

FOOD HABITS OF SOUTHERN WISCONSIN RAPTORS

PART I. OWLS

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The primary object of the studies by which the following data on owls were gathered was to determine the relation of birds of prey to the Eastern Bob-white (*Colinus virginianus virginianus*). In addition to studies of quail and raptor by intensive field observations to ascertain exact or nearly exact covey losses, special effort was made to obtain the quantitative data so necessary for an ecological approach to the problem. Thus the material collectively has broader application than to a single game species. The major part of the research was carried on in Dane, Sauk, and Columbia counties by the Wisconsin Quail Investigation (Sporting Arms and Ammunition Manufacturers' Institute, U. S. Biological Survey, and University of Wisconsin).

A technique (see Errington, 1932) of visiting the favorite winter and spring roost trees of individual owls and of tethering out grown juveniles (to be fed late into the summer by adult birds) made possible the acquisition of some thousands of more or less accurately dated pellets from seven owl species. In some instances, nearly complete diets of certain owls over periods of months were recorded. Previous papers (Errington, 1930a, 1932) have dealt with the experimental checking by which it was demonstrated that even animal matter as delicate as 13 gram (10 day old) quail chicks withstood Horned Owl digestion sufficiently well to be recognizable in pellets, and that, in short, pellets reflected quite satisfactorily ordinary strigine food habits.

The specific origin of the various pellet lots, unless otherwise stated, is considered reasonably correct, for most of the doubtful pellets have been discarded. Least satisfactory are those of fall deposition (judged by contained juvenile prey, etc.), but found in late winter and really too valuable in filling in important seasonal gaps to throw away—least satisfactory not so much because of doubtful origin but because of the difficulty with which old pellets are dated. In general, there can be little doubt as to the source of fresh pellets picked up under known favorite owl roosts, from or under occupied nests, or from beside tethered juveniles. Then, too, I have taken pains to familiarize myself with the habits and idiosyncrasies of a number of individual owls contemporaneous with the collection of their pellets.

It may be said, preliminarily to the presentation of data according to species, that the bulk of the pellet analyses were conducted by myself at Madison, hurriedly, and with the aid of an improvised and none too adequate osteological reference collection. I have Biological Survey analyses on my most troublesome 1930 specimens, namely, 25 Barred Owl pellets, 69 of Horned Owl, and odd pellets and stomachs, but these comprise a small proportion of my total volume of material. A final check-over of the balance will unquestionably reveal vertebrate items missed, items duplicated, and, not inconceivably, some items misidentified, particularly as concerns the smaller mice.

Supplementary to the pellet analyses, data were obtained during the seasons of 1930 and 1931 on 21 nests of Horned Owl, 9 of Barred Owl, 4 of Long-eared Owl, and 2 of Screech Owl. Observational data procured were mainly incidental to the winter quail mortality studies. Since pellet data and those derived from nest visits and "sign reading" to a conspicuous extent overlapped, data from the latter two sources will not be listed in their entirety.

SAW-WHET OWL *Cryptoglaux acadica*

Evaluation of data.—Fair but scanty. There is chance of a slight contamination of Screech Owl pellets in the Pine Bluff lot.

No. 1. *West of Pine Bluff.*—January (?) to March, 1930, 70 pellets plus fragments of about 15 more, presumably the winter's accumulation of a single owl seen but once in the juniper thicket which served as headquarters. Contents, on basis of skulls alone: meadow mouse (*Microtus*), 13; deer mouse (*Peromyscus*), 51; junco, 1. Exclusive of the preceding were 23 pellets of skull-less mouse remains, mostly *Peromyscus*.

Wild life species of sizes perhaps suitable for prey present within one-quarter mile of the junipers: meadow mice (extremely abundant but well protected by snow), deer mice (abundant), bluejays, hairy and downy woodpeckers, nuthatches, chickadees, etc. (common).

East of Prairie du Sac.—March 16, 1930, 2 pellets from a migrant, both of which seemed to be made up of the same deer mouse.

Summary of Saw-whet Owl Food Habits.—The diet of this little owl apparently is strictly limited by the size, abundance and availability of prey. It is probable that one fair-sized mouse lasts two meals.

Adverse effect upon quail: none. A covey (7 to 23) was within the cruising radius of the Pine Bluff saw-whet.

SCREECH OWL *Otus asio*

Evaluation of data.—Poor. Data are few, scattered and much restricted to winter and spring months. The Denzer lot (no. 3) may have some contamination of saw-whet pellets.

No. 2. *Madison.*—November, 1929, to May, 1931, contents of 72 pellets, principally from the University campus, roughly divided up as to seasons:

Fall, 1929: meadow mouse, 12; shrew (*Blarina*), 1.

Winter, 1929-30: meadow mouse, 15; deer mouse, 1; small bird, 4.

Fall, 1930: deer mouse, 1; small bird, 4; fish, 1.

Winter, 1930-31: meadow mouse, 2; deer mouse, 1; shrew, 2; small bird, 14.

Spring, 1931: meadow mouse, 1; shrew (*Blarina* and *Sorex*), 2; small bird, 12; pellets containing fish, 3; pellets high in insects, 5; pellets containing crayfish (*Cambarus*), 2.

Of basic significance might be considered the effect on the Screech Owl's diet of the 1930 die-off of the meadow mice which in 1929 had attained a pronounced abundance peak. Meadow mice virtually gone, the owls took to other prey, mostly English Sparrows, though native warblers and finches did not escape without some loss.

