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THE BIOLOGY AND NESTING DENSITY OF BREEDING AMERICAN KESTRELS AND LONG-EARED OWLS ON THE BIG LOST RIVER, SOUTHEASTERN IDAHO

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This study addresses some nesting parameters of American Kestrels (*Falco sparverius*) and Long-eared Owls (*Asio otus*) along the Big Lost River on the Idaho National Engineering Laboratory (INEL) Site in southeastern Idaho. Although both are common raptors over much of North America, little attention has been paid to the nesting parameters of either in a desert environment, and no reports on North American Long-eared Owls have considered as many nests through a breeding season as the present study.

STUDY AREA AND METHODS

The INEL Site is a 2315 km^2 government reservation on the upper Snake River Plain. The area is a cool desert (Odum 1971) and big sagebrush (*Artemisia tridentata*)-grass vegetation types are predominant (Harniss and West 1973). The average elevation of the INEL Site is 1524 m and the topography is flat to rolling.

The study was conducted along 25 km of the Big Lost River which flows into the INEL Site before disappearing into the Big Lost River Sinks near Howe, Idaho. The river flows for much of the spring and early summer; but by late summer the flow on the lower river has been greatly reduced or eliminated by the diminished snow melt and the upstream removal of irrigation water. The average width of the upper reaches of the Big Lost River on the INEL Site is 9.6 m (Kerry Overton, pers. comm.). The characteristic vegetation of the Snake River Plain is interrupted along the Big Lost River by cottonwood trees (*Populus* spp.) which grow immediately along its banks. These trees range in size from saplings to well over 9 m tall and they occur sporadically along the lower part of the river.

Our observations on the INEL Site took place in 1975 and 1976. The spring of 1975 was cool and wet, while the spring of 1976 was comparatively warm and dry. In the nesting season (March through August) the average precipitation was 12.6 cm in 1976 and 14.7 cm in 1975 and the average temperature was nearly 2°C lower in 1975 than in 1976. In particular, the months of April and May averaged 4.5°C and 5.8°C cooler in 1975 than 1976 and the average precipitation was 0.3 cm and 0.2 cm greater for those months in 1975 than 1976 (National Oceanographic and Atmospheric Administration records).

In 1975, 7 nesting boxes (see Hammerstrom et al. 1973) were placed 3 to 8 m high in cottonwood trees along the upper 8 km of the Big Lost River on the study area. In 1976, 7 more nesting boxes were placed along the same section of river and 6 were placed further downstream. The boxes were widely separated along the river.

In late March of 1975 and early April of 1976, TC surveyed the Big Lost River by walking the river bank and investigating each tree which contained a large nest or cavity. The study area was surveyed again in May and June both years to be sure any late-nesting birds were found.

To avoid disturbing the birds, a nest was not visited until it was decided that the eggs probably had hatched. Because nesting dates varied considerably, some nests were visited twice during incubation while others were not revisited until the young were 7 to 10 days old.

After most nests had young in them, TC checked each every 2 days in 1975 and 3 days in 1976 and removed all prey remains that were no longer of food value to the young. Castings were removed only from Long-eared Owl nests since the bony remains in them are easily identifiable (Errington 1930) and hawk castings offer little reliable food habit data (Errington 1932). The material in the castings was identified by comparison with skeletons from the Idaho State University Museum collection.

The number of eggs or young in nests was determined by direct observation. In nests that were not visited until after all young had hatched, we assumed that any unhatched egg would be left in the nest for a short period of time; therefore, clutch-size and brood-size were considered the same if the nests were visited no later than 4 days after the youngest nestling had hatched. Three Long-eared Owl nests were found in 1975, 2 after the young fledged; thus, the number of eggs laid per nest was determined by the number of young seen in the 2 family groups plus the contents of 1 other nest.

Only nests in which eggs were laid were considered in calculating productivity. The number of young American Kestrels fledged from a nest was determined by counting the number of young which were still in the nest no more than 3 days prior to the time it was vacated. Since Long-eared Owls move out of the nest onto branches in the nest tree and nearby trees before they are free-flying (Whitman 1924), we assumed that they had fledged if they were seen at or around the nest or in branches of the nest tree.

The percent biomass of prey items in the diet of these raptors was calculated using individual mass values obtained from Kochert (1975), Poole (1938), Spector (1956), Tinkle (1973) or from mean weights of specimens in the Idaho State University Museum.

