk *(Buteo jamaicensis harlani)* sailed rapidly over the nest. Although it remained perched, the owl called several times and was visibly agitated.

I observed no instances of hawk-owls being pursued by other raptors and no instances of predation on adults or young were recorded. Hawk-owls, however, often were harassed by other birds, particularly the Gray Jay, American Robin *(Turdus migratorius)*, and Varied Thrush *(Ixoreus naevius)*. Robins and Varied Thrushes attacked hawk-owls vigorously, diving from above and in 3 to 4 instances struck perched owls. These attacks disrupted the activities of hunting owls, and on several occasions males flew to the nest area with Robins or Varied Thrushes in pursuit. A male hawk-owl once responded aggressively when it was attacked by an American Kestrel *(Falco sparverius)*. During the descent phase of each of the kestrel's 10 pendulum attacks, the owl jumped from its perch into the air and presented its talons to the falcon.

Cryptic Posture. On 2 different occasions, once in response to the approach of a goshawk and once in the presence of a low-soaring Golden Eagle, male hawk-owls assumed vertically elongated postures. The owl stiffened and the feathers of the breast, belly, and back were drawn tightly to the body. The wings also were pulled tightly against the body and the leading edge was aligned vertically. The feathers in the facial disc above the eyes were raised, making the eyes appear very large.

The posture was identical to the "concealing pose" of the Northern Saw-whet Owl *(Aegolius acadicus)* and the Boreal Owl *(Aegolius funereus)* as described by Catling (1972), and apparently is the same posture assumed by several other small strigids, including the Eastern Screech Owl *(Otus asio)*, Long-eared Owl *(Asio otus)*, and Elf Owl *(Micrathene whitneyi)* (Bent 1938; Ligon 1968).

1981 Breeding Season. Hawk-owls were seen occasionally in 1981, and did not nest in the study area. Other researchers have noted similar declines in hawk-owl numbers and reproductive success in interior Alaska (Dixon 1938; Murie 1963). Even though hawk-owls were not observed to breed in 1981, there were 14 sightings of single owls between 24 March and 15 September. Twice owls were observed < 2 km, and once only 0.3 km from 1980 nest sites.

Although hawk-owls feed on birds, squirrels, and young hares, they apparently depend on microtines for successful nesting, thus resembling other strigid rodent specialists which also respond to low rodent densities by failing to breed. Among 10 species of Fenno-Scandian owls, hawk owls were second only to Snowy Owls *(Nyctea scandiaca)* in the proportion of Microtinae in the diet (Mikkola 1983).

Hawk-owls did not breed again in the study area until 1984 when a pair layed eggs at a nest used in 1980. It was not determined if the owls bred successfully.

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Appendix 1. Weights of prey species used to compute biomass consumption by hawk-owls.

SPECIES	NO. OF SPECIMENS	MEAN WEIGHT (G)	SOURCE
Birds			
Lagopus lagopus	60	550	UA[a]
L. lagopus or *Canachites canadensis*	—	40	estimated mean juvenile wt.
Perisoreus canadensis	33	72	UA[a]
Spizella arborea	—	7	estimated mean juvenile wt.
Zonotrichia leucophrys	26	25	UA[a]
Small birds	—	22	estimated mean juvenile wt.
Mammals			
Sorex cinereus	25	4	UA[a]
Sorex hoyi	25	3	UA[a]
Lepus americanus	24	325	mean juvenile wt., UA[a]
Tamiasciurus hudsonicus	29	160[b]	mean wt., UA[a]
Clethrionomys rutilus	25	23	UA[a]
Microtus miurus	25	27	UA[a]
M. miurus or *Microtus pennsylvanicus*	20	27	UA[a]
Microtus oeconomus	25	29	UA[a]
Microtus sp.	—	27	estimated
Lemmus sibiricus	25	34	UA[a]
Unidentified microtine	—	25	estimated

[a]Specimens in University of Alaska Museum
[b]Mean weight from a combination of adult and juvenile weights

Third World Conference on Birds of Prey, 1987. An International Conference will be held 22-27 March 1987 at Eilat, Israel. The Conference will be organized by the World Working Group on Birds of Prey in conjunction with the Israel Raptor Information Center and the U.S. Hawk Mountain Sanctuary Association. The Conference will consist of seven paper sessions, each of which may occupy up to one whole day. The themes and organizers are as follows: 1) Conservation and biology of rare raptors—U.-Meyburg and N. Collar; 2) Conservation and biology of rare owls—R. J. Clark and H. Mikkola; 3) Raptors on migration and wintering grounds—M. Fuller and J. M. Thollay; 4) Population biology and breeding—I. Newton; 5) Raptors in polluted environments—R. Risebrough and J. Ledger; 6) Education—Y. Leshem and J. Brett; 7) Legislation—P. Robinson. Contributions to these different themes can also take the form of poster papers.

The Conference will take place within the framework of an international festival, which will include a raptor photography competition (under the patronage of Eric Hosking), a painting and drawing competition (patron, Roger Tory Peterson), a film festival and competition, and ornithological and cultural excursions and tours.

During this season, the famous and massive migration movement of raptors over Eilat is in full swing, and in 1985 included 1.1 million raptors of 30 species. **For further information, write to the Honorable Secretary of the World Working Group, Mr. R. D. Chancellor, 15 Bolton Gardens, London SW5 0AL, UNITED KINGDOM.**