No. 3. *Denzer.*—December, 1929, 17 probable Screech Owl pellets from wooded hilly country. Contents on basis of skulls: meadow mouse, 4; deer mouse, 8.

No. 4. *North of Prairie du Sac.*—January (?) to March, 1930, about 18 Screech Owl pellets from woods along Wisconsin River. Contents on basis of skulls: Norway rat, 1; meadow mouse, 5; deer mouse, 8.

No. 5. *West of Pine Bluff.*—February (?) to March 15, 1930, about 12 probable Screech Owl pellets from a wild, dense woodlot. Contents on basis of skulls: meadow mouse, 4; deer mouse, 4.

The owls of nos. 3, 4, and 5 had access to approximately the same winter bird life mentioned under no. 1.

No. 6. *Daleyville.*—March to mid-April, 1931, 10 pellets from a wooded "island" in a farming community: meadow mouse, 4; deer mouse, 9; small bird, 1; crayfish, 1.

Miscellaneous Screech Owl pellets and stomachs, mainly from spring, 1931: meadow mouse, 2; deer mouse, 5; shrew (*Blarina*), 2; small bird, 1; stomach full of crickets, 1; pellets high in insects, 4.

Summary of Screech Owl Food Habits.—My Wisconsin record for Screech Owl vertebrate and large invertebrate prey totals up to 137 individuals, in the following proportions: Norway rat, 1; meadow mouse, 49; deer mouse, 37; shrew (*Blarina*, 6;

Sorex, 1), 7; small bird (predominantly English Sparrow according to feather evidence of kills), 36; fish, 4; crayfish, 3.

As a rule Screech Owls ate about what was most convenient to catch and of a size easy to handle. Their preferred prey seemed to be mice if such were available; in the event of mouse shortage they turned readily to small birds. During the warmer months large invertebrates (crayfish, June beetles, crickets) made up a considerable portion of their food. No evidences were found of Screech Owls taking birds larger than finches, though the owls of no. 2 had unlimited opportunities to do so.

Adverse effect upon quail: likely none under ordinary circumstances. Quail coveys in observational areas were not known to be molested in any way by Screech Owls.

SHORT-EARED OWL *Asio flammeus*

Evaluation of data.—Good, for winter. The data, while not as numerous as might be wished, are so uniform that they may be looked upon as rather typical for the months that Short-eared Owls are seen in southern Wisconsin.

No. 7. *East of Pine Bluff.*—December, 1929, and January, 1930, 55 pellets from an owl that habitually perched on the tops of a few corn shocks left in a field over winter: meadow mouse, 34; deer mouse (a field form, probably *Peromyscus maniculatus bairdi*), 103; snow bunting, 1.

In the above small field (a quail observational area) the most ideal game-rodent-predator balance prevailed that I have ever noted. A fine covey of around 20 quail relied for food and cover upon the very corn shocks used by the Short-eared Owl, yet were untroubled by the latter. The owl picked up the mice that ran from shock to shock, keeping them down well enough to reduce the damage by about two-thirds—this in a winter of terrific rodent-bird food competition and when the interiors of almost all shocks examined elsewhere were heaped with mouse debris.

A heavy population of snow buntings, goldfinches, redpolls, tree sparrows, etc., in stubble fields nearby, to appearances drew but scant attention from the owl.

No. 8. *Southeast of Madison.*—February, 1930, 10 pellets from roosts on haystacks: meadow mouse, 10; deer mouse, 2.

No. 9. *West of Pine Bluff.*—February and March, 1930, 11 pellets from roosts in a sweet clover patch: meadow mouse, 5; deer mouse, 8.

This owl had access to the same bird life as the one of no. 7. A covey of 18 quail wintered in the short-ear's exact territory, with no loss during two months of censusing.

Miscellaneous.—Short-eared Owl kills and pellet contents, mostly from the vicinity of Madison, and for January, 1931: meadow mouse, 19; deer mouse, 2. The only non-winter datum I have is from a stomach sent in September 27, 1930, from the center of the state (Babcock). Contents: meadowlark.

Summary of Short-eared Owl Food Habits.—Total vertebrate kills on file: meadow mouse, 68; deer mouse, 115; snow bunting, 1; meadowlark, 1.

The Short-eared Owls seemed to show a distinct preference for small mammalian over small avian prey, even at times when small birds may have actually far outnumbered the rodents which were depended upon for food. The seeming preference for mammals might be explained by the short-ear's penchant for diurnal hunting; small birds, though in tremendous flocks, doubtless are too elusive in daylight for such a slow predator, hence the latter relies upon mice which it can catch. Again, it is probable that the species settles itself into a hunting routine to which it clings indefinitely unless forced by environmental changes to alter its habits.

Adverse effect upon quail: none in the light of evidence at hand, at any rate none for the winter months.

LONG-EARED OWL *Asio wilsonianus*

Evaluation of data.—Excellent from October to March, fair for April, May, June and September, very weak for July and August. Although the most intensive studies

dealt with the winter of 1929-30, the species was watched closely enough in 1930-31 to obviate any likelihood of important departures from known food habits passing unnoticed.

No. 10. *McFarland*.—September, 1929, to February, 1930, 177 pellets from two Long-eared Owls in a one-acre tamarack swamp, from fall until the time that the owls were evidently shot toward the end of the winter. Pellet contents: meadow mouse, 252; deer mouse, 4; shrew (*Blarina*), 2.

Small birds most abundant were tree sparrows and the usual winter species partial to tamaracks. A covey of quail used the swamp as cover until starvation compelled them to move, about January 1, 1930.

