*Prairie Nat.* 18(2): 1986, pp. 65-78

# Winter Ecology of Bald Eagles in Southcentral Nebraska

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ABSTRACT — Approximately 200 bald eagles wintered along a 370-km section of the Platte and North Platte rivers in Nebraska during the winters of 1978-79 and 1979-80. A preponderance of the wintering eagles were adults, with the adult:subadult ratio highest during the harsh winter of 1978-79. Nocturnal roosts were located primarily in tree plantings near the river, with mean tree age at the roosts ranging from 39 to 84 years. Bald eagles utilized a diverse prey base that included fish, birds, and mammals. Remains of 56 prey species were identified from pellets; 76% of pellets contained birds, 34% mammals, and 11% fish. Eagles foraged principally on fish when ice covered less than 80% of channels and water levels were moderate to low. Waterfowl and mammals dominated the diet when the river was almost entirely frozen or water levels were high. Mallards, eastern cottontails, and carp were the principal avian, mammalian, and piscine prey, respectively. Eagles traveled long distances from the river to feed on field-feeding waterfowl when alternate prey were not available. Fish were underrated in pellets because body components are more digestible than other major prey consumed.

Approximately 1500 of the estimated 8300 bald eagles (*Haliaeetus leucocephalus*) wintering in the 48 contiguous states occur in the central plains states (South Dakota, Nebraska, Kansas, and Oklahoma) (Lincer et al. 1979). This population is associated primarily with major rivers. The birds near the northern edge of the winter range in Nebraska experience extreme cold and heavy snow cover but relatively little information is available on the winter ecology of this population. In this paper, we describe population characteristics, roost sites, and food habits of bald eagles along the Platte and North Platte rivers during a cold (1978-79) and normal (1979-80) winter.

## STUDY AREA

The study was conducted along approximately 370 km of the Platte and North Platte rivers in southcentral Nebraska (Fig. 1). These rivers cross about 885 km of Nebraska and generally flow east from their origin in the Rocky Mountains of Colorado. Dominant riparian woodland vegetation of the study area included eastern plains cottonwood (*Populus deltoides*), willow (*Salix* spp.), and false indigo (*Amorpha fruticosa*). Smooth brome (*Bromus inermus*), bluegrass (*Poa pratensis*), and a variety of native grasses and forbes typical of a floodplain tallgrass and mixed-grass prairie comprised the herbaceous cover (Currier 1982).

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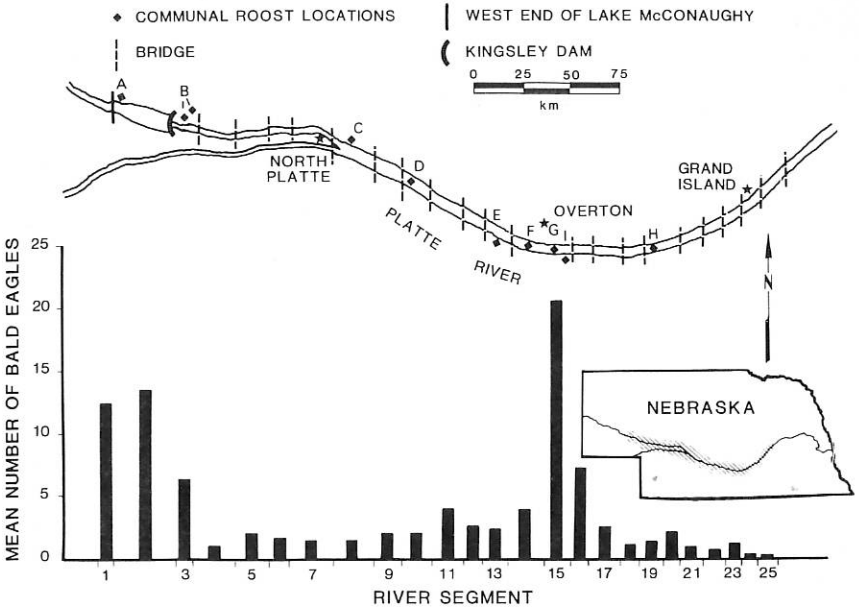


Figure 1. Distribution of nocturnal communal roosts of bald eagles on the 367-km study area, and average number of eagles sighted per river segment, based on aerial surveys during the winters of 1978-1979 and 1979-1980.

Most of the area is underlain by alluvial deposits of sand, loam, and gravel (Williams 1978).

From west to east within the study area, the elevation decreases from 952 to about 540 m above sea level (from U.S. Geol. Surv. topographical maps) and mean annual precipitation increases from about 46 to 58 cm (U.S. Dep. Comm. 1978). The river channel gradually widens from west to east and becomes more braided, pasture acreages and small grain and cattle production decrease, and irrigated corn production increases (U.S. Dep. Agric. 1978). Habitat types change from a sandhills prairie community to a riparian tall-grass prairie and woodland community.

