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Symposium: The Impacts of Lead Poisoning to Fish and Wildlife

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Lead Poisoning In Birds: Revisiting A Chronic Problem

Milton Friend*, *USGS National Wildlife Health Center, WI*

Despite ample documentation of the toxic effects of spent lead shot on waterfowl it took more than a century for sufficient momentum to develop to successfully implement a nationwide ban in the USA on the use of lead shot for waterfowl hunting. That ban has been in place since the start of the 1991 hunting season. Attention has now shifted to lead poisoning in other bird species, including that caused by the ingestion of lead sinkers and lead bullet fragments. This presentation highlights primary hurdles personally encountered along the road to nontoxic shot implementation. The insights provided are lessons of value for negotiating current travel along the road leading to further reductions in lead poisoning in wild birds. The hurdles to be negotiated in this journey extend beyond biology to those of social and economic content. Therefore, this issue and its resolution involve far more than the indisputable fact that lead is a toxic substance. The application of experiences gained can help expedite current transitions being sought and avoid continued debate and bird mortalities from lead poisoning.

Lead Poisoning in Wild Birds: Exposure, Clinical Signs, Lesions, and Diagnosis

Chris Franson*, *USGS National Wildlife Health Center, WI*

Wild birds are exposed to lead by a variety of routes, including ingestion of lead shot, bullet fragments, lead fishing weights, and lead paint chips and through exposure to atmospheric lead, mining wastes, and lead-contaminated industrial effluents. Massive exposure of an individual may result in acute mortality with few clinical signs or lesions, but the disease is usually more prolonged with several weeks elapsing between exposure and death. Clinical signs include weight loss, weakness, lethargy, unsteady gait, bile staining around the vent, and anemia. Affected birds can be expected to have elevated protoporphyrin and reduced activity of delta-aminolevulinic acid dehydratase in blood. Gross lesions include emaciation, esophageal impaction, submandibular edema (particularly in Canada geese), enlarged gall bladder, bile staining of the stomach lining and intestinal contents, and pale areas in muscle (particularly heart and gizzard). Particulate lead may or may not be found in the gastrointestinal tract. Blood, liver, and kidney are the tissues most frequently used for lead analysis in support of diagnostic evaluations. Lead concentrations vary among tissues and depend to some extent on the length of time since exposure. In birds, liver lead concentrations of >2 ppm wet weight are often considered evidence of exposure, and liver residues of >6-8 ppm wet weight may be associated with toxicity in many species. However, a diagnosis of lead poisoning as a cause of death is based on a combination of pathology, toxicological findings, clinical signs, and field observations. If pathology and clinical signs are consistent with lead poisoning, the presence of elevated lead in tissues, not necessarily the magnitude, is particularly important in a diagnosis.

Environmental Lead from Hunting, Shooting and Fishing Sports: Implications for Management of Biota by Natural Resource Agencies

Barnett A. Rattner*, *Patuxent Wildlife Research Center, USGS, MD*
J. C. Franson, *National Wildlife Health Center, USGS, WI*
Steven R. Sheffield, *Bowie State University, MD*
Chris Goddard, *Great Lakes Fishery Commission, MI*
Nancy J. Leonard, *Michigan State University, MI*
Douglas Stang, *New York State Department of Environmental Conservation, NY*
P J. Wingate, *Minnesota Department of Natural Resources, MN*