RESULTS AND DISCUSSION

American Kestrel Nesting Biology

Phenology.—American Kestrels were not resident on the INEL Site but arrived in late March and April. Using an incubation period of 30 days (Roest 1957, Smith et al. 1972) we calculated that the first American Kestrels to nest on the Site began incubating eggs in mid-May in 1975 and 12 days earlier (early May) in 1976 (Fig. 1). The mean hatching and fledging dates for 10 nests in 1975 were 25 June and 24 July, respectively. In 1976 the mean hatching date for 14 nests was 12 June and the mean fledging date was 9 July. The onset of nesting behavior was varied and in both 1975 and 1976 more than 3 weeks elapsed between the earliest egg hatching dates and the latest.

Young American Kestrels hatched 12 days earlier in 1976 than in 1975 and there was a 13-day difference in the mean egg hatching dates. The mean fledging dates were even more variable and occurred 15 days later in 1975. The cooler, wetter spring, particularly during courtship and egg-laying (April and May) may have delayed the onset of nesting in 1975. Roest

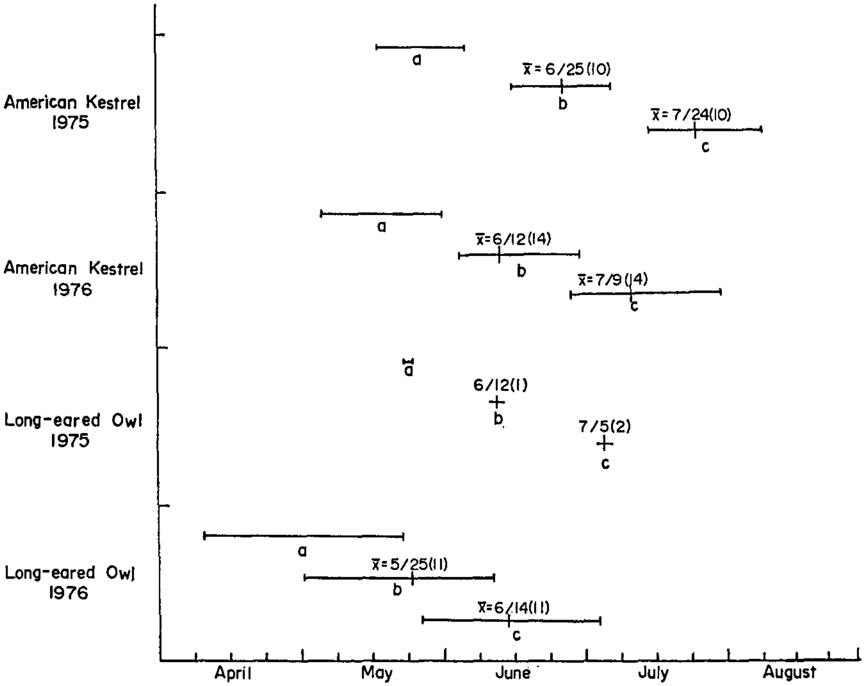

FIG. 1. Nesting phenology (bar represents length of time from earliest to latest dates) of American Kestrels and Long-eared Owls on the INEL Site in 1975 and 1976, showing mean dates and sample sizes; a = egg-laying, b = hatching, c = fledging.

(1957) suggests that egg-laying dates for American Kestrels are probably dependent upon local weather conditions. An increase in available prey in the early spring might also have hastened the onset of nesting behavior, though we collected no data on prey availability.

The period of time from hatching to fledging, 29.3 ± 3.9 (SD) days in 1975 versus 27.7 ± 3.5 days in 1976, is not significantly different in the 2 years (Group Comparison t; $t = 1.04$, $P > 0.05$). Porter and Wiemeyer (1972) reported that captive American Kestrels were in the nest an average of 28.4 days (26–32 day range), while Craighead and Craighead (1956) reported 31 and 29 days for wild birds in Michigan and Wyoming, respectively.