No. 11. *Madison* (Eagle Heights).—November, 1929, to April, 1930, 35 pellets from more than one owl, lumped to give a food habits composite for the area (a wild life refuge): meadow mouse, 43; deer mouse, 4; shrew (*Blarina*), 1.

Conspicuous bird life: quail (89 censused in March on about 500 acres), blue-jays, cardinals, native and English sparrows, hairy and downy woodpeckers, nut-hatches, creepers, chickadees.

No. 12. *Denzer*.—March 29, 1930, a report had come in concerning hunters who in December had found a concentration of Long-eared Owls in the dogwood and alder growths bordering a creek. One man had shot 17 in a day and said that about as many more got away. The owls had been shot, of course, because of "killing off the rabbits." I looked over the creek brush, found plenty of roosts, and remains of some of the dead owls. There were hundreds of pellets in sight at once from strategic places, thousands altogether.

Ninety-seven pellets picked up at random gave: meadow mouse, 128; deer mouse, 27; shrew (*Blarina*), 1. Approximately 300 pellets looked over hastily on the ground failed to yield anything but these three genera of mammals.

No. 13. *Southwest of Madison*.—May to middle of June, 1930, bulk of pellet material from beneath a late Long-eared Owl nest: meadow mouse, 32; deer mouse, 4; shrew (*Blarina*), 5.

Alternate prey available: an abundance of the summer bird life usually found in southern Wisconsin woodlots, that is, flickers, catbirds, thrashers, flycatchers, etc.

No. 14. *West of Prairie du Sac*.—October, 1929, to May, 1930, winter accumulation of Long-eared Owl pellets from two tracts (about 1 and 3 acres) of conifers planted in a sand prairie. Pellets examined in bulk: Norway rat, 2; meadow mouse, 2,108; deer mouse, 373; shrew (*Blarina*), 1; small bird, 10.

These conifers are a favorite winter rendezvous for many birds, including jays, goldfinches, waxwings, and crossbills. The surrounding prairies, too, are often rich in boreal species.

A program of long-ear nest studies came to an abrupt end by virtue of an annual human "sporting" custom of "cleaning out the owls" on Sunday afternoons.

No. 15. *West of Prairie du Sac*.—September to November, 1930, bulk pellet material from same area as no. 14: cottontail (juvenile), 1; meadow mouse, 101; deer mouse, 50; shrew (2 each of *Blarina* and *Sorex*), 4; small bird, 3.

No. 16. *West of Prairie du Sac*.—Middle of April to middle of May, 1930, pellets from nesting Long-eared Owls in juniper-grown hills a couple miles northeast of no. 14: meadow mouse, 41; deer mouse, 8; shrew (one each of *Blarina* and *Sorex*), 2; small bird, 13. The following small birds were identified from pellets and nests: brown thrasher, horned lark, Savannah sparrow, white-throated sparrow, junco, towhee, scarlet tanager.

Miscellaneous.—Long-eared Owl pellets and stomach contents, mostly from February and March, 1931: Norway rat, 1; meadow mouse, 27; deer mouse, 27; shrew (*Blarina*), 1.

Summary of Long-eared Owl Food Habits.—Total vertebrate kills from pellets and stomachs (quantitative data) amount to 3273: juvenile cottontail, 1; Norway rat, 3; meadow mouse, 2732; deer mouse, 497; shrew, 14; small bird (mostly finches), 26.

The mammal-bird ratio, manifestly too top-heavy with winter data to be representative of year-round food habits, may be apportioned between the seasons:

Fall, winter, early spring, 1929-30, 2946 mammals (99.66%): 10 birds (.34%).
Late spring, early summer, 1930, 92 mammals (87.62%): 13 birds (12.38%).
Late summer, 1930, 25 mammals (92.6%): 2 birds (7.4%).
Fall and early winter, 1930, 131 mammals (99.24%): 1 bird (.76%).
Late winter and early spring, 1931, 56 mammals (100%).

Attention might be drawn to the surprising similarity of food habits for the winters of 1929-30 and 1930-31, despite the drastic reduction of meadow mice early in 1930. Although the deer mice supplanted in part the meadow mice, the steady occurrence of the latter in the Long-ear's diet leads one to suspect that the food habits of this owl are inexplicable in simple terms of availability of prey. Why did not the Long-ear prove itself the opportunist that the Screech Owl did (see no. 2), when the meadow mice dropped off? Was it inflexibility of instincts? Or were the meadow mice remnants still the most available prey, though not the most abundant?

Adverse effect upon quail: negligible. I have a solitary record of a quail kill—a weathered sternum in a Long-ear nest. Long-eared Owls were common in some of my best quail observational areas (see Errington, 1930b, 1931b) and caused no discernible trouble.

BARN OWL *Tyto alba pratincola*

Evaluation of data.—Excellent except for the restricted locality and except that the pellets were not kept separate in the strictest sequence of ages.

No. 17. *Madison (Shorewood and Eagle Height areas).*—June (?), 1929, to February, 1930, 319 pellets from 4 Barn Owls which to the best of my knowledge frequented mainly an old rock quarry and also certain planted evergreen thickets. There had apparently been a successful nesting in the quarry in the season of 1929.

Pellet contents totaled 893 kills: Norway rat, 8; meadow mouse, 742; deer mouse, 24; shrew (110 of *Blarina* and 5 of *Sorex*), 115; bluejay, 1; small bird, 3.

Alternate prey available: the variety of bird life given under no. 11.

