———. 1975. Yearling male Eastern Bluebird assists parents in feeding young. Auk 92: 801-802.
———. 1976. Further observations on a family of Eastern Bluebirds. Bird-Banding 47: 160-161.
———. 1977a. "Courtship feeding" attempt between two male Eastern Bluebirds. Jack-Pine Warbler 55: 45.
———. 1977b. Breeding adaptations in the Eastern Bluebird. Condor 79: 289-302.
———. 1978a. Two successive male Eastern Bluebirds tending the same nest. Auk 95: 606-608.
———. 1978b. Five years of observations of a male Eastern Bluebird. Jack-Pine Warbler 56: 161-163.
POWER, H. W., III. 1966. Biology of the Mountain Bluebird in Montana. Condor 68: 351-371.
———. 1975. Mountain Bluebirds: experimental evidence against altruism. Science 189: 142-143.
———. 1980. Male escorting and protecting of females at the nest cavity in Mountain Bluebirds. Wilson Bull. 92: 509-511.
———. 1981. Searching for altruism in birds. Auk 98: 442-425.
RIDGWAY, R. 1907. The birds of North and Middle America. Bull. U.S. Natl. Mus. 50, part 4.
SCOTT, L. 1971. Male Eastern Bluebird assists female Mountain Bluebird in raising young. Blue Jay 29: 126-127.
TINBERGEN, N. 1956. Social behavior in animals. New York, John Wiley & Sons, Inc., pp. 72-86.
TRIPP, R. 1984. More bluebirds feeding chickadees. Sialia 6: 47.
TRIVERS, R. L. 1971. The evolution of reciprocal altruism. Quart. Rev. Biol. 46: 35-57.
WETHERBEE, K. B. 1933a. Some complicated bluebird family history. Bird-Banding 4: 114-115.
———. 1933b. Eastern Bluebirds in juvenal plumage feed young of second brood. Bird-Banding 4: 199-200.
WILLIAMS, G. C. 1966. Adaptation and natural selection: A critique of some current evolutionary thought. Princeton, New Jersey, Princeton Univ. Press.
WILSON, E. O. 1975. Sociobiology: the new synthesis. Cambridge, Massachusetts, Belknap Press of Harvard Univ. Press, pp. 117-120.

Received 3 February 1984, accepted 2 August 1984.

Food Habits of Long-eared Owls (*Asio otus*) at a Communal Roost Site During the Nesting Season

T. H. CRAIG,[1] E. H. CRAIG,[1] AND LEON R. POWERS
Department of Biology, Northwest Nazarene College, Nampa, Idaho 83651 USA

Food habits of Long-eared Owls (*Asio otus*) have been investigated both for nesting pairs of owls and nonnesting birds (e.g. Marti 1976, Sonnenberg and Powers 1976, Marks and Yensen 1980). In addition, communal winter roosting of this species has been documented (Randle and Austing 1952, Craighead and Craighead 1956: 443, Hilliard et al. 1982). However, we have not found literature references to communal summer roosts of Long-eared Owls. This paper reports on a large communal roost of Long-eared Owls in the summer of 1982 and describes the food habits of the owls as determined from castings found at the roost.

The roost site was located in southeastern Idaho along a small, dry channel of Birch Creek. The creek is located on the Idaho National Engineering Laboratory (INEL), a government reservation approximately 75 km northwest of Idaho Falls, Idaho. Cool desert habitat, with big sagebrush (*Artemesia tridentata*)-grass associations predominating, surrounds the creek. Similar vegetation covers the creek bed, although the growth is more dense and is interspersed with a few clumps of low-growing birch trees (*Betula* sp.) and willows (*Salix* sp.).

On two visits to the area (16 April and 12 May 1982), we flushed 2 Long-eared Owls from willows along the creek. On a third visit to the area on 2 June, we found 3 Long-eared Owl nests and flushed approximately 40 Long-eared Owls along 400 m of creek bottom. We visited the 3 nests on 18 June and found 1 empty and 2 containing 3 young each. We also flushed a minimum of 28 owls in the vicinity of these nests (14 from one nest site). On another visit to the area on 21 June, we captured 13 adult owls in mist nets placed along the creek bottom. Two of these owls died during banding, one apparently from injuries incurred in striking a net, while the other probably died from heat prostration. Twelve of the 13 owls were weighed and banded. By comparing the weights of the owls to those given in Snyder and Wiley (1976), we determined that 8 males and 4 females were captured. On our last visit to the study area on 28 June, we again saw a large number of owls and collected about 2,500 castings from roost sites along the creek bottom. Most of the castings were well formed and appeared less than 3 months old.

