



March 4, 2025

The Honorable Brian Feldman, Chair
Senate Education, Energy & Environment Committee
2 West Miller Senate Office Building
Annapolis, MD 21401

Re: SB 634 – Hunting - Nonlead Ammunition, et cet. - FAVORABLE

Dear Chairman Feldman, Vice Chair Kagan, and Members of the Committee:

My name is Jim Keen. I am an agricultural and animal protection veterinarian with a Ph.D. in infectious disease epidemiology. I have 37 years of experience as a food animal clinician, a veterinary infectious disease researcher with USDA in Nebraska, and a faculty member at the University of Nebraska School of Veterinary Medicine.

I am currently the Director of Veterinary Science at the Center for a Humane Economy, an animal protection non-profit. I live in eastern South Dakota but I have two brothers and their families who live in Bethesda, Maryland.

I urge the Maryland Senate Education, Energy, and the Environment Committee to support [SB 634](#). A provision of this bill would sensibly require the Maryland Department of Natural Resources (DNR) to create and execute a lead-hunting ammunition phase-out on or before July 1, 2029.

[Human health and environmental risks of lead ammunition for deer hunting](#)

Overview: For millions of Americans, game meat, especially venison from harvested deer or elk, is a primary or secondary source of animal protein. There are about 12 million deer hunters in the US, including [about 125,000 \(2% of the population\) in Maryland](#). American hunters harvest, and their families, friends, and neighbors consume, about 6 million deer annually. According to the Maryland DNR, the total number of deer harvested across the state from September 8th, 2023 through February 3rd, 2024 was 72,642, a number that includes animals harvested during the archery, firearms, and muzzleloader seasons.

About 95% of deer are killed with lead ammunition. However, if an animal is shot using lead ammunition, the meat can be toxic to people who ingest it and to wildlife who scavenge the field-dressed remains or gut piles. [This means that many thousands of Maryland's citizens and visitors, including highly lead-toxicosis susceptible children and pregnant women, are exposed to and poisoned to some degree by lead ammunition every year.](#)

Lead is an extremely toxic heavy metal with no biological function. It is poisonous to people and animals at any level. The ingestion of even small quantities of lead has a myriad of adverse health impacts on people, especially children, pregnant women, and unborn children in the womb. Lead is particularly damaging to the brain and nervous system. Because of its well-known toxicity, lead is banned from gasoline, paints, and various household items in most developed countries. Lead ammunition, however, is still widely used for hunting and shooting worldwide and is [now likely the greatest, largely unregulated source of lead that is knowingly discharged into our environment](#) by the ton every year.

While lead was banned from waterfowl ammunition in the U.S. in 1991, the majority of people who hunt other types of game still use lead ammunition. A growing body of scientific evidence highlights how the use of lead bullets and shot is causing unnecessary and preventable lead exposure in people, domestic animals, wildlife, and ecosystems, taking the poison far beyond the gun barrel. Poisoning from spent lead ammunition was for decades mainly regarded as a disease of waterfowl, but it also puts at [risk the health of raptors, scavengers, and other terrestrial species, including humans](#) who frequently consume hunted game. Lead present in ammunition is now a “One Health” imperative.

Lead contamination from hunted meat has the potential to impact the health of millions of people in the U.S. who are connected to the hunting community, including [low-income non-hunting recipients of donated venison](#). [Despite mounting concerns, lead ammunition use continues as hunters and their families remain unaware or mistrustful of the dangers](#). There are non-lead ammunition alternatives to lead that are reliable, accurate, and affordable. However, hunters are slow to switch, and hunting lobby groups generally oppose any mandatory shift to non-lead bullets, slugs, or shot. By adopting lead-free alternatives, hunters can ensure cleaner wild game, protect themselves, their families, and friends who consume their venison from an unnecessary poisonous chemical risk, and have fewer impacts on nongame wildlife. In other words, to be true wildlife conservationists.

I - A brief history of lead - Lead is a soft, pliable, elemental metal that is found in naturally occurring deposits around the world. While it has been used for centuries for many purposes, lead poisoning has also been known in humans for at least 2,500 years. However, the highly toxic properties of lead have become well-known over just the last 100 years through the issues of food contamination in cans sealed with lead solder, the toxic effects of lead-based paints and glazes, the polluting effects of leaded gasoline, the presence of lead in drinking water passing through pipes connected with lead solder, and, more recently, the toxic effects of lead ingested by wildlife.

People have been consuming meat from wild game animals killed with lead ammunition since the invention of firearms in the early 15th century. The popularity of lead bullets is largely due to their availability, low cost, and their ballistic properties as a soft, malleable, and dense metal.

