NESTING AND FOOD HABITS OF THE LONG-EARED OWL (ASIO OTUS WILSONIANUS) IN MICHIGAN

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NESTING AND FOOD HABITS OF THE LONG-EARED OWL (*ASIO OTUS WILSONIANUS*) IN MICHIGAN

By
William Holliday Armstrong

AN ABSTRACT

Submitted in Partial Fulfillment
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Approved Dan W. Hayne

ABSTRACT

This study was conducted to determine the nesting and feeding activities, the approximate incubation period, the length of time the young remained in the nest, the types of food utilized, the amount of food used, and the wintering habits of the Long-eared Owl in Michigan. Two nesting areas and five winter roosting areas were studied in lower Michigan and approximately 2079 pellets of the species were analyzed.

Individual Long-eared Owls have been noted to migrate but part of the population appears to be non-migratory. Present data show no preference of the Long-eared Owl for coniferous or deciduous habitat.

Eggs are layed from early March to the middle of June and recorded clutches varied from two to seven eggs. During the incubation stage, the male guarded the nest while the female incubated the eggs. Attentiveness of the adults to the young increased and reached a maximum when the young were four days old, and then decreased as the young grew more capable of caring for themselves. Rates of development of the young were unequal and affected by dominance of one young over another. Young that could fly nearly as well as the adults were still fed and cared for by the adult.

Hunting activity of the Long-eared Owl was usually governed by the season of the year and showed seasonal variation. Young owls were fed by the adults and were dependent upon the adults for two months, when my study ended. Evidence obtained during this study indicated that the

family may remain together through at least part of the following spring. Strong evidence supported seasonal changes in diet of the Long-eared Owl and indicated that the species takes the prey most readily available. The Long-eared Owl was found to be pre-eminently a predator of mice in Michigan.

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INTRODUCTION

The Long-eared Owl was one of the most interesting of animals. The species has been studied very little in Michigan, with the extent of most investigations being to record the date of a nest and the number of young and eggs. Even these investigations have been few in number.

The more extensive investigations in Michigan of the activities of Long-eared Owls have been conducted by Pirnie (1943), Sturgeon (1940), and Wood (1951). Most outstanding of the few investigations of Long-eared Owl pellets in Michigan has been the work of Wilson (1938). Other notable pellet investigations in Michigan include those by Warthin and Van Tyne (1922), Spiker (1933) and Geis (1952). Notable contributions from other states include a nesting study in New York by Whitman (1924), a growth study by Sumner (1929) in California and a life history of the species by Bent (1938). An old and still much quoted record is that of Doubleday (1898). Important contributions from investigations of other species of owls were made by Mathews (1921) and Southern (1955). Lesser contributions to Long-eared Owl data in Michigan have been made by Brigham (1946), Wallace and Black (1948), Jorae (1951), Wickstrom (1953 and Black (1955).

I began this study of the Long-eared Owl in Michigan in 1954 after Dr. George Wallace was informed of a Long-eared Owl roost near the University in March of that year. The owls left in the middle of April and during the rest of 1954 I found and examined approximately one thousand of their pellets. The following February (with assistance) I

discovered another winter roosting area of the species. A roosting area near Jackson, Michigan was reported in March, 1955 and the owls left suddenly while I was conducting a study. Later in March, I was informed of a Long-eared Owl nest near Ann Arbor, Michigan, and investigations of this area were made by daily trips from East Lansing. This same month, Long-eared Owls were observed at the Kellogg Bird Sanctuary in the courtship stage and my efforts were turned there too. Considering the above difficulties, it is small wonder that relatively little nesting information has been recorded in Michigan for the long-eared Owl.

This investigation is divided into two main parts:

1. A nesting study of the species; for this data were collected at two nests in the spring of 1955.
2. A food study; this included observations during the breeding cycle, and the data from approximately two thousand pellets of adult Long-eared Owls collected during the winters of 1953-54 and 1954-55 from five different roosting areas.

MATERIALS AND METHODS

The primary objective of field work was to study the nests and food of Long-eared Owls. Nests and wintering roosts were located by personal searching, and by questioning fellow students and other field workers, who kindly reported occupied areas. Field notes cover a period of at least 78 hours of observation on 43 different days.

Pellets as found at these field locations were sacked and dated for later examination. Field notes were recorded and if possible, photographs were taken of the particular area.

Analyses of the pellets were carried out at the University. The most satisfactory method was to break the pellet open by hand, and with forceps and finger tips, dig and sift away every portion of fur or feathers, leaving the bones of the prey. Wallace (1948) found that the skulls of the various mammalian prey were least likely to have been broken in field pellets of the Barn Owl (Tyto alba), and thus were most satisfactory for an accurate count of prey as well as for identification. In the present study, this observation was confirmed by counting all bones in 72 whole pellets. The crania and mandibles were more frequently whole in the pellets than were other bones. The bones most susceptible to breaking were the smaller ones, such as the radius and ulna. Generally, the larger bones, such as the femur, humerus, and pelvic girdle, were present. In one lot of pellets some of the skulls were missing; here limb bones were also counted to determine number of prey. Over the

whole study, however, Dr. Wallace's observation was closely supported.

Attempts to locate Long-eared Owls during the breeding cycle were made by visiting areas in which other investigators reported observing evidence of the birds. If a nest had not been found here previously, the author remained in the area until dusk and listened for the call distinctive of this species. The calling was indicative of the approximate nesting site. Two nests were located in this manner.

After a nest was discovered, four different techniques were used to study the Long-eared Owl family: 1. moving around throughout the nesting area, listening for calls, watching the nest and the adult birds; this technique was valuable in locating a probable hunting territory of the adult female, observing courtship displays, and incubation intervals; 2. observing the nest continually throughout a day or night from either of two blinds, one on the ground and the other in a tree; this technique was useful during the late incubation stage and early nestling stage when the female was never observed off the nest and appeared to be receiving food from the male; 3. climbing up to the nest and examining the eggs or young to determine the stage of development; this technique was important in determining the exact time of hatching, in observing and measuring the young to determine their rate of growth, and in observing various forms of behavior of both young and adults; and 4. listening for the feeding calls of the young Long-eared Owls to locate the family for further surveillance; in this way, the rate of growth of the young owls could be followed and their behavior could be observed for a

time after they left the nest.

Small mammals were live-trapped and marked in conjunction with one nesting study where the author attempted to measure the rate of feeding of the Long-eared Owl family upon a population of its prey. Live traps were set in the vicinity and were visited twice a day, when possible. If animals were caught, the procedure was as follows: the date and place where taken were recorded; if a mouse, the individual was tagged (if not previously tagged) and released where caught. In notes mice were identified as to species (the exception being Peromyscus sp. caught at the beginning of the trapping period), ear and tail measurements and sex were recorded along with tag numbers. Traps were usually baited with corn and apple. The mice were tagged with fingerling fish tags (No. 3) in the skin over the back of the neck. This location apparently afforded least opportunity for a tag to be lost. No instance of loss of a tag was observed.

Notes and photographs were made concerning other animals found in the area and also in studying types of vegetation.

DISTRIBUTION

The distribution of the Long-eared Owl over North America has been described by Bent (1938). He delimits a wide distribution over nearly all the United States and over the timbered regions of Canada, including the tree belt along the streams on the western plains and even on the deserts. He describes the breeding range as extending north to Saskatchewan and Nova Scotia, south to Sourthern California and Missouri, west to California and British Columbia, and east to Maine and New Jersey.

For Michigan, Fig. 1. shows the nesting records which were found for the years between 1938 and 1955; these include nests from this study. Nests have been observed in the following localities:

Rose Lake, Clinton County (Rose Lake Experimental Station notes)

Baker Sanctuary, Eaton County (Brigham, 1946)

Kellogg Bird Sanctuary, Kalamazoo County (Pirnie, 1943 and author's study)

Ypsilanti and Stony Creek, Washtenaw County (Sturgeon, 1940 and author's study)

Monroe County (Wallace and Black, 1948)

Grass Lake, Missaukee County (Jorae, 1951)

Imlay City, Lapeer County (Wickstrom, 1953)

Linwood, Bay County (Black, 1955)

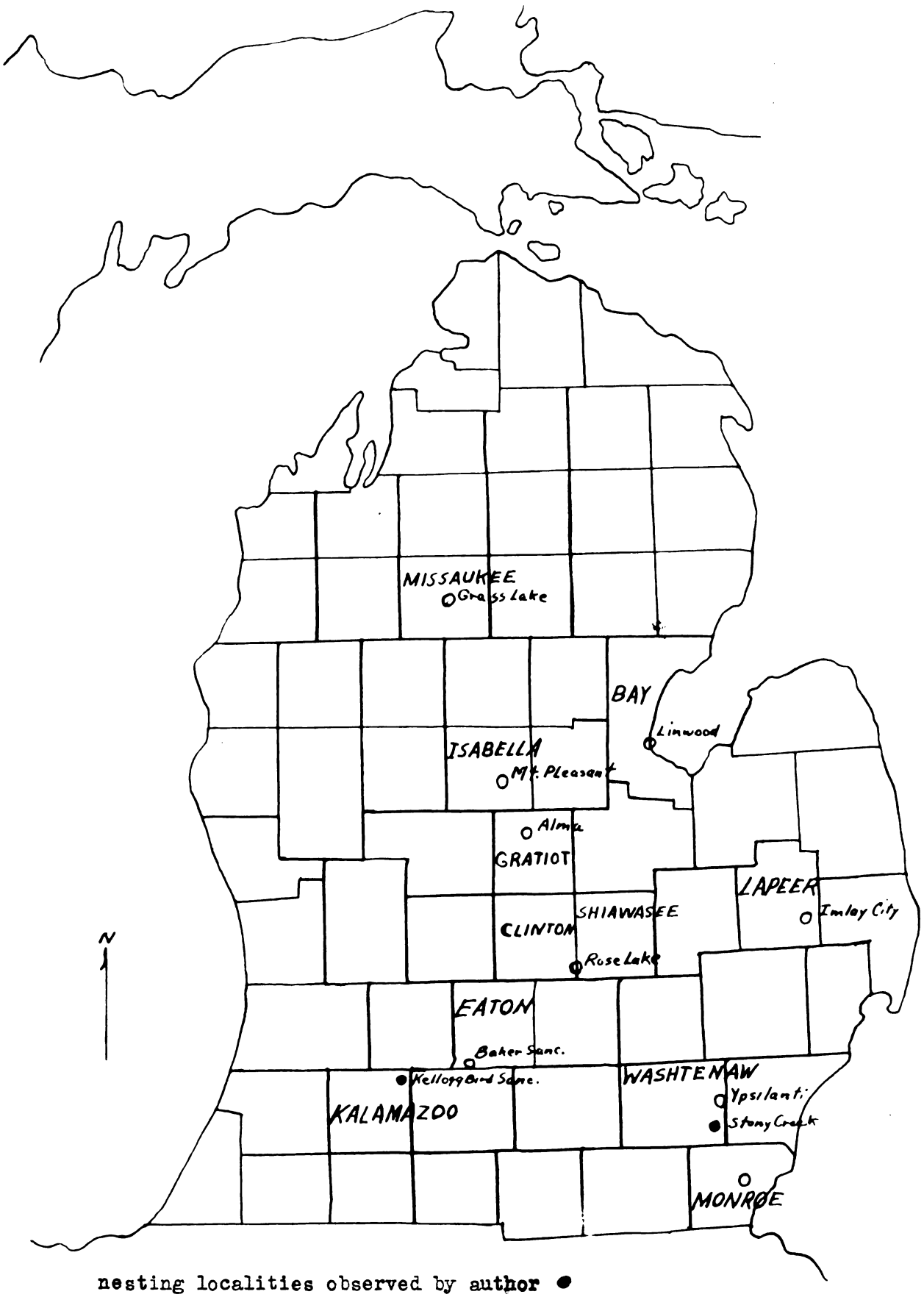
Mt. Pleasant, Isabella County (Black, 1955)

The distribution of these nesting records is shown on Fig. 1. Wood (1951, not included in the records above) described nests of the Long-eared Owl in Monroe County, Ann Arbor, Jackson County, Barry County, and Kalamazoo County; and the most northern of Wood's records, a nest in Eldorado, Crawford County.

Few data have been published concerning the migration of the Long-eared Owl. Some early dates of spring arrival north of the regular winter range, as described by Bent, extend from March 3 in Rutland, Vermont to April 18 in Osler, Saskatchewan. Some late dates of fall departures from regions north of the regular winter range, as described by Bent, have been from October 1 in Halifax, Nova Scotia to November 18 in Argusville and Marstenmoor, North Dakota. Bent states that there is little published information on times of arrival and departure in regions south of the breeding range, but that in general, the Long-eared Owl arrives in these areas in the latter part of November and December and leaves in late February and March. Bent records two long-distance movements of banded Long-eared Owls: the first concerning a bird banded at Rosebud, Alberta, on July 4, 1933 and next seen at Layton, Utah, on February 2, 1935; the second record that of a movement from Escondido, California, to Corbeil, Ontario, sometime between April 22 and October 9, 1934.

It seems possible that not all Long-eared Owls are migratory. While Wood (1951) noted that banding records indicate the Long-eared Owl to be migratory in at least the northern part of its range, (he cites as

evidence a bird banded at Williamston, Ingham County, April 27, 1932, and recovered in February, 1936, at Gladstone, Virginia) the same worker listed several winter sight observations. In the present study nesting sites were observed adjacent to winter roosts, suggesting the possibility that the same birds used both.



nesting localities observed by author ●

other recorded nesting localities ○

Figure 1.

Some nesting localities of the Long-eared Owl in Michigan

BREEDING AREAS

The Long-eared Owl in Michigan seems to prefer neither coniferous nor deciduous type nesting habitat. In this and other studies, nests have been found in white pine, scotch pine, tamarack, red maple and elm. While Wilson (1938) noted nesting in a distinct hardwood habitat, the present study, (1955), records two different nesting areas in stands of white pines (Pinus strobus). Other recorded nests of the Long-eared Owl include one found in Tamarack (Larix laricina) and one red maple (Acer rubrum), both at the Rose Lake Wildlife Experimental Station in Clinton County, Michigan, (Rose Lake Experimental Station records). Pirnie (1943) reported two nests and Sturgeon (1939) reported one nest, all three in Scotch pine (Pinus sylvestris). Brigham (1946) found a Long-eared Owl nest in an elm (Ulmus sp.) at Baker Sanctuary, Eaton County, Michigan.

