Unites States Senate Committee on Environment and Public Works
March 17, 2015
Hearing entitled, "Bipartisan Sportsmen's Act of 2015"
Subcommittee on Fisheries, Water, and Wildlife
Questions for the Record to Wayne Pacelle, President and CEO, The Humane Society of the United States

Senator Booker:

1) Mr. Pacelle, I am concerned about a provision in the overarching Sportsmen's Act package, S. 405, that could potentially open millions of acres of public lands to trapping. Could you please provide this Committee with information on traps in general, and why your organization opposes this provision?

Late last fall, a family's Saint Bernard, Brooklyn, went missing near public lands open to hiking outside of Casper, Wyoming. Desperate to find him, the family's children set out on a search mission with their two other Saint Bernards, Jax and Barkley. Less than a mile away from their home, one of the Saint Bernards ran down a hill and suddenly went silent. The children ran after him. One of the children recounted what happened next:

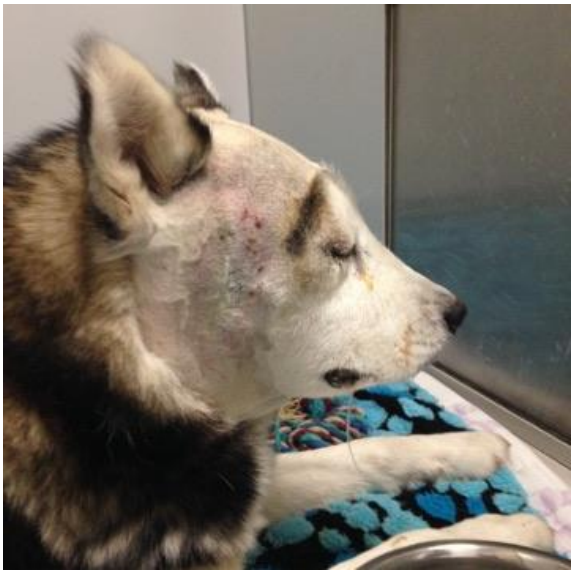
> "[The younger child] got a closer look at him and started screaming, 'it's a trap.' And there was a snare trap that was tied around his neck that had suffocated them. My other St. Bernard, 10 feet away, we look at him and he's caught in another trap. And so we both rush over there to try to break the wire free that was tied around his neck, but he was fighting us and was trying to fight to get loose, and the wire just got too tight; and we both, there was nothing we could do.… Later that night, we found Brooklyn, the dog who originally went missing, and we found her in a trap as well."[1]

Jax, Barkley, and Brookyln – the three Saint Bernards killed by a neck snare last fall. "No animal should have to suffer like that and no person should be forced to helplessly witness it," said the children's aunt. *Source: Christina Russo, "'Antiquated' Trapping Laws Can Inflict Torture On Wildlife ... And Family Pets," The Dodo, Mar. 25, 2015*.

The Wyoming Game and Fish Department ruled out an investigation of this incident, stating that it "did not find anything illegal going on with the trapping activity in this situation," and instead cautioned the public to be more "aware of their surroundings" when on public lands, noting that the Department had no idea where traps are located.[2]

[1] Tom Morton, "Traps Kill Family's Three St. Bernards Near Garden Creek," K2radio.com, Dec. 3, 2014, *available at* http://k2radio.com/traps-kill-familys-three-st-bernards-near-garden-creek/?trackback=tsmclip

Trappers kill at least six million American "target" animals every year, primarily raccoons, muskrats, coyotes, nutria, beavers, opossum, and foxes.[3] Trappers accidentally kill countless "non-target" animals, including threatened and endangered species[4] and cats and dogs,[5] like Brooklyn, Jax and Barkley. But because trappers are not required to report their "non-target" catches, it is impossible to know how many "non-target" animals traps kill every year.[6]



Kobe, a 7 year-old husky rescued on December 23, 2014, from a body-gripping trap south of Moose Lake, Minnesota. "It's unknown how many days Kobe was caught with his face in this trap," said Friends of Animals Director Cynthia Haglin, "because the current regulations require a trapper to check this type of trap only once every three days." *Source: Friends of Animals Humane Society, Minnesota.*

These archaic devices have been around for almost two centuries. The naturalist Charles Darwin wrote of steel leghold traps during the time of Lincoln's presidency:

> If we attempt to realize the sufferings of a cat, or other animal when caught, we must fancy what it would be to have a limb crushed during a whole long night, between the iron teeth of a trap, and with the agony increased by constant attempts to escape. Few men could endure to watch for five minutes an animal struggling in a trap with a crushed and torn limb … It is scarcely possible to exaggerate the suffering thus endured from fear, from acute pain, maddened by thirst, and by vain attempts to escape.[7]

Today the leghold traps Darwin described are the most widely used traps in America.[8]

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[2] "Snare Traps That Killed 3 St. Bernards Were Completely Legal," KCWY13, Dec. 4, 2014, *available at* http://www.kcwy13.com/home/headlines/Snare-Traps-That-Killed-3-St-Bernards-Were-Completely-Legal-284824601.html.