## METHODS

The number of bald eagles inhabiting the study area was estimated from evening or predawn censuses (Edwards 1969) at 11 nocturnal communal roosts and from midmorning aerial surveys along the rivers. Midmorning aerial surveys were initiated between 0850 and 1039 hr CDT at monthly intervals during 1978-79 (14 December, 17 January, 16 February, and 15 March) and bimonthly intervals during 1979-80 (30 November, 14 December, 8 and 21 January, 1 and 16 February, and 1 and 14 March). Aerial surveys were conducted from a Cessna 180 flown at 30-150 m above the river at 130-190 km/hr from east to west. The pilot and an observer searched for eagles and a recorder plotted locations on

aerial photographs. Percent ice cover and waterfowl numbers were estimated for each river segment (area between bridges) during aerial surveys. Round-trip duration of flights ranged from 253 to 316 min. Eagles were aged as adult, subadult, or unknown. Only individuals with a completely white head and tail were classed as adults.

In order to quantify physical characteristics of stands containing nocturnal roosts, between 15 and 40 trees 15 cm dbh or larger were sampled using the point-centered quarter method (Cottam and Curtis 1956). Relative dominance, relative frequency, and relative density were calculated in order to derive importance values for each tree species (Mueller-Dombois and Ellenburg 1974). Similarities between stands were compared using Sorenson's Index (Sorenson 1948, Mueller-Dombois and Ellenburg 1974). Height, dbh, and age of individual roost trees were recorded.

Food habits were determined from regurgitated pellets, prey remains, and observations of foraging eagles. Pellets and prey remains were collected every 1-2 weeks below perches and 11 communal roosts (Fig. 1) from 19 December 1978 to 28 March 1979 and 3 December 1979 to 14 March 1980. Each pellet was examined and prey species were identified. Frequency of occurrence of prey was calculated for each roost. A maximum of one occurrence per pellet was tallied for any prey species. Prey use was compared bimonthly and between winters.

## RESULTS AND DISCUSSION

### Population Characteristics

*Distribution.* — Bald eagles were distributed throughout the 370 km of river channel during the study, but relative abundance varied widely among river segments (Fig. 1). Largest concentrations were in the vicinity of Jeffrey's Island (Roost F) and below Kingsley Dam (Roost B). The distribution of eagles along the river and location of nocturnal roosts were influenced by waterfowl concentrations, fishery accessibility, and/or the availability of open water (Fig. 2). Average percent open water was greater in January and February 1980 (77% and 45%) than in January and February 1979 (16% and 17%, respectively). Although milder weather conditions during 1980 resulted in much more open water than in 1979, eagle and waterfowl distributions remained similar to the previous winter. Eagles were more broadly distributed following spring ice breakup, which occurred about 15 March in both years.

During January and February, bald eagles concentrated at the nocturnal roosts. These winter residents appeared to have a strong fidelity for particular areas. As the season advanced and migrants arrived, use of winter roosts declined. The birds were dispersed over a wider area and roosted at other sites in addition to traditional winter roosts. These "transitory" roosts were difficult to locate and were not used consistently. By mid-April, eagles had migrated from the area.

*Relative abundance and age ratios.* — The maximum number of roosting bald eagles counted during a single census period was 151 in 1978-79 and 196 in 1979-80 (Table 1). Individual roosts contained from 0 to 60 eagles. Numbers during the first winter are conservative because not all nocturnal roosts had been located. Aerial counts had 22% fewer eagles than roost counts during January