Productivity.—The mean number of eggs in American Kestrel nests in 1975 was 4.5 ± 0.7 and 4.7 ± 0.7 in 1976 (Table 1). In 1975 a mean of 3.7 ± 1.8 young hatched from these nests and in 1976 the mean was 4.0 ± 1.8 young/nest. In both years all young which hatched also fledged

TABLE 1

MEAN CLUTCH-SIZE AND NESTING PRODUCTIVITY OF AMERICAN KESTRELS AND LONG-EARED OWLS ON THE INEL SITE IN 1975 AND 1976

	N	Mean clutch-size	Percent of nests hatching 0 eggs	1 eggs	2 eggs	3 eggs	4 eggs	5 eggs	6 eggs	Mean
American Kestrel 1975	13	4.5	15.4	0.0	7.7	0.0	30.8	46.1	0.0	3.7
American Kestrel 1976	23	4.7	13.0	4.4	0.0	0.0	21.7	60.9	0.0	4.0
Long-eared Owl 1975	3	3.0	0.0	0.0	66.7	33.3	0.0	0.0	0.0	2.3
Long-eared Owl 1976	15	5.3	13.3	0.0	6.7	0.0	6.7	60.0	13.3	4.2

	N	Percent of nests fledging 0 young	1 young	2 young	3 young	4 young	5 young	6 young	Mean
American Kestrel 1975	13	15.4	0.0	7.7	0.0	30.8	46.1	0.0	3.7
American Kestrel 1976	23	13.0	4.4	0.0	0.0	21.7	60.9	0.0	4.0
Long-eared Owl 1975	3	33.3	0.0	33.3	33.3	0.0	0.0	0.0	1.7
Long-eared Owl 1976	16	12.5	0.0	6.2	0.0	25.0	43.8	12.5	4.1

successfully. There were no significant differences in the productivity ($\bar{x}$ number of young to fledge) of American Kestrels in 1975 and 1976 (Group Comparison *t*; $t = .42$, $P > 0.05$). More nests fledged 5 young than any other number and there was a higher percent of nests to contain 5 eggs and fledge 5 young in 1976 than in 1975 (60.9% vs. 46.2%). Smith et al. (1972) also found that the most frequently occurring clutch-size was 5 eggs. Although other researchers report up to 6 eggs (Bent 1938, Roest 1957, Smith et al. 1972), none of the nests on the INEL Site contained more than 5 eggs. The mean productivity of American Kestrels on the INEL Site approximated that reported by Hamerstrom et al. (1973) of 4.0 young/nest and Nagy (1963) of 4.4 young/nest; $N = 7$. However, it was higher than that reported by Smith et al. in 1972 (2.3 young/nest; $N = 22$), in Utah. Since young American Kestrels were assumed to have fledged if they were seen in the nest 3 days prior to the time the nest was vacated, the actual mean number of young to fledge from nests would be expected to be somewhat lower than reported herein.

There was an 80% increase in the number of active American Kestrel nests that were found from 1975 to 1976 (from 13 nests or 0.5 nests/km of river to 23 nests or 0.9 nests/km of river). This increase may have resulted from the improved weather conditions in 1976 or because 13 more nest boxes were placed on the study area in 1976.

Nest boxes.—Of the 7 nest boxes available in 1975, 3 were successfully used by American Kestrels. Two others were visited by American Kestrels early in the year but as the sides were removed no nesting occurred. Two others were used by Starlings (*Sturnus vulgaris*) and Common Flickers (*Colaptes auratus*).

American Kestrels visited 11 nests boxes in 1976 and successfully hatched eggs in all but 2, where the clutches failed. Eight other nest boxes were used by Starlings; 1 box was not used. In 1 successful nest box, we found 2 Starling eggs with a clutch of 5 American Kestrel eggs.

Since we found only 30 potential natural nesting cavities along the Big Lost River (many were used by other bird species) the nest boxes may have influenced the number of nesting pairs of American Kestrels on the study area. They did not affect productivity as there was no significant difference in the productivity of American Kestrels in nest boxes and in natural nest sites (Group Comparison t; $t = .04$, $P > 0.05$).

Nest-sites.—The average entrance diameter of 12 American Kestrel nests along the Big Lost River was 9.3 ± 3.5 cm (range, 7.5 cm–18.0 cm) and the average height of 17 nests was 2.7 ± 1.4 m (range, 1.0 m–6.0 m). Three of the nests were in snags, the tops of which were completely open. Two American Kestrel nests were in old Black-billed Magpie (*Pica pica*) nests which had intact canopies similar to those reported by Roest (1957) and Bent (1938). One of these nests was in the same tree in which a Long-eared Owl nested. Another American Kestrel nest, in a nest box, was in the same tree in which a Red-tailed Hawk (*Buteo jamaicensis*) nested. Some American Kestrel nests were as close together as 100 m. Nagy (1963) reported nests which were 33 m apart. Eight of the American Kestrel nests used in 1975 were reused in 1976 (3 were in nest boxes). Both Craighead and Craighead (1956) and Smith et al. (1972) found that some American Kestrel nests were reused on their study areas.