Area A

The first breeding area studied, designated as Area A, covered 1.7 acres, lying 13 miles south of Ann Arbor, Michigan, and three-tenths of a mile east of U.S. Route 23. It consisted of a dense stand of white pines (Pinus strobus) averaging 30-40 feet in height. Dead branches extended out from each of the trees within the stand, from ground level to about three feet above the ground. Investigation of many spots in the stand could be made only by crawling.

The vegetation surrounding this stand of white pine was chiefly

grassland with open grassland on two sides and an orchard on the other two sides. In the orchard, grasses were abundant beneath the fruit trees and suggested a savannah type vegetation. Thus, the site in which the Long-eared Owls stayed during the day consisted of an "island stand" of white pines surrounded by grassland over which the owls hunted at night.

Area B

The second breeding area studied, designated as Area B, was in the northwest corner of the Kellogg Bird Sancturary. (Fig. 4). Area B consisted of a dense stand of white pines (Pinus strobus) and occupied an area of about 30 to 480 yards. The trees within the stand were estimated to be 40 - 50 feet high and varied from six to eight inches in diameter. Just as was true in Area A, it was difficult for a person to move around within the stand because of dead branches extending out from the base of each tree.

An oak-hickory woodlot was adjacent to the entire western border of the stand. The oaks (Quercus sp.) and hickories (Carya sp.) were estimated to average 60 feet in height. Cover was found only in the crowns of the trees or in those young saplings which were occasionally covered by vines. The oak-hickory woodlot extended East and West something over 50 yards but then gave way to smaller and a greater variety of trees and shrubs with a greater variety of species. About 50 - 75 yards beyond this began cottages and lawns around Gull Lake proper.

Figure 2. Area A in the background.

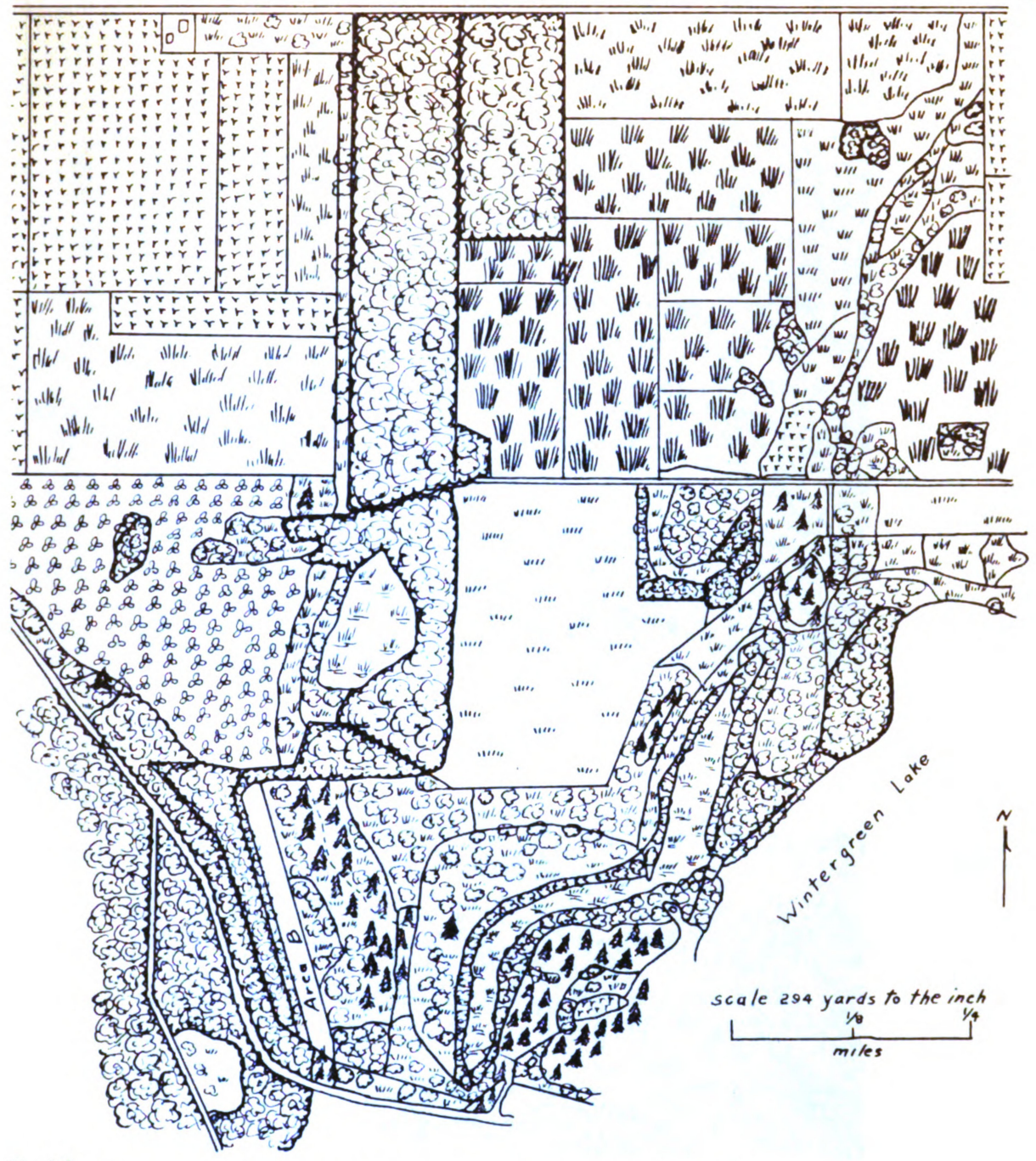
Figure 3. Area A, the nesting site is just above the author.

Several large brush piles were found in a large gravel pit in this same area. The oak-hickory woods continued southeast of the gravel pit for about 250 yards and then dropped very suddenly to a lower level along its southeast facing slope.

Area B was bounded along its entire eastern border by a steep slope 50 yards wide. A comparatively thick growth of small trees was found here and included staghorn sumac (Rhus typhina), large-toothed aspen (Populus grandidentata), black cherry (Prunus serotina), trembling aspen (Populus tremuloides), and red cedar (Juniperus virginiana). Grasses and weeds were abundant along the slope and in the basin. The vegetation changed at the base of the slope where thick stands of white spruce (Picea glauca) were prevalent. The spruces, which were 20-30 feet tall, provided the thickest cover available in the Kellogg Bird Sanctuary.

A large cultivated field bounded Area B on the north, and was covered primarily with clover (Trifolium sp.) and alfalfa (Medicago sp.). The lower, northern part of the field contained two small swales with a dense stand of shrubs. A large swale, 150 by 200 yards, was situated about 100 yards northeast of Area B.

Other cultivated and uncultivated fields lay still farther north. Thus, Area B resembled Area A in being a thick stand of white pine, but differed in being continuous with other wooded areas, with contiguous and interspersed grass lands.



fields –

cultivated

Clover and alfalfa

grazing, grasses sparse

grazing, grasses medium

general non-grazing

grasses thick

marsh

overgrown – woody plants <

woody plants >

thickets

deciduous woods

coniferous woods

Figure 4.

A vegetation map of nesting Area B and adjacent areas

Figure 5. General habitat of Area B.

Figure 6. The ground blind in Area B. Note the density of the pine stand.

WINTER ROOSTING AREAS

Wilson (1938) found winter roosts of the Long-eared Owl in Michigan only in coniferous stands. The present investigation confirms this generalization, the five winter roosts investigated all being in coniferous stands.

1. The first Long-eared Owl roost made known to the author was situated in Lansing township, Ingham County, Michigan. Approximately twelve owls were present in November, 1953, and four were seen the following March. The owls disappeared during the middle of April. The Lansing winter roosting area consisted of two Norway Spruce-White Spruce groves, one measuring 100 by 20 yards and the other approximately 100 by 650 yards. The small grove was adjacent to a house and yet was preferred for roosting. Here conditions existed which were similar to the dense undergrowth already described for the coniferous groves of breeding Areas A and B. In the larger grove spruces grew in a more scattered pattern with dense green branches about the tree bases, extending to the ground. A large field and a beech-maple woodlot bounded both spruce groves.

2. The second winter roosting area investigated was situated approximately ten miles south of Jackson in Jackson County, Michigan. Four owls were present when observations were made in February, 1954. Within this area dense growths of tamaracks and pitcher plants (Sarracenia purpurea) grew profusely on either side of a fast flowing, narrow stream. The pellet accumulations were found beneath the clumps of tamarack. Two

dense lowland deciduous woods and a marsh, approximately a mile in length and 600 yards in width, bounded the stream.

3. A third winter roosting area was investigated in the middle of March, 1954. This area is already described as breeding Area A.

4. The fourth winter roosting area was situated adjacent to breeding Area B, comprising the thick stand of white spruce already described for this area.

5. The fifth winter roosting area was within the Kellogg Bird Sanctuary. Although Long-eared Owls had been observed in the locality during the winter, there was none to be seen when I investigated the roost in March, 1955. The area lay nearly a mile southeast of Area B, and consisted of a dense stand of white pine and jack pine (Pinus banksiana). The trees were approximately eight inches in diameter and 30 to 40 feet in height. The tangle of dead branches within the stand was again very dense.

Thus, the winter roosts of the Long-eared Owl found in Michigan have all been in dense stands of conifers. This vegetation was the densest habitat available to the owls during the winter period. In the present study roosts were observed in Norway Spruce-White Spruce and White Spruce stands, clumps of tamarack and stands of White Pine-Jack Pine and White Pine.

Figure 7. The characteristic pose of the adult Long-eared
t helps conceal the species so well.

THE RELATION OF ENVIRONMENT TO THE LONG-EARED OWL

All parts of the environment of the Long-eared Owl probably have some effect on the owls. However, some features appear to be the more important.

The dense growth of the coniferous stands provide most effective concealment for the owls and their nests and protect the owls from the sun, wind and rain during most of the day. The amount of sunlight appears to be most important in governing certain activities of the Long-eared Owl. This can be noted when evening activity begins at definite times throughout the breeding cycle, usually at dusk, with daytime activity being limited to the nestling period, and hunting always beginning to the west of their nesting or roosting sites. Weather probably limits the activity of the adult female Long-eared Owl during the incubation and early nestling periods, since the eggs cannot survive being chilled and newly hatched nestlings seem susceptible to extremes in the weather. Adults and fledglings did not, however, appear to be bothered by wind or rain. (A young fledgling, 28 days old, was observed on the night of June 10 in Area B. The night was cloudy and windy with rain, yet the young owl showed no sign of being disturbed as it perched in an exposed site on the tip of a pine bough.)

The deciduous woods provides protection for young Long-eared Owls. Both the deciduous woods and open field provide hunting areas for the

Figure 7. The characteristic pose of the adult Long-eared Owl that helps conceal the species so well.

adult owls, and habitat for prey mammals and birds and for animal competitors.

The winter roosting areas seem to provide effective concealment. Few records of winter observation of the Long-eared Owl in Michigan are to be found in the literature. Some authors believe that the lack of observation, here and in other areas of the United States, is due to the type of habitat in which the species is found, and to the nocturnal habits of the bird. Bent (1938) has noted, "Probably this owl is much commoner than is generally supposed, especially in the East, where it finds such effective concealment in dense coniferous thickets. The Long-eared Owl. . . spends the day well hidden in the densest cover it can find . . . . . for this reason it is seldom seen and may be common where its presence is not suspected. It is more conspicuous and so seems more abundant in the deciduous trees of the West, especially in winter." I found the dense growth of conifer stands and the color of the Long-eared Owls helped to conceal the owls almost completely in the winter months.

THE BREEDING CYCLE

The breeding cycle in Area A was under observation by the author from March 30 to May 17, 1955. Those stages of the breeding cycle which took place during this period included early incubation to the fledgling stage. The breeding cycle in Area B was observed throughout most of its duration and lasted from March 30, when courtship was first observed, to approximately June 16, when the young fledgling had learned to fly quite well.

Information on breeding in Michigan is to be found in 17 nesting records of the Long-eared Owl. Thirteen of these records have been reported in the Jack-Pine Warbler from 1938 to 1955. In addition, I found two nests in 1955, and I have used two unpublished nesting records of the Rose Lake Wildlife Experimental Station bringing the total to 17 records in Michigan in the last 18 years. (Map 2)

Seasonal distribution of nests extends from as early as March 5 to as late as June 15 in these records. Wood (1951) reported an exceptionally late set of eggs on May 24, 1889. I observed a set of eggs in Area B which did not hatch until May 14, but the latest set of eggs was found on June 15 by Jorae (1951) at Grass Lake, Missaukee County. An early set of eggs was described by Wood for March 30, 1904. In Area A, the eggs appeared in the nests between March 13 and 15, but the earliest record of eggs comes from Rose Lake in 1943 where four eggs were found on March 5.

Eleven of the 17 reported Long-eared Owl nests in the last 18 years furnish reliable nesting data. In 7 of the 11, eggs are reported in April. In 3 of the 11, eggs are reported in March, and in one case, eggs are reported in June. Thus, eggs are laid in March, April, or May and hatch in April, May or June.

Further investigations may show late nests to be those of the young from the year before. I found a suggestion that young may remain with the parents through at least part of the next breeding season, for in Area A approximately four non-nesting owls remained with a pair of nesting owls well into the breeding cycle.

Courtship

Although I was unable to determine the exact duration of the courtship period, I observed activity of the Long-eared Owl in Area B on five different days prior to egg laying. The first observation was on March 31 approximately two weeks before egg laying. I observed the following phases of the courtship pattern in approximately the order listed: competitive calling, aerial performance, non-competitive calling, nest selection, and copulation. Two or more of these phases may occur together. Courtship is really one continuous process.

Competitive Calling

Competitive calling was heard in Area B on March 31. Calls were similar to those of the Mourning Dove. The owls began to call at dusk

and continued at irregular intervals for approximately 45 minutes. A call consisted of whoo - whoo - whoo, with an average interval of three seconds between each syllable, and each syllable a short utterance. Although sex determination was not considered possible at this time, field notes record calls of individual owls were of different pitches. This was the only time when Mourning Dove-like calls were heard.

Doubleday (1898) described the hooting of the species in the springtime as somewhat like that of the Screech Owl but more subdued, and in New York, Whitman (1924) found that the hooting in the early spring consisted of single low hoots, several times repeated.