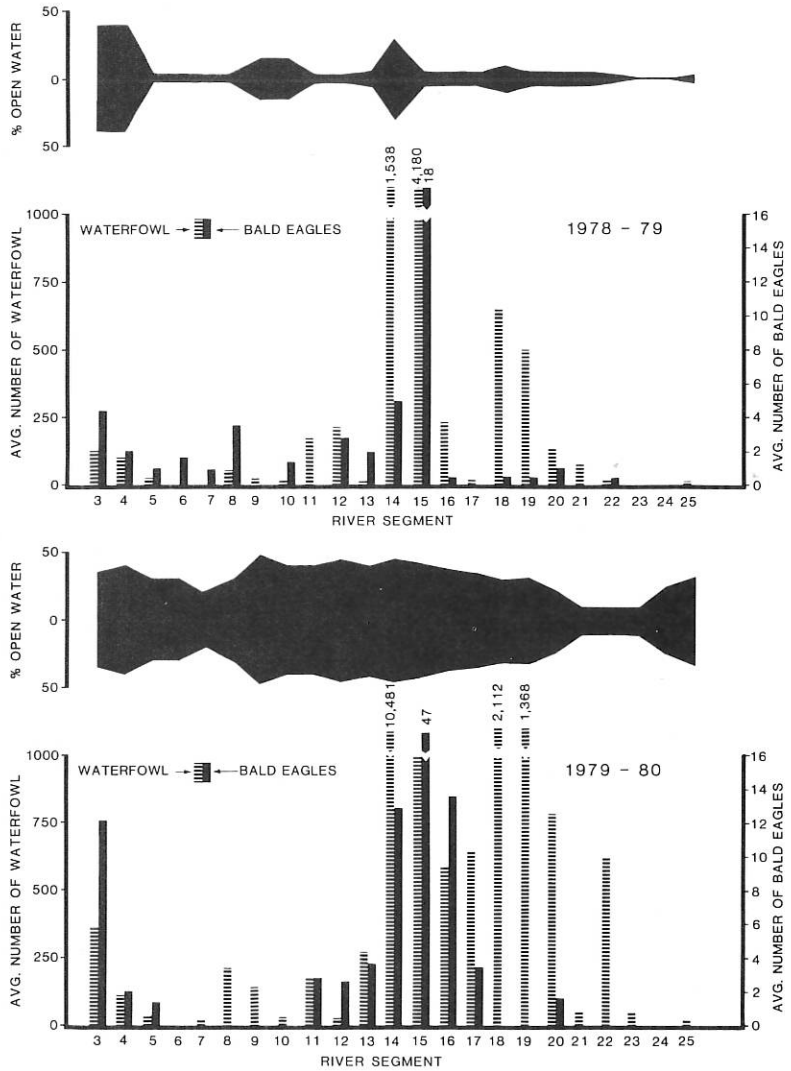


Figure 2. Distribution and abundance of bald eagles and waterfowl during January and February, 1979 and 1980, in relation to availability of open water (locations are identified in Fig. 1)

and February when roost fidelity was high. Aerial counts were inherently biased towards adults as dark plumaged subadults were difficult to see from above, especially in the absence of snow cover.

In 1979, the adult:subadult ratio at roosts shifted from 1.2:1 in January to a maximum of 3.0:1 during late February — early March, then declined to 1.0:1 by the end of March (Table 1). Age ratios at roosts in 1979-80 fluctuated less,

Table 1. Number and age ratio (adult:subadult) of bald eagles during winter based on roost counts and aerial surveys.

| | December | January | February | March |
|---|---|---|---|---|
| 1978-79 | | | | |
| Roost | — — | 83(1.2:1) | 111(3.0:1) | 151(1.0:1) |
| Aerial | 52(3.9:1) | 66(2.2:1) | 61(3.2:1) | 224(4.4:1) |
| 1979-80 | | | | |
| Roost | 69(1.6:1) | 196(2.4:1) | 141(2.0:1) | 115(2.6:1) |
| Aerial | 36(2.3:1) | 219(2.8:1) | 83(2.4:1) | 121(2.7:1) |

ranging from 1.6:1 to 2.6:1. Aerial census results showed an age ratio of 2.9:1 in both years combined while the ratio at roosts was 1.9:1, reflecting the aerial bias for adults. March was not included in these calculations because of the breakdown in roost fidelity and the influx of migrants as the season progressed.

Adults predominated in both winters, although a larger proportion of adults was present during the harsh winter of 1979 than in the relatively mild winter of 1980. Bald eagles may have wintered further south in 1979, as evidenced by the large influx of birds in March (Table 1). Steenhof (1978) summarized age relationships of wintering bald eagles and felt that subadults winter further south. The majority of wintering eagles in Missouri were subadults, although the ratio of adults:subadults was greatest during periods of harsh weather and low food availability (Griffin et al. 1982).

Roost Sites

*Diurnal.* — Approximately 60% (n = 1,353) of the bald eagle sightings were associated with riparian woodlands and about 15% were found in shelterbelts/woodlots. Over 11% of the sightings were in tilled fields. Roost I (Fig. 1) was the only communal day roost discovered and was a tree planting surrounded by cornfields and pasture. As many as seven eagles used Roost I in 1979 only.

*Nocturnal.* — The nocturnal roosts of bald eagles were located primarily in tree plantings near the river; only three roosts occurred in natural riparian woodlands. Importance values of trees within each roost were greatest for cottonwoods, except for Roost I which had an equal component of box elder (*Acer negundo*) (Table 2). Total stand density was greatest for Roost $B_1$, followed by Roost D which was a riparian woodland.