A review of sources, exposure and toxicity of lead originating from fishing and shooting activities was drafted for the American Fisheries Society and The Wildlife Society, so that a joint position statement could be developed. Spent lead ammunition greatly exceeds estimates of lost fishing tackle. Lead shot, bullets, and fishing tackle are not readily dissolved, but in some circumstances lead can be mobilized (soft acidic waters) to exceed water quality criteria, cause lethality (some species/life stages of fish and amphibians), and elicit hematological and pathological lesions. Toxicity of ingested lead shot is well-documented in birds and mammals, but not in fish or amphibians. A few studies have shown that the ban on lead shot for hunting waterfowl reduced the incidence of lead poisoning. However, upland and scavenging birds remain at risk, and many states/provinces have restricted the use of lead ammunition for species other than waterfowl. Hazards of lead fishing sinkers to wildlife were only recognized in the 1970's (swans, loons). Restrictions on sale and use of lead fishing tackle have been instituted in several countries to protect these and other species. However, effects of lead fishing tackle on wildlife populations have not been adequately studied, and hazards to fish populations are unknown, but thought to be minimal. Regulatory efforts have been undertaken to evaluate and approve safe alternatives to lead shot. However, except for the hunting waterfowl and coots, and mourning doves in some locations, nontoxic shot and bullets are not routinely used for other types of shooting. Substitutes for lead fishing tackle are commercially available, and because of their similarity to approved shot, toxicity testing of many of these products may not be warranted. Our understanding of the hazards of lead and alternative materials used in shooting and fishing would be improved by research, monitoring, and modeling efforts of fate, exposure and toxic effects.

Abstracts from Conference: Ingestion of Spent Lead Ammunition: Implications for Wildlife and Humans, Boise, Idaho, May 12- 15, 2008

The Peregrine Fund

Abstract No.104 - **Biological and Societal Dimensions of Lead Poisoning in Birds in the USA**

Milton Friend (1), J. Christian Franson (1), William L. Anderson (2)
(1) USGS National Wildlife Health Center
(2) Illinois Natural History Survey

The ingestion of spent lead shot was known to cause mortality in wild waterfowl in the USA a century before the implementation of nontoxic shot regulations began in 1972. The biological foundation for this transition was strongly supported by both field observations and structured scientific investigations. Despite the overwhelming evidence, various societal factors forestalled the transition to nontoxic shot for waterfowl hunting until 1991. Now, nearly 20 years later, these same factors weigh heavily in current debates about nontoxic shot requirements for hunting other game birds, requiring nontoxic bullets for big game hunting in California condor range and for restricting the use of small lead sinkers and jig heads for sport fishing. As with waterfowl, a strong science-based foundation is requisite for further transitions to nontoxic ammunition and fishing weights, and relevant social issues must be adequately addressed. We provide a brief historic review of lead poisoning in birds in the USA prior to 1970 and proceed to emphasize the biological and social issues that arose during the heated conflict that extended from the mid 1960s until the end of the 1980s and to discuss their resolution. We also outline the broad spectrum of conditions under which lead poisoning of birds has occurred in the USA, thus providing an overview of the hazards for wildlife exposed to lead in the environment. These conditions include lead toxicosis in waterfowl in isolated areas of Alaska, poisoning of flesh-eating birds from consumption of lead shot and bullet fragments in scavenged carcasses and poisoning associated with lead from non-hunting activities such as sport fishing, shooting sports, mining and consumption of lead-based paint chips and other materials. Our collective experiences with lead poisoning in birds include laboratory research, field investigations and personal involvement in providing evaluations and testimony that served to guide the U.S. Fish and Wildlife Service's phase-in of nontoxic shot requirements for waterfowl hunting in the USA. These experiences have taught us that the societal aspects of the lead poisoning issue are as important as the biological components and must be adequately addressed before alternatives to toxic lead shot ammunition, fishing weights and other materials will be accepted as an investment in wildlife conservation.

Abstract No. 106 - **Technical Review of the Sources and Implications of Lead Ammunition and Fishing Tackle to Natural Resources Prepared by the American Fisheries Society and The Wildlife Society**

Barnett Rattner, J.C. Franson, S.R. Sheffield, C. Goddard, N.J. Leonard, D. Stang, and P.J. Wingate.

USGS—Patuxent Wildlife Research Center, Beltsville Laboratory, Beltsville, MD 20705