II - The toxic effects of lead - Lead poisoning occurs when lead builds up in the body over an extended period, often months or years. Exposure to lead can affect multiple body systems and is particularly harmful to young children and women of childbearing age [Even small amounts of lead can cause serious health problems](#). Lead is an element, so it does not break down. Children younger

than 6 years are especially vulnerable to poisoning, which can severely affect mental and physical development. At very high levels, lead poisoning can be fatal.

Children who survive severe lead poisoning may be left with permanent intellectual disability and behavioral disorders. At lower levels of exposure that cause no obvious symptoms, lead is now known to produce a spectrum of injury across multiple body systems. In particular, lead affects children's brain development, resulting in reduced intelligence quotient (IQ), behavioral changes such as reduced attention span, increased antisocial behavior, and reduced educational attainment.

- When lead is ingested, it attacks organs and many different body systems. Lead poisoning can damage the brain, central nervous system, and reproductive system, and cause kidney disease, cancer, high blood pressure, anemia, impotence, birth defects, miscarriage, nerve disorders, memory and concentration problems, and a host of other health disorders. In large enough doses, lead can cause brain damage leading to seizures, coma, and death.
- Lead exposure also causes anemia, hypertension, renal impairment, immunotoxicity, and toxicity to the reproductive organs. The neurological and behavioral effects of lead are believed to be irreversible.
- Lead in the body is distributed to the brain, liver, kidney, and bones. It is stored in the teeth and bones, where it can accumulate over time. Human exposure is usually assessed through the measurement of blood lead.
- Lead in bone is released into the blood during pregnancy and becomes a source of exposure to the developing fetus.
- No level of exposure to lead is known to be without harmful effects.
- Lead exposure is largely preventable.

III - How do lead bullets contaminate meat? Most rifle bullets used for large game hunting are designed to expand upon impact to ensure maximum deadly effect. Expanding, high-velocity lead bullets fragment upon impact, producing shrapnel of various sizes, often microscopic, especially in larger game animals. Many of the fragments in the animal's tissues are tiny microparticles that are too small to see with the naked eye or sense when eating. These fragments scatter into the muscle and entrails of hunted animals, including white-tailed deer. For the venison consumer, these particles accumulate over time and contribute to rising lead levels, increasing the risk of health problems. *A single round can shatter into millions of smaller fragments up to 45 cm away from the bullet's trajectory especially when they strike bone in deer.*

Scientists have used X-rays to visualize and count sometimes hundreds of minute lead particles in hunted meat, and have detected high concentrations of lead in hunted carcasses using chemical analysis. Critically, most lead shards are too small to be seen with the naked eye and minuscule fragments (nanoparticles) are not even detectable by X-rays. The lead shards can also dissolve and poison the surrounding tissues. Both the fragments and the contaminated meat are poisonous when consumed. Shotgun ammunition is another common source of lead in hunted meat.

A strong body of scientific research demonstrates that lead-based ammunition frequently contaminates hunted meat and increases blood lead levels of humans and animals who consume it. The U.S. Food and Drug Administration does not recognize a safe limit for lead in meat.

- In 2008, the [Minnesota Department of Natural Resources](#) experimentally shot 80 deer and sheep carcasses and evaluated the presence of lead in each. High-velocity ballistic tip bullets left an average of 141 fragments, an average of 11 inches from the wound channel; some were farther. Soft-core and bonded bullets fragmented less and left 80-86 fragments 9-11 inches from the wound channel. Some fragments were too small to see with anything but a sensitive X-ray image.
- A 2009 study of [30 deer harvested with lead bullets in Wyoming](#) and processed by 22 different meat processors found an average of 136 lead fragments per deer; 32% of the burger packages had at least one metal fragment. Twenty percent of the packages had only one fragment, 7% had two fragments, and 5% had 3 to 8 fragments. Burger packages always have more lead fragments than steaks and roasts. The Minnesota Department of Agriculture tested 1,029 commercially ground burger packages and found fragments in 26% but in only 2% of 209 packages containing whole cuts of meat. In a 2008 Wisconsin study, researchers collected 183 packages of venison burger from hunters' freezers, food pantries, and meat processors. They found that 85% of commercially processed burgers and 92% of hunter-ground packages were free of lead.
- [Ground venison packets from shotgun- and archery-harvested White-tailed Deer in Illinois](#) in 2013 and 2014 were analyzed for metal contamination. Radiographs indicated that 48% of 27 ground venison packets from 10 shotgun-harvested deer contained metal fragments, while none of the 15 packets from three archery-harvested deer contained fragments.
- Multiple studies have found a direct link between game harvested with lead ammunition and spikes in blood lead. For example, in a [2009 North Dakota study](#) with 736 participants, participants who consumed wild game had higher blood lead levels than those who did not consume wild game.
- There is no record of anyone ever getting sick from consuming lead bullet fragments. However, no study has been conducted in the U.S. to understand monthly patterns of blood-lead levels among people who eat lead-hunted meat.