[3] These numbers are a very low estimate. They rely on self-reporting and in many states exclude predators, whose deaths are not required to be reported at all. *See* Association of Fish and Wildlife Agencies, "National Furbearer Harvest Statistics Database, 2012-13 Harvest Season Data," *available at* http://fishwildlife.org/?section=furbearer_management_resources.

[4] *See, e.g.*, Rob Chaney, "Injured Eagle Shows Risks of Trapping, Missoula Raptor Researcher Says," The Missoulian, Feb. 3, 2015, *available at* http://missoulian.com/news/local/injured-eagle-shows-risks-of-trapping-missoula-raptor-researcher-says/article_a1235f1a-aa7f-5667-a80d-4351160c7007.html.

[5] *See, e.g.*, John Lauritsen, "Hunter Asks For More Trapping Regulations After Dog Dies in Conibear," Minnessota CBS Local, Dec. 18, 2014, *available at* http://minnesota.cbslocal.com/2014/12/18/hunter-asks-for-more-trapping-regulations-after-dog-dies-in-conibear/.

[6] DK Onderka et al, "Injuries to Coyotes and Other Species Caused by Four Models of Footholding Devices," Wildlife Society Bulletin 18:175-182 (1990).

[7] Charles Darwin, "Trapping Agony," The Gardeners Chronicle and Agricultural Gazette, Apr. 1863, *available at* https://awionline.org/sites/default/files/products/store-trappingagony-101711.pdf.

[8] Association of Fish and Wildlife Agencies, "Best Management Practices for Trapping Practices in the United States" (2006), *available at* http://www.fishwildlife.org/files/Introduction_BMPs.pdf, at 7.

None of the traps routinely used by American trappers meets even the most basic humane standards:

- **Leghold traps** (sometimes called "foothold traps" or "steel-jawed leghold traps") consist of two steel jaws, sometimes padded, which clamp together on an animal's foot or leg, wounding but not killing the animal. The European Union and eight U.S. states have completely or partially banned the use of leghold traps on animal welfare grounds.[9] Nature writer and Fund for Animals founder Cleveland Amory described being caught in a leghold trap as like "having your fingers crushed in a car door for 24 to 48 hours."[10] Even the "Best Management Practices for Trapping Practices in the United States" compiled by the Association of Fish and Wildlife Agencies, allow for up to 30 percent of animals trapped in leghold traps to suffer severe trauma and the remaining 70 percent to suffer mild to moderate trauma.[11] The American Veterinary Medical Association (AVMA) opposes the use of conventional, unmodified steel jawed leghold traps, noting that they "pose a risk of injury to both target and non-target animals … and intermittent collection of animals caught in leg-hold traps means that fear may sometimes be extended as long as 24-hours."[12] In fact, this understates the length of suffering endured – some states only require trappers to check leghold traps once every 72 hours.[13]

Cub, the "wonder dog," who survived getting caught in a leghold trap in New Mexico in February, 2015. "[Veterinarians] think he had been walking on his bones for weeks, since the healing showed it was not a new injury," Judy Paulsen, from Project Coyote, told The Dodo. "It's amazing the dog didn't bleed to death. He must have had such a strong will to live." *Source: Stephen Messenger, "'Miracle' Dog Exposes America's Shameful Use of Leghold Traps," The Dodo, Mar. 3, 2015, available at https://www.thedodo.com/miracle-dog-expose-trap-horror-1022299525.html.*

- **Neck snares** are loops of steel cable designed to catch around the neck of an animal, tightening under the pressure of a mechanical spring or the animal's thrashing. A 2015 peer-reviewed scientific study concluded that no currently available mechanical or

[9] G Iossa, CD Soulsbury and S Harris, "Mammal Trapping: A Review of Animal Welfare Standards of Killing and Restraining Traps," Animal Welfare 16: 335 (2007), at 338, 347.
[10] Quoted in Letter to the editor, *The Kingston Daily Freeman*, Nov. 17, 1975.
[11] *See Supra* note 9, at 5.
[12] AVMA, Policy Statement on "Trapping and Steel-jawed Leghold Traps," *available at* https://www.avma.org/KB/Policies/Pages/Trapping-and-Steel-jawed-Leghold-Traps.aspx; AVMA, "Literature Review on the Welfare Implications of Leghold Trap Use in Conservation and Research," April 30, 2008, *available at* https://www.avma.org/KB/Resources/LiteratureReviews/Documents/leghold_traps_bgnd.pdf.
[13] *See, e.g.*, Wyoming Game and Fish Commission regulations, Chapter 4, Section 9(a), *available at* https://wgfd.wyo.gov/web2011/imgs/QRDocs/REGULATIONS_CH4.pdf.