Aerial Performance

Aerial performance of the Long-eared Owl was observed in Area B on March 31 and April 9. Flights were sporadic and irregular and consisted of turning, twisting, diving, and wing slaps. An owl would suddenly disappear in a swoop or dive to the pines, and on several occasions, a cracking noise was heard, evidently made with the wings slapping each other. The similarity of these flights to the flights of the Short-eared Owl (Asio flammeus) as described by Mathews (1921) was marked. Mathews described the species as acrobatic and leading intruders from the vicinity of the nest with astonishing feats of flying, clapping its long wings together over its back, turning somersaults and dropping like a stone to the ground. Bent (1938) described a remarkable courtship flight of the Short-eared Owl where the owl's wings were beat together beneath it eight

to twelve times in a second or two. In the present study, this rapid wing-clapping was not observed in the Long-eared Owl. Here the "claps" were only single beats, never repeated. Pirnie (1943) observed two Long-eared Owls at the Kellogg Bird Sanctuary "stunting", and thought it perhaps part of their courtship performance. Pirnie made these observations on January 8 and judging from his field observations, egg laying could not have started until late March or the first part of April. Thus, if the stunting described by him was part of courtship, then this last activity must last for well over two months.

Non-competitive Calling, and Copulation

Non-competitive calling and possible copulation were observed in Area B on April 9. I approached Area B that evening with caution, hoping to catch a glimpse of a Long-eared Owl leaving its roost. A large bird was flushed and shortly thereafter, at 7:15 P.M., calling began between two Long-eared Owls. The calling began at dusk and continued between two owls for approximately five minutes. Each call consisted of a single whoooo.

Immediately after calling, a Long-eared Owl made an investigating swoop of the area from which the bird had flushed, and landed approximately 60 feet from a nest I had thought was abandoned. It then searched the immediate area with quick movements of its head, made another investigating swoop and landed closer to the nest. Finally, it glided in onto the nest.

This same owl made very short sounds similar in their rhythm to a "clucking chicken" while moving around on the nest. After this procedure,

it called a high-pitched whoooooo, (identifying it as a female; see section on Sex Determination on this point) intermittently with a softer and lower whu - whu - whu, repeated. Then the male glided into the area, half circled the tree and gave a wing slap before alighting in the nest. Both owls called soft and low - wuh - wuh - wuh, repeated and the male left. The female began calling again the whoooooo, uttered three to ten seconds apart.

Presently the male appeared again in a tree approximately 20 feet away from the nest and called, whoooo, but on a much lower pitch than that of the female. The female immediately called - wuh - wuh - wuh, repeated. The notes were repeated very rapidly and sometimes uttered together as wuhwuh. In Approximately a minute, the male glided partly around the tree and landed next to her. She suddenly erupted with a very loud - wuh, and the male flew off. The female then called more softly.

In ten minutes, the male appeared calling again, and the female became excited. The male called for two or three more minutes, glided in onto the nest and the same actions already described in the preceding paragraph were repeated again. The male left and all was quiet. The time was 7:45 P.M., thus the entire sequence of acts happened within a half hour.

These activities of the Long-eared Owl were most unique and were never observed again in the entire study. Undoubtedly, the activity shown was part of the courtship process. The author, hidden on the ground, could not observe the pair of owls in the interior of the nest. However, both the frequency of male visits to the nest and the unusual reactions of the

female, pointed strongly toward the possibility of the copulatory act.

Nest Selection

Nest selection in Area B took place at some unknown time between March 30 and April 9. Calling between three owls was heard all around the site where I later found a Long-eared Owl nest. Thus, competitive calling could have been the phase leading up to the final nest selection.

The Nest

Nests have been recorded in Michigan on the ground, at ten feet, and from 20-35 feet above the ground in the past 18 years. M.T. Sturgeon (1939) reported a Long-eared Owl nest in Ypsilanti, Michigan, 20-25 feet from the ground, Brigham, (1946) found a nest 35 feet above the ground in Baker Sanctuary, and Pirnie (1943) studied a nest at the Kellogg Bird Sanctuary, only ten feet from the ground and built upon an abandoned crow's nest. Two nests were reported at Rose Lake in 1942 and 1943, the former 20 feet from the ground and the latter 30 feet. The nests observed by the author in Areas A and B were at heights of 27 feet and 25 feet respectively. The nest in Area A was an abandoned nest of a Crow (Corvus brachyrhynchos) while a Cooper's Hawk (Accipiter cooperi) was probably the former resident of the nest in Area B. Bent (1938) described the Long-eared Owl as occupying former squirrel, Crow and Cooper's Hawk nest in Massachusetts and nests of the Magpie (Pica pica) in western United States. Most remarkable was a nest of the Long-eared Owl on the ground, described by Jorae (1951). Six

eggs were discovered in this nest on June 15 near Grass Lake in Missaukee County, Michigan. The ground is the usual nesting place of the Short-eared Owl (Asio flammeus). Bent (1938) reported that Long-eared Owls have been observed several times to nest on the ground in the United States and England; he shows a photograph of such a nest taken in Montreal. Nests of the Long-eared Owl in Michigan are placed at heights ranging from ten to 40 feet according to Barrows (1912). Barrows found that the majority of nests were abandoned Crow's nests more or less repaired for the purpose.

The nests of the Long-eared Owl are of variable size depending on the type of abandoned nest selected for use. In 1943, a nest at Rose Lake measured 16 inches in total diameter, and the outside diameter of a nest in Area A observed by the author measured 17-20 inches. The measurements of two nests in Massachusetts and one nest in Saskatchewan were reported by Bent (1938). The Massachusetts nest had an outside diameter of 20 by 8 inches, with a cavity measuring seven by six inches, two inches deep. The nest in Saskatchewan was unusually large, measuring 48 by 23 inches over all and an inner cavity of 10 by 9 inches. Bent also described a nest in Massachusetts composed of sticks, rubbish, strips of inner bark and pine needles, and lined with chips of outer bark and downy feathers of the owl.

Thus, in Michigan, the Long-eared Owl nests on the ground and to a height of 40 feet. In the literature was found one record of a ground nest, one of a nest ten feet above the ground and eight records of nests 20-35 feet above the ground over the past 18 years. The general belief

is that abandoned Crow's nests are among the first choice of the Long-eared Owl, and then squirrel and hawk nests.

Sex Determination

There was a distinct difference in the pitch of the calls of the two adult birds at Area B. This difference, consistent and easily recognizable to the author's ear, was interpreted as a sexual characteristic, the call of the female being markedly higher in pitch. Unfortunately, it was impossible to confirm this method of recognizing sex, for to have collected the two birds would have ended the study in mid-course.

The decision to regard the bird with the higher pitched call as the female was supported by field observations. For example, during incubation, the bird on the nest was heard to give the higher pitched calls. Dr. H.N. Southern has kindly commented by letter to the author regarding this observation, "I think you may take it in the first place that incubation is done entirely by the female, which gives one a very good clue to voice differences". Further, Miller (1935) stated that the hoot of the female Long-eared Owl is "four to five half tones higher" than that of the male. Thus, the difference in pitch of the calls provided a method for field discrimination of sex between two otherwise almost identical birds.

Although the female Long-eared Owl is known to be slightly larger than the male (Poole, 1938), the present author could not detect this difference in the field.

Eggs

Color and Size

The single egg I examined was white and nearly spherical, measuring 33 by 39 mm. Barrows (1912) reported the average size to be 33 by 42 mm. (1.66 by 1.28 inches). The average size of 103 eggs measured in the United States National Museum was 32.5 by 40 mm. according to Bent (1938). Extremes in width from 30 to 35 mm. and in length from 37.5 to 43.5 mm. were found. Sumner (1929) found the average weight of Long-eared Owl eggs in California to be 24.8 grams, with a range of weights from 21.5 to 27.1 grams.

Egg Laying

Wallace (1955) stated that although owls usually lay their eggs every other day, in some cases they may skip more than a day between layings. In Area A, egg laying began between March 13th and 15th; seven eggs were laid in 10 or 11 days, with irregular intervals of one to five days between eggs. In Area B, two eggs were layed between April 18th and 22nd; these hatched less than 24 hours apart. Whitman (1924) stated that egg laying of the Long-eared Owl took place on alternate days in Ithaca, New York. From Pirnie's (1943) data, a difference of five to six days is shown between the hatching of the first and second eggs, suggesting a like interval between laying dates.

Size of Clutch

Altogether I have obtained reliable data on 12 nests of the Long-eared

Figure 8. The nest with eggs in Area B. Note the nest composed in part of leaves, presumably left by a former occupant.

Owl in Michigan (see section on Distribution and Fig. 1). One nest had seven eggs, two nests six, six nests five, two nests four, and one nest had two eggs. Thus, the average number of eggs per nest was five, with a range of two to seven. Bent (1938) maintained four or five eggs to be the average number with the range from three to eight.

It is possible that the nest in Area B was a re-nesting, since the egg laying took place late in the nesting season and since the clutch contained only two eggs. Barrows (1912) stated that like most other birds of prey when robbed of its eggs, the Long-eared Owl will lay a second set in the same nest or renest in the same vicinity. The Long-eared Owl found by Pirnie (1943) evidently abandoned her nest with no indication of re-nesting.

Success of Hatching

Six eggs hatched and one egg was infertile from the clutch of seven eggs in Area A. Two of the young disappeared during the second week or shortly thereafter. When last observed, one of the birds was 10 days old, and the other approximately 14 days old.

Both young owls from the clutch of two eggs in Area B lived 25 days. One died at this age, presumably because the adults did not feed it after the author placed it in a wire-mesh enclosure to collect pellets.

Whitman (1924) in Ithaca, New York, found that five out of six eggs hatched in a Long-eared Owl nest. Southern (1955) found a correlation between the abundance of mice and the success of Tawny Owls (Strix aluco)

in rearing young. He stated, "When mice are neither abundant nor very scarce, the owls lay eggs and allow them to chill (presumably because the hen must leave the nest to feed if the male cannot bring her enough prey) or may lose chicks through starvation".

Pre-incubation

Pre-incubation activities lasted 9 to 13 days, from April 9 to 18 or 22, in Area B.

Incubation

Period of Incubation

The incubation period of the Long-eared Owls in Area A began between March 13 and 15 and lasted from 23 to 26 days. Egg-laying took place concurrently with incubation. Bent (1938) stated that the incubation period is generally considered to be approximately 21 days for the species.

The concurrence of egg-laying and incubation could not be determined in the Area B study. However, evidence suggested a re-nesting, since incubation in this nest did not begin until April 18 or 22. Incubation in this nest lasted from 22 to 26 days.

Evening Activity During Incubation

The time of evening activity seemed to be regulated by approaching darkness. Activity began in Area B on April 14 at 7:18 P.M., and ended

at 8:00 P.M. Two weeks later, activity began at 7:54 P.M., and ended at 8:28 P.M.

Male Activities During Incubation

All observations on this point were made in Area B. The interest of the male Long-eared Owl in nesting activities appeared to decrease during the incubation period. For example, the male usually began evening activity by calling, but he did not call at all during the last 13 days of incubation. The duration of calling was variable, with periods of from less than a minute to several minutes and even 15 minutes being recorded.

Each evening during incubation, the female owl left the nest in search of prey. During the first half of incubation, the male remained at this time in the nesting area, and at times flew close to the nest. The male often called for a short time as the female left, and then called again when she returned. The call was usually a low monotone whoooooo. The last time any activities of the male were observed during the incubation period was on the afternoon of June 1. I climbed toward my blind which was situated above the nest and approximately 30 feet away. The female was on the nest. The male owl reacted to my presence with short, soft, high-pitched cries and ended the calling with low monotone whoos. He stopped calling, however, before I reached the blind.

Although present in the area, the male showed no actions of any kind after June 1, during the last half of incubation.

Female Activities During Incubation

The interest of the female Long-eared Owl in nesting activity seemingly increased during the incubation period. This conclusion was drawn from the frequency of calling and magnitude of responses to stimuli to which she was subjected by the author throughout the period. Again, all observations were made in Area B.

Although Pirnie (1943) stated that a female Long-eared Owl would abandon its nest if disturbed too often during the early stages of incubation, neither of the birds deserted in the present study. The female Long-eared Owl was flushed three times during the first half of incubation. The first interruption occurred on perhaps the first day of incubation, then eight days later, there were two interruptions in the same day. The female saw the author close by on four other occasions in early incubation. She was flushed five different times during the last half of the incubation period and saw the author on three other occasions. This owl did not desert.

The female owl usually was present on the nest during the day. During the early stages of incubation, she left the nest for periods during the day; later she was absent only during the evenings when she left to obtain food. She seemed to hunt in a deciduous woods lying west of the nest and approximately 300 to 400 yards away.

On one occasion, I made an attempt to examine the nest while the female owl was hunting. The male was in the area but did not call. I believe the female heard the breaking of branches. She gave a high

chicken-like call, flew to a perch in an adjacent tree, and called a shrill child-like cry when she discovered me in the tree. She resumed her nightly foray after I climbed down.

Normally her hunting excursions would last eight to ten minutes. Generally, she would call from the hunting area. The calls were whoooooo, high pitched and repeated more rapidly than any call of the male.

The author had to apply a greater stimulus to flush the female Long-eared Owl from her nest during the latter nine days of incubation than was necessary earlier. During the period, a slap on the trunk of the tree or climbing the tree was necessary to flush her. Attentiveness was even greater as the time of hatching drew closer with flushing requiring even greater stimuli. On May 12, she did not leave the nest until I had climbed the tree and was standing directly in front of her. Finally she flew off and snapped her bill while in flight. On this day, I found two pipping spots on one egg. On May 13, while on the nest, she spread her wings, erected feathers on her back, breast, and neck and snapped her bill. The second egg was now pipped in one spot but as yet peeping was not heard in either egg.

Pipping and Hatching

Pipping was observed on the two eggs in the Area B nest. No observations were made on May 11. Two pipping spots were observed on one egg on May 12 at 2:35 A.M. Peeping was heard on May 13 at 11:00 A.M. from within this egg. The other egg was now pipped in one spot. The first

Figure 9. An undisturbed female on the nest during incubation in Area B.

Figure 10. The alert female on the nest during the nestling stage in Area B.

egg hatched on the morning of May 14 and the second egg hatched on May 15 in the early morning. Thus, there was a lapse of 48 hours between pipping and hatching in the case of the first egg in Area B. The first egg hatched at the Area A nest on April 7 or 8.