IV – A “One Health” imperative - “One Health” is the idea and approach that the well-being of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and interdependent. Lead ammunition is a One Health issue because it can harm all of these domains through various pathways. For example:

- Wildlife can be poisoned by lead from ammunition through scavenging, predation, or ingestion of lead shot, which can affect their survival, reproduction, and behavior.
- A lead fragment the size of a grain of rice is lethal to a mature bald eagle, meaning that a standard 150-grain lead bullet can poison 10 eagles. The deadly metal accumulates in an eagle's system throughout their lives, meaning that there is no safe amount of lead exposure. For this reason, lead is often called “the silent killer.”

- [Ecosystems can be contaminated by lead from ammunition](#), which can accumulate in the soil, water, and plants, and affect the biodiversity and functioning of natural systems.

V - Conclusion - Lead ammunition poses a threat to people, animals, and ecosystems. No responsible, and ethical hunter wants to inadvertently poison with lead themselves, their family and friends, or [kill an eagle or other raptor](#). As conservationists, many hunters who are using toxic lead ammunition or improperly disposing of animal remains are probably uninformed about this issue, rather than indifferent to the impacts lead ammunition can have on non-target organisms. By choosing to adopt lead-free alternatives, hunters can ensure cleaner wild game and fewer impacts on nongame wildlife. [Non-lead ammunition is readily available](#) and similar in cost to lead ammunition.

[Despite overwhelming scientific evidence and increasing policy imperatives](#), state and national bans on the use of lead shotgun and rifle ammunition are few. North American and European arms industries have developed non-toxic shot and bullets that are as effective and comparably priced as their lead counterparts. [Additional scientific research or evidence is not needed to demonstrate the deleterious impacts of lead ammunition on humans, wildlife, and ecosystems](#). The same rationales that were used to remove lead from gasoline, paints, and household items should now be applied to lead-based hunting ammunition. This is now a socio-political issue requiring political mettle and is no longer in the scientific domain. By choosing to adopt lead-free alternatives, hunters can ensure cleaner wild game and fewer impacts on nongame wildlife.

In closing, for the health and welfare of the people and wildlife in Maryland, please support HB 741 to create a lead-hunting ammunition phase-out on or before July 1, 2029.

[Please see the attached addendum of photographs of lead bullet fragmentation inside game carcasses to better understand how lead is readily and frequently ingested by people or wildlife.](#)

Thank you.

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Center for a Humane Economy

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VI - Selected references on risks from lead ammunition

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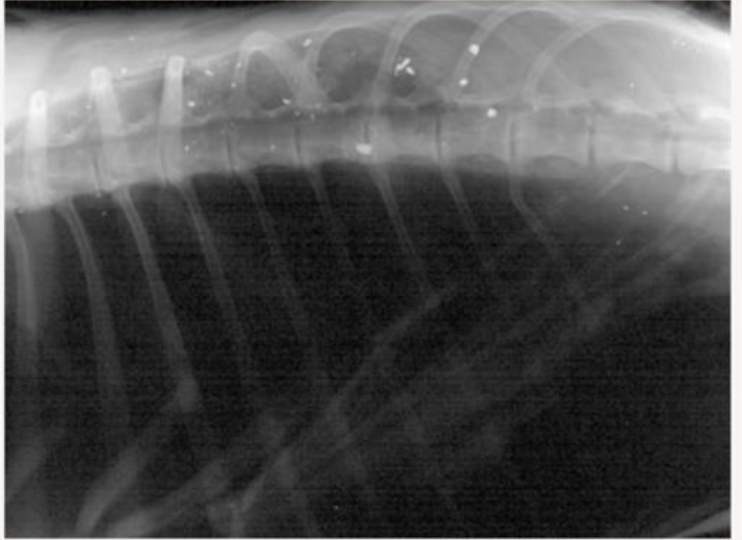
Traditional lead bullet fragmentation on entry



Copper bullet on entry showing zero fragmentation



An assortment of lead bullets showing shot fracturing next to similar fired copper variants