Summary of Barn Owl Food Habits.—The natural question of what effect the subsequent meadow mouse failure had on the diet of these owls can be partially answered. Of the four (?) Barn Owls studied, one was collected by an ornithologist in November, two were found dead from hunger and cold in early February (see Errington, 1931a), and no sure trace was seen of the fourth after the last of the month. The continued adherence to the mammalian diet, even under stress of want, and amid an abundance of winter birds, may point to an inadaptability possibly delimiting the northern range of the species.

Adverse effect upon quail: negligible, if any. A fragmentary, shapeless, weathered, and moss-grown pellet of some kind beneath one of the roost crevices in the quarry disclosed quail remains, but the pellet was much older than any of the bona fide barn owl pellets. Indeed, on the basis of the quail's gizzard contents of black locust and sweet clover seed (a common food combination of desperate, starving bobwhites), the pellet can be dated back to the severe winter of 1928-29, when it is not known that Barn Owls were in the quarry at all.

BARRED OWL *Strix varia*

Evaluation of data.—Excellent for spring and summer of 1931, except for the fewness of birds studied; otherwise too fragmentary.

No. 18. *Dane, Sauk, and Columbia counties.*—March to middle of May, 1930, pellets from 6 nests: cottontail (juvenile), 1; flying squirrel, 2; fox squirrel (juvenile), 1; meadow mouse, 10; deer mouse, 8; house mouse (*Mus*), 2; unidentified mouse, 4; robin, 1; bluejay, 1; flicker, 3; small bird, 19; frog, 4; salamander, 2; crayfish, 1. Total vertebrate and large invertebrate kills: 59 in proportions of 28 mammals (47.46%), 24 birds (40.68%), misc., 7 (11.86%).

In addition to the pellet material evidences of the following species were found about the nests: mole (*Scalopus*), Barn Swallow, Tree Swallow, Bank Swallow, Cardinal, White-throated Sparrow, junco, towhee, Yellow-headed Blackbird, Brown Thrasher, Yellow-bellied Sapsucker, Hairy Woodpecker, kingfisher, and Screech Owl. Flicker and bluejay feathers were most often to be noted.

No. 19. *Southwest of Lodi*.—May 24 to August 8, 1931, pellets from a tethered juvenile (attended and fed by adult owls): cottontail (juvenile), 9; flying squirrel, 4; grey (?) squirrel (juvenile), 1; chipmunk (*Tamias*), 3; meadow mouse, 10; deer mouse, 77; mole, 2; shrew (19 *Blarina* and 2 *Sorex*), 21; Ruffed Grouse (?) chick, 1; small bird, 11; snake, 6; frog, 5; pellets high in insects, 15; crayfish, 2. Total: 167, in proportions of 127 mammals (76.05%), 12 birds (7.18%), misc., 28 (16.77%).

No. 20. *North of Prairie du Sac*.—May 24 to July 12, 1931, pellets from a juvenile tethered along the Wisconsin River: cottontail (juvenile), 2; flying squirrel, 1; meadow mouse, 2; deer mouse, 27; small mink, 1; bat (*Myotis*), 1; mole, 6; shrew (*Blarina*), 5; flicker, 2; Screech Owl, 1; small bird, 11; snake, 1; frog, 1; fish, 3; pellets high in insects, 1; pellets high in crayfish, 30. Total: 95, in proportions of 45 mammals (47.37%), 14 birds (14.73%), misc., 36 (37.9%).

Miscellaneous pellets, stomachs, etc., give: cottontail (juvenile), 2; ground squirrel (*Citellus*), 1; suckling grey (?) squirrel, 1; deer mouse, 6; frog, 1; snake, 1; fish, 1; crayfish, 2.

Summary of Barred Owl Food Habits.—It can perhaps be surmised from the data, without discussion, that the food of the Barred Owls was determined in the main by what was available to them. Their food was further determined by what was within the power of their weak feet to kill. The ordinary size limit for avian prey was the flicker; for mammalian prey, moles and part-grown cottontails. The mink listed in no. 20 is the one glaring exception that I have encountered, though it is not to be said positively that the mink had not died from causes other than Barred Owl talons. Possibly it had attempted liberties with the tethered owlet. Altogether, the Barred Owl seems endowed with about as mild a personality as a raptor could have and yet maintain a predaceous existence, in some instances subsisting for considerable periods upon large invertebrates (insects and crayfish) or upon fish or amphibians.

Adverse effect upon quail: none discovered. While a Barred Owl doubtless has the strength to kill a quail that it gets firm hold of, the probabilities of its making a catch appear so slight as to be of trifling consequence. Quail, for one thing, have not been noted to care especially for the deep woods which constitute the Barred Owl's usual haunts. Again, bob-white coveys in the winter observational areas have habitually frequented the favorite hunting grounds of the much more formidable Horned Owls without undue casualties.

GREAT HORNED OWL *Bubo virginianus*

Evaluation of data.—Generally excellent save for late summer and early fall. There is, however, a serious weakness in the pellet tabulations which have to do with large and medium-sized prey; single kills have been known to be represented in more than one pellet, which representations when listed as separate kills are certainly productive of quantitative error. Fore and hindquarters of individual quail, flying squirrels, and other distinctive prey are often found in different pellets; a cottontail or the like may serve for several meals. For lack of any better way of handling the matter, the mere occurrence in a pellet of a portion of an animal too big to be eaten at once is commonly put down in the following data as a kill, though not without appreciation of the short-comings of such procedure.