Nestling Stage

Variation in Age of Young

The ages of the young Long-eared Owls in the nest at Area A were estimated by comparing their wing, tarsus, and total lengths with those of the two young of known age in the Area B nest. The six young on April 19 in Area A were accordingly judged to be of the following ages: 1, one day old; 2, three or four days; 1, seven days; 1, eight plus days; and 1, eleven or twelve days. The two young Long-eared Owls in the Area B nest had a difference in age of less than 24 hours.

Whitman (1924) studied a nest in Ithaca, New York, in which five young Long-eared Owls ranged in age from one to eight days. Pirnie (1943) described a nest located at the Kellogg Bird Sanctuary, in which the total age range of five young Long-eared Owls was one to seven days.

Thus, age differences of consecutively hatched siblings vary anywhere from less than 24 hours to three or four days. Total age ranges of siblings have been found by various workers to be from one to twelve days.

Adult Activity During the Nestling Stage

Adult activity during the nestling stage consisted of hunting, feeding

the young and calling. The adults were observed to be calling and flying, and to be feeding the young (14 days old) at 8:25 P.M. on May 28. This same type of activity began at 7:30 P.M. and continued to 12:00 P.M. on June 2 and on May 20, it was observed first at 12:20 A.M. and lasted throughout the rest of the night.

Male Activities During the Nestling Stage

All observations in this section were made in Area B.

The male began the morning, before dawn, by calling in soft wails, as whoooooo - whoooooo. These calls lasted several minutes and were interrupted only when he moved to a new position, approximately 50 yards from the last and always near the nesting area. Frequently, (when he seemed to detect something strange in the area) the wails were interrupted with a loud, gruff, wuh - wuh - wuh - wuh - wuh - wuh. One such call, a wuhh, but not repeated, was made when a crow landed momentarily in the owl's territory and called. On May 6, when the young were 6 days old, the male began calling an hour before dawn, and continued at intervals until 20 minutes after dawn.

The male began the evening activities by calling. On June 2, he called continually from 7:30 P.M. to 9:25 P.M. with 10 seconds elapsing between individual calls. He later twice flew away, returned, and called for a few minutes after each return. Calling was resumed again by 11:10 P.M. and lasted until 11:25 P.M.

The male was present in the nesting site during the day. He was

frequently harrassed by Blue Jays and sometimes by Crows. He took no aggressive action towards these birds, but he was once observed to fly away from the nesting site. This action would help to draw potential enemies of the young owls away from the nest.

The males maximum attention to the nest and young owls was shown on May 19, when the nestlings were four to five days old. The author was climbing to the nest when the male appeared in a conifer 15 to 20 feet away. He squealed and spread his wings, feigning an injury, then clicked his bill. He flew to another tree still clicking his bill. This reaction varied; two days later, on May 21, the male appeared but did not call or react in other ways. On June 2, he gave the alarm call as the author climbed to the nest. The male's alarm call was a gruff - wuh - wuh repeated one to six times, or perhaps only low, soft wails as whoo. Occasionally, he snapped his bill.

Pirnie (1943) described a similar reaction of an adult Long-eared Owl in protecting a nestling 25 days old. Pirnie stated, "The adult owl fluttered to the ground cripple-like and kept up a rapid-fire assortment of calls and cries". Injury feignings by adult Long-eared Owls has been described by others, in New York by Whitman (1924), in California by Sumner (1929), and in Virginia by Addy (1939).

Female Activities During the Nestling Stage

The female remained on the nest day and night in the early nestling stage in Area B and was not observed to leave the nest until the young

were 15 days old. The male brought food to the nest during this time. (see page 77).

The tendency for the female to protect the young could be gauged by the amount of aggressiveness shown. This action increased until the young were four to five days old, and beyond this age, it decreased. The nest in Area B showed this behavior pattern more clearly, perhaps because the young were of the same age. At this nest, during the entire nestling stage, the female could be removed from the nest only by force.

The chronological development of the behavior was as follows:

1. Only slight aggressiveness was shown by the adult female when the young were one day old. She attacked the author with her feet when flushed from the nest. No further aggressive action was shown. At approximately this same stage of the nestling period, Pirnie (1943) reported that an adult owl remained until Pirnie was within four feet of the nest, then the owl left but without aggressive action. Sumner (1929) described the death of a very young Long-eared Owl in California which was knocked out of the nest and killed by the fall when the adult bird departed the nest in great haste.

2. The highest degree of aggressiveness was shown by the adult female on May 19 when the young were four to five days old. In the morning, an unsuccessful attempt was made to force her from the nest. A stick was thrust against the owl's body, forcing her to the opposite side of the nest. After I withdrew the stick, she hissed and lunged back across the nest. In the afternoon, the author remained below, out of sight, and

thrust the stick, with a sack tied to the end, overhead and into the nest. The female attacked the stick as I withdrew it, but she went back into the nest. Again the stick was thrust in. This time, when I withdrew it, she gripped the sack with her talons and tore at it with her bill. Then, she flew off. While I examined the young owls, the female attacked seven to eight times, hitting my arm the first time. Between these attacks, she perched in an adjacent pine tree and called in long wails and low and growl-like calls - wuh - wuh - wuh. She did not go back to the nest until I left the nesting site. Bent (1938) gives numerous descriptions of display, and remarks, "I know of no bird that is bolder or more demonstrative in the defense of its young, or one that can threaten the intruder with more grotesque performances or more weird and varied cries". Bent also mentions a note from Grinnel and Storer (1924) telling of a Long-eared Owl which attacked a photographer several times and once inflicted slight scalp wounds.

3. Less aggressive action was exhibited by the adults when the young were seven days old. A stick was again thrust into the nest. The female gripped the stick, backed off the nest, and finally flew away. This was followed by two passes at the author while he was climbing down with the young. Less aggressive action was taken when the young were 14 days old. At this time, she left as soon as the stick was thrust into the nest.

4. The adult was not on the nest the day the young were 19 days old. It was heard calling in the area at 11:50 P.M. and shortly thereafter, flew over the nest while the author was in the tree.

5. In contrast to the female in Area B, the female in Area A never had to be forced from the nest during the nestling stage. She flew from the nest when the author was directly below it on May 27 when the young owls were one to twelve days old. She then attacked the author two times, hitting him the first time on the back, evidently with her wings. The attacks were then followed up by swoops at the author. She left the nest as the author climbed the tree when the young were 9 to 20 days old, but she did not attack. She called bwauk - bwauk - bwauk from an adjacent pine as the author left the area. Reactions of the female owl to being flushed were the same as described when the young were 15 to 26 days old. Pirnie (1943) reported one adult Long-eared Owl at the Kellogg Bird Sanctuary scolding him from the nest and another adult owl circling overhead while he climbed to the nest. The young in this latter nest were 9 to 16 days old.

6. The adult female was still on the nest in Area B when the young were 19 days old. She helped feed the young when she left the nest at this time. In Area A, an adult owl was still on the nest when the young were 17 to 26 days old.

Behavior of Nestling Young

Young owls responded to stimuli by bill snapping, hissing, spreading their wings, erecting their feathers, squawking, and attacking with their talons. The frequency of these actions increased with the age of the young, throughout the nestling stage.

Figure 11. The female on the nest in Area B during the hatching period. A fragment of one egg and the first hatched young are visible behind the egg in the foreground.

Figure 12. Area A, soaring of an adult over the nesting site.

Young Long-eared Owls seven days old snapped their bills when approached and when handled. Whitman (1924) described this same reaction of a young Long-eared Owl eight days old in Ithaca, New York.

Young, 13 to 15 days old that were not approached or handled, were usually lying flat in the nest, making no movement. However, a nestling 14 days old did respond to being handled by erecting its feathers and throwing back its wings in a defensive action. This was accompanied by hissing and bill snapping. Whitman (1924) first observed a young Long-eared Owl with wings outspread in defense when the young owl was 14 days old.

Young owls 17 to 21 days old showed several kinds of activities. They erected their feathers, spread their wings, and sometimes appeared to attack me crossing the nest by short hops towards me when I approached them. They backed up to the edge of the nest with feathers still erect and wings spread when I continued to provoke them. One young owl examined, 19 or 20 days old, finally squawked in protest after it was handled for two or three minutes.

Young were between 25 and 26 days old before their wings were developed sufficiently to permit them to leave the nest. One individual (25 or 26 days old) immediately jumped out of the nest when it saw me peering in. It floated down with wings outspread, bounced off a few pine boughs, and landed safely on the ground. It assumed a supine position when I approached it on the ground and used its talons for defense. The young owl immediately jumped out again after I replaced it in the nest, landing safely on a branch nine feet above the ground. Other young

Figure 13. Nestlings six and seven days of age from Area B.

Figure 14. A nestling 13 or 14 days of age from Area B.

(17 to 21 days old) in the same nest made no attempt to leave. Sumner (1929) found that young Long-eared Owls, approximately 26 days old, were not ready to leave the nest voluntarily and yet they backed off it when he approached. He also observed young lying on their backs in a defensive pose.

The literature indicates that much of the defensive behavior of young birds is learned by imitation of the adults and older nestlings. However, a certain amount of the behavior must be attributed to instinct. A young owl from Area B whose eyes had been open only two days snapped its bill as a response to fear or hunger. A captive owl which had been in my possession since age seven days, spread its wings and erected its feathers in a typical fashion.

Appearance of Nestlings

The external appearance of the nestling, from hatching to the time it is ready to leave the nest, is discussed in the following paragraphs. Notes were based upon the two young in the Area B nest and one young from Area A.

Shortly after hatching, the young Long-eared Owl was wet, with the feather tracts easily seen. The bill and feet appeared large in proportion to the rest of the body. A few hours after this when the young bird became dry, the trunk, head and tarsus were covered with white down. No changes were observed four days after hatching. Five days after hatching, the eyes opened. The iris was yellow.

Figure 15. A nestling 25 to 26 days of age showing a response to provocation.

Figure 16. The adult and three young are on this nest in Area A.

Figure 17. Nestlings on the nest in Area A. The two young in the foreground are 17 to 21 days of age. The larger is 25 to 26 days old.

At seven days of age, black feathers had developed at the base of the orbit region, on either side of the bill, and the bird could hold its head erect for a few minutes. At ten days, black stripes of feathers appeared on the back and belly. Eleven days after hatching, the black stripes became more evident.

At twelve days, the black feathers in the orbit region had developed on the inside, across the lower side, and on the edge of the outside corner of the orbital area. The breast was light gray. The belly had nine horizontal arc-like stripes of feathers and there were two gray tufts on the head. Thirteen days after hatching, over 12 of these arc-like stripes of feathers appeared on the dorsal side and at the base of the wing. Transverse stripes of feathers developed in the wing covert region. The tips of the first three to four primaries appeared dark.

At fifteen days of age, the orbit region was entirely black. At seventeen or nineteen days, the head was grayish with faint horizontal gray stripes. The back and wings were striped. The tips of the first six to seven primaries were reddish-brown. At twenty-one days, the first eight to nine primaries were reddish-brown with horizontal black stripes. The tufts of feathers on the head appeared semicircular and each had two transverse stripes. At twenty-three days, the face feathers were colored red-brown. At twenty-six days, the primaries and secondaries were well developed and the rectices were developed, though the coverts, breast and head were still downy.

Figure 18. A nestling seven days of age.

Figure 19. A nestling twelve days of age.

Fledgling Stage

Adult Activities During the Fledgling Stage

Adult activity during the fledgling stage was characterized by hunting and by caring for the young (all observations here were made in Area B). During the day, the adults protected the young while at night they hunted food and fed the young. (See Page 75 Food Habits). The adults devoted more time to these activities during the earlier part of the period than they did later. Hunting and feeding seemed to occupy about 18 hours a day during the early days of this period, but only about five hours later (8:00 P.M. to about 1:30 A.M.). Bent (1938) stated that both parents during this period rushed to the fledglings' defense and attempted to lure intruders away by feigning injury, by feigning capture of prey, or by other acts. I observed injury feigning only once, and then by the adult female.

Female Activities During Fledging

The female owl remained near the nest throughout the first day of fledging (June 3, when the young owls were 20 days old). Earlier this same day, at 5:25 A.M., she called woouh - woouh - woouh - woouh (silent for 15 to 20 seconds), woouh - woouh (silent for 15 to 20 seconds) woouh - woouh - woouh from within the nest. Fifteen minutes later, she perched outside the nest and watched the young inside the nest. She called at irregular intervals from 5:44 A.M. until 9:20 A.M., once calling continuously for one and one-half hours during this period. The call was unusual

and can be described as wough - wough - wough. The call changed at 9:28 A.M. to a very soft well - well. The same type of calling was again heard that evening, beginning at 7:15 P.M. These were short calls, lasted only a few minutes, and were heard six different times until 9:30 P.M.

Certain actions of the female were observed in response to activities in the area. A black squirrel was in the area at 7:40 A.M. on June 4 and it jumped onto the trunk of the nest tree. The adult attacked the squirrel and within two seconds had knocked it to the ground with her talons. She then stationed herself at a point between the two young and above them. One fledgling was still in the nest and the other perched approximately five feet away. The adult left this spot briefly at 8:25 A.M. and called from a telephone line, then returned. One of the young fell from its perch at 9:35 A.M. While I was replacing this young in the nest, both adults were in an adjacent pine. One of the adults flew over the other fledgling, which was perched nearby and then flew near me. The female began calling normally again 15 minutes after this incident, although the male was still giving his warning call and the young owl which had been replaced still showed its defiant display.

On one occasion when the fledglings were 27 days old, the female called with a shrill child-like cry while the author was still 100 feet from the young.

Adult Activity, Sex Unknown

At 8:00 P.M. June 11 (fledglings 28 days old), I heard one young calling

about 150 feet southwest of the nesting site. While I was still 100 feet to the east, an adult began calling wuh - wuh - wuh and made a gliding flight out over me. The call changed to quorrel - quorrel - wuowh with a rasping quality fifteen minutes after I hid.

After dark (at 9:00 P.M.), I tried to find the young owl by investigating dense cover in which it could hide. While I was climbing a sapling to search for the young owl in the dense crown of the tree, an adult owl flew to the ground beneath the tree and called a shrill child-like cry. The adult seemed much aroused. I climbed down and searched for the young owl on the ground, but did not find it. Approximately two hours later, an adult was observed feeding the young owl in the same tree. The next morning after searching, I found the young owl approximately three feet higher in the tree than the point I had reached the previous night.