Food habits.—In 1975 and 1976, the majority of the diet by biomass of the American Kestrel was avian prey (Table 2). Most were unidentified passerines or Western Meadowlarks (*Sturnella neglecta*) which were presumably captured as young birds since Western Meadowlarks fledge in the first weeks of June (Timothy Reynolds, pers. comm.). Conversely, Smith et al. (1972) and Heintzelman (1964) found more mammalian remains than avian remains in American Kestrel nests. In 1976, the percent biomass of mammals increased from 15.7 to 44.9% while the reptilian component dropped from 15.8 to 1.5%. The reason for this shift in prey remains may be the timing of nesting on the INEL Site. In 1975 American Kestrels were feeding their young later in the summer, when reptiles and young passerines were more available. Smith et al. (1972) found 3.0% of the total prey biomass to be

TABLE 2

PREY REMAINS FOUND IN AMERICAN KESTREL NESTS ON THE INEL SITE IN 1975 AND 1976

	1975 (9 nests)			1976 (10 nests)		
	N	Biomass (g)	% biomass	N	Biomass (g)	% biomass
Ord's kangaroo rat (*Dipodomys ordii*)	0	0.0	0.0	1	55.5	1.8
Deer mouse (*Peromyscus maniculatus*)	3	51.0	2.8	2	34.0	1.1
Montane vole (*Microtus montanus*)	0	0.0	0.0	7	241.5	7.6
Least chipmunk (*Eutamius minimus*)	3	234.0	12.9	13	1014.0	32.0
Northern pocket gopher (*Thomomys talpoides*)	0	0.0	0.0	1	76.0	2.4
Starling (*Sturnus vulgaris*)	0	0.0	0.0	3	180.0	5.7
Western Meadowlark (*Sturnella neglecta*)	8	768.0	42.4	12	1152.0	36.3
Common Flicker (*Colaptes auratus*)	1	100.0	5.5	0	0.0	0.0
Unidentified birds	15	360.0	19.9	15	360.0	11.4
Short-horned lizard (*Phrynosoma douglassi*)	11	267.3	14.8	1	24.3	0.8
Sagebrush lizard (*Sceloporus graciosus*)	6	18.0	1.0	7	21.0	0.7
Insects	12	12.6	0.7	11	6.6	0.2
Total	59	1810.9	100.0	73	3164.9	100.0
% Mammal			15.7			44.9
% Bird			67.8			53.4
% Reptile			15.8			1.5

insects while on the INEL Site 0.7 and 0.2% were insects in 1975 and 1976, respectively. Since only prey remains from the nest were examined (no castings were collected), the actual mammal and insect components would be expected to be higher as both are more likely to be eaten entirely and immediately. The small number of prey remains collected undoubtedly presents a somewhat biased indication of the food habits of American Kestrels on the INEL Site.

Long-eared Owl Nesting Biology

Phenology.—Long-eared Owls were found on the Big Lost River throughout the year; but, most migrated and during the winter the number of owls was greatly reduced. Wilson (1938) found Long-eared Owls in Ann Arbor, Michigan, to be migratory while Armstrong (1958) reports that in southern Michigan, breeding areas were adjacent to winter roosts.

Using an incubation period of 21 days (Bent 1938) and a nestling period of 21.4 $\pm$ 2.9 days (determined in this study in 1976), egg-laying would have taken place from 22 through 25 May in 1975 and from the second week in April to the fourth week in May in 1976.

In 1976 the mean date of egg hatching for 11 Long-eared Owl nests was 25 May and of fledging, 14 July. There was some overlap from one nest to another as the egg-laying dates for various nests spanned up to 41 days. Hence, some Long-eared Owls were laying eggs while other pairs were fledging young.

The egg-laying dates in both years are comparable to those reported by Armstrong (1958). Reynolds (1970) found 1 nest in Oregon which contained eggs in April and Bent (1938) reports that, of 79 records in California and southern Canada, all contained eggs from 1 March to 5 June which would include the dates on the INEL Site. The egg hatching and branching dates in 1976 are also similar to those reported elsewhere (Bent 1938, Armstrong 1958, Reynolds 1970).