The Sorenson's Index provided a measure of similarity between roosts (Table 3). Roost I was the most dissimilar, whereas the remaining roosts exhibited varying degrees of similarity, all of which exceeded 55%. The average age of roost trees was well over 50 years; the mean age at each roost ranged from 39 to 84 years

Table 2. Importance values[1] of trees in bald eagle roosts.

| Roost | $B_1$ | $B_2$ | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| Cottonwood (*Populus deltoides*) | 300 | 300 | 209 | 231 | 196 | 177 | 195 | 245 | 108 |
| Red mulberry (*Morus rubra*) | | | | | | 61 | 27 | 42 | 54 |
| Box elder (*Acer negundo*) | | | 30 | 23 | 76 | | 17 | | 108 |
| Green ash (*Fraxinus pennsylvanica*) | | | 10 | 46 | | 24 | 38 | | |
| Coyote willow (*Salix exigua*) | | | | | | | 24 | | 30 |
| Hackberry (*Celtis occidentalis*) | | | 16 | | 28 | | | | |
| Red cedar (*Juniperus virginiana*) | | | | | | 18 | | 14 | |
| American elm (*Ulmus americana*) | | | 36 | | | 19 | | | |
| Total | 300 | 300 | 301 | 300 | 300 | 299 | 301 | 301 | 300 |
| Trees/ha | 645 | 384 | 305 | 373 | 223 | 173 | 287 | 373 | 422 |

[1]Importance value = relative dominance + relative frequence + relative density.

Table 3. Sorenson's index between bald eagle nocturnal roosts.

| Roost | $B_1$ | $B_2$ | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| $B_1$ | | | | | | | | | |
| $B_2$ | 100.0[a] | | | | | | | | |
| C | 69.4 | 69.4 | | | | | | | |
| D | 77.0 | 77.0 | 80.5 | | | | | | |
| E | 65.4 | 65.4 | 80.6 | 73.0 | | | | | |
| $F_1$ | 59.0 | 59.0 | 68.6 | 59.1 | 59.0 | | | | |
| G | 64.8 | 64.8 | 73.8 | 83.2 | 70.6 | 76.0 | | | |
| H | 81.6 | 81.6 | 69.4 | 76.9 | 65.2 | 77.6 | 73.8 | | |
| I | 36.0 | 36.0 | 46.0 | 72.0 | 61.4 | 48.0 | 58.6 | 99.8 | |

[a]Expressed as percent similarity. S.I. = 2W/A + B x 100 where W = the sum of the smaller importance value (I.V.) of species in common; A = the sum of I.V. for all species in stand A; and B = the sum of I.V. for all species in stand B.

(Table 4). Bald eagles used older trees with an open crown and lateral structure; consequently, most of the roosts were located in tree plantings near the river. Trees in these sites have reached maturity and were in a state of decline, although seedlings were present in the understory. Trees in natural riparian woodlands near several of the nocturnal roosts were about 15 to 50 years younger than those at roost sites (Currier 1982). Undoubtedly this difference in age distribution of trees in planted and natural sites relates to the predominance of roosts in planted stands.

Roost tree characteristics are available for Oklahoma and South Dakota (Lish and Lewis 1975, Steenhof et al. 1980) where cottonwoods were the dominant tree species used. Our findings revealed slightly shorter, yet larger diameter, trees than those reported by Steenhof et al. (1980), but were very similar to the findings of Lish and Lewis (1975).

Table 4. Characteristics of *Populus deltoides* used by roosting bald eagles (data collected in winter 1980).

| | Average | | | | | |
|---|---|---|---|---|---|---|
| Roost | Age[a] | dbh (cm) | Height (m) | N | Condition of trees | Tree planting |
| A | 84 (2)[b] | 94.2 | 21.8 | 4 | Living with dead branches | Yes |
| $B_1$ | 70 (2) | 61.1 | 18.2 | 3 | Living with dead branches | Yes |
| $B_2$ | 64 (2) | 79.1 | 29.5 | 3 | Living with dead branches | Yes |
| C | 83 (2) | 78.8 | 26.4 | 5 | Living with dead branches | Yes |
| D | 39 (4) | 42.5 | 17.1 | 8 | Living with dead branches | No |
| E | 72 (3) | 65.1 | 21.9 | 5 | Dead and living with dead branches | Yes |
| F | 69 (3) | 58.5 | 19.6 | 9 | Dead and living with dead branches | Yes |
| G | 64 (4) | 64.1 | 21.3 | 20 | Living with dead branches | No |
| H | 49 (5) | 45.0 | 22.2 | 8 | All living | Yes |

[a]Added 5 years to each reading to correct for early growth.
[b]Number of trees cored.

Food Habits

*Location.* — On 43 visits to perches and roosts, 2088 pellets or prey remains were collected during 1978-79; 833 pellets or prey remains were collected on 63 visits during 1979-80. Prey composition varied among sites. Waterfowl dominated pellets collected in the vicinity of Lake McConaughy and areas downstream of Roost E (Figs. 1 and 3). Distribution of waterfowl intake reflects location of wintering concentrations of mallards (*Anas platyrhnynchos*) and Canada geese (*Branta canadensis*). Waterfowl were the major winter prey at Swan Lake National Wildlife Refuge in Missouri (Griffin et al. 1982), in coastal Maine (Todd et al. 1982) and in Oklahoma (Lish and Lewis 1975). Prey use varied from east to west on the study area, reflecting differences in species distribution. Pronghorn (*Antilocapra americana*), for example, were observed only in the western quarter of the study area and occurred in pellets exclusively at western roosts. Mallards, carp (*Cyprinus carpio*), eastern cottontails (*Sylvilagus floridanus*), and deer (both white-tailed, *Odocoileus virginianus*, and mule deer, *O. hemionus*) were distributed throughout the study area and represented at most roosts. Canada geese wintered along ice-free portions of the Platte and North Platte rivers but were most abundant and persistent at the Clear Creek Wildlife Management Unit (near Roost A) and Jeffrey's Island (near Roost F). Relative frequencies for geese were highest at these roosts, reflecting greater availability. The Kingsley Dam spillway at Lake McConaughy provided foraging and roosting areas for common mergansers (*Mergus merganser*) and their occurrence in pellets was greatest at Roost B near that site. Bald eagles generally foraged within 8 km of roosts.