A joint technical review of lead originating from shooting and fishing activities was prepared for the American Fisheries Society and The Wildlife Society with the ultimate goal of drafting a position statement. Spent lead ammunition greatly exceeds estimates of lost fishing tackle. Lead shot, bullets, and fishing tackle are not readily dissolved, but in some circumstances lead can be mobilized (soft acidic waters) to exceed water quality criteria, cause lethality (some species/life stages of fish and amphibians), and elicit hematological and pathological lesions. Toxicity of ingested lead shot is well-documented in birds and mammals, but not in fish or amphibians. A number of studies have shown that the ban on lead shot for hunting waterfowl reduced the incidence of lead

poisoning. However, upland and scavenging birds remain at risk, and many states and provinces have restricted the use of lead ammunition for species other than waterfowl. Hazards of lead fishing sinkers to wildlife were only recognized in the 1970's (swans, loons). Restrictions on sale and use of lead fishing tackle have been instituted in several countries to protect these and other species. However, effects of lead fishing tackle on wildlife populations have not been adequately studied, and hazards to fish populations are unknown, but thought to be minimal. Regulatory efforts have been undertaken to evaluate and approve safe alternatives to lead shot. However, except for hunting waterfowl and coots, and mourning doves in some locations, nontoxic shot and bullets are not routinely used for other types of shooting. Substitutes for lead fishing tackle are commercially available, and because of their similarity to approved shot, toxicity testing of many of these products may not be warranted. Our understanding of the hazards of lead and alternative materials used in shooting and fishing would be improved by research, monitoring, and modeling efforts of fate, exposure and toxic effects. There are at least three position options that might be adopted by the American Fisheries Society and The Wildlife Society. Namely, the introduction of lead into the environment from hunting, shooting sports and fishing activities (1) is adequately regulated and the toxicological consequences of ingestion of lead are currently considered acceptable, (2) could be restricted in locations where lead poses an unacceptable hazard to biota and their supporting habitat, or (3) could be phased out with a goal of complete elimination. The leadership of both societies could interact with various government, academic and conservation entities to disseminate information about hazards and toxic effects of lead ammunition and tackle, as well as the availability and ecological benefits of safe alternatives.

Abstract No. 202 - **Lead Exposure in Mourning Doves: Results of a Field Survey and Comparisons with Experimental Findings**

J. Christian Franson (1), Scott P. Hansen (1,2), John H, Schulz (3)

(1) USGS National Wildlife Health Center

(2) Current affiliation: Wisconsin Department of Natural Resources

(3) Missouri Department of Conservation

To evaluate lead exposure in mourning doves (*Zenaida macroura*), we examined carcasses of 4,884 hunter-killed doves from Arizona, Georgia, Missouri, Oklahoma, Pennsylvania, South Carolina, and Tennessee. One or more ingested lead pellets were found in 2.5% of 4,229 carcasses collected at hunting areas where the use of lead shot was permitted, with ingestion rates among areas varying from 0% to 20.8%. Ingested steel shot were found in 2.4% of 655 carcasses collected from two areas requiring the use of nontoxic shot. Of the dove carcasses for which age was determined, 69.9% were hatch year and 30.1% were after hatch year. With one exception, all doves with ingested shot were hatch year birds, and the proportions of hatch year males and females with ingested lead shot did not differ significantly. Doves with ingested lead shot had from one to 43 pellets in their gizzards, with 3.8% having >15 lead pellets. Of the birds with ingested steel shot, 25% had >15 steel pellets in their gizzards. The frequency of lead shot ingestion in doves did not differ between birds collected early in the hunting season (September 1 through September 7) and those collected later in the season (September 8

through December 24). From the areas where lead shot was used for hunting, 8.3% of doves had liver lead concentrations >6 ppm dry weight and 26.8% had >20 ppm dry weight of lead in their wing bones, concentrations often used as indicators of lead exposure above normal background levels. Where steel shot was required for hunting, 2.0% of doves had liver lead concentrations >6 ppm dry weight and 11.1% had bone lead concentrations >20 ppm dry weight. The median liver and bone lead concentrations in doves with ingested lead shot were 36.89 ppm dry weight and 89.33 ppm dry weight, respectively. Median liver and bone lead concentrations in doves without ingested shot were <1.0 ppm dry weight and <3.0 ppm dry weight, respectively. In doves without ingested lead shot, the median concentration of lead in wing bones of after hatch year birds was significantly greater than the median in wing bones of hatch year birds. We compare and interpret these findings in relation to previous field surveys and recent experimental studies of the ingestion and toxicity of lead shot in mourning doves. Finally, we discuss the issue of ingested lead shot in mourning doves as a source of secondary lead exposure for predators and scavengers.