Accumulation and effects of lead and cadmium on wood ducks near a mining and smelting complex in Idaho

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A study of wood ducks (Aix sponsa) was conducted along the Coeur d’Alene River system in northern Idaho in 1986 and 1987. Most of this area has been subjected to severe contamination from lead and other metals from mining and smelting since the 1880s. In 1986, a preliminary study of wood duck nesting was conducted in the contaminated area; incubating hens captured in nest boxes were bled and weighed. Blood samples were used to determine lead and cadmium concentrations and physiological characteristics. In 1987, an intensive study of wood ducks involved trapping and monitoring nest boxes in the contaminated area. Blood and tissue samples were also taken from wood ducks from a reference area without known contamination from metals. Lead levels in blood and tissues of most wood ducks from the contaminated area frequently exceeded those considered hazardous to birds; maximum levels (wet weight) of lead were 8 µg g⁻¹ in blood and 14 µg g⁻¹ in liver. Changes in physiological characteristics constituted the only evidence of potentially adverse effects from lead. In the contaminated area, nesting success (55% unadjusted, 35% Mayfield estimate) was less than in other areas where predation was low and nest boxes were used; but lead concentrations and physiological characteristics of blood were similar in successful and unsuccessful hens.

Values of ALAD, hemoglobin, and body mass were negatively correlated with blood concentrations of lead, whereas protoporphyrin was positively correlated with lead levels in the blood. Some of the protoporphyrin values (1,091 µg dl⁻¹ in a male and 756 µg dl⁻¹ in a female) equalled those associated with lead toxicosis in experimental birds. ALAD activity was low in most birds from the contaminated area; values of 0 were obtained from 11 birds. Lead levels in blood, ALAD, protoporphyrin, and hemoglobin were significantly different between birds from the contaminated and reference areas. Concentrations of lead in ingesta of wood ducks ranged from 0.9 to 610 µg g⁻¹ in the contaminated area and 0.2 to 0.6 µg g⁻¹ in the reference area. Levels of cadmium in kidneys of wood ducks ranged from 1 µg g⁻¹ to 20 µg g⁻¹ in the contaminated area and from only to 0.1 µg g⁻¹ to 1 µg g⁻¹ in the reference area. Cadmium concentrations were less than known effect levels.

Keywords: wood ducks; lead; cadmium; reproduction; protoporphyrin; ALAD

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Introduction

The adverse effects of lead shot on waterfowl are well documented (Sanderson and Bellrose, 1986); serious problems persist in many areas (US Fish and Wildlife Service, 1986). Wood ducks (*Aix sponsa*) have, unlike most waterfowl, little propensity for ingesting lead shot (Bellrose, 1959). In northern Idaho, wood ducks and other waterfowl accumulated high levels of lead (Krieger, 1990) and other waterfowl including tundra swans (*Cygnus columbianus*), other ducks, and Canada geese (*Branta canadensis*) died from plumbism related to ingestion of lead (apparently lead sulfide) in sediments and plants (Chupp and Dalke, 1964; Krieger, 1990; Blus *et al.*, 1991). The lead originates from mining and smelting, which began in northern Idaho in the 1880s (Ellis, 1940). A large smelting industry developed and flourished until closure of the major smelters and lead mine near Kellogg in 1981. Mining and smelting persist at a much reduced rate. Most mines and smelters were located along the South Fork of the Coeur d'Alene River (Fig. 1). Vast quantities of mine wastes were dumped into the South Fork, draining downstream into Lake Coeur d'Alene (Ellis, 1940). Average monthly emissions from the main smelter stack contained an estimated 8–12 metric tons of lead from 1955 to 1973 (Burrows *et al.*, 1981). As late as 1973, daily discharges of metals into the South Fork included 4,400 kg zinc, 245 kg lead, and 57 kg arsenic (Rabe and Flaherty, 1974).

Here, we report on lead accumulation in wood ducks and its effects on physiological characteristics and reproductive success in the Coeur d’Alene River system during 1986 and 1987. Other segments of this study dealing with osprey (*Pandion haliaetus*) and tundra swans were published previously (Blus *et al.*, 1991; Henny *et al.*, 1991).

Fig. 1. The Coeur d’Alene River system and Lake Coeur d’Alene, northern Idaho. The contaminated study area extended from Rose Lake to Lake Coeur d’Alene.