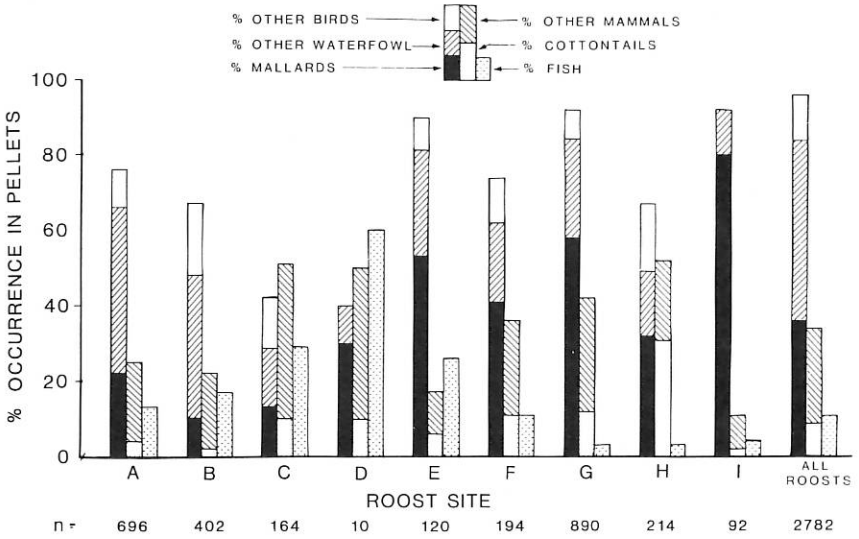


Figure 3. Frequency of occurrence of prey items in bald eagle pellets collected at nocturnal communal roosts along the Platte and North Platte rivers.

*Year effect.* — Forty-six prey species were identified from regurgitated pellets and an additional four species from carcass remains during winter 1978-79 (Table 5). On average, 1.2 species were identified per pellet; 62% of pellets contained waterfowl remains, 12% other birds, 37% mammals, and 13% fish. Principal prey species were mallards, 38% occurrence in pellets, followed by eastern cottontails (11%). Carp and gizzard shad (*Dorosoma cepedianum*) were the primary fish found in pellets or as scraps.

Table 5. Frequency of occurrence of bald eagle food species in egested pellets collected in Nebraska during the winters of 1978-1979 and 1979-1980.

