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LEAD-SHOT INGESTION BY BALD EAGLES IN WESTERN ARKANSAS

THOMAS A. NELSON, CARLA MITCHELL, AND CAROLYN ABBOTT

ABSTRACT—A study was conducted on Holla Bend National Wildlife Refuge, in western Arkansas, to determine the extent to which bald eagles (*Haliaeetus leucocephalus*) wintering on the area were exposed to lead shot. Waterfowl comprised a significant portion of the diet; 61% of egested bald eagle castings contained waterfowl remains. Lead shot was found in 9 of 31 waterfowl carcasses that provide much of the winter food supply of bald eagles on the refuge. Lead shot was found in 7% of 82 egested castings, indicating that eagles do ingest lead shot in the process of feeding.

In recent years, a great deal of interest has been directed toward lead-poisoning as a mortality factor among bald eagles (*Haliaeetus leucocephalus*; Pattee and Hennes, 1983; Feierabend and Myers, 1984). It has long been recognized that large numbers of waterfowl succumb annually to lead (Bellrose, 1975). However, only recently has there been an attempt to compile and analyze information on the extent to which lead may affect bald eagles feeding on dead or crippled waterfowl. Feierabend and Myers (1984) reported that: 1) a growing body of evidence suggests that significant numbers of bald eagles die annually from lead-poisoning; 2) a minimum of 77 bald eagles died of lead-poisoning between 1966 and 1984; and 3) these data probably under-estimated the actual extent of the problem as most eagle carcasses are never recovered. Bald eagles are particularly vulnerable because population levels are low and because they readily feed on dead or crippled prey, particularly waterfowl (Pattee and Hennes, 1983).

Arkansas is one of 27 states with documented cases of bald eagle mortality due to lead poisoning (Feierabend and Myers, 1984). Holla Bend National Wildlife Refuge, Pope Co., Arkansas, is a major wintering area for bald eagles and waterfowl and has had documented cases of lead poisoning in waterfowl. Therefore, the report by Feierabend and Myers (1984) listed Pope Co. as one of 89 counties nationwide where there is a high risk of bald eagles being poisoned by lead after ingesting lead pellets present in dead or crippled waterfowl. While there was a clear potential for poisoning of eagles wintering on Holla Bend, no quantitative data were available for assessing the extent to which eagles were actually exposed to lead shot. This report summarizes the results of a study conducted on Holla Bend during the winter of 1985–1986 to evaluate the extent to which wintering bald eagles were exposed to lead shot. The objectives of the study were to: 1) determine the frequency of occurrence of waterfowl in the diet of wintering bald eagles using the area; 2) evaluate the extent of lead shot in waterfowl carcasses on the area; and 3) determine the frequency of occurrence of lead shot in egested castings produced by bald eagles using Holla Bend.

MATERIALS AND METHODS—Holla Bend is a 2,600-ha refuge located in west-central Arkansas on the Arkansas River. Approximately 40,000 ducks and 10,000 geese use the refuge during winter months.

Mallards (*Anas platyrhynchos*) comprise about 90% of wintering ducks, but northern pintail (*Anas acuta*), American wigeon (*Anas americana*), snow geese (*Chen caerulescens*), and Canada geese (*Branta canadensis*) are also common winter residents. Waterfowl hunting is prohibited on the refuge but is common on adjacent private land. Bald eagles have wintered on Holla Bend since its establishment in 1957. Annual censuses show that eagle numbers have varied considerably from year to year but have generally increased from less than a dozen annually during the early 1960s to a high of 46 in 1979 (M. Perry, in litt.).

The communal roost used by bald eagles wintering on the study area was located by plotting the flight paths of eagles observed just prior to sunset and soon after sunrise on topographic maps. Castings were collected two to three times weekly at the roost site and under several diurnal perches. Collecting at the roost site was restricted to mid-day periods to avoid disturbance. Castings were placed in individual bags and labelled with date and location. Each was oven-dried in the laboratory for 24 h at 65°C prior to analysis. Castings were fluoroscoped to identify those containing lead or steel shot; later, each casting was separated manually to identify food contents. Remains of vertebrate species were identified by hair, feather, or otolith characteristics as observed under a dissecting microscope. These were verified using a standard key or through comparisons with preserved specimens and photographs in the vertebrate collection at Arkansas Tech University (Stains, 1958).

Waterfowl carcasses were collected during the course of other field activities. Carcasses were frozen and subsequently fluoroscoped to determine whether shot was present in the carcass. Those containing shot were dissected to verify whether the shot was lead or steel and whether it was embedded in the body or free in the digestive tract.

RESULTS AND DISCUSSION—Analysis of the food habits of wintering bald eagles was based on 82 castings collected during January and February 1986. The evaluation of food habits based on castings can be biased, because foods differ in digestibility (Errington, 1932; Sabine, 1981). However, sufficient castings were collected on Holla Bend to make a general assessment of the food habits of wintering bald eagles, particularly regarding their use of waterfowl.

Avian remains were most common in castings, occurring in 65 (79%) of those examined (Table 1). Waterfowl, particularly snow geese, mallards, and Canada geese, were commonly consumed. These results are consistent with previous studies in central states. Of 600 castings collected over several years in Missouri, 598 contained waterfowl remains (Griffin et al., 1980). In Oklahoma, waterfowl remains were found in 61% of 109 castings, while, in southern Illinois, 95% contained waterfowl (Lish and Lewis, 1975; Sabine, 1981).