Male Activities During Fledging

The male was identified by call during the fledgling stage, on June 3 when at 7:15 P.M. I was replacing a fledgling in the nest and the male began his warning cry wuh - whuh - whuh. He continued calling until 8:30 P.M. Next, he flew to a perch near my blind, where he gave six calls, separated by long silences, concluding at 9:15 P.M. On six other occasions, the male called in the same manner, but only for short periods.

Differences in Age at Fledging

The two nests differed in the range of ages represented. In Area A, there was a difference of eight to nine days between the ages of the oldest

and youngest fledglings, a range reduced by two days on May 3 when the two youngest owls disappeared. The difference between ages of the two oldest young was approximately four days. The oldest of these young owls developed faster than its sibs, it may, therefore, have had a better chance to survive. By May 3, no attempt had been made by this oldest young to leave the nest, even though it seemed to be quite capable of keeping its balance. When the author peered into the nest, this young owl immediately jumped out and floated to the ground unharmed. It was then 25 to 26 days old.

The situation was quite different in Area B where the two young owls, of approximately the same age, left the nest when 20 days old. The presence of the author and the continuous calling by the female may have had some influence in causing an early date of fledging. Whitman (1924) in Ithaca, New York, told of a young Long-eared Owl leaving the nest when four weeks old, after the other young owls had earlier left the same nest.

Fledgling Activities

The apparent degree of reluctance to leave the nest varied among fledglings. In Area B, one fledgling moved around in the nest approximately 12 minutes before it left, while the other fledgling, 12 to 23 hours younger, moved around in the nest about ten minutes before leaving, then left the nest, and after almost falling, it returned immediately to the nest. It finally left one hour and forty-eight minutes later. Southern (1955) observed a young Tawny Owl (Strix aluco) in England which made

a premature attempt to leave a nesting box, nearly fell, and then returned to the nest, not to reappear for several nights.

After the young owls left the nest, the principal activities observed were those of exploring the environment and of expanding the home range.

Exploratory behavior was observed more often during the first part of the fledgling period than later. In Area B, young owls first stood on the nest and stared at objects, then moved their heads in a circular fashion (in a plane parallel to the body) with their eyes fixed on the object. This movement was rather rapid and first either clockwise or counterclockwise, then reversed. Southern (1955), in studying the Tawny Owl (Strix aluco) in England, states that because the owl's eyes can sense only moving objects, this head movement is necessary, to cause stationary objects to move across the field of view. Exploration by the young owls continued, they jumped down onto lower limbs of the nesting tree or moved further out on the same limb and continually inspected objects, using the above described head movement. The young often watched the adults in this same manner.

Further development in the young owls was observed about 14.5 hours after the first leaving of the nest, when fledglings, perched on a limb in a squatting position, stood up and stretched their wings outward, demonstrating an improved ability to balance.

Still later, the fledglings had moved far enough from the nest so they could not be observed by the author without a careful search for

them. At this time, they moved their heads very slowly and kept their gaze upon the author.

A typical response of young owls to human presence was to spread their wings and to erect feathers on their back, neck and breast. Sometimes they hissed and snapped their bills. This response was observed in birds 20 days old but was much more apparent in an individual 29 days old.

On one occasion, a young owl attempted to escape before responding as described above. In Area A, the author tried to capture a fledgling (30 - 35 days old) which was perched 20 to 25 feet off the ground in a pine tree. The owl jumped down onto the lower branches and then to the ground, where it ran quite well. A very aggressive reaction was shown by this same fledgling when it was captured and handled by the author. The owl not only erected its feathers and spread its wings, but attacked by jumping forward, extending its legs and grasping the author's trousers with its talons. The owl then maintained its position by beating its wings at a fast rate.

Movements of young owls after leaving the nest were generally away from the nest site. Southern (1955) made this same observation in studying the Tawny Owl in England. The following observations were made upon this point for the Area B nest.

June 3 --19 & 20 Days Old

Fledgling A		Fledgling B	
5:32	A.M. - moved to the nest edge	6:00 A.M.	- moved to the nest edge
5:33.5	A.M. - jumped back into the nest	6:10 A.M.	- was outside of the nest and then jumped back in
5:35	A.M. - moved to the nest edge		
5:44	A.M. - moved to a limb		

Figure 20. A fledgling 21 days of age from Area B.

Figure 21. A fledgling 22 days of age from Area B.

Figure 22. Aggressive defense action shown by a fledgling between 30 and 35 days of age.

June 3 --19 & 20 Days Old (contd)

	Fledgling A		Fledgling B
6:00	A.M. - moved further out to a position south of the nest	7:00 A.M.	- stood up in the nest
6:10	A.M. - moved further and almost into the adjacent tree	7:48 A.M.	- climbed out on a limb just north of the nest
7:25	A.M. - moved further and occupied a position five feet south of the nest	9:20 A.M.	- same position
4:25	P.M. - moved further and occupied a position 100 feet south of the nest and four feet off the ground	2:30 P.M.	- same position
7:30	P.M. - replaced in the nest by the author	7:00 P.M.	- replaced in the nest by the author
8:12	P.M. - moved to a position lying one foot south of the nest	7:45 P.M.	- moved to a position two feet north of the nest
8:18	P.M. - moved further	8:22 P.M.	- moved further to a position ten feet north of nest
8:22	P.M. - moved to a position lying eight feet south of the nest	8:30 P.M.	- moved further to an adjacent tree
			(This bird was enclosed to try to collect pellets; experiment was a failure as bird died somewhere between June 7 and June 9, at 23 to 25 days of age)

June 10 - 27 Days Old

A.M. - moved to a position further out and lying 110 feet south of the nest

1:00 P.M. - moved to a position further out and lying 175 feet south of the nest and 20 feet from ground level

June 11 - 28 Days Old

9:00 P.M. - moved further and occupied a position southwest of nest and 40 feet from the ground level

June 12 - 29 Days Old

9:25 A.M. - occupied the above position

The movement of each fledgling was away from the nest, and once the initial movement out of the nest had been made, there was no return. Possible factors influencing the young during this time includes the calls and movements of the adult birds.

Plumage Development and Appearance of Fledglings

Older fledglings may resemble adults in appearing very long and narrow as they perch in a coniferous tree. The following description of the young is based upon the surviving bird of the Area B nest and a captive owl from Area A.

At 21 days, the first eight or nine primaries were reddish-brown with horizontal black stripes, back and wings striped, and tips of the first six or seven primaries were reddish-brown. At 23 days, the face feathers were colored reddish-brown. At 24 days, the new primary feathers were better developed than the new rectrices. At 26 days, the new primaries, new secondaries, and new rectrices were well developed. The wing coverts, breast feathers and head feathers were still downy.

At 33 days, the rusty feathers were unsheathed further in the orbicular area. A very noticeable white patch of feathers extended from the chin and the gular region to approximately one-third of the distance up the outer perimeter of the orbicular area. A black line of feathers was unsheathed on the outer perimeter of the orbicular area and extended ventrally to the inside of the white patch and then became very narrow and faded out. White lines of feathers had developed on the cranial edge of

Figure 23. A fledgling between 39 and 40 days of age.

the wing at the region of the distal end of the radius and extended distally.

When the bird was 34 days old, the white feathers on the cranial edge of the wing were better developed. At 35 days, rusty feathers covered nearly all of the orbicular area. A heavy black line of feathers bounded the outer perimeter of the white patch which had developed in the ventral part of the orbit. The rest of the head was downy gray. The dorsal surface of the primaries and secondaries were tan and heavily barred with reddish-brown.

Rate of Development of the Young

All owls did not develop at the same rate. In Area B, the two young Long-eared Owls fledged June 3 when 20 days old. Development of the two young appeared equal until they were 25 or 26 days old when one of them died. The remaining young was capable of full flight when it was 30 or 32 days old. In Area A, the eldest Long-eared Owl fledged from the nest when it was 25 or 26 days old. It flew well when 39 or 40 days old, while on the same day one of its sibs, between 34 and 35 days of age and no more than eight days younger, was not yet developed to the point where the eldest was two weeks before. Slower development was indicated by a slower development of plumage.

Thus, in time to acquire full power of flight, the two young in Area B developed at approximately equal rates, and both faster than the owls in Area A where the younger owls developed slower than the eldest in the same nest.

Effect of Different Rates of Development of the Young

Different rates of development of the young Long-eared Owls created correspondingly different times when fledglings showed the same degree of independence. The eldest young in Area A was developed enough by the time it left the nest to maintain its balance in flight and float to the ground or to an adjacent tree. Two siblings and the adult Long-eared Owl were in the nest when fledging of the first young took place.

The young in Area B remained in the nest for a shorter time than did the young in Area A. In contrast to the eldest young in Area A, these owls could not float to the ground the day they left the nest. At this time, they used their wings only to maintain balance when perched in the nest tree; one used its wings to aid in jumping from one branch to another about a foot away. The young owls seemed particularly vulnerable to predators at this time, for example, one of the fledglings lost its balance three different times under natural perching conditions. The last observed fall of this owl was when it had been out of the nest for three and one-half hours. This time it momentarily hung by its feet, but finally landed on the ground. The owl was not injured, it walked away from the nest tree and appeared only curious towards its surroundings. Sumner (1929) in discussing Long-eared Owls in California, stated that the inability of the young to remain in the nest until the power of flight is gained would appear to be a considerable liability to the species, especially because of danger from predatory animals.

Post-fledgling Stage

During this stage, young Long-eared Owls flew nearly as well as the adults but were still under the care of the parents. Between June 15 and July 3, I visited Area B six times and observed the one post-fledgling remaining, when it was 32 to 50 days of age. The adults still protected and cared for the young owl, whose development enabled it to occupy a greater home range. Activity of the adults took place concurrently with that of the young, beginning between 8:00 and 8:30 P.M., and lasting until about 3:30 A.M. I was never present to record the activity around dawn.

Activities of Young During the Post-fledgling Stage

During the post-fledgling period, the young Long-eared owl was observed on four occasions. Activities at three of these times are noted in the following paragraphs.

1. When the young owl was 33 days of age, the author observed it perched on an exposed branch approximately 40 feet from the ground. The author threw large objects towards it expecting that it would leave its perch and float to the ground. After several minutes, the owl flew away.

2. The young Long-eared Owl became silent in response to the warning call of the adults when it was 50 days old. The author was listening to the young call and approached the area from which the call was coming. An adult Long-eared Owl called wuh - wuh - wuh whereupon the young immediately stopped calling. The young's only call was a frail squeak, and was not audible to the author for more than 50 yards.

3. When the young Long-eared Owl was 34 days old, it was observed making short flights in tree tops and was heard calling three or four times during the time it waited to be fed. It would disappear into the foliage after each flight, thus the call might serve to inform the adults as to the whereabouts of the young.

The young owl occupied a greater part of the apparent home range during the post-fledgling period and was capable of short flights. It was always observed in deciduous trees during the late spring and summer, within an area 100 to 150 yards in diameter.

Adult Activities During the Post-fledgling Stage

The activities of the adult Long-eared Owl centered around protection and feeding of the young during the post-fledgling period, when only one adult was observed in the area at one time.

The warning call mentioned previously as heard during other periods was heard again during this period. The call was whuh - whuh - whuh (repeated).

Another type of call was heard twice, on June 10 and June 15, during this period. This was a soft call and was normally given from the same perch on a telephone line. The call may be described as whurrr - whurrr - whurrr.

Appearance of Post-fledglings

A general description of the color of the captive young Long-eared Owl from Area A from age approximately 36 days to age 59 days old follows:

At 37 days, the face was rusty; on the outer perimeter of the orbit was located an inner ventral white patch, a median black line and an outer tan line; a white patch extended from the chin and gular region about one-third the distance dorsally to the outer perimeter of the orbit; black bordered the median perimeter of the orbit ventrally and one-half the distance around the orbit, the black then bordered the white patch; light tan composed the outside perimeter of the orbit. The breast and upper abdomen was gray, streaked with brown and some tan. The lower abdomen, crissum, and legs were rusty. The tarsus was white. The anterior edge of the wing at the region of the distal end of the radius was light tan and extended distally to the proximal end of the primaries. The primaries and secondaries were light tan with reddish-brown bars; the bastard quill coverts were reddish-brown; the greater primary coverts were light tan and heavily streaked with reddish-brown; the greater secondary coverts were gray and lightly streaked with reddish-brown; the median and lesser secondary coverts were reddish-brown. The back was dark tan heavily barred with brown. The dorsal surface of the tail was tan with brown bars. The top and back of the head was downy gray.

At 45 days, a white facial patch extended one-half the distance up the outer perimeter of the orbit. The breast was gray and streaked with light brown. At 48 days, a white facial patch extended dorsally and lay outside of a ventrally projecting black margin around the orbit. At 59 days, tan appeared on the head; longitudinal brown streaks appeared down the back of the head; the breast was tan and white, heavily streaked with

Figure 24. A fledgling 39 days of age.

dark brown in the upper part and lightly streaked in the lower part; and dark brown and black feathers were located in the ear tufts.

Summary of Calls

The voice of the Long-eared Owl has been described by several authors. Sumner (1929) reported that the adult Long-eared Owl gave forth a series of squeaks and whines, and cried when protecting its young. He said that the young gave loud shrill prolonged squeaks. Whitman (1924) stated that in New York Long-eared Owls gave low pitched wocks, single low hoots, uttered wild and curious cries when protecting their young, and gave a high-pitched "quick", repeated several times when the adults were greatly stirred. I described this last call on page 22, when I compared it to that of a "clucking chicken". Whitman said this call turned into a scream when the bird was excited. However, I have not interpreted any of the calls as screams. Addy (1940) described Long-eared Owls in Virginia which uttered calls and cries. Doubleday (1898) observed a subdued hooting in the spring; other calls described by the same author included a soft toned wu-hunk repeated slowly, a low twittering whistling note, dicky - dicky - dicky, and the most common call, a prolonged me-ow-ow-ow much as a cat's cry. Says Doubleday, ". . . . . it would seem folly for a bird that lives chiefly on mice to utter it".