The castings were soaked in a weak NaOH solution and sieved through screen wire and 0.3-cm hardware

---

[1] Present address: Box 1, Lee Creek Road, Leadore, Idaho 83464 USA.

TABLE 1. Prey remains found in Long-eared Owl castings collected in July 1982 at a communal roost, southeastern Idaho. Biomass (g) was calculated from average weights (U.S.D.I. 1979, Burt and Grossenheider 1964: 284); subtotals are provided in parentheses.

Prey	*n*	%	Biomass (g)	% biomass
Mammals	(3,718)	(93.5)	(110,576.6)	(95.6)
Perognathus parvus	1,321	33.2	19,815.0	17.1
Peromyscus maniculatus	1,209	30.4	22,971.0	19.9
Lagurus curtatus	536	13.5	16,214.0	14.0
Unidentified microtine— *Microtus* sp. or *L. curtatus*	154	3.8	5,518.3	4.8
Microtus sp.	94	2.5	2,820.0	2.4
Thomomys talpoides	92	2.3	18,400.0	15.9
Reithrodontomys megalotis	65	1.6	715.0	0.6
Dipodomys ordii	61	1.5	3,233.0	2.8
Microtus longicaudus	41	1.3	1,937.3	1.7
Sorex merriami	32	0.8	64.0	<0.1
Sylvilagus nuttallii	30	0.7	6,450.0	5.6
Onychomys leucogaster	24	0.6	792.0	0.7
Microtus montanus	19	0.5	570.0	0.5
Sylvilagus idahoensis	17	0.4	5,780.0	5.0
Sylvilagus sp.	14	0.3	3,885.0	3.4
Eutamias minimus	3	<0.1	96.0	<0.1
Spermophilus townsendii	2	<0.1	362.0	0.3
Sorex cinereus	2	<0.1	12.0	<0.1
Lepus sp.	2	<0.1	942.0	0.8
Birds	(84)	(2.1)	(4,704.0)	(4.1)
Unidentified birds	84	2.1	4,704.0	4.1
Reptiles[a]	(3)	(<0.1)	(48.0)	(<0.1)
Unidentified lizards	3	<0.1	48.0	<0.1
Arthropods[a]	(172)	(4.3)	(307.0)	(0.3)
Orthoptera (*Stenopelmatus* sp.)	135	3.4	270.0	0.2
Homoptera (*Okanagana* sp.)	27	0.7	27.0	<0.1
Coleoptera (unidentified sp.)	7	0.2	7.0	<0.1
Arachnida (*Paruroctonus boreas*)	1	<0.1	1.0	<0.1
Arachnida (unidentified sp.)	2	<0.1	2.0	<0.1
Total	3,977		115,635.6	

[a] These should be considered minimum figures because we did not thoroughly examine the castings for insect or reptile remains.

cloth. All dentaries and many skull bones of mammals were collected and used for species identification (Table 1). Similarly, skull bones and sterna of birds were collected for quantification. Reptile and insect parts were collected incidentally because it was obvious that these animals were a small component of the owls' diet.

Peromyscus maniculatus, Perognathus parvus, Thomomys talpoides, and *Lagurus curtatus* were the most important prey of Long-eared Owls in terms of frequency of occurrence and total biomass. Microtines comprised 23.4% and *P. maniculatus* 19.9% of the biomass consumed by Long-eared Owls in our study, which is in agreement with Marti's (1976) findings that microtines (*Microtus* spp.) are by far the most important prey of these owls in North America, with *Peromyscus* spp. second in importance. Marks and Yensen (1980) and Sonnenberg and Powers (1976) found *Microtus montanus* and *Dipodomys ordii* to be the most important prey in southwestern Idaho, with *Peromyscus maniculatus* next in importance. *Thomomys talpoides, D. ordii, P. maniculatus,* and *M. montanus* were the major prey of Long-eared Owls in another study on the INEL conducted about 25 km south of the roost site (Craig and Trost 1979). The differences in prey species taken by owls on the INEL in 1982 and and in the Idaho studies cited probably reflect a difference in availability of different prey species. For example, the area around the roost site does not appear to be good habitat for *M. montanus* or *D. ordii.* The large number of mammalian species preyed upon (19 vs. 7, 4, and 7 in the other Idaho studies) and the presence of insects and comparatively large numbers of birds as prey further indicate that the owls were feeding opportunistically and did not concentrate on a few species.

Marks and Yensen (1980) indicated that most prey of Long-eared Owls weigh between 10 and 60 g, and prey over 100 g probably are not important in their diet. We concur and suggest that the heavier prey, such as rabbits (*Sylvilagus* sp.), hares (*Lepus* sp.), and pocket gophers (*T. talpoides*), in our study probably were young juveniles or carrion.