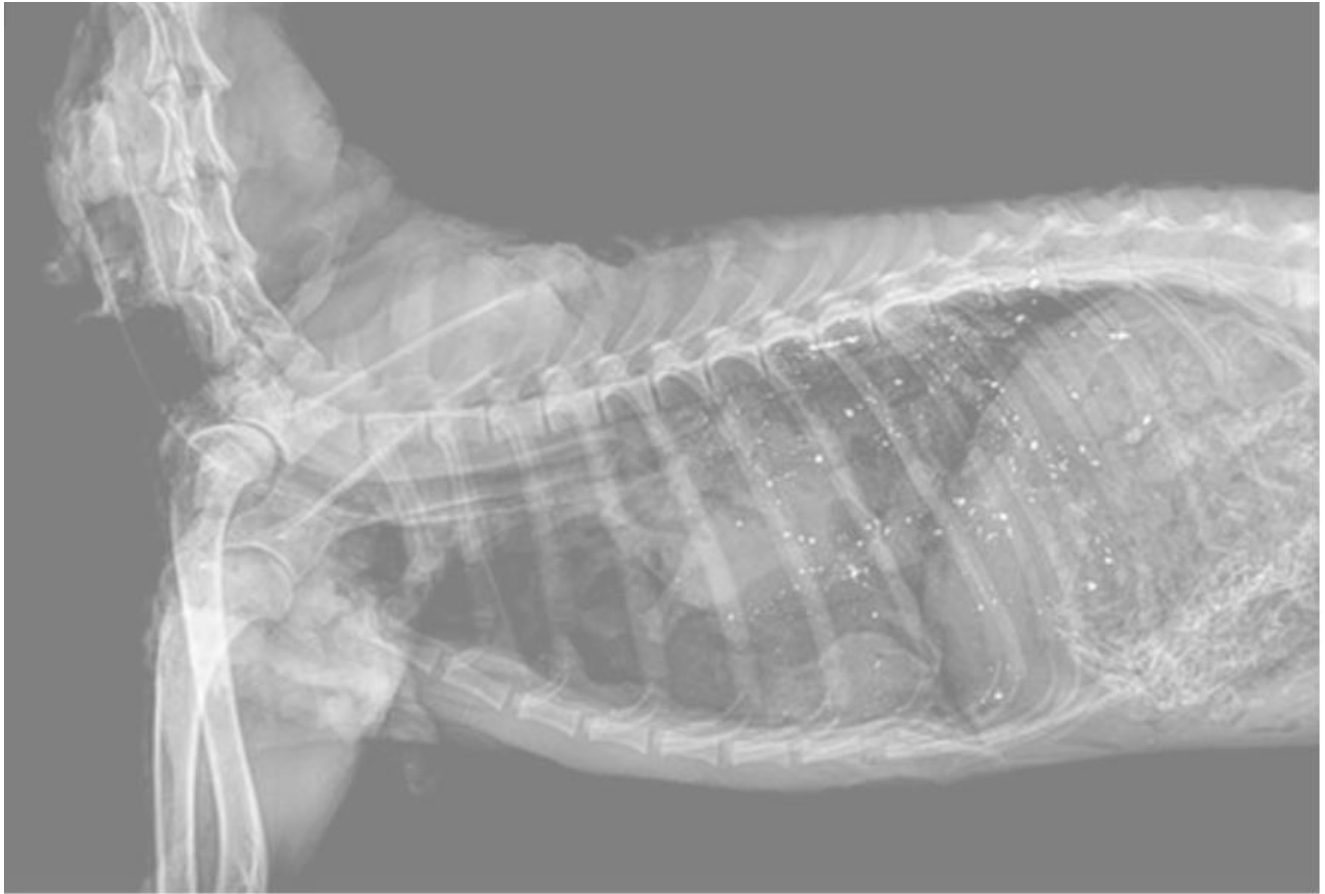
X-ray showing presence of lead bullet fragments in deer backstrap.

Images from <https://huntingwithnonlead.org/>



Figure from: Arnemo JM, 2022. "Lead ammunition used by hunters has us all in its sights." Outreach, Inland Norway University of Applied Sciences.

https://researchoutreach.org/wp-content/uploads/2023/06/Jon-M.-Arnemo_8em.pdf



A radiograph (X-ray) showing lead bullet fragmentation in a deer carcass. The “white spots” are bullet fragments. Many lead fragments are microscopic and are undetectable during butchering or when the venison is eaten. <https://ca.audubon.org/news/man-who-sounded-alarm-about-lead-ammunition-and-public-health>

HOW DOES LEAD AFFECT BALD EAGLES?



Legal hunting and fishing support conservation efforts. However, the use of lead ammunition and fishing tackle can have unintentional consequences for native wildlife.



Lead enters our ecosystem when gut piles or carcasses are abandoned, when quarry escapes after being shot, or when fish break the line and swim off with tackle.



Going lead-free protects bald eagles and other wildlife. Lead-free alternatives are becoming more affordable, offer greater accuracy, and ensure the highest quality game meat.



A lead fragment the size of a grain of rice is lethal to eagles. Lead accumulates in the system over time, so there is no safe amount of lead exposure.



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Est. 1955

X-rays of deer carcasses shot with lead bullet & copper bullet.



- Bright white spots = lead fragments
- Spread throughout animal's body
- Contaminate meat & environment

30 caliber Winchester magnum lead core w/ copper jacket

- Highly toxic
- Hundreds of fragments



- No copper bullet fragments



30 caliber Winchester magnum solid copper bullet

- Non-toxic
- No fragmentation