The young on our study area remained in the nest 21 days in 1976. Armstrong (1958) reports that at 25 or 26 days, young are sufficiently feathered to leave the nest. Since Long-eared Owls branch long before they are able to fly (Whitman 1924), investigators may mistakenly assume the early disappearance of young to be a result of juvenile mortality.

Productivity.—In 1975 we found only 3 active Long-eared Owl nests on the study area (0.1 Long-eared Owl nests/km of river); in 1976 we found 16 nests (0.6 Long-eared Owl nests/km of river). Long-eared Owls laid a mean of 3.0 $\pm$ 1.0 and 5.3 $\pm$ 0.7 eggs in 1975 and 1976, respectively, and from these 2.3 $\pm$ 0.6 and 4.2 $\pm$ 1.9 young hatched. In 1976, 5 eggs hatched in 60% of the nests and 4 or 5 young fledged in 68.8% of these nests.

Reports in the literature on the productivity of Long-eared Owls are limited. The mean clutch size on the INEL Site in 1976 is comparable to that reported by Armstrong (1958) who found an average of 4.9 $\pm$ 1.3

eggs (N = 11) per nest. Murray (1976) reported that clutch size of 18 Long-eared Owl nests in the same latitude as southeastern Idaho (40–44°N) was 4.37 eggs/clutch, which is lower than the mean clutch-size found on the INEL Site. Bent (1938) reported that clutch-size of Long-eared Owls ranged from 3 to 8 eggs and Armstrong (1958) reported a nest with 7 eggs; but, the largest clutch on our study area consisted of 6 eggs (6 nests contained 6 eggs each). Two nests failed while adults were incubating; both may have been abandoned because TC disturbed the owls during nesting. One nest was abandoned in early May but by mid-June another nest, hitherto undiscovered, was found approximately 100 m away. The nest contained recently hatched young and may have been a renesting attempt by the original pair. Bent (1938) reported a nest in which 2 broods were raised in the same year and suggested that both broods were produced by the same pair of birds.

In 1975 3 nests on the Big Lost River produced young but 1 nest was destroyed by a predator after 2 young had hatched. The 2 other nests were not found until the young had branched. These family groups consisted of at least 5 young; thus Long-eared Owls fledged an average of 1.7 ± 1.5 young/nest in 1975.

The fledging success $\left(\frac{\bar{x}\text{ number to fledge}}{\bar{x}\text{ number eggs}}\right)$ on the INEL Site in 1976 was 77%. Craighead and Craighead (1956) found a success of 93% for 13 young in Moose, Wyoming and further report an average of 4.3 young produced per adult pair. Stophlet (1959) reported an average of 2.7 ± 1.5 young were found in 6 nests or in family groups around nests; but, no clutch-size data were recorded. On the INEL Site 4.1 ± 1.8 young fledged per nest in 1976.

Nest sites.—There were 18 nests attended by adult Long-eared Owls in 1976; 1 was abandoned before laying and 2 others failed during incubation. Seventeen of the nests were in old Black-billed Magpie nests. One nest was on a Black-billed Magpie nest, the top of which was indented and some fine bark was lining the recess. This was the only nest in which any modification was apparent. Bent (1938) reported that Long-eared Owls occupy old Black-billed Magpie nests.

We found 88 old Black-billed Magpie nests on the study area which appeared to be suitable for Long-eared Owl nestings, and 20% of these were used by the owls in 1976. Since Black-billed Magpies nest later than Long-eared Owls on the INEL Site, they do not seem to be competitors for nest-sites. The average height of the Black-billed Magpie nests used by Long-eared Owls was 2.2 ± 1.0 m. When incubation began a significant percent (88) of the nests had all or a portion of the canopy intact (Clopper and Pearson chart, .95 confidence belt for proportion; Dixon and Massey 1957).

Food habits.—No prey remains were recovered from Long-eared Owl nests in 1975. In 1976, a total of 97 prey remains were found at the nest sites of Long-eared Owls, 61 of which were from castings (Table 3). The danger of biasing data on food habits by counting castings that are partially composed of prey items already recorded was minimized by visiting the nest at 3 day intervals. Thus, the prey which were eaten over that period were represented in the castings as well as the few prey items which were in the nest the day of the visit.