| | Occurrence | | | | | |
|---|---|---|---|---|---|---|
| | 1978-1979 | | 1979-1980 | | Combined | |
| | n = 2057 | | n = 801 | | n = 2858 | |
| | n | % | n | % | n | % |
| Birds | | | | | | |
| Canada goose (*Branta canadensis*) | 107 | 5.2 | 121 | 15.1 | 228 | 8.0 |
| Green-winged teal (*Anas crecca*) | 31 | 1.5 | 5 | 0.6 | 36 | 1.3 |
| Mallard (*A. platyrhynchos*) | 780 | 37.9 | 279 | 34.8 | 1059 | 37.0 |
| Northern pintail (*A. acuta*) | 4 | 0.2 | 10 | 1.2 | 14 | 0.5 |
| Gadwall (*A. strepera*) | 4 | 0.2 | — | — | 4 | 0.1 |
| American wigeon (*A. americana*) | 3 | 0.1 | — | *a | 3 | 0.1 |
| Lesser scaup (*Aythya affinis*) | 1 | <0.1 | — | — | 1 | <0.1 |
| Hooded merganser (*Lophodytes cucullatus*) | 3 | 0.1 | — | — | 3 | 0.1 |
| Common merganser (*Mergus merganser*) | 54 | 2.6 | 7 | 0.9 | 61 | 2.1 |
| Unidentified waterfowl | 288 | 14.0 | 135 | 16.8 | 423 | 14.8 |
| Red-tailed hawk (*Buteo jamaicensis*) | 1 | <0.1 | — | — | 1 | <0.1 |
| Ferruginous hawk (*B. regalis*) | — | — | — | * | — | * |
| Unknown buteo | 1 | <0.1 | — | — | 1 | <0.1 |
| Ring-necked pheasant (*Phasianus colchicus*) | 31 | 1.5 | 11 | 1.4 | 42 | 1.5 |
| Greater prairie-chicken (*Tympanuchus cupido*) | 5 | 0.2 | — | * | 5 | 0.2 |
| Sharp-tailed grouse (*T. phasianellus*) | 3 | 0.1 | — | — | 3 | 0.1 |
| Northern bobwhite (*Colinus virginianus*) | 2 | 0.1 | — | — | 2 | 0.1 |
| American coot (*Fulica americana*) | — | — | 8 | 1.0 | 8 | 0.3 |
| Sandhill crane (*Grus canadensis*) | 3 | 0.1 | — | — | 3 | 0.1 |
| Black-billed magpie (*Pica pica*) | — | — | — | * | — | * |
| American crow (*Corvus brachyrhynchos*) | 1 | <0.1 | — | — | 1 | <0.1 |
| European starling (*Sturnus vulgaris*) | — | * | — | — | — | * |
| Red-winged blackbird (*Agelaius phoeniceus*) | — | — | 2 | 0.2 | 2 | 0.1 |
| Western meadowlark (*Sturnella neglecta*) | 22 | 1.1 | 2 | 0.2 | 24 | 0.8 |
| Unknown birds | 164 | 8.0 | 79 | 9.9 | 243 | 8.5 |
| Subtotal | 1508 | 73.3 | 659 | 82.3 | 2167 | 75.8 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Mammals | | | | | | |
| Virginia opossum (*Didelphis virginianus*) | 2 | 0.1 | — | — | 2 | 0.1 |
| Soricidae | 3 | 0.1 | 1 | 0.1 | 4 | 0.1 |
| *Sorex* spp. | 2 | 0.1 | — | — | 2 | 0.1 |
| Eastern mole (*Scalopus aquaticus*) | 2 | 0.1 | 1 | 0.1 | 3 | 0.1 |
| Leporidae | 40 | 1.9 | 30 | 3.7 | 70 | 2.4 |
| Eastern cottontail (*Sylvilagus floridanus*) | 223 | 10.8 | 36 | 4.5 | 259 | 9.1 |
| *Lepus* spp.[b] | 18 | 0.9 | 17 | 2.1 | 35 | 1.2 |
| Black-tailed prairie dog (*Cynomys ludovicianus*) | 40 | 1.9 | 5 | 0.6 | 45 | 1.6 |
| Fox squirrel (*Sciurus niger*) | 32 | 1.6 | 5 | 0.6 | 37 | 1.3 |
| Plains pocket gopher (*Geomys bursarius*) | 24 | 1.2 | 10 | 1.2 | 34 | 1.2 |
| Ord's kangaroo rat (*Dipodomys ordii*) | 1 | <0.1 | — | — | 1 | <0.1 |
| Deer mouse (*Peromyscus maniculatus*) | 2 | 0.1 | — | — | 2 | 0.1 |
| Northern grasshopper mouse (*Onychomys leucogaster*) | 3 | 0.1 | — | — | 3 | 0.1 |
| Meadow vole (*Microtus pennsylvanicus*) | 31 | 1.5 | 44 | 5.5 | 75 | 2.6 |
| Muskrat (*Ondatra zibethica*) | 17 | 0.8 | 3 | 0.4 | 20 | 0.7 |
| Meadow jumping mouse (*Zapus hudsonius*) | 2 | 0.1 | — | — | 2 | 0.1 |
| Raccoon (*Procyon lotor*) | 7 | 0.3 | 1 | 0.1 | 8 | 0.3 |
| Mink (*Mustela vison*) | 1 | <0.1 | — | — | 1 | <0.1 |
| Striped Skunk (*Mephitis mephitis*) | 4 | 0.2 | 1 | 0.1 | 5 | 0.2 |
| Domestic pig (*Sus scrofa*) | 5 | 0.2 | — | — | 5 | 0.2 |
| *Odocoileus* spp. | 39 | 1.9 | 10 | 1.2 | 49 | 1.7 |
| Pronghorn (*Antilocapra americana*) | 11 | 0.5 | — | — | 11 | 0.4 |
| Domestic cow (*Bos taurus*) | 17 | 0.8 | 5 | 0.6 | 22 | 0.8 |
| Domestic sheep (*Ovis aries*) | — | — | 1 | 0.1 | 1 | <0.1 |
| Unknown mammals | 224 | 10.9 | 45 | 5.6 | 269 | 9.4 |
| Subtotal | 750 | 36.5 | 215 | 26.8 | 965 | 33.8 |
| Fish | | | | | | |
| Gizzard shad (*Dorosoma cepedianum*) | 19 | 0.9 | 9 | 1.1 | 28 | 1.0 |
| Carp (*Cyprinus carpio*) | 95 | 4.6 | 47 | 5.9 | 142 | 5.0 |
| *Carpoides* spp. | 3 | 0.1 | — | — | 3 | 0.1 |
| Shorthead redhorse (*Moxostoma macrolepidotum*) | 1 | <0.1 | — | — | 1 | <0.1 |
| Ictaluridae | — | * | — | * | — | * |
| Flathead catfish (*Pylodictis olivaris*) | — | * | — | — | — | * |
| Percicthyidae | — | * | — | — | — | * |
| Percidae | 16 | 0.8 | — | — | 16 | 0.6 |
| Walleye (*Stizostedion vitreum*) | 8 | 0.4 | — | — | 8 | 0.3 |
| Unknown fishes | 112 | 5.4 | 7 | 0.9 | 119 | 4.2 |
| Subtotal | 254 | 12.3 | 63 | 7.9 | 317 | 11.1 |
| Invertebrates | | | | | | |
| Crayfish | 2 | 0.1 | — | — | 2 | 0.1 |
| Cricket | — | — | 1 | 0.1 | 1 | <0.1 |
| Grasshopper | — | — | 2 | 0.2 | 2 | 0.1 |
| Subtotal | 2 | 0.1 | 3 | 0.4 | 5 | 0.2 |
| Plants | | | | | | |
| Vegetation | — | — | 2 | 0.2 | 2 | 0.1 |
| Cereal grains | 78 | 3.8 | 12 | 1.5 | 90 | 3.1 |
| Subtotal | 78 | 3.8 | 14 | 1.7 | 92 | 3.2 |