Calls of the Long-eared Owls in Area B, as I heard them, impressed me as being a means of communication between the owls during the breeding cycle and thus as playing a most significant role. Supporting this belief

is the appearance of different calls in each of the stages of the breeding cycle. According to my data, I differ somewhat with Saunders (1951) as to the importance of these calls. He indicated that owl calls are more frequently used in late summer when nesting activities are entirely over, and, therefore, he reasoned that the calls do not have the significance in mating which a true song is supposed to have. According to Saunders, call and alarm notes of all birds are definite, used under certain specific conditions, and "evidently have meaning". Although some calls of the Long-eared Owl were nearly like songs, to my ear, certain authorities (See Saunders, 1951) question whether one may classify any of the sounds uttered by owls as songs. Accordingly, I here refer to all of them as calls and list them according to the part of the breeding cycle in which they were heard.

<u>During Courtship</u>

Was heard at three different pitches (Page 21).

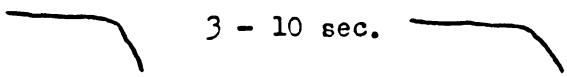
whoo whoo whoo

Took place between the male and female Long-eard Owls (Page 22).

whoooooo

Uttered by the female Long-eared Owl while on the nest but preceded

the egg-laying period. (Page 23).



whoooo whoooo

A. Given intermittently with the preceding call and less than a second elapsed between syllables. (Page 23).

B. Took place between the male and female Long-eared Owls while both were on the nest during the possible copulatory act.

wuh wuh wuh wuh wuh wuh wuh

Given by the female Long-eared Owl while on the nest and appeared to be in anticipation of the male's return during the copulatory phase. (Page 23).

wuh wuh wuhwuh wuh wuh wuh wuhwuh

Given by the male Long-eared Owl while near the nest and was made to the female owl on the nest. (Page 23).

whoooo

<u>During Incubation</u>

Given by the male Long-eared Owl when the female of the species left

the nest to feed. (Page 31).

whoooo whoooo whoooo

The female Long-eared Owl reacted to intruders by giving a high chicken-like call and crying. (Page 33).

The male and female Long-eared Owls called to each other with whoooo-whoooo, as already described in the courtship calls. The calls of the female were higher pitched and repeated more rapidly than the calls of the male. (Page 23).

<u>During the Nestling Stage</u>

The male Long-eared Owl began the morning and evening activity with this call. (Page 36).

whoooo whoooo

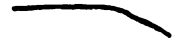
Two types of calls were given by the male Long-eared Owl when something strange was detected by him in the nesting area. The first was loud and gruff. (Page 36).

wuh wuh wuh wuh wuh

or

wuh

The male Long-eared Owl sometimes indicated alarm by this low and soft call.



whooo

Under extreme conditions, the male Long-eared Owl showed alarm by squealing. (Page 37).

The female Long-eared Owl expressed alarm by crying with long wails and calling low and growl-like wuh - wuh - wuh. (Page 39).

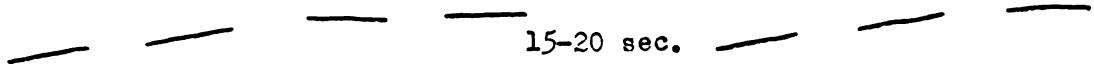
The female Long-eared Owl indicated alarm by this call. The call was very similar to the wuh-wuh-wuh call described in the preceding paragraph but was much more emphatic. (Page 40).

bwauk bwauk bwauk bwauk

During the Fledgling Stage

The female Long-eared Owl gave three different calls on the day the young owls became fledglings. The last was very soft. (Pages 49 and 50).

1.



15-20 sec.

woouh woouh woouh woouh woouh woouh woouh

2.

wough-woughwuh-wough

3.

well well

An adult Long-eared Owl was observed making this rasping-like call when the young owls were 28 days old. (Page 51).

quorrel quorrel wuowh

An adult Long-eared Owl was observed making this soft call when the young owls were 32 days old. (Page 63).

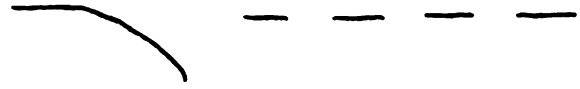
whurrrr whurrrr whurrrr

Feeding Calls

An adult Long-eared Owl gave this soft call when feeding the young which were 18-19 days old. (Page 79).

wough wough wough

An adult Long-eared Owl gave this hoarse call in reply to the young and before the young were fed.



wuhrrr cha cha cha cha

The young Long-eared Owls were noted to call before and during feeding. The single notes were soft, short, high pitched or flute-like squeaks.

RELATION TO OTHER VERTEBRATES

A list of those vertebrates which were observed by the author, and which may have affected the Long-eared Owl included amphibians, reptiles, birds and mammals. Statements concerning the effects of the various animals upon the Long-eared Owl are largely speculative; more precise relationships could be established only by further study. Animals classified as competitive are those considered to compete with owls as to food, hunting, roosting, and nesting areas, while non-competitive animals are those which serve as food for the owls. Records of vertebrates in the same areas occupied by the Long-eared Owls were assembled from sight records, as from analyses of owl pellets and from records of a small-mammal trapping study.

Vertebrates Possibly Competitive with Long-eared Owls

As to food: Cooper's Hawk (*Accipiter cooperii*), Red-tailed Hawk (*Buteo jamaicensis*), Red-shouldered Hawk (*Buteo lineatus*), Marsh Hawk (*Circus cyaneus*), Great Horned Owl (*Bubo virginianus*), Screech Owl (*Otus asio*), Barred Owl (*Strix varia*), Saw-whet Owl (*Aegolius acadica*), Short-tailed Shrew (*Blarina brevicauda*), Masked Shrew (*Sorex cinereus*), Least Shrew (*Cryptotis parva*), Short-tailed Weasel (*Mustela cicognanii*), Long-tailed Weasel (*Mustela frenata*), Least Weasel (*Mustela rixosa*), Domestic Cat (*Felis domestica*), milk snake (*Lampropettis triangulum*), blue racer (*Coluber constrictor*), massasauga rattlesnake (*Sistrurus catenatus*). (Burt, 1948 and Manville, 1952).

As to nesting areas and space, and roosting space: Crow (Corvus brachyrhynchos), Blue Jay (Cyanocitta cristata), Gray Squirrel (Sciurus carolinensis), Fox Squirrel (Sciurus niger), Man (Homo sapiens).

Possible predation upon eggs and young: Raccoon (Procyon lotor), Gray Squirrel (Sciurus carolinensis), Fox Squirrel (Sciurus niger).

As to interference in hunting areas: spring peeper (Hyla crucifer).

On April 14 in Area B, the author noted a great upwelling of the spring peeper's song from a swale lying northeast of the nest about 300 yards. The author noted that when he stood in a field directly north, adjacent to the nesting area, the spring peeper's song prevented his hearing of any other sounds. Thus, assuming the same auditory interference with owls, one of the most accessible hunting areas of the Long-eared Owl might have been huntable only by sight. It is possible that this explains in part the action of the female Long-eared Owl which appeared to hunt only in the deciduous woods west of the nest when observed late in the incubation period. Schwartzkopff (1952) noted that owls depend on their ears to an exceptional degree and even show specializations within the ear.

Vertebrates Non-competitive with Long-eared Owls

Vertebrates recovered from the pellets and nests of the Long-eared Owl: Blue Jay (Cyanocitta cristata), Crow (Corvus brachyrhynchos), Starling (Sturnus vulgaris), English Sparrow (Passer domesticus), Eastern Meadowlark (Sturnella magna), Red-wing Blackbird (Agelarus phoeniceus),

grackle, Cowbird (Molothrus ater), Cardinal (Richmondena cardinalis), Pine Siskin (Spinus pinus), Slate-colored Junco (Junco hyemalis), Tree Sparrow (Spizella arborea), Field Sparrow (Spizella pusilla), Fox Sparrow (Passerella iliaca), Swamp Sparrow (Melospiza georgiana), Song Sparrow (Melospiza melodia), pheasant or chicken, Song, Vesper, or White-throated Sparrow, unidentified birds, Meadow Vole (Microtus pennsylvanicus), Bog Lemming (Synaptomys cooperi), Meadow Jumping Mouse (Zapus hudsonius), Prairie Deer or, and White-footed Mouse (Peromyscus sp.), House Mouse (Mus musculus), Norway Rat (Rattus norvegicus), Short-tailed Shrew (Blarina brevicauda), Masked Shrew (Sorex cinereus), Least Shrew (Cryptotis parva).

FOOD HABITS - FIELD OBSERVATIONS

Hunting Activity

The time and frequency of hunting of the Long-eared Owls varied by the season, being different during spring and during the nesting period than during other seasons. However, certain non-nesting owls, perhaps young of the previous year, seemed to depart from this seasonal pattern.

Non-nesting Individuals

Non-nesting Long-eared Owls were observed in Area A at the same time a pair was nesting there. Perhaps the three or four individuals seen were yearlings from the same nesting pair, for Bent (1938) says the Long-eared Owl family keeps more or less together during the summer and fall and perhaps the winter too.

On one occasion, four observers took up observation positions 100 to 200 yards out from each corner of Area A. Three or four owls were observed six times in a period of 25 minutes, flying silently, about ten feet from the ground. A single owl landed on a brush pile and then darted to the ground.

On another occasion, the author observed two Long-eared Owls when their evening hunt began in early April of 1954 in the Lansing winter roosting area. They flew about 50 yards after leaving their roosts and landed in separate trees about six feet above the ground, and appeared to look around.

Thus, hunting took place both from perches near the ground and by flying near the ground. All hunting activity observed always began west of the roosting area.

During the Breeding Cycle

During Pre-incubation

Certain observations were made in Area B before incubation. On one occasion, the female left the nest at dusk and hunted for about ten minutes in a deciduous woods lying several hundred yards west of the nest. Trapping in this area revealed a small population of mice in brush piles. At another time, the male Long-eared Owl was observed after dusk in thick stands of spruces lying east of Area B. Thus, the owls in Area B did not appear to hunt in the open fields but were seen in the spruce stand and deciduous woods.

It is possible that at this time hunting could not have taken place in the fields because of the great upwelling of the spring peeper's song from a nearby marsh. The adjacent fields may have been impossible to hunt, except by sight alone. In contrast, movements of the mice were easily audible in the spruce grove. Southern (1955) reported that most owls locate their prey by hearing it.

During Incubation

On each of the five evenings when observations were made during this period, the female Long-eared Owl left the nest quite regularly at 8:15 or 8:20 P.M. and was gone about ten minutes. On April 29, I observed the

female scrutinizing the surrounding area from her perch in the deciduous woods, but may beetles (Phyllophaga sp.) were the only prey for the owl that the author could observe. In England, Southern (1955) found that the main items of diet of the Tawny Owl (Strix aluco) were mice and voles, yet from late spring through early autumn, these birds fed extensively of cockchafers, ground beetles, earthworms, young moles and rabbits, according to Southern because ground vegetation was thick during this period and mice and voles were not easily found.

During the Nestling Stage

The male appeared to obtain all the food in the early stages of the nestling period. The female Long-eared Owl was never observed off the nest at this time in seven visits to the nest.

Daytime hunting by the male when the young were several hours to one day old was evidenced by the presence of diurnal prey. A decapitated Meadow Vole (Microtus pennsylvanicus) was found on the morning of the day eggs hatched and on that afternoon, at 4:30 P.M., there was a freshly killed Meadow Jumping Mouse (Zapus hudsonius), both within the nest.

Lincoln (1920) noted that Long-eared Owls occasionally hunt in the daytime and Whitman (1924) stated they hunt during the daytime when it is necessary to supply demands of the family.

On May 19, when the young were four and five days old, two decapitated Meadow Voles which were in the nest in the morning, were gone at 3:30 P.M. A single decapitated Meadow Vole was found in the nest at 3:00 P.M. the day the young were between six and seven days old. Crow feathers were

Figure 25. Two nestling Long-eared Owls and two Meadow Voles in the nest in Area B.

found in the mouth of a nine day old owl in Area A.

The young Long-eared Owls in Area B were observed being fed by an adult when the young were 18 to 19 days old. The young called at broken intervals for nearly two hours before they were fed and the adult gave a soft rising call wough - wough - wough while feeding them.

Thus, the male apparently obtained the food for the family during the early nestling stage. Later caring for the young was a joint responsibility of both adults. Although a jumping mouse in the nest during the early nestling stage indicated diurnal hunting by the male, this species of mouse did not appear in the owl pellets examined. Wilson (1938) found a relatively small percentage of jumping mice in Long-eared Owl pellets he examined.

During the Fledgling Stage

All observations upon fledglings were made in Area B. A 27 day old owl was observed being fed at 1:00 A.M., June 10. The adult called softly before flying into the place where the young was perched, and soft chipping notes of the young could be heard while it was being fed. The notes of the young owl were single, short, high-pitched or flute-like squeaks. The young owl was perched on the tip of a pine bough 15 to 20 feet above the ground. The adult flew to the young owl, hovered, and apparently placed bits of food in the fledgling's mouth, since no whole mouse was seen. The feeding operation did not take more than one minute. The night was cloudy and windy, with rain, illustrating the extreme conditions under which the adult Long-eared Owl could hunt. Southern (1955)

found that the Tawny Owl (Strix aluco) in England could see mice when there was less than one millionth of a candle power or the amount of light falling on the forest floor on a cloudy summer night. The feeding activities of the adults appeared to decrease during the latter part of this stage, to judge from the lesser frequency with which adult activity was observed.

When the young was 28 days old, the adults fed it at 1:00 A.M. and again at 1:30 A.M.

During the Post-fledgling Stage

The young owl was heard calling at approximately 8:30 P.M. on June 17 (34 days old) while it was making flights of approximately 100 yards. Feeding of the young owl by the adults took place shortly after each of these movements.

The apparent release of innate adult feeding behavior was observed on June 18. The author, attempting to obtain photographs of an adult Long-eared Owl, had caged a captive 67-day old owl and set up two cameras two to three feet away from the cage. The young owl had been starved for one day, and it was calling more often than usual. At 1:00 A.M., within a few minutes, an adult Long-eared Owl made two apparent attempts to reach the young owl, striking the cage with its wings both times. There are two important facts here, first, that the young owl was not the offspring of this particular adult, and second, that conditions were far from natural in the area. It would seem here that the feeding behavior pattern of the

adult Long-eared Owl occurred in spite of fear for itself.