No. 21. *Verona*.—Fall (?), 1929, to August, 1931, 190 pellets from 2 Horned Owl territories:

Fall (?), 1929, to March, 1930, 40 pellets: cottontail, 11; Norway rat, 7; meadow mouse, 38; deer mouse, 100; house mouse, 1; shrew (*Blarina*), 3; small bird, 1.

April, 1930, 16 pellets: cottontail (incl. 1 juvenile), 6; Norway rat, 5; meadow mouse, 4; deer mouse, 16; unidentified mouse, 3; crow, 4; domestic pigeon, 1.

May, 1930, 21 pellets: cottontail, 11; meadow mouse, 2; deer mouse, 5; unidentified mammal (incl. 1 mouse), 3; crow, 1; bluejay, 1; domestic chicken, 1; King Rail, 1; unidentified bird, 5; snake, 1.

August, 1930, 2 pellets: cottontail, 1; shrew (*Blarina*), 1; insects.

Fall (?), 1930, to February, 1931, 34 pellets: cottontail, 23; Norway rat, 4; meadow mouse, 19; deer mouse, 42; shrew (*Blarina*), 2; domestic pigeon, 1.

March, 1931, 12 pellets: cottontail, 5; Norway rat, 1; meadow mouse, 4; deer mouse, 42; quail, 1; unidentified bird, 1.

April, 1931, 7 pellets: cottontail (incl. 3 juvenile) 9; deer mouse, 7.

May, 1931, 19 pellets: cottontail (incl. 6 juvenile), 20; Norway rat, 5; chipmunk, 1; meadow mouse, 3; deer mouse, 36; shrew (*Blarina*), 1; small bird, 2; pellets high in insects, 2.

June, 1931, 14 pellets from tethered owl: cottontail (incl. 4 juvenile), 7; Norway rat, 4; meadow mouse, 1; deer mouse, 3; domestic chicken, 4; snake, 1.

July, 1931, 21 pellets from tethered owl: cottontail (incl. 2 juvenile), 7; Norway rat, 2; meadow mouse, 1; deer mouse, 2; weasel, 1; domestic chicken (all sizes of young), 12; pellets high in insects, 1.

August, 1931, 4 pellets from tethered owl: domestic chicken, 4.

For the Verona area, the data are spread out sufficiently to give some idea of the year-long food habits of the Horned Owl. Disregarding what hiatuses remain and the question of how representative the nearly straight diet of domestic chicken toward the end of the observational period may be, the 1929-31 known vertebrate kills (subject in part to the criticism made in evaluation of data) sums up to 504.

Totals for each type are: cottontail (incl. 16 juvenile), 100; Norway rat, 28; chipmunk, 1; meadow mouse, 67; deer mouse, 253; weasel, 1; shrew (*Blarina*), 7; unidentified mammal, incl. mice, 7; crow, 5; bluejay, 1; domestic pigeon, 2; domestic chicken, 21; quail, 1; King Rail, 1; small and unidentified birds, 8; snake, 2.

Present in the area were a fair population of quail and a light population of Ruffed Grouse.

No. 22. *Pine Bluff*.—January (?) 1930, to August, 1931, 223 pellets from 5 Horned Owl territories:

January (?) to March, 1930, 28 pellets: cottontail, 12; muskrat, 1; Norway rat, 3; meadow mouse, 18; deer mouse, 43; house mouse, 1; shrew (*Blarina*), 4; Long-eared Owl, 1; small birds, 2.

Fall (?), 1930, to January, 1931, 16 pellets: cottontail, 10; flying squirrel, 1; meadow mouse, 2; deer mouse, 36; weasel, 1; shrew (*Blarina*), 1; Ruffed Grouse, 1; small bird, 1; pellet high in insects, 1.

February, 1931, 80 pellets: cottontail, 57; flying squirrel, 4; Norway rat, 2; meadow mouse, 41; deer mouse, 65; weasel, 1; Ruffed Grouse, 1; small bird, 1.

March, 1931, 18 pellets: cottontail, 13; meadow mouse, 5; deer mouse, 17; meadow-lark, 1; domestic pigeon, 1; small bird, 2; snake, 2.

April, 1931, 18 pellets: cottontail (incl. 1 juvenile), 12; Norway rat, 2; meadow mouse, 4; deer mouse, 46; bluejay, 1; snake, 1.

May, 1931, 21 pellets, partly from tethered owl: cottontail (incl. 5 juvenile), 15; Norway rat, 5; meadow mouse, 1; deer mouse, 8; shrew (*Blarina*), 1; flicker, 1; Screech Owl, 1; domestic pigeon, 2; domestic chicken, 1; small bird, 5; pellets high in insects, 2.

June, 1931, 19 pellets from tethered owl: cottontail (incl. 2 juvenile), 13; Norway rat, 6; deer mouse, 1; skunk (adult?), 1; domestic chicken, 1.

July, 1931, 15 pellets from tethered owl: cottontail (incl. 1 juvenile), 1; Norway rat, 7; meadow mouse, 1; skunk (juvenile), 1; domestic chicken, 4.

August, 1931, 8 pellets from tethered owl: cottontail (incl. 1 juvenile), 2; chipmunk, 1; Norway rat, 6; meadow mouse, 1; pellets high in insects, 1.

Omitting the first isolated lot of 28 pellets, we might look upon the remainder of the above as furnishing a somewhat accurate cross-section of the Horned Owl's food habits in the Pine Bluff area for practically a full year, that is, fall (?) of 1930 to late summer, 1931, notwithstanding the preponderance of February material.