Sordahl and Tirmenstein (1980) reported observing a possible helper at a Long-eared Owl nest. The presence of so many owls roosting communally, sometimes beneath active Long-eared Owl nests on the INEL, suggests that some sort of cooperation may have occurred at the nest sites. However, we have no evidence that such behavior happened even though about 6 h were spent in observing one nest through night-viewing devices on two nights in early June (Jim Watson pers. comm.; pers. obs.). Furthermore, on all visits to the nests, only one or two owls defended against our intrusion.

This research was funded by the Office of Health and Environmental Research of the U.S. Department of Energy and is a contribution from the INEL Ecology Program. We thank Ryan Miller for field and laboratory assistance and Carl O. Marti and Tex A. Sordahl for comments on the manuscript. Robert B. Finley, Jr., and Brett Riddle identified the mammalian remains and Mike Stafford identified the insect remains reported here.

Literature Cited

BURT, W. H., & R. P. GROSSENHEIDER. 1964. A field guide to the mammals. Boston, Houghton Mifflin Co.

CRAIG, T. H., & C. H. TROST. 1979. The biology and nesting density of breeding American Kestrels and Long-eared Owls on the Big Lost River, southeastern Idaho. Wilson Bull. 91: 50-61.

CRAIGHEAD, J. J., & F. C. CRAIGHEAD. 1956. Hawks, owls and wildlife. Harrisburg, Pennsylvania, Stackpole Co.

HILLIARD, B. L., J. C. SMITH, M. J. SMITH, & L. R. POWERS. 1982. Nocturnal activity of Long-eared Owls in southwestern Idaho. J. Idaho Acad. Sci. 18: 47-53.

MARKS, J. S., & E. YENSEN. 1980. Nest sites and food habits of Long-eared Owls in southwestern Idaho. Murrelet 61: 86-91.

MARTI, C. D. 1976. A review of prey selection by the Long-eared Owl. Condor 78: 331-336.

RANDLE, W., & R. AUSTING. 1952. Ecological notes on Long-eared and Saw-whet owls in southwestern Ohio. Ecology 33: 422-426.

SNYDER, N. F., & J. W. WILEY. 1976. Sexual size dimorphism in hawks and owls of North America. Ornithol. Monogr. No. 20.

SONNENBERG, E. L., & L. R. POWERS. 1976. Notes on the food habits of Long-eared Owls (*Asio otus*) in southwestern Idaho. Murrelet 57: 63-64.

SORDAHL, T. A., & D. A. TIRMENSTEIN. 1980. Possible helper at a Long-eared Owl nest. Western Birds 11: 57-59.

U.S. DEPARTMENT OF THE INTERIOR. 1979. Snake River birds of prey. Special Res. Rept., Bureau of Land Mgmt., Boise District, Idaho.

Received 9 April 1984, accepted 2 August 1984.

Visual Angle and Formation Flight in Canada Geese (*Branta canadensis*)

FRANK H. HEPPNER,[1] JEFFREY L. CONVISSAR,[2] DENNIS E. MOONAN, JR.,[2] AND JOHN G. T. ANDERSON[1]
[1]*Department of Zoology, University of Rhode Island, Kingston, Rhode Island 02881 USA, and*
[2]*Department of Pathology, The Miriam Hospital, Providence, Rhode Island 02906 USA*

The V formation, a special case of line-formation flight (Heppner 1974) practiced by large water birds such as geese and cormorants, has spawned several hypotheses about its functional significance. One school of thought (Lissaman and Shollenberger 1970, Badgerow and Hainsworth 1981) holds that the formation evolved to minimize the energy cost of flying, possibly by recapturing some of the energy lost by individual birds through the induced drag associated with winged flight. A different view (Bent 1925, Gould and Heppner 1974) is that the V formation might be related to social or visual factors, and V-formation flight might be a by-product of the characteristics of the visual field of line-formation flying birds. Vision might be essential in coordinated, close-order movements (Potts 1984). If a V-formation flying bird were to have the central monofovea (Duke-Elder 1958) typical of many birds, it would be advantageous to align oneself in the formation such that a neighbor ahead would be positioned on one's optic axis. In this way, the neighbor's image would fall on the fovea, yielding the best possible resolution. If the eyes are relatively immobile in their sockets, as is the case with most birds, it would be possible to bend the neck to change the field of view, but that would increase aerodynamic drag. Although the two hypotheses are not mutually exclusive, it would be instructive to know the angle of view of the eyes of a typical line-formation flying bird, and further, to examine the mobility of the eyes in the sockets of such a species.

During the hunting season of 1982, we obtained the heads of 5 Canada Geese (*Branta canadensis*) from hunters in the field. The heads were immediately preserved in 5% formalin for later examination in the laboratory.