The last adult feeding of the young observed at night during this study took place at 3:15 A.M. when the young Long-eared Owl was 36 days old. An unusual call, a loud whurrr - cha - cha - cha - cha, with a hoarse quality, was given by the adult before it fed the young. The last feeding cry of the young Long-eared Owl was heard by the author when the young owl was 50 days old. Bent (1938) reported that young Long-eared Owls were fed by the adults until the young were eight or nine weeks old; at this time, they had gained full power of flight and could hunt for themselves. The author observed a young owl flying quite well when only 33 days old; thus, this young was capable of full flight before it was seen to hunt for itself. Southern (1955) found young of the Tawny Owl in England to be dependent upon the parents until age three months. The same author found indirect evidence suggesting that newly independent chicks suffered a very high mortality and evidence indicated this was due to an inability of the young to obtain food. Young Long-eared Owls might not suffer this particular mortality loss because the family remains together through the fall. This gregarious nature of the family of the Long-eared Owls was discussed by Bent (1938).

FOOD HABITS - PELLET ANALYSIS

During the breeding cycle, only pellets of young Long-eared Owls were examined while during the post-breeding cycle, only pellets of adults were examined. Winter accumulations of pellets from the post-breeding cycle were found in five different winter roosting areas.

Pellets Produced by Young Owls

Neither of the two young Long-eared Owls in Area B were observed to eject pellets until it was 16 or 17 days old. In contrast, the author observed a captive owl a little over eight days old, which formed pellets within 24 hours after being fed animal remains. It is possible that the nestlings were not fed either the proper quantity or quality of food by the adult owls. It is not known why the adult owls continued to feed the young in this manner when the young are apparently capable of receiving a different diet. Pirnie (1943) did not find any pellets under the nest of a Long-eared Owl before the oldest nestling was 16 days old. He credited the delay to the fact that early feedings consisted of small and readily digestible bits of meat while later feedings included larger pieces with more fur and bone.

A number of pellets from young owls of known age were collected; the average measurements are as follows:

10 days, 2 pellets:	avg. length	- 38.5 mm
	avg. diameter	- 14.0 mm
12 days, 3 pellets:	avg. length	- 41.7 mm
	avg. diameter	- 16.0 mm

13 days, 1 pellet:	length	- 47.0 mm
	diameter	- 16.0 mm
14 - 15 days, 2 pellets:	avg. length	- 43.0 mm
	avg. diameter	- 15.0 mm
16 - 17 days, 4 pellets:	avg. length	- 49.8 mm
6 pellets:	avg. diameter	- 16.3 mm
18 - 20 days, 5 pellets:	avg. length	- 38.4 mm
	avg. diameter	- 13.8 mm
25 days, 2 pellets:	avg. length	- 42.0 mm
	avg. diameter	- 16.7 mm
26 days, 1 pellet:	length	- 29.0 mm
	diameter	- 13.5 mm
30 days, 1 pellet:	length	- 26.0 mm
	diameter	- 13.0 mm
39 days, 2 pellets:	avg. length	- 36.5 mm
	avg. diameter	- 13.0 mm

Thus, there appears to be no trend of increasing size in pellets produced by owls aged 10 to 39 days. Comparison with pellets produced by adult owls, however, suggests that those of the juvenile birds are slightly smaller.

Contents of Young Owl Pellets

The autor erected a funnel-like wire receptacle immediately beneath the nest in Area B to collect pellets of the young owls. The six pellets collected (May 31 to June 3) contained: four meadow voles (Microtus pennsylvanicus), five whitefooted or prairie deer mice (Peromyscus sp.), one short-tailed shrew (Blarina brevicauda), and five unidentified mice (decaoitated).

Size of Adult Owl Pellets

Measurements of length, diameter and weight were made of 72 whole Long-eared Owl pellets taken from accumulations found during 1953 and 1954 in the Lansing winter roosting area. Average measurements and ranges were:

	Number Measured	Average	Maximum	Minimum
Length in mm	72	46	92	20
Diameter in mm	72	19	29	10
Weight in grams	68	3.20	7.48	0.38

Two pellets weighing 4.4 and 5.1 grams on the day of regurgitation lost upon drying for two weeks, 2.3 and 2.7 grams respectively.

The smallest pellet (which contained only one humerus) was 20 mm long, and weighed .4 grams. The largest pellet had a length of 70 mm, and weighed 7.5 grams. The next largest pellet had a length (maximum of all pellets) of 92 mm, and weighed 6.2 grams. The smallest pellet containing two animals (one Microtus pennsylvanicus and one Sorex cinereus; with only one major bone missing) was 23 mm long, and weighed 1.9 grams. The pellet containing the maximum number of animals (two Microtus pennsylvanicus and three Peromyscus sp.) had a length of 70 mm. Wilson (1938) reported the range in sizes of pellets of the Long-eared Owl to be: in length 2.7 to 8.4 cm.; in diameter 1.3 to 2.2 cm.; with average measurements of approximately 5 to 6 cm in length and 1.5 cm in diameter.

Number of Adult Owl Pellets

The exact number of pellets examined could not be determined because many pellets either broke up upon falling, or disintegrated from weathering. An accurate count of prey in 72 whole pellets was made, and from this an approximation of the total number of pellets was derived. The approximation was made according to the following formula used by Wallace (1948):

$$\frac{\text{No. whole pellets (72)}}{\text{No. animals in whole pellets (113)}} = \frac{\text{No. of broken pellets (X)}}{\text{No. of animals in broken pellets (3263)}}$$

X = 2079 pellets examined

The average number of prey per pellet was 1.57.

Wilson (1938) found an average of 1.7 prey items per pellet. The average number of prey per pellet does not equal the average number of prey consumed per day as shown by daily observations made upon a group of Long-eared Owls in the Lansing winter roosting area. The owls were counted each day, and all pellets were collected and examined, with the following results:

Date	No. of Owls	No. of Pellets	No. of Prey Animals
April 3	1	2	2
April 5	3*	4	7
April 6	3	6	6
April 7	3	4	4
April 8	3*	6 plus	8
April 9	2	2 plus	5

Date	No. of Owls	No. of Pellets	No. of Prey Animals
April 10	3	3	5
April 11	2	2	2
Total During 8 Days	20	29 =	39 =
		1.4 pellets per owl per day	1.3 animals per pellet

*These numbers are uncertain.

This rough approximation revealed that the Long-eared Owl sometimes may eject more than one pellet per day.

Identification of Adult Owl Pellets

The average Long-eared Owl pellet is long and cylindrical and measured approximately 4.6 cm. in length and 1.9 cm. in diameter. Variation existed as I have already shown.

The only pellets included in this study were those thought to be surely from Long-eared Owls. Pellets were used from roosting areas where Long-eared Owls were positively identified, or from large accumulations of pellets in known Long-eared Owl habitat. Large accumulations of pellets were important in identifying roosts of the Long-eared Owl because of the gregarious nature of the species.

There was relatively little variation in diameter among pellets observed by the author; similarly Wilson (1938) found that Long-eared Owl pellets seldom varied more than a few millimeters in diameter. While a few Long-eared Owl pellets may resemble those of the Screech Owl, the diameters of the Long-eared Owl pellets were always much greater than

those of Screech Owl pellets. Long-eared Owl pellets are too small in diameter to be confused with pellets of the larger Barred Owl (Strix varia) or Great-horned Owl (Bubo virginianus). Pellets of the Short-eared Owl (Asio flammeus) are more similar to pellets of the Long-eared Owl, and since the Short-eared Owl is also gregarious (Bent 1938), some confusion might occur where the ranges of the two species overlap. Here positive identification of the owls should be made before deciding the identity of the pellets.

Contents of Pellets of Adult Owls

The prey animals found in the Long-eared Owl pellets from the five roosting areas are listed on Table 1. Mice, making up 95.7 to 97.0 percent of all prey numbers, were used most heavily. Within the mouse population, the Meadow Vole (Microtus pennsylvanicus) was most important, and comprised 73.3 to 91.1 per cent of the total. Pellets from the roost in Area A, the roost adjacent to Area B and the roost in Jackson County showed 73.3, 76.1 and 75.6 per cent Meadow Voles, respectively. The relative abundance of these animals in the owl pellets may be an indication of their relative abundance in the three areas. Pellets collected from the white pine winter roost and the Lansing winter roost contained higher proportions, 85.3 and 91.1 per cent Meadow Voles, respectively. Prairie Deer and White-footed Mice were found in the Long-eared Owl pellets in sufficient numbers to appear to be a steady source of food in most areas. The winter mouse prey was supplemented by two other species, the Bog Lemming

TABLE 1

PREY SPECIES FOUND IN PELLETS OF THE LONG-EARED OWL FROM NESTING AND ROOSTING AREAS, PRESENT STUDY

	Winter in Area A		Winter adjacent to Area B		Winter one mile from Area B		Winter Jackson County		Winter Ingham County		Summer in Area A		Summer in Area B		Total	
Prey Mammals	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Microtus pennsylvanicus	532	(65.0)	363	(70.5)	112	(75.2)	128	(63.7)	1038	(79.1)	62	(40.0)	72	(60.5)	2307	(70.6)
Probable *Microtus*	68	(8.3)	29	(5.6)	15	(10.1)	24	(11.9)	157	(12.0)	15	(9.7)			308	(9.4)
Synaptomys cooperi	7	(.9)	2	(.4)			9	(4.5)					1	(.8)	19	(.6)
Peromyscus sp.	176	(21.5)	100	(19.4)	17	(11.4)	34	(16.9)	72	(5.5)	27	(17.4)	28	(23.5)	454	(13.9)
Mus musculus	1	(.1)													1	(.0)
Unknown mice													16	(13.5)	16	(.5)
Total Mice	784	(95.8)	494	(95.9)	144	(96.6)	195	(97.0)	1267	(96.6)	104	(67.1)	117	(98.3)	3105	(95.0)
Rattus norvegicus	2	(.2)													2	(.1)
Blarina brevicauda	3	(.4)	12	(2.3)	4	(2.7)	4	(2.0)	14	(1.1)	9	(5.8)	2	(1.7)	48	(1.5)
Sorex cinereus	1	(.1)	2	(.4)			1	(.5)	5	(.4)					9	(.3)
Cryptotis parva	12	(1.5)													12	(.4)
Sorex or *Cryptotis*	1	(.1)	1	(.2)							1	(.7)			3	(.1)
Prey Insects																
Phyllosticta sp.											2	(1.3)			2	(.1)
Catalpa lanigera											1	(.7)			1	(.0)
Prey Birds	15	(1.8)	6	(1.2)	1	(.7)	1	(.5)	26	(2.0)	38	(24.5)			87	(2.7)
Total Prey	818	(100.)	515	(100.)	149	(100.)	201	(100.)	1312	(100.)	155	(100.)	119	(100.)	3269	(100.)

(Synaptomys cooperi) in three areas, and the House Mouse (Mus musculus) in one.

The remaining prey of the Long-eared Owl made up less than five per cent of the owl's total diet and included the Norway Rat (Rattus norvegicus) and various species of shrews and birds.

Pellet Analyses by Other Workers

Pellet analyses of Long-eared Owls by other workers in Michigan (Table 2) give further information. The following studies have been made of winter pellet deposits: A.S. Warthin, Jr. and J. Van Tyne (1922), who examined 110 pellets collected near Ann Arbor, Michigan on January 21, 1922; Charles J. Spiker (1933) who collected and examined 200 pellets on February 19, 1933; near Saline, Michigan; Aelred D. Geis (1952) who examined a number of pellets recovered during the winter of 1951-52 at the Kellogg Bird Sanctuary, Michigan; and Kenneth A. Wilson (1938) who recovered pellets from September, 1932 to May, 1933, at a site in the vicinity of Ann Arbor, Michigan. Wilson observed a small representation of Zapus hudsonius implying that his pellet analysis probably was not in total a winter one. Wilson's study also adds a bat to the list of Long-eared Owl prey, (Myotis lucifugus). Geis's study revealed that only one bird species, the Pine Grosbeak (Pinicola enucleator) was preyed upon by the Long-eared Owl. All four studies show that Microtus pennsylvanicus was preyed upon far more than any other animal and that mice comprised practically all of the prey.

TABLE 2

PREY SPECIES FOUND IN PELLETS OF THE LONG-EARED OWL
BY OTHER INVESTIGATORS IN MICHIGAN

	Warthin and VanTyne		Spiker		Wilson		Geis		Total	
Prey Mammals	No.	%	No.	%	No.	%	No.	%	No.	%
Microtus pennsylvanicus	111	(88.1)	170	(85.4)	1458	(75.4)	423	(85.1)	2162	(78.4)
Peromyscus sp.	4	(3.2)	21	(10.6)	209	(10.8)	50	(10.1)	284	(10.3)
Synaptomys cooperi	8	(6.4)	3	(1.5)	184	(9.5)	9	(1.8)	204	(7.4)
Zapus hudsonius					25	(1.3)			25	(0.9)
Total Mice	123	(97.7)	194	(97.5)	1876	(97.0)	482	(97.0)	2675	(97.0)
Rattus norvegicus	1	(0.8)			2	(0.1)			3	(0.1)
Blarina brevicauda	2	(1.6)	4	(2.0)	41	(2.1)	7	(1.4)	54	(2.0)
Cryptotis parva					2	(0.1)			2	(0.1)
Myotis lucifugus					1	(0.1)			1	(-)
Prey Birds										
Pinicola enucleator							8	(1.6)	8	(0.3)
Passer domesticus			1	(0.5)					1	(-)
Birds (general)					13	(0.7)			13	(.5)
Total prey	126	(100.)	199	(100.)	1935	(100.)	497	(100.)	2757	(100.)

Contents of Summer Pellets

Adult owl pellets were collected during the summer from Area A and Area B (Table 1). The summer prey from Area B did not appear to change much from that in the winter, with a somewhat greater percentage of Prairie Deer and White-footed Mice and fewer Meadow Voles, with one Bog Lemming (Synaptomys cooperi), Short-tailed Shrews (Blarina brevicauda) and unknown mice.

The summer pellets from Area A showed a somewhat different distribution of prey than winter pellets from the same area, with a relatively low percentage of Meadow Voles, a relatively high percentage of Short-tailed Shrews, the appearance of insects, and a great increase in numbers of prey birds. The decrease of Meadow Voles appears significant; either the Long-eared Owl preferred other prey, or the other prey species were more readily available. In line with the latter explanation, Southern (1955) found a correlation between cover and prey types of the Tawny Owl, with the large owl even eating earth worms during the summer when the cover was too thick for it to find mice and voles. Bent (1938) called attention to an unpublished manuscript by Griffinus (1932) who made a study of small mammal populations in the vicinity of Ann Arbor, Michigan, along a marsh which was hunted by a family of Long-eared Owls. Griffinus showed that a close relationship existed between the relative numbers of mammalian prey consumed by the Long-eared Owls and the relative numbers of small mammals trapped in the area. Thus, these owls apparently fed upon the mammals which were most readily available.