Totals from 195 pellets: cottontail (incl. 10 juvenile), 123; flying squirrel, 5; chipmunk, 1; Norway rat, 28; meadow mouse, 55; deer mouse, 173; weasel, 2; skunk,

2; shrew (*Blarina*), 2; meadowlark, 1; bluejay, 1; flicker, 1; Screech Owl, 1; domestic pigeon, 3; domestic chicken, 6; Ruffed Grouse, 2; small bird, 9; snake, 3.

The Horned Owl territories where the Pine Bluff material was collected were of a rugged, wooded, hilly type interspersed with cultivated fields. Quail and Ruffed Grouse were abundant within short cruising radii of most of the owls, but the Bob-whites suffered only trivial Horned Owl losses in the winter observational areas for weeks at a time (see Errington, 1930b, 1931b).

No. 23. *Madison (Pheasant Branch and Owen's Woods)*.—Fall (?), 1929, to middle of April, 1930, contents of 64 pellets: cottontail, 8; flying squirrel, 3; Norway rat, 16; meadow mouse, 70; deer mouse, 129; unidentified mouse, 2; shrew (*Blarina*), 25; bluejay, 1; small bird, 4.

The bird life of this area was much the same as that given under no. 11. Cottontails had been greatly reduced by over-shooting.

No. 24. *Madison (Hammersley Slough, just southwest of town)*.—Early fall, 1930, to July, 1931.

Early fall, 1930, to January, 1931, 48 pellets: cottontail, 31; flying squirrel, 1; Norway rat, 20; meadow mouse, 13; deer mouse, 38; shrew (*Blarina*), 1; quail, 6; unidentified bird, 1.

February, 1931, 11 pellets: cottontail, 11; deer mouse, 3; quail, 1; Mallard (probably the same bird), 2.

March, 1931, 10 pellets: cottontail, 7; Norway rat, 1; deer mouse, 1; robin, 1; coot (?), 2; Mallard, 3.

April, 1931, 17 pellets: cottontail, 15; Norway rat, 2; meadow mouse, 6; deer mouse, 8; shrew (*Blarina*), 1; coot (plus one foot in another pellet), 1; Mallard, 2.

May, 1931, 28 pellets from adults and tethered juvenile: cottontail (incl. 1 juvenile), 16; Norway rat, 3; meadow mouse, 5; deer mouse, 2; flicker, 1; Lesser Yellow-legs, 1; gallinule, 1; rail, 4; Mallard, 3; Pied-billed Grebe, 1; medium-sized unidentified bird, 3; small bird, 5; snake, 1; pellets high in insects, 2.

June, 1931, 10 pellets from tethered owl: cottontail (incl. 1 juvenile), 3; fox squirrel, 1; chipmunk (juvenile), 1; muskrat (juvenile), 3; Norway rat, 5; deer mouse, 1; gallinule, 1; medium-sized unidentified bird, 1; small bird, 1; snake, 1; pellets high in insects, 3.

July, 1931, 5 pellets from tethered owl: chipmunk (plus fur in another pellet), 1; Norway rat, 1; deer mouse, 2; quail, 1.

The Hammersley Slough area, occupied by a nesting pair of Horned Owls, was scarcely outside of the city limits of Madison and was made up of diverse environments—suburbs, truck gardens, golf courses, a marsh, pastured and un-pastured woodlots. The wooded tract in which the nest was situated was over-pastured, hence, unproductive of game, so the owls had to do most of their hunting elsewhere.

That they were rather pressed for food at times is indicated by the diversity of forms taken, by the distance to some of their known sources of prey ($\frac{1}{4}$ mile or more), and by the relatively frequent representation of quail and diurnal Sciuridae, which latter two ordinarily may be regarded as of accidental occurrence in Horned Owl diet. In fact, depredations were traced to only two quail coveys, these coveys having an original combined population of around 40 birds (minus 9 that I collected for specimens throughout fall and winter), far below populations in some other Horned Owl territories (see Errington, 1930b, 1931b) where the total Bob-white loss varied from nothing to a bird or two for the winter.

Ring-necked Pheasants were locally well established, but I never ran across any kills by Horned Owls.

Total vertebrate prey from 129 pellets, early fall 1930 to July, 1931, neglecting probable errors from duplication, 247, in proportions of: cottontail (incl. 2 juvenile), 83; flying squirrel, 1; fox squirrel, 1; chipmunk, 2; muskrat, 3; Norway rat, 32; meadow mouse, 24; deer mouse, 55; shrew (*Blarina*), 2; robin, 1; flicker, 1; quail, 8; Lesser Yellow-legs, 1; Coot (?), 3; gallinule, 2; rail, 4; Mallard, 10; Pied-billed Grebe, 1; medium-sized unidentified bird, 5; small bird, 6; snake, 2.

No. 25. *Madison (Lake Wingra Wild Life Refuge)*.—Winter 1930-31, 35 pellets: cottontail, 29; flying squirrel (probably the same one), 2; Norway rat, 1; meadow mouse, 1; deer mouse, 14; weasel, 1; shrew (*Blarina*), 4; rusty (?) blackbird, 1.

The Wingra situation, contrasted with that of the Hammersley Slough area, illustrates the bearing of plentiful "buffer species" on the diet of a versatile predator.

Up to a hundred Mallard ducks frequented shore-line springs of the refuge all winter, and the lone owl's territory was cohabited by three large coveys of quail, yet he was known to get but two (and one of these kills was not unquestionable) quail (see Errington, 1931b) and no ducks during a four months' sojourn. Why? Because the refuge was over-run with rabbits, and *Bubo* had slight need of ranging very far in quest of something to eat. On the other hand, the owls of no. 24, finding comparatively "lean pickings" near home, had to take almost anything they could get.