Chickens, presumably scavenged from local poultry dumps, were another common food consumed by eagles on our study area. Some of the greatest concentrations of eagles in western Arkansas have been observed on such dumps (S. Carney, pers. comm.). While the bald eagle is well adapted to the role of scavenger, these dumps may pose a potential threat, if they serve as reservoirs for infectious diseases or pesticides. The extent of this problem is unknown but warrants further investigation.

Mammals were common food items, particularly rabbits (*Sylvilagus floridanus* or *Sylvilagus aquaticus*) and opossums (*Didelphis virginiana*). These species are common on Holla Bend and were probably available in the open fields frequented by eagles. Rabbits, muskrats (*Ondatra zibethicus*), and opossums were also common in the diets of bald eagles wintering in Oklahoma and Illinois (Lish and Lewis, 1975; Sabine, 1981).

Fish remains were infrequent in the castings collected during our study, however, eagles were frequently observed feeding on fish along the Arkansas River. We believe fish were a more important item in the winter diet than was

TABLE 1—Food contents of 82 bald eagle castings collected on Holla Bend National Wildlife Refuge, January and February 1986.

Food item	Frequency	% frequency
Birds		
Snow goose (*Chen caerulescens*)	20	24.4
Mallard (*Anas platyrhynchos*)	12	14.6
Chicken	12	14.6
Canada goose (*Branta canadensis*)	9	11.0
Green-winged teal (*Anas crecca*)	6	7.3
American wigeon (*Anas americana*)	3	3.7
Red-winged blackbird (*Agelaius phoeniceus*)	2	2.4
Unidentified species	1	1.2
Mammals		
Rabbits (*Sylvilagus* sp.)	6	7.3
Opossum (*Didelphis virginana*)	5	6.1
Unidentified species	4	4.9
Fish		
Freshwater drum (*Aplodinotus grunniens*)	2	2.4

indicated by our data. Fish are highly digestible and provide little material to bind remains together in a casting. Lish and Lewis (1975) reported that fish remains were absent from castings collected in Oklahoma but were commonly found under diurnal feeding perches. Fish were preferred over waterfowl by bald eagles in Missouri when winter fish kills occurred (Griffin et al., 1980).

Of 31 waterfowl carcasses collected, nine (29%) contained lead shot, ranging from 1 to 11 pellets per carcass ($\bar{X} = 4.1$). Eight birds contained shot embedded in the flesh or body cavity; one mallard had a single lead pellet in the gizzard. Although sample size was small, there was a tendency for geese to carry more embedded pellets than ducks.

The source of lead shot ingested by eagles appears to vary among locales. In the central states, lead in castings has almost always been associated with waterfowl remains, as was the case on Holla Bend (Dunstan, 1974; Griffin et al., 1980; Sabine, 1981). However, in Utah, lead shot was ingested by eagles feeding on hunter-killed rabbits (Platt, 1976).

Of the 82 castings collected, six (7.3%) contained one lead pellet; another contained two non-toxic steel pellets. All shot was found associated with waterfowl remains. Lead was found in three castings containing remains of snow geese, twice with remains of mallards, and once with remains of Canada geese.

While tissue-bound lead in the carcasses consumed by eagles may contribute to poisoning, current data indicate that ingested lead shot is the primary source of poisoning (Pattee and Hennes, 1983). Clearly, not all exposure to lead shot is fatal; the presence of shot in egested castings demonstrates this. Rather, it appears to be the continual ingestion and regurgitation of shot over a period of time that constitutes the usual source of lead poisoning among bald eagles (Pattee and Hennes, 1983). Experimental dosing of five captive bald eagles with lead shot lead to the deaths of four individuals and blinding in the fifth. Death

occurred at the minimum dosage of 10 lead pellets (Pattee et al., 1981). The effects of chronic sub-lethal lead exposure on reproduction and disease resistance are unknown.

Previous studies suggest that the percentage of eagle castings containing lead shot varies among states and between areas within a state. Dunstan (1974) reported lead shot in 50 to 60% of eagle castings in northern Illinois, while Sabine (1981) found lead shot in 6% of those sampled in the southern portion of that state. In Utah, 71% of castings collected at a roost site contained shot (Platt, 1976), while, in Missouri and Minnesota, frequencies of 9% and 11% were reported, respectively (Griffin et al., 1980; Pattee and Hennes, 1983). The frequency of occurrence of lead shot in castings collected on Holla Bend (7%) is relatively low when compared to other published figures but is of a magnitude to warrant concern.

As hunting is prohibited on Holla Bend, the primary source of the lead ingested by resident eagles appears to be either the movement of crippled birds onto the refuge from other locations or eagles feeding on dead or crippled birds outside refuge boundaries. The percentage of carcasses found to contain lead shot on our study area is generally consistent with reports from other central states (Elder, 1950; Bellrose, 1953; Griffin et al., 1980). As long as a substantial percentage of waterfowl carry lead shot and these birds continue to concentrate on Holla Bend, eagles using the area will continue to be exposed to lead poisoning.

The most satisfactory management option to reduce the lead-poisoning problem in waterfowl and bald eagles is to eliminate lead shot from waterfowl hunting. The Arkansas Game and Fish Commission is implementing a plan to phase-out the use of lead shot for waterfowl hunting over 5 years from 1986 to 1991. Under this plan, the counties surrounding Holla Bend will require steel shot for all waterfowl hunting beginning in the 1988–1989 season. Our data suggest that these counties are a high priority for conversion to steel shot. However, because both waterfowl and bald eagles move readily over great distances, restricting the use of lead shot only in limited areas will not be sufficient to solve the lead poisoning problem; ultimately a nationwide solution is necessary. Results from this study underscore the need to move quickly in this direction.

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Address of authors: *Fish. and Wildl. Biol. Program, Arkansas Tech Univ., Russellville, AR 72801.*