manual neck snares meet even the minimal international certification standards, which require most animals to be killed within five minutes.[14] The study cited research showing that, even in ideal laboratory conditions, it took researchers 30 to 40 minutes to kill a red fox with a neck snare.[15] Little data exists on how long animals suffer in neck snares in the wild, but one study found that many animals were still alive over 12 hours after being snared.[16] It also noted that "snared animals can die slowly from their injuries, but also from exposure, exhaustion, dehydration, or starvation" when trappers are not required to routinely check their snares.[17] In Wyoming, where neck snares killed the Saint Bernards Brooklyn, Jax, and Barkley, trappers are only required to check their snares once every seven days.[18]

- **Mechanically Powered Killing Devices,** including body-crushing or rotating-jaw traps (e.g. Conibear™ traps), are designed to kill an animal when two rotating jaws close on each side of the animal's neck or chest.[19] The number of "non-target" animals killed or injured by body-crushing traps may equal if not exceed the number of target animals captured.[20] The Association of Fish and Wildlife Agencies' "best practice" calls for these traps to kill only 70 percent of animals within five minutes.[21] During those five minutes, the animal will typically be severely wounded, with open cuts or crushed internal organs. And there is no indication how many trappers follow these "best practices," which are of course voluntary.

Bella, a 20 month-old beagle, killed by a Conibear trap during a hunting trip on Valentine's Day 2009, on public land owned by the Army Corps of Engineers near Kanopolis Lake, Kansas. "I had read how to get them off. I'm afraid all my efforts did was prolong the agony of her death," said Bella's owner. "I would like to get kill traps off of public hunting land … Far more hunters and hikers use that area than trappers, and hunters use dogs." *Source: Footloose Montana, available at http://www.footloosemontana.org/wp-content/uploads/2012/01/Beagle-dies-in-Conibear-KS031309.pdf.*

[14] G Proulx, D Rodtka, MW Barrett, M Cattet, D Dekker, E Moffatt, RA Powell, "Humaneness and Selectivity of Killing Neck Snares Used to Capture Canids in Canada: A Review," Canadian Wildlife Biology & Management 4:1 (2015), at 61.
[15] *Id*. at 57
[16] *Id*. at 58
[17] *Id*. at 61
[18] Wyoming Game and Fish Commission regulations, Chapter 4, Section 9(b), *available at* https://wgfd.wyo.gov/web2011/imgs/QRDocs/REGULATIONS_CH4.pdf.
[19] *See supra* note 9, at 6.
[20] BJ Naylor and M Novak, "Catch Efficiency and Selectivity of Various Traps and Sets Used for Capturing American Martens," Wildlife Society Bulletin 22:489-496 (1994).
[21] *See supra* note 9, at 6.

- **Submerged Aquatic Traps** are body-crushing traps, cage traps, cable devices, or leghold traps set underwater or on the surface of a lake with a one-way sliding lock to drag the animal under.[22] The Association of Fish and Wildlife Agencies' "best practice" for aquatic traps merely requires "that the equipment must prevent the animal from surfacing once it has submerged."[23] But muskrat and beavers take four and nine minutes respectively to die from drowning-induced hypoxia, even after accounting for their frantic struggling when trapped, which deprives them of oxygen.[24] The AVMA's 2013 Guidelines on Euthanasia states clearly that "Drowning is not a means of euthanasia and is inhumane."[25] Even wildlife managers agree that drowning, although convenient for trappers, does not constitute a humane death.[26]

Section 105(a)(2)(A) of S.405, the "Bipartisan Sportsmen's Act of 2015" would define "trapping" as "hunting." The bill's hunting preference provisions would thus presumptively open most public lands to trapping. But, despite radically increasing the locations in which traps could be used, the bill includes no safeguards to ensure that traps do not inflict horrific pain on humans or animals. The bill also includes no restrictions to protect threatened species, dogs and cats, or children from traps. In its current form the bill will thus cause many more animals to suffer, and create more tragedies, like the deaths of Brooklyn, Jax, and Barkley.