No. 26.—*Southwest of Daleyville*.—Winter of 1930-31, 9 pellets: cottontail, 7; flying squirrel, 1; deer mouse, 18; shrew (*Blarina*), 1.

April, 1931, 4 pellets: cottontail, 4.

The Daleyville area was a vestigial block of rough, wooded land in an otherwise denuded dairy community. In the woods lived a number of Ruffed Grouse; adjacent, several coveys of quail.

No. 27. *McFarland (Lake Kegonsa)*.—Fall, 1929, and winter, 1929-30, 21 pellets: cottontail, 5; Norway rat, 7; meadow mouse, 35; deer mouse, 21; shrew (*Blarina*), 1; Song Sparrow, 1; Red-winged Blackbird, 1; starling, 1; bluejay, 1.

Fall (?), 1930, 5 pellets: cottontail, 4; meadow mouse, 4; deer mouse, 3; shrew (*Blarina*), 1.

New Years (?) to March, 1931, 12 pellets: cottontail, 9; Norway rat, 1; meadow mouse, 4; deer mouse, 6; shrew (*Blarina*), 1; Screech Owl, 2; small bird, 1.

April, 1931, 8 pellets: cottontail, 5; meadow mouse, 7; deer mouse, 1; weasel, 1; shrew (*Sorex*), 2; robin, 1; gallinule, 1; duck (*Marila*), 1; small bird, 1; crayfish, 1.

The McFarland area, regrettably, had to be dropped from observation about the time that waterfowl began to be brought to a Horned Owl nest, so the above data may leave the most interesting chapter of the story untold.

No. 28. *North of Middleton*.—Winter, 1929-30, to spring, 1930, 19 pellets: cottontail, 4; fox squirrel, 1; meadow mouse, 24; deer mouse, 52; flicker, 1; Coot, 1; small bird, 2.

Late fall (?), 1930, to February, 1931, 28 pellets: cottontail, 19; meadow mouse, 2; deer mouse, 54; domestic chicken, 2.

March, 1931, 8 pellets: cottontail, 7; Norway rat, 1; deer mouse, 1; flicker, 1.

April, 1931, 8 pellets: cottontail, 8; deer mouse, 4.

The Middleton data were obtained from a large unpastured woodlot surrounded by thickly settled farming country. There was a slough within a half mile of the woods. Considerable poultry was to be seen around the farm yards.

No. 29. *Southwest of Baraboo*.—Fall (?), 1930, to March, 1931, 14 pellets: cottontail, 8; meadow mouse, 16; deer mouse, 20; Ruffed Grouse, 1.

April, 1931, 31 pellets: cottontail, 27; deer mouse, 4; Ruffed Grouse, 1; small bird, 2; crayfish, 1.

The Baraboo data were secured from a range of wooded hills where wild life can be said to exist under conditions as nearly primal as any persisting in this quarter of the State. Ruffed Grouse—note the two in the 45 pellets—were conspicuously on the upward trend of their cycle, and were to be flushed almost anywhere in the woods.

No. 30. *Southwest of Lodi*.—Fall (?), 1929, to March, 1930, 41 pellets: cottontail, 17; Norway rat, 9; meadow mouse, 56; deer mouse, 25; house mouse, 1; shrew (*Blarina*), 1; small bird, 1.

No. 31. *Roxbury*.—Fall (?), 1929, to spring, 1931, 109 pellets from 4 Horned Owl territories:

Fall (?), 1929, to March, 1930, 47 pellets: cottontail, 37; fox squirrel, 1; meadow mouse, 21; deer mouse, 36; unidentified rodent, 1; shrew (*Blarina*), 2; Snow Bunting, 1; snake, 1.

April, 1930, 12 pellets: cottontail, 11; fox squirrel, 1; meadow mouse, 1.

May, 1930, 6 pellets: cottontail, 6; small bird, 1.

Late winter and early spring, 1931, 44 pellets: cottontail, 35; flying squirrel, 1; Norway rat, 1; meadow mouse, 5; deer mouse, 9; Screech Owl, 1; domestic pigeon, 1; small bird, 1.

No. 32. *Prairie du Sac*.—Fall (?), 1929, to June, 1931, 196 pellets from 3 Horned Owl territories:

Fall (?), 1929, to February, 1930, 30 pellets: cottontail, 12; Norway rat, 2; meadow mouse, 17; deer mouse, 81; unidentified mouse, 1; bluejay, 1; Ruffed Grouse, 1; quail, 2; small bird, 2.

March, 1930, 12 pellets: cottontail, 10; Norway rat, 1; Ruffed Grouse, 1.

April, 1930, 8 pellets: cottontail, 7; meadow mouse, 1; deer mouse, 3; shrew (*Blarina*), 1.

Fall (?), 1930, to March, 1931, 68 pellets: cottontail, 43; Norway rat, 6; meadow mouse, 8; deer mouse, 72; shrew (*Blarina*), 1; crow, 1; quail, 2; small bird, 5.

April, 1931, 41 pellets, partly from a tethered juvenile: cottontail (incl. 3 juvenile), 33; Norway rat, 1; deer mouse, 46; shrew (*Blarina*), 1; meadowlark, 1; crow, 2; bluejay, 1; flicker, 2; domestic chicken, 1; quail, 2; small bird, 7.

May, 1931, 24 pellets from tethered owl: cottontail (incl. 4 juvenile), 17; Norway rat, 1; meadow mouse, 2; deer mouse, 18; meadowlark, 2; Screech Owl, 1; rail, 2; medium-sized unidentified bird, 1; small bird, 8.

June, 1931, 13 pellets from tethered owl: cottontail (incl. 9 juvenile), 15; deer mouse, 3; small bird, 5.

Areas 30, 31, and 32 were of the same general topography, being more or less wooded ranges in dairy country, with occasional marshes and varying acreages in cultivation. All of the areas supported a fair population of Ruffed Grouse; no. 32 had also one of the heaviest quail populations yet studied.

An approach to a local year-round picture of Horned Owl food habits can be made by combining the no. 32 data from fall (?), 1930, to June, 1931. Contents of 146 pellets: cottontail (incl. 16 juvenile), 108; Norway rat, 8; meadow mouse, 10; deer mouse, 139; shrew (*Blarina*), 2; meadowlark, 3; crow, 3; bluejay, 1; flicker, 2; Screech Owl, 1; domestic chicken, 1; quail, 4; rail, 2; medium unidentified bird, 1; small bird, 25. Total items, 310.

Miscellaneous pellets and stomach contents: cottontail, 9; meadow mouse, 2; deer mouse, 4; house mouse, 1; meadowlark, 1; domestic chicken, 1.

Summary of Great Horned Owl Food Habits.—The Horned Owl's food habits depend largely upon where the bird is situated. While a cross-section of average food habits pertaining to a township or to a continent might be compiled, radical departures from the average are bound to result from pronounced changes in availability of prey, as evidenced by the toll upon domestic chickens in no. 21 and upon ducks in no. 24.

Changes in availability do not necessarily correspond with changes in numerical status, though the two could be roughly synonymous in the case of most mammalian and some avian prey, provided that not too many other variables—"buffers," food and cover values, weather, emergencies, etc.—upset environmental equations. The availability of Ruffed Grouse appears to increase proportionately to the increase of the grouse, whereas this principle does not appear to hold so well for quail. The Norway rat, an alien successfully maintaining itself as a permanent resident in our southern Wisconsin fields wherever conditions are right, seems even in low population densities peculiarly vulnerable to the Horned Owl in winter.

The food habits of the Horned Owl, for reasons easily understandable, have helped to incur for the species almost universal condemnation and persecution. It is evident that this predator may have an expensive appetite and that any defense of a creature which costs a community poultry or game (notably where rabbits, for all of their own injurious potentialities, are ranked as game) runs the risk of being resented as social impropriety, if not heresy. It is evident that the Horned Owl's diet would be virtually impossible to defend before a public claiming right of ownership for a large percentage of the items represented, an indefensible diet perhaps from the immediate material standpoint. Not so evident is the Horned Owl's full significance in what we are pleased to designate the economy of nature. The mere fact that certain life phenomena are not readily fathomable from the surface does not detract from the possibility of their being of equal, or of greater, magnitude than those we suppose to be obvious.

Just what is the import of the 5 weasels in the past year's collection of less than 800 Horned Owl pellets—pellets from three counties in which the weasel population as a whole was not noticeably excessive? This season I also found circumstantial

evidence of a Horned Owl having brought tragedy to a family of young Cooper Hawks, and another site where an adult Cooper Hawk had been eaten in typical Horned Owl manner. I have witnessed, too, the utterly crazed behavior of a mother Cooper Hawk on account of a Horned Owl which had chanced to trespass into her nesting territory. Are these fragmentary data worthy of casual mention only, or do they hint the functioning of a powerful natural mechanism which we either do not recognize or ignore? May they link, for example, the apparent ascendancy of weasels and Accipiters with the decline of large raptors in the eastern United States? I do not imply that I know.

Nor do I imply that Horned Owl pressure, under virgin conditions or elsewhere, serves as an adequate check, *in itself*, upon the increase of weasels and Accipiters. Such pressure, nevertheless, added to other environmental pressures might be strongly enough contributory to lower the population level at which the aggregate of checks, organic and inorganic, becomes dominantly operative. Nor do I imply, even were the Horned Owl to prove the major influence in the control of important species tending in spite of man to multiply to serious proportions, that we should lose sight of other sides to the question. I am not attempting recommendations except that we, who undertake what we hope is sound management of wild life resources, strive to wean ourselves from narrow interests and rule-of-thumb methods.

The whole subject of predator and prey-inter-relationships is very obscure; to no predatory species does this generalization appear better applicable than to the Horned Owl. We have some data relating to this species which are good so far as they go. We have some data, yes, but we must admit that we have only the most elementary of ideas as to their ecological meaning. Here is room for research.

Adverse effect of the Horned Owl upon quail: ordinarily a light, constant pressure, rather predictable under uniform conditions, though occasional coveys (as the ones preyed upon by the owls of no. 24) suffer severe losses. In the Wisconsin observational areas, Horned Owls living in the midst (within $\frac{1}{4}$ mile) of quail populations of around 50 birds averaged one kill about every two months (see Errington, 1931b). With lesser quail populations and at greater distances from the owl headquarters the mortality rate diminished perceptibly. I suspect, from the few data I have upon the topic, that most bob-white kills by Horned Owls are brought about through exposure of coveys night-flushed by mammals (experimental evidence indicates that quail have no fear of rabbits, however), a conception in essential agreement with Stoddard's (1931) views from his Georgia work. I have never been able to detect any correlation between poor physical condition in a quail and the likelihood of its falling prey to a Horned Owl, as in the case of the Red-tailed Hawk (see Errington, 1930b, 1931b, 1931c).

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