[a]Species listed with an asterisk (*) were identified by carcass remains only.
[b]Includes white-tailed (*Lepus townsendii*) and black-tailed (*L. californicus*) jackrabbits.

Twenty-nine species were identified from regurgitated pellets and an additional five species from carcass remains during winter 1979-80 (Table 5). Waterfowl accounted for 70%, mammals 17%, other birds 13%, and fish 8% of the prey items. Mallards occurred most often (35%) followed by Canada geese (15%). Mallard remains were highest at Roost E adjacent to river segment 14, locations of the largest waterfowl concentration during January and February (Figs. 1 and 3). Meadow voles (*Microtus pennsylvanicus*), jackrabbits (*Lepus* spp.), and cottontails were the primary mammals consumed and carp the dominant fish.

Weather conditions had a marked effect on foraging patterns and eagle food habits. In 1978-79, temperatures were among the coldest on record and only about 17% of the river channel remained open during January and February, compared to 77% and 45% for these months in 1980 (Fig. 2). During January and February 1979, temperatures averaged 8.2 and 7.7° C below normal whereas temperatures averaged 0.4 and 2.2° C below normal during these months in 1980 (U.S. Dep. Comm. 1978-1980).

Waterfowl intake was influenced indirectly by weather conditions. Extensive observations made during studies of mallard winter ecology suggest the primary source of mallards in the eagle diet during the 1978-79 winter were kills kleptoparasitized from other raptors (Jorde and Lingle, unpubl. data). When alternate prey were not available because of ice and snow, eagles flew up to 20 km from the river channel to where mallards were field-feeding. Most of the waterfowl remains in pellets collected during the mild 1979-80 winter came late in the season and apparently were diseased birds (Fig. 4). An estimated 80,000 waterfowl carcasses were present in southcentral Nebraska between late February and early April as a result of an avian cholera outbreak (Friend 1981).

Fish dominated the diet of eagles when channels remained open and water levels were moderate to low, whereas warm-blooded vertebrates formed a much larger proportion of the diet when ice covered most of the river. Todd et al. (1982) reported fish were more digestible than birds or mammals so form fewer pellets. This trait was reflected in the low number of pellets per eagle per month during periods of limited ice cover (Table 6). During winter 1978-79, the mean number of pellets per eagle increased markedly from December through February until ice covered over 80% of the channel and fish became unavailable (Table 6). The number of pellets per eagle continued to increase in March 1979 despite widespread access to open water. During winter 1979-80, the river remained mostly open (Fig. 2) and the mean number of pellets per eagle remained relatively low until March when water levels rose substantially and eagles shifted from a predominantly fish diet to one dominated by birds and mammals. Pellet numbers increased from a low of 27 (0.2 pellets/eagle) between 29 January and 11 February (Julian dates 29-42) to a peak of 323 (2.8 pellets/eagle) during 11-24 March (Julian dates 72-85), while average flows in the Platte River at Overton increased from 62 to 79 $m^3$/sec (U.S. Geol. Surv., Lincoln, Neb.), respectively.