TABLE 3

PREY BIRDS FOUND IN PELLETS OF THE LONG-EARED OWL IN THE PRESENT STUDY

	Blue Jay	Starling	English Sparrow	Eastern Meadowlark	Red-Wing Blackbird	grackle	Cowbird	Cardinal	Pine Siskin	Slate-colored Junco	Tree Sparrow	Field Sparrow	Fox Sparrow	Swamp Sparrow	Song Sparrow	young bird - pheasant or chicken	Song, Vesper or White-throated Sp.	larger than English Sparrow	English Sparrow size and smaller
Winter																			
Roost in Area A			3					2			3				3			1	3
Roost adjacent to Area B	1				1	1									1			1	1
Roost one mile from Area B								1											
Roost in Jackson County																		1	
Roost in Ingham County	1		4				1	4	1	1	2	1	1		6				4
Summer																			
Area A		2	3	1			1	2						1		1	5	16	6
Area B																			

An Attempt to Measure Predation by the Owls Upon a Mouse Population

An attempt was made in Area B to measure the rate of feeding of the Long-eared Owl family upon a population of mice. As many mice as possible were live trapped and tagged between April 9 and June 18. Pellet searches were carried out in hope of recovering tags from the tagged mice in the pellets.

The pellets were very difficult to locate; it is doubtful that recovery was made of even 25 percent of all pellets ejected. Southern (1955) was successful in recovering tags from pellets when he studied the Tawny Owl (Strix aluco) in England. The pellets were critically examined for metal tags, both with a fluroscope and by hand. No tags were found.

It was impossible to estimate directly the proportion of mice caught by the owls in the prey population because no tags were recovered in the pellets. It is possible even so to calculate reasonable estimates of the following: a maximum percentage of the mouse population tagged; a minimum population of mice hunted over by the owls; and a maximum rate of predation. These matters are discussed in the following paragraphs.

The problem was approached by asking how large a food population was required by the owls so that a sample captured by the owls could be expected to contain no marked mice. This sample consisted of those mice captured by the owls (and recovered in owl pellets by the author) during the time when the tagged mice were present and available. The question was answered by interpolating in a table of 95 per cent

confidence limits for binonial distribution (Snedecor, 1948), under the heading of "non observed" in samples of the observed sizes.

The upper confidence limit recorded was the probable maximum proportion of the mouse population marked, assuming all marked animals were available to the owls in the same manner as untagged animals. Knowing the number of mice tagged, the minimum population hunted was computed by a simple proportion. This computation is carried out below based upon two groups of mice.

1. All mice in pellets; mice of all species comprised 89 individuals. The interpolated confidence limits were from 0 to 4.7 per cent with a sample of 89 and none tagged. Thus, marked animals did not likely exceed 4.7 per cent of the total mouse prey population.

2. Only Meadow Voles (Microtus pennsylvanicus): remains of 56 Meadow Voles were found in the pellets which provided confidence limits of 0 to 6.6 per cent for the mice tagged.

Estimates of minimum prey population size were computed next. The 137 animals tagged were not likely to exceed 4.7 per cent of the population for all small mammals. Thus, there was at least 2915 animals. For Microtus pennsylvanicus alone, the 56 animals tagged were not likely to be more than 6.6 per cent of the population. Thus, there was a population of at least 848 Microtus sp. It must be recognized that these values are only reasonable lower limits for estimates of prey population, and since no information on upper limits can be offered here, the actual populations may have been several or many-fold these values.

The consumption of all species of mice by the Long-eared Owl family varied between four and six mice per day. This suggested a rate of utilization from the minimum total mouse population of not more than 0.2 per cent per day. The daily consumption of Meadow Voles appeared to be not more than 0.5 per cent per day assuming 60 per cent of the mouse prey population were Meadow Voles, or on a daily basis, approximately four of the six prey. The effect of predation upon these mice by the owls is even less significant when it is realized that the estimated mouse prey population is a minimum figure, and if it is in fact larger, the effect of predation is even smaller.

Comparison of Mice Tagged and Those Found in Pellets in the Same Area

Tagged mice totaled 161, with 81 Prairie Deer and White-footed Mice and 56 Meadow Voles. Two species of mice not observed in the owl pellets in this study were also tagged; one House Mouse (*Mus musculus*) and 23 Meadow Jumping Mice (*Zapus hudsonius*). One House Mouse was found in pellets from the winter roost in Ann Arbor, Michigan. Jumping mice never appeared in the pellets from Area B; one carcass was found in the Long-eared Owl nest but at the same time, a relatively large number of these mice were present in one of the trapping areas (nearly one mile northeast of Area B) where 15 Meadow Voles, 15 Meadow Jumping Mice, 10 White-footed and 10 Prairie Deer Mice were taken. The abundance of Jumping mice in the field and their absence in the pellets suggest either that the owls feed selectively or that jumping mice are less

vulnerable. Wilson (1938) however, found remains of jumping mice in Long-eared Owl pellets from Michigan. (Table 2).

SUMMARY

The Long-eared Owl is distributed throughout the United States. In Michigan, most breeding records come from the southernmost part of the state.

Individual Long-eared Owls have been observed to migrate, however, part of the population appeared to be non-migratory since winter roosts have been observed in nesting areas.

In Michigan, either a coniferous or a deciduous habitat may be used for nesting. Both breeding areas observed by the author were in groves of white pine.

Five winter roosting areas were observed by the author. These were in stands of Norway white spruce or white spruce, clumps of tamarack, and stands of white-jack pine or white pine.

The courtship pattern of the Long-eared Owl consisted of competitive calling, aerial performance, non-competitive calling, nest selection and copulation. Perhaps the most unique aspect was aerial performance which consisted of turning and twisting flights and wing slaps.

Long-eared Owl nests in Michigan have been recorded from ground level to a height of 40 feet. The two nests observed by the author were at heights of 27 and 25 feet and were abandoned nests of the Crow and apparently the Cooper's Hawk.

The eggs are white and nearly spherical, layed from early March to the middle of June in Michigan. Recorded clutches vary from two to seven

eggs. Eggs are laid at intervals of from less than 24 hours, to five days.

Pre-incubation was a short period of 9 to 13 days just prior to egg-laying, and activities during this time were very similar to those shown during early incubation. The incubation period of the Long-eared Owl in Area A lasted 23 to 26 days and in Area B from 22 to 26 days. During the incubation period in Area B, the female's interest in nesting activity seemingly increased while that of the male appeared to decrease. Pipping was observed on the eggs in Area B two days before hatching. Peeping was heard from this egg the day before hatching. In Area A, the interval between the first and last eggs hatching ranged from one to twelve days while in Area B, less than 24 hours elapsed between the two hatchings.

Activity of the adult Long-eared Owls consisted of hunting, feeding the young, and calling. Adult attention to their young increased from hatching and reached a maximum when the young were four days old, then decreased as the young grew more capable of caring for themselves. The male was the principle provider of food for the family in the early nestling stage. The female remained on the nest during this period and was not observed off the nest until the young were 15 to 19 days old. The young Long-eared Owls in Area A remained in the nest longer than those in Area B, the eldest remaining until 25 to 26 days old. In Area B, the two young left the nest when 20 days old.

During the fledgling stage, adult activity was characterized by hunting and caring for the young, largely a joint responsibility of both adults. This attentive activity decreased as the young grew more capable of caring for themselves. The principal fledgling activities were those of exploration and expansion of home range. Fledglings did not attempt to return to the nest. Fledglings appeared gray and downy with the color of the feathers in and around the orbicular region of a fledgling, a most useful criterion for determining the age of young Long-eared Owls.

The rate of development of the fledglings was noted by observing plumage development and time to acquire full power of flight.

During the post-fledgling period, the young Long-eared Owls flew nearly as well as the adult but were still under adult care. The young occupied a greater home range during this stage.

Calls of the Long-eared Owl were grouped into the stages of the nesting cycle. The sexes of the adult owls were recognized by the author on the basis of recognizable differences existing between the pitches of the two owls. The adults were observed giving 23 different calls. They were described as follows: Mourning Dove-like, soft rhythmic growls, high-pitched cries, chicken-like calls, gruff growls, squealing, wailing, emphatic bwauks and various soft cries. The young Long-eared Owls cried to be fed by giving soft flute-like squeaks.

Competitive and non-competitive vertebrates were observed in and around breeding areas and winter roosting areas. Two main groups were

significant: The competitive mammals and birds preying in part upon the same prey species as did the Long-eared Owls; non-competitive mammals and birds, particularly the mice, which made up the prey species of the Long-eared Owl.

Hunting appeared to take place in the coniferous and deciduous woods rather than in the adjacent fields in Area B. The male responded by diurnal hunting and appeared to be provider for the rest of the family during the early nestling stage. Feeding the young was a joint responsibility of both adults during late nestling stage. During the fledgling stage, a young Long-eared Owl was observed being fed, apparently small bits of food. Young owls appeared to be dependent upon the adults for at least two months as noted by a feeding cry of a young owl 50 days old.

The average size of the young Long-eared Owl pellet was slightly smaller than the adult pellets, being 40.8 mm by 15.0 mm as compared to 46 mm by 19 mm. There was strong evidence supporting a seasonal diet of the Long-eared Owl as shown by the contents of summer pellets of the adult owls in Area A.

The author observed 3263 prey items in approximately 2079 pellets. A prey count in 72 whole pellets revealed an average of 1.57 prey per pellet. The average prey per pellet should not be accepted as the average prey consumed per day by the particular Long-eared Owl.

The contents of pellets from five winter roosts of the Long-eared Owl revealed that the species in a pre-eminent predator of mice in Michigan. The Meadow Vole comprised most of the Long-eared Owl's diet of mice.

The Prairie Deer or White-footed Mouse appeared as a steady source of food and the Bog Lemming and House Mouse were additional mice. Other winter prey of the Long-eared Owl included the Norway Rat, Short-tailed Shrew, Masked Shrew, Least Shrew, and various songbirds, including many Fringillids.

At the Kellogg Bird Sanctuary, an attempt was made to measure the rate of feeding of the Long-eared Owl family upon a population of its prey. Mice were trapped, tagged and released in the areas around Area B, the most distant area being one mile away. Estimates were made of the following: a maximum per cent of the mouse population tagged; a minimum population of mice hunted over by the owls; and an estimated maximum rate of predation. The rate of predation was not more than 0.2 per cent per day of the total mouse population and not more than .5 per cent per day of Meadow Voles.

LITERATURE CITED

Addy, E.
1940 General notes (Notes from Virginia). Auk, 57:423.

Barrows, W.B.
1912 Michigan Bird Life. East Lansing, Spec. Bull. Mich. Agric. 2:300-306

Bent, A.C.
1938 Life histories of North American birds of prey. U.S. Nat. Mus. Bull., 170:153-169, 179.

Black, C.T.
1955 Michigan bird survey, summer, 1955. Jack-Pine Warbler, 33:128.

Brigham, E.M. Jr.
1946 Baker Sanctuary notes. Jack-Pine Warbler, 24:74.

Burt, W.H.
1948 The Mammals of Michigan. Ann Arbor, Univ. of Mich. Press, pp. 45-53, 79-237.

Doubleday, N.B.
1898 Birds That Hunt and are Hunted. New York, Doubleday & McClure Co., p. 338.

Geis, A.D.
1952 Winter food habits of a pair of Long-eared Owls. Jack-Pine Warbler, 30:93.

Jorae, I.F.
1951 A ground nest of the Long-eared Owl. Jack-Pine Warbler, 29:154.

Manville, M.H.
1952 The snakes of Michigan. Ext. Bull. 315, Mich. State College Coop. Ext. Serv., E. Lansing.

Mathews, F.S.
1921 Fieldbook of wild birds and their music. New York and London, G.P. Putnam's Son's, pp. 10-14.

Miller, A.A.
1935 Some breeding birds of the Pine Forest Mountains, Nevada. Auk, 52:467-468.

Pirnie, M.D.
1943 A pine tree nesting of the Long-eared Owl. Jack-Pine Warbler, 21:108-111.

Poole, E.L.
1938 Weights and wing areas in North American Birds. Auk, 55:514-516.

Saunders, A.A.
1951 A Guide to Bird Songs. New York, Doubleday and Co., Inc.,

Schwartzkopff, J.
1955 On the hearing of birds. Auk, 72:341-343.

Snedecor, G.W.
1946 Statistical Methods. Iowa State College Press, Chpt. 1:4.

Southern, H.N.
1955 Nocturnal animals. Sci. Am., 92 (10):88-98.

Spiker, C.J.
1933 Analysis of 200 Long-eared Owl pellets. Wils. Bull., 45:198.

Sturgeon, M.T.
1940 Sparrow Hawks and Long-eared Owl nests on the Michigan State Normal College campus. Jack-Pine Warbler, 18:3-6.

Sumner, E.L., Jr.
1929 Comparative studies in the growth of young raptores. Conder, 31:103-105.

Wallace, G.J.
1946 Seasonal records of Michigan birds - spring. Jack-Pine Warbler, 24:161-162.

1948 The barn owl in Michigan. Tech. Bull. 208, Agric. Exp. Sta., Mich. State College, East Lansing, p. 33.

1955 An Introduction to Ornithology. New York, Macmillan Company, Chpt. 7:171.

Wallace, G.J. and C.T. Black
1948 Seasonal records of Michigan birds - spring, 1948. Jack-Pine Warbler, 26:169.

Warthin, A.S. Jr., and Van Tyne, J.
1922 Pellet analysis of the Long-eared Owl. Auk, 39:417.

Whitman, F.N.
1924 Nesting habits of the Long-eared Owl. Auk, 41:479.

Wickstrom, G.
1951 Seasonal records of Michigan birds - spring, 1951. Jack-Pine Warbler, 29:96.

1953 Seasonal records of Michigan birds - summer, 1953. Jack-Pine Warbler, 31:144.

Wilson, K.A.
1938 Owl studies at Ann Arbor, Michigan. Auk, 55:187-197.

Wood, N.A.
1951 The Birds of Michigan. Ann Arbor, Univ. of Mich. Press, p. 237.

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