Flexible Dietary Response and Feeding Ecology of the Red-shouldered Hawk, *Buteo lineatus*, in Iowa

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We observed that mammals comprised 92% of the identified prey items brought to three Red-shouldered Hawk (*Buteo lineatus*) nests in Iowa during a drought in 1977. The following year, 85% of the prey items delivered to four nests in the same study area were amphibians and arthropods. The nesting territories were mostly covered by shallow water in 1978, and mammal densities were probably reduced causing the hawks to switch to available alternate prey.

Key Words: Red-shouldered Hawk, *Buteo lineatus*, diet flexibility, prey switching, Iowa.

Several workers (e.g. Craighead and Craighead 1956; Smith and Murphy 1979; Smith et al. 1981; Baker and Brooks 1981) have examined the response of raptor populations to changing densities of their prey species. Although the numerical response of raptors has been well documented (Newton 1976), pronounced switching to an alternate prey species (or functional response) has not received as much attention (Phelan and Robertson 1978). Craighead and Craighead (1956:301) noted that Red-shouldered Hawks (*Buteo lineatus*) in Michigan shifted from a diet clearly dominated by Meadow Voles (*Microtus pennsylvanicus*) in the winter to one that included mammals, birds, snakes, frogs, and crayfish in the spring and summer. The Meadow Vole, however, was still the most abundant prey species in the food remains, and the diets of breeding hawks were similar in both years of their study (Craighead and Craighead 1956:276). Adamcik et al. (1979), in a 10-year study, showed that mammals dominated the percentage frequency and biomass of the diet of breeding Red-tailed Hawks (*Buteo jamaicensis*), but during cyclic lows of Snowshoe Hares (*Lepus americanus*) a partial dietary shift to waterfowl occurred, which was accompanied by a severe reduction in productivity. Here, we describe a dramatic shift in the diet of a small breeding population of Red-shouldered Hawks inhabiting the Mississippi River floodplain in northeastern Iowa.

Methods

We identified prey items brought to three nests in 1977 (62 hrs) and four nests in 1978 (121 hrs) by watching from blinds located 30-70 meters from the nests. Observations during both years began when nestlings were approximately one week old and were continued through fledging. Three nests observed in 1978 were within the nesting territories studied in 1977. The relative proportions of different prey remains in castings collected beneath nests were determined by identifying 25 random samples (Chamrad and Box 1964) taken from each of 40 pellets and 11 pellet fragment consolidations ($51 \times 25 = 1275$ samples). A pellet fragment consolidation included all incomplete pellets collected from underneath a nest at the same time. Mammal hair was identified using a reference collection and the characteristics given by Moore et al. (1974). In 1977, the small mammal species available in marsh edge habitat and floodplain forest were determined by snap trapping (30 traps set on each of seven consecutive nights in each habitat). Trapping could not be done in 1978 because nesting territories were flooded. Chi-square statistics were calculated based on the number of mammal and other prey occurrences recorded.

Results

The proportion of mammal and other prey were significantly different between years, both for items brought to the nest (Table 1; $X^2 = 68$, $P < 0.001$, d.f. = 1) and in pellets (Table 2; $X^2 = 131$, $P < 0.001$, d.f. = 1). In 1978, mammals were the dominant prey in pellets (Table 2), but comprises less than 8% of the items brought to the nest (Table 1). Pellet analyses are seriously biased in that amphibian, reptile, and crayfish remains are poorly represented (Craighead and Craighead 1956: 276; Snyder and Wiley 1976: 6; Portnoy and Dodge 1979). Excluding the unidentified food items, mammals comprised 92% of the food items brought to nests in 1977, but only 10% of the items in 1978 (Table 1).

Both observations and pellet analysis showed similar ratios between the numbers of Meadow Voles and *Peromyscus* spp. in the diet (4:1). By either method, Meadow Voles were an important part of the red-

TABLE 1. Percentage of different food items brought to Red-shouldered Hawk nests in 1977 and 1978.

Food Item	Year 1977 N = 58	1978 N = 106
Mammals	56.9	7.5
Amphibians[a]	3.4	34.0
Arthropods[b]	0.0	28.3
Reptiles[c]	0.0	2.8
Birds	1.7	1.9
Unidentified	37.9	26.4

[a]*Rana pipiens* and *R. catesbeiana* were identified.
[b]Crayfish (Cambaridae) and caterpillars.
[c]*Thamnophis sirtalis* and *Nerodia sipedon* were identified.

TABLE 2. Percentage of different prey by occurrence represented in Red-shouldered Hawk pellets in 1977 and 1978.