Bella, a Lab-Husky cross caught in a steel-jawed leghold trap while on a walk in November, 2014, in Labrador, Canada. "Seeing Bella stuck in that trap, in excruciating pain, was one of the worst, most helpless feelings of my life," said Peg Pelley. "She's going to be okay now, but this isn't the end of the story. So many other animals, including our two dogs, are still in danger of being caught in traps." *Source: Peg Pelley, via Humane Society International.*

2) Is it true that many other countries have banned body-gripping traps?

Yes. More than 80 nations have banned the most commonly used body-gripping trap – the steel-jawed leghold trap – including the United Kingdom, Germany, Norway, Brazil, and Israel.[27] In particular, the Council of the European Communities in

[22] *Id.*
[23] *Id.*
[24] *See supra* note 10, at 338.
[25] AVMA, Guidelines for the Euthanasia of Animals: 2013 Edition, at 102 *available at* https://www.avma.org/KB/Policies/Documents/euthanasia.pdf.
[26] JW Ludders, et al., "Drowning is not euthanasia," Wildlife Society Bulletin 27:666-670 (1999).
[27] *See supra* note 10, at 335. *See also* CH Fox, CM Papouchis, Cull of the Wild: A contemporary analysis of wildlife trapping in the United States (Sacramento, Ca: The Animal Protection Institute, 2004), at 2; Hansard, Parliament of New South Wales, "Steel-Jawed Leghold Traps" (Sept. 16, 1993), *available at* http://www.parliament.nsw.gov.au/prod/parlment/hansart.nsf/V3Key/LC19930916050.

1991 banned the use of the leghold trap in all Community member nations (today all members of the European Union), and restricted the import of fur from countries using the trap.[28] In banning the trap, the Council noted that "the abolition of the leghold trap will have a positive effect on the conservation status of threatened or endangered species of wild fauna both within and outside the Community."[29]

In 1997, the EU granted American fur exporters market access after the U.S. represented that the "competent authorities" in all 50 US states had advised that "the use of conventional steel-jawed leghold restraining traps [in all 50 states] is being phased out within six years of the entry into force of the Agreement on Humane Trapping Standards between Canada, the European Community and the Russian Federation."[30] That Agreement entered into force in July, 2008. Seven years later, steel-jawed leghold traps remain the most commonly used traps in America.

3) *My experience with The Humane Society of the United States has been overwhelmingly positive. In my own state of New Jersey, I have seen The HSUS's disaster team mobilize to provide critical on-the-ground care to animals affected by Hurricane Sandy. And in addition to disaster response, I know the Humane Society works to protect animals across the United States in a wide variety of ways – from promoting humane legislation here on Capitol Hill to working in the trenches with law enforcement on animal fighting raids. But judging by our recent hearing, it's clear to me that not everyone understands the true scope and significance of your organization's efforts. Would you please provide us with additional information on the mission of The Humane Society of the United States and tell us more about its work?*

The Humane Society of the United States and our affiliates provide direct care to more than 100,000 animals each year—more than any other animal welfare organization—through our sanctuaries, veterinary programs, and emergency shelters and rescues. We work to professionalize the field of animal care with our education and training programs.

We confront the largest national and international problems facing animals, which local shelters don't have the reach or the resources to take on, such as animal fighting, puppy mills, horse slaughter and soring, seal killing and other forms of commercial slaughter of marine mammals, captive hunting and the wildlife trade, and inhumane slaughter and factory farming.

While we come to the aid of animals in crisis, we also attack the root causes of problems. Our most important goal is to prevent animals from getting into situations of distress in the first place. We drive transformational change for animals—bringing a wide set of tools to take on the biggest fights, confronting multi-billion dollar industries, and staying the course until we achieve reform. Here are some of the things that The HSUS has accomplished:

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[28] Council Regulation (EEC) No 3254/91 of 4 November 1991 prohibiting the use of leghold traps in the Community and the introduction into the Community of pelts and manufactured goods of certain wild animal species originating in countries which catch them by means of leghold traps or trapping methods which do not meet international humane trapping standards, *available at* http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31991R3254.

[29] *Id.*

[30] *See* Side letter from Donald Kursch, US Charge D'Affaires, Brussels (Dec. 18, 1997), in Official Journal of the European Communities, L 219/35, *available at* http://ec.europa.eu/environment/biodiversity/animal_welfare/hts/pdf/l_21919980807en00260037.pdf.

- **Changing the landscape on animal cruelty.** In the mid-1980s, only four U.S. states had felony penalties for malicious animal cruelty. We methodically went state-by-state to change the status quo, and now all 50 states have felony animal cruelty laws. We've also passed federal laws prohibiting animal crush videos and other forms of animal cruelty.

- **Changing the landscape on animal fighting.** When we began our animal fighting campaign in the 1980s, only a dozen states had felony dