

many wildlife species. Additionally, nontoxic alternatives exist for nearly every application where lead is currently used. As supply and options continue to increase for nontoxic alternatives, price should decrease. It is encouraged that each hunter, angler and recreational shooter carefully consider how he/she might voluntarily reduce lead impacts to wildlife.

For additional information:

Rattner, B.A., J.C. Franson, S.R. Sheffield, C.I. Goddard, N.J. Leonard, D. Stang and P.J. Wingate. Sources and Implications of Leadbased Ammunition and Fishing Tackle to Natural Resources. Wildlife Society Technical Review. The Wildlife Society, Bethesda, Md., USA.

http://www.nwhc.usgs.gov/publications/fact_sheets/pdfs/lead_poisoning_wild_birds_2009.pdf.



Impacts of Lead Ammunition and Sinkers on Wildlife

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Introduction

This document is intended to provide information to sportsmen/women on the impacts of lead on wildlife species from recreational sport hunting and fishing. Discussion and interest on this subject has been growing within the natural resource, and hunting and fishing communities. We hope this summary document will assist hunters and anglers in making informed decisions. Additionally, the future use of lead in ammunition and fishing tackle may be banned. Thus, it is necessary for the public to understand the issue so they might provide input on future management actions. We have synthesized relevant information, as well as provided suggested alternatives, for hunters and anglers. We hope you find this document useful and encourage you to further explore the impacts of lead on the environment.

Background

Lead is a heavy metal that is designated as Pb in the periodic elements table. It is known as a nonessential element to biological life. However, it has been found to be a useful material in many applications. This metal has been used by humans for centuries as it is abundant and easy to smelt. Its malleability, low cost and density has made it attractive for ammunition and lead weights in fishing tackle. Unfortunately, lead is extremely toxic. The metal has been shown to cause anemia, neurological impairment and immune system impairment. A major problem with lead is that it bioaccumulates in animal tissue. This means that it is absorbed at a faster rate than it is expelled. Thus, toxic levels can be reached if continued lead is absorbed. Due to these serious health issues, lead was banned from paint in 1977, plumbing used for drinking water in 1986 and gasoline in 1996 in the U.S. However, it is still widely used in other applications such as ammunition and weights (e.g., lead sinkers for fishing tackle). While lead has been linked to human health concerns for centuries, only recently has its harm to wildlife been addressed. Lead is especially problematic for birds, since lead can accumulate

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in a bird's gizzard where it is continually ground into smaller particles and readily absorbed into the blood stream.

Sources and amount of lead

The primary sources of lead from sporting activities are from lead shot, lead bullets and lead fishing weights. The Environmental Protection Agency (EPA) estimates that about 70,000 tons of lead is deposited at shooting ranges each year. While this presents many water quality challenges, the more direct threat to wildlife is lead deposited in the field while hunting and fishing. Prior to the lead ban for waterfowl hunting, it was estimated that more than 2,700 tons of shot were deposited in wetlands each year. Most troubling was that waterfowl tend to congregate in large numbers. Thus, waterfowl hunting and lead shot tended to be concentrated. Likewise, dove hunting may be concentrated on prepared dove food plots and harvested agriculture fields. It is estimated that more than 2.5 million pellets per acre were deposited each year in some of these fields. While lead bullets from rifle hunting contribute far less total lead into the environment, fragments remaining in animal carcasses or gut piles left in the field are hazardous to many scavenging animals.

Lead also is used extensively in fishing. Nearly 4,000 tons of lead sinkers are purchased in the U.S. each year. While it is not known how much of that is deposited into the aquatic environment, it is assumed that a high percentage of this lead is lost each year. Various studies have examined the amount of lead along shorelines, and the results have ranged from almost none up to staggering amounts (more than 100 pieces per square yard) in heavily fished areas.

The availability of all this lead shot, bullets and fishing tackle is dependent on the depth of the lead in the soil. In grassland and forest settings, the lead may be available only for a short time before litter covers it. However, in agriculture areas lead may be covered and then uncovered annually through cultivation. Additionally, management practices such as fire, grazing and disking can make it available in native habitats. Thus, the long-term persistence can be hundreds of years depending on the management of that site. In aquatic systems lead has been found to accumulate at the top of the sediment and remain there for long periods of time. Lead breaks down within 100 years to 300 years, and is no longer available for direct ingestion by wildlife; however, it can then

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enter the water system and continue to poison wildlife and people.

Impacts to wildlife

Ingestion of lead by birds

There are several ways that birds can consume lead. It can be consumed in contaminated plant material, sediment or animal carcasses. Lead may be even be mistaken for food or grit, which is used in the gizzard to grind food. These last two examples are the most common. Incidental exposure of lead from pellets lodged in the skin or other tissue appears to be of minimal concern, as lead is not easily absorbed into the bloodstream through tissue.

The earliest records for impacts to birds involved waterfowl in the late 1800s, yet it would be several decades before the full impacts were realized. Waterfowl are particularly vulnerable to lead due to the high concentration and availability of lead shot on bare soil (prepared fields) and in shallow wetlands. Prior to the lead ban, estimates of waterfowl mortality in the U.S. ranged from 1.6 million to 3.9 million birds per year. This ban has led to a 50 percent reduction of lead ingestion by waterfowl, saving about 1.4 million ducks annually. One #4 lead pellet has negative impacts for three months after ingestion. As few as one or two lead pellets can kill waterfowl. Even if mortality does not occur, poisoned waterfowl have depressed activity and are more at risk of harvest or predation.

Upland game birds also are susceptible to lead poisoning. Lead impacts have been documented for virtually every species of upland game bird in the U.S., including ring-necked pheasant, northern bobwhite and wild turkey, but perhaps no other upland game bird is more at risk than the mourning dove. The primary reason for their susceptibility is the same as waterfowl's--concentrated hunting. Some dove fields collect more than 2.5 million pellets per acre each year. Since the ground is often bare or nearly so in prepared fields, lead is more available for ingestion. Also, the size shot commonly used for dove hunting is very similar to seeds consumed by the



Figure 1. Popular shot sizes for bird hunting is similar in size to many preferred game bird foods. Clockwise from top left, #6 lead shot, #8 lead shot, woolly croton seed and Pennsylvania smartweed seed.

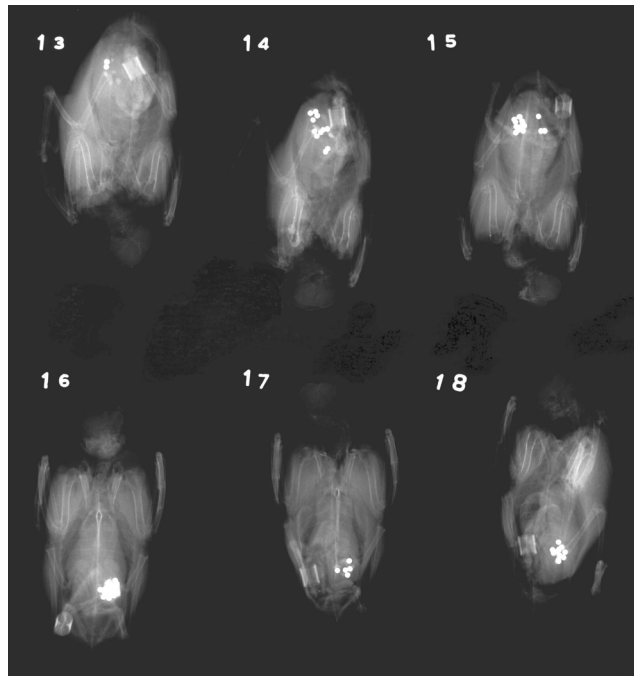


Figure 2. Lead shot ingested by mourning doves is apparent in these X-ray images. Note the bright areas indicating the dense lead shot (Courtesy of Missouri Department of Conservation).

mourning dove (Figure 1). Doves have difficulty maintaining their core body temperature after ingesting lead and appear to die rapidly. As few as two pellets can kill a mourning dove, but doves often consume multiple pellets (Figure 2). There is little known about the impacts of lead on passerine bird species (e.g., sparrows, thrushes, etc), but it is likely that lead is most detrimental to species that forage on the ground.

Lead ingestion is not limited to shot; fishing tackle also is a concern for some aquatic birds. Swans, geese, ducks, pelicans and loons have died from lead poisoning. Lead tackle under 2 ounces is most often consumed. Loons probably ingest the lead incidentally as they are eating bait off broken fishing lines. Some studies have found that about half of all loon mortalities were due to lead poisoning. Swans all over the world also have high mortalities from lead. In fact, 90 percent of the mortality of some mute swan populations in Britain was due to lead poisoning from fishing tackle.

Raptor and scavenger impacts

Consumption of lead shot, bullets or bullet fragments has been a mortality cause for rare and endangered birds of prey and scavengers. For example, through 1996 there were five states where at least 20 bald eagles died from ingesting lead from carcasses. This is a continual problem for the endangered California condor in California, Utah and Arizona, where strategies to reduce lead poisoning may include capturing birds to cleanse lead from the blood or having both mandatory and voluntary "no lead" zones for big game hunting. One strategy that has proven successful in Arizona is issuing vouchers for free copper ammunition to license holders. Any unrecovered or wounded animal shot with lead ammunition could potentially cause lead poisoning mortality

of a bird of prey. Lead poisoning also can occur in scavenging mammals such as coyotes, wolves and foxes, but because mammals pass lead pieces through their digestive system rather quickly, it is not usually fatal.

Alternatives to lead

Fortunately, just as nontoxic alternatives have been available for waterfowl hunters for decades, there are now readily available alternatives for upland gamebird hunting and big game hunting. Various alloys of tungsten and bismuth are available, but steel has been the most popular choice due to lower costs and higher availability. The main things to know when using steel shot for upland hunting is to use larger shot (because it is less dense than lead) and a more open choke (because it does not deform like lead). General recommendations are as follows:

- 1) Go up two shot sizes to achieve similar effectiveness. For example, if you typically shoot #8 lead, change to #6 steel.
- 2) Use a slightly heavier load. For example, if you typically use 1 ounce lead loads, use 1 1/8 ounce when shooting steel. This will adjust for the decreased pellet count associated with increased shot size (see Table 1).
- 3) Use a more open choke. For example, if you would typically use a modified choke for lead shot, change to an improved cylinder or skeet choke for steel.
- 4) Pattern your gun to determine the best choke/shot size/shot weight combination for your needs.
- 5) Avoid shooting steel shot through old guns or really tight chokes, which could cause barrel damage.

The following chart should serve as a good starting point.

Table 1. Nontoxic equivalents for common lead shot sizes.

Lead			Recommended Steel Equivalent		
Size	Shot wt.	Pellets	Size	Shot wt.	Pellets
4	1	135	2	1 1/8	141
4	1 1/8	152	2	1 1/4	156
4	1 1/4	169	2	1 3/8	172
5	1	170	3	1 1/8	173
5	1 1/8	191	3	1 1/4	193
6	7/8	203	4	1	191
6	1	232	4	1 1/8	215
6	1 1/8	251	4	1 1/4	239
6	1 1/4	276	4	1 3/8	263
7.5	7/8	302	5	1	244
7.5	1	345	5	1 1/8	275
7.5	1 1/8	388	5	1 1/4	305
7.5	1 1/4	431	5	1 3/8	336
8	7/8	358	6	1	317
8	1	409	6	1 1/8	357
8	1 1/8	461	6	1 1/4	396
8	1 1/4	511	6	1 3/8	436

Some hunters are concerned about the cost of using nontoxic shot. While premium steel and alloy loads can cost considerably more than lead shot, some steel loads are priced comparably to lead. Copper rifle bullets are now being produced by multiple manufactures with performance similar to

lead bullets. Finally, there are many nontoxic alternatives for lead fishing weights. Metals such as steel, brass and tungsten are produced in an array of sizes and types. Steel and brass are less dense than lead, thus the size for an equivalent weight will be larger. Tungsten is actually denser than lead. However, none of these alternatives are as pliable as lead.

Current restrictions on lead

In the U.S., nontoxic shot is required for all waterfowl hunting including ducks, geese, swans and coots. Nearly half of all states have specific lead regulations beyond the federal restrictions, many requiring nontoxic shot on certain management units. Additionally, many public hunting areas have toxic shot regulations. Waterfowl Production Areas (WPA) and U.S. Fish and Wildlife Service refuges generally require nontoxic shot for hunting upland bird species because these areas are managed primarily for waterfowl and often contain numerous wetlands. The limitations are put in place to prevent lead shot accumulation in and around these wetland units.

Some species-specific issues have led to both mandatory and voluntary lead limitation. For example, areas supporting the federally endangered California condor have regulations in place to reduce consumption of lead-contaminated big game carcasses by condors. California requires nontoxic ammunition for big game hunting in areas where condors occur, and both Arizona and Utah provide vouchers to hunters to purchase nontoxic rifle ammunition in the portions of those states where condors occur. This voluntary program has been popular with hunters (with more than 80 percent compliance) and moderately effective at reducing lead risk to the California condor.

Currently five states have some restrictions on lead in sport fishing. However, several federal lands have bans on lead for fishing. Other countries, such as the United Kingdom, have banned lead fishing tackle altogether. It is difficult to gauge the success of lead bans on wildlife populations due to limited information. However, the ban on lead for waterfowl has both greatly reduced the availability of lead and the associated mortality for waterfowl.

There is concern about impacts future restrictions might have on outdoor activities. A common concern is that lead bans will increase the cost of hunting and fishing to the point that sportsman numbers drop. Based on past experience with lead restrictions in waterfowl hunting, we might expect an initial drop in hunter numbers. However, as waterfowl populations increased in the 90s, the number of hunters followed. In fact, the number of federal duck stamps sold only dipped during the 1992 season (the year after the ban) from 1.43 million to 1.35 million hunters. The following year it was back to 1.4 million and continued to rise to a high of 1.7 million hunters in 1997. Thus, it is unlikely that a complete ban on lead in ammunition and fishing tackle would contribute to large, sustained declines in hunting and fishing activities.

Summary

It is probable that in the coming years there will be continued restrictions placed on public lands limiting the use of lead ammunition and fishing tackle. It is the responsibility of hunters and anglers to limit the negative impacts that might occur on wildlife populations and the natural resources. There is ample data to indicate that lead has negative impacts for