Food Item	Year 1977 N = 375	1978 N = 900
Microtus pennsylvanicus	70.1	38.4
Peromyscus	16.5	13.6
Other mammals[a]	3.7	5.1
Total Mammals	90.3	57.1
Bird feathers	9.4	22.7
Crayfish	0.0	9.8
Insects	0.3	9.8
Other[b]	0.0	0.6

[a]Shrews (Soricidae), *Ondatra zibethicus* (Muskrat), *Reithrodontomys megalotis* (Western Harvest Mouse), *Tamias striatus* (Eastern Chipmunk).
[b]Unidentified snake and frog.

shoulder diet. Most of the feathers found in pellets (Table 2) were hawk-like down feathers and probably were accidently swallowed during preening; thus, they do not represent prey items. The higher incidence of feathers in pellets in 1978 (Table 2) was probably due to the consumption of fewer mammals and the resultant lower rate of pellet production in that year. More pellets were found in 1978 only because of an intensive search done in that year.

Discussion

We believe the major shift in prey types between years (Table 1) was associated with changes in water levels in the Mississippi River backwaters and marshes. A severe drought occurred in 1977, whereas water levels were higher than normal in 1978. Mean tailwater elevations (water level below dam) at nearby Lock and Dam No. 9 were 1.06 m higher in March-June 1978 than in 1977 (unpublished data, U.S. Corps of Engineers, Lock and Dam No. 9, Lynxville, Wisconsin). During the 1978 breeding season, much of the hawk nesting territories were covered by shallow water and hence a severe decline in mammal densities probably occurred. Amphibians and crayfish were not censused, but they were obviously abundant in 1978, while only a few anurans and no crayfish were seen during the 1977 drought.

Breeding Iowa red-shoulders primarily restrict their activity to floodplain forests and associated marshes and wet meadows (Bednarz and Dinsmore 1981). *Microtus*, which made up the bulk of the 1977 diet (Table 2), were trapped only at the edge of the marsh and not in the floodplain forest. *Peromyscus* were trapped in both marsh edge and floodplain forest habitat. All of the primary prey animals (Meadow Voles, amphibians, and crayfish; Tables 1 and 2) in the study area were generally restricted to marshes and wet meadows, suggesting the importance of those habitats as hunting areas for nesting Red-shouldered Hawks.

Productivity was excellent in both years (9 young from three nests in 1977 and 14 young from four successful nests in 1978). Campbell (1975) suggested that a long-term decrease in reptiles and amphibians and an increase in mammals may contribute to the replacement of red-shoulders by Red-tailed Hawks and Great Horned Owls (*Bubo virginianus*). Our results showed that, with short-term changes in water levels, red-shoulders adapted to the available prey and were capable of successfully raising young with either mammal or alternative prey. We suggest that the red-shoulder does not depend on any particular kind of prey, but rather, is adapted to the forested floodplain system (Bednarz and Dinsmore 1981) and its varying frequencies of prey types.

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First record of the Bitterroot, *Lewisia rediviva*, in Alberta.

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The Bitterroot (*Lewisia rediviva* Pursh) is reported for the first time for Alberta. Plants were found in exposed sites at about 1750 m elevation on two rocky ridges 22 km west of Pincher Creek. These populations are probably derived, by wind dispersal, from Bitterroot populations in southeastern British Columbia.

Key Words: Bitterroot, *Lewisia rediviva*, Alberta, wind dispersal.

In the summer of 1982 one of us (GRM), on a field trip in the Pincher Creek area of Alberta, found and photographed flowering specimens of a plant which was tentatively identified as the Bitterroot, *Lewisia rediviva* Pursh, a species hitherto not known east of the continental divide in Canada. A preliminary confirmation was made subsequently from senescent specimens in 1982 and final confirmation was made in 1983. The present note documents the existence of this remarkable flowering plant, the state flower of Montana, in Alberta.

We located two populations of the Bitterroot in southwestern Alberta, one 3 km north and the other 1.3 km east of Mt. Backus (22 km west of Pincher Creek, 49°26′N, 114°16′W). The original discovery took place on a ridge locally called Kylo Hill at the headwaters of Screwdriver Creek, at an elevation of approximately 1700 m. Like other ridges in the area, Kylo Hill is a ridge of tilted bedrock which runs parallel to the Rocky Mountain system nearby. The upper slopes on the southwest flanks are generally open and covered with fairly dense vegetation of *Stipa* sp., *Selaginella densa*, dwarf shrubs of *Rosa* sp. and *Amelanchier alnifolia, Sedum lanceolatum, Polemonium pulcherrimum, Artemisia campestris, Senecio canus,* and *Koeleria cristata*. In a few patches the prevailing winds and exposure have broken the sod (Figure 1), and the partly pulverized lithosol is completely exposed except for a few depauperate individuals of *Eriogonum ovalifolium, Potentilla hippiana, Erigeron compositus*, and *Agoseris glauca*. It is in such exposed patches that many Bitterroot plants are