Mammals were consumed more frequently during winter 1978-79 than during 1979-80 (Table 5). Mammalian prey consisted of carrion and live animals taken primarily when poor channel foraging conditions for fish caused eagles to search elsewhere for food, a situation that was more prevalent during winter

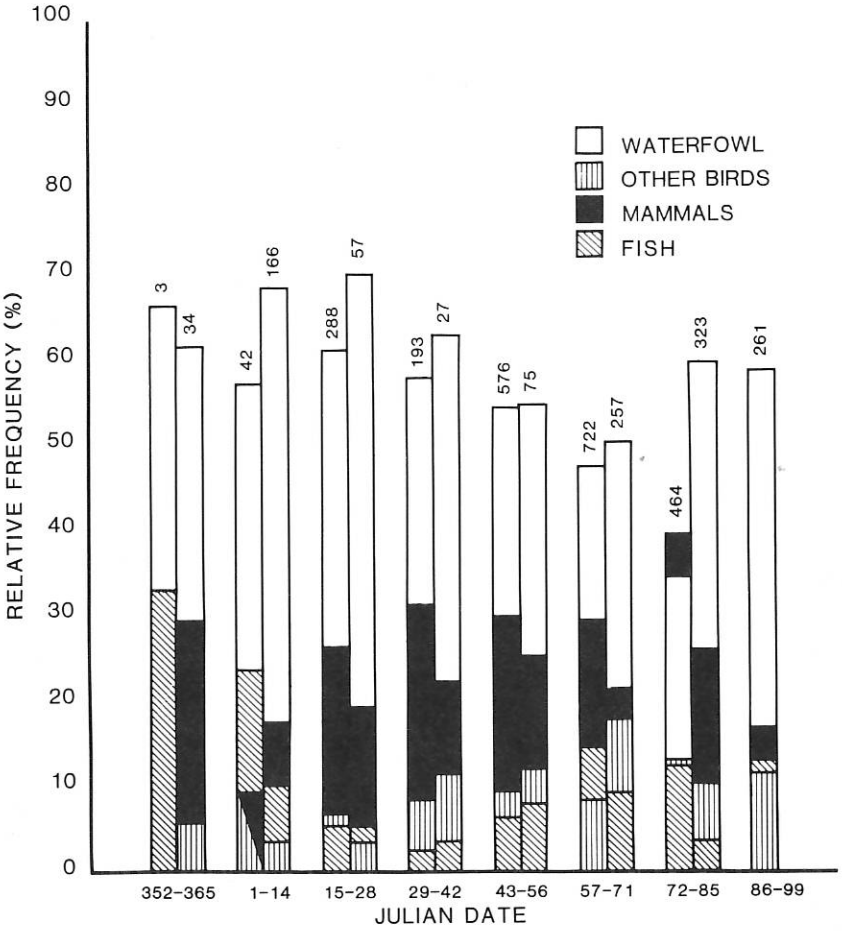


Figure 4. Relative frequency of major bald eagle prey taxa during winter 1978-79 (left bar) and 1979-80 (right bar). Sample size is indicated at the top of the bar.

1978-79 (Fig. 4). Carrion included road-killed wildlife, domestic livestock left in fields, and other animals that had succumbed to various causes. Composition of mammalian prey appeared to be strongly influenced by presence or absence of snow cover. Cottontails, for example, were a major food item during the severe winter of 1978-79 when snow blanketed the study area for several months (Table 5). In 1979-80, with mild conditions and lack of snow cover, occurrence of cottontail remains in pellets declined by 84%. During the winter of 1979-80 when there was little snow cover, meadow voles were nearly fourfold as common in the diet of eagles than during the previous winter. Jackrabbits were a common food item during both winters. They also have been reported

Table 6. Number of pellets/eagle/month recovered from nocturnal communal roosts in comparison to percentage ice cover on the Platte River. Sample sizes are in parentheses.

| Period | Month | | | | |
|---|---|---|---|---|---|
| | December | January | February | March | $\overline{X}$ |
| 1978-79 | | | | | |
| Pellets/eagle | 0.2 (3/20)[a] | 3.1 (258/83) | 5.3 (665/111) | 6.3 (1102/151) | 5.0 (2028/365) |
| % ice cover | 57 | 84 | 83 | 4 | |
| 1979-80 | | | | | |
| Pellets/eagle | 0.7 (46/69) | 0.9 (170/196) | 0.6 (85/141) | 4.3 (500/115) | 1.5 (801/521) |
| % ice cover | 2 | 23 | 55 | 3 | |

[a]Maximum count of eagles at all roosts during month.

an important food for wintering bald eagles in Kansas (Imler 1937) and Utah (Edwards 1969).

## ACKNOWLEDGMENTS

We are grateful to numerous individuals for their help during this study. Field technicians R. Atkins, J. Cochnar, D. Jenson, D. Janke, W. Norling, M. Hay, and C. House assisted in collection of field data. P. J. Currier helped collect vegetation data and K. L. Lingle drafted preliminary figures. D. G. Jorde provided valuable field observations gathered during concurrent studies of the wintering mallard population. R. J. Greenwood and K. J. Reinecke critically reviewed earlier drafts of the manuscript. We appreciate statistical support provided by D. H. Johnson. The Platte River Whooping Crane Trust allowed the senior author time from other duties to complete this manuscript.

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