The majority of the prey of Long-eared Owls on the INEL Site was small mammals (97.2%) which are active at night (Burt and Grossenheider 1952). *Microtus* spp. were found to be the most important prey of Long-eared Owls by Scott (1948), Armstrong (1958) and Getz (1961); but, on the INEL Site northern pocket gophers (*Thomomys talpoides*) composed the highest biomass of any prey item and accounted for 42.8% of the diet of this owl. The literature review by Marti (1976) documents northern pocket gophers as only 0.7% of the total biomass of the prey of Long-eared Owls in North America.

Ord's kangaroo rats (*Dipodomys ordii*) composed 16.5% of the diet of Long-eared Owls (or 10% frequency of occurrence) on the INEL Site which is in contrast to the 32.6% frequency of occurrence reported by Sonnenberg and Powers (1976), in southwestern Idaho. Few birds or insects were found as prey of the Long-eared Owl.

All remains of montane voles (*Microtus montanus*), Great Basin pocket mice (*Perognathus parvus*), and most northern pocket gophers were found in castings but not as prey items in the nest. Since most nests were visited during the morning, these prey may have already been consumed while Ord's kangaroo rats and deer mice (*Peromyscus maniculatus*) had not, perhaps because they were captured in the early morning. This suggests that if quantitative data on food habits of nocturnal raptors is desired, the investigator should visit the nest at night.

Since Long-eared Owls are adapted to hunt in open areas (Getz 1961, Marti 1976), the Big Lost River with its abundance of nest-sites is an ideal nesting area. Why then were there fewer active nests found in 1975 on the INEL Site? The influence of the cooler, wetter weather in 1975 or a decrease in available prey may have been responsible. Hagen (1965) reports that in Norway, Long-eared Owl populations and productivity are linked to micro-rodent cycles. However, Marti (1974) reports that local populations of Long-eared Owls fluctuate; they are in an area 1 year but gone the next. Thus, the apparent increase in the nesting population on the

TABLE 3

PREY REMAINS FOUND IN 13 LONG-EARED OWL NESTS ON THE INEL SITE IN 1976, COMPILED FROM PREY AND CASTINGS FOUND AT THE NEST

	N	Biomass (g)	% Biomass
Ord's kangaroo rat (*Dipodomys ordii*)	10 (3)[1]	555.0	16.5
Deer mouse (*Peromyscus maniculatus*)	29 (9)	493.0	14.6
Montane vole (*Microtus montanus*)	14 (14)	483.0	14.3
Great Basin pocket mouse (*Perognathus parvus*)	19 (19)	285.0	8.5
Northern pocket gopher (*Thomomys talpoides*)	19 (14)	1444.0	42.8
Shrew (*Sorex* sp.)	1 (1)	18.0	0.5
Unidentified birds	4 (0)	96.0	2.8
Insect	1 (1)	0.6	< 0.1
Total	97 (61)	3374.6	100.0

[1] Parenthetical numbers represent remains found in castings.

INEL Site may be accredited to a vacillating local population of Long-eared Owls.

SUMMARY

The nesting biology of the American Kestrel and the Long-eared Owl was studied during 1975 and 1976 along the Big Lost River on the INEL Site in southeastern Idaho. In 1975 the mean clutch-size of American Kestrels was 4.5 eggs/clutch ($N = 13$) and in 1976 it was 4.7 eggs/clutch ($N = 23$). Long-eared Owls laid a mean of 3.0 eggs/nest ($N = 3$) in 1975 and 5.3 eggs/nest ($N = 15$) in 1976. The productivity of American Kestrels was 3.7 young/nest in 1975 and 4.0 young/nest in 1976. The productivity of Long-eared Owls was 1.7 young/nest in 1975 and 4.1 young/nest in 1976.

Avian prey composed the majority of the diet by biomass of American Kestrels in 1975 and 1976. Changes in the percent mammalian and reptilian prey occurred during these years. Mammalian prey made up 97.2% of the total diet by biomass of Long-eared Owls in 1976. Northern pocket gophers composed the highest percent in biomass.

There was an increase in American Kestrel nests found on the INEL Site from 1975 to 1976 and an increase in Long-eared Owl nests in the same year. The reasons for the increase of both species may be the same—adverse weather conditions in 1975 and/or

an increase in available prey. Other reasons may also have been responsible. There were more American Kestrel nest-sites in 1976 than in 1975 since the number of nesting boxes erected on the Big Lost River was increased and local Long-eared Owl populations have been known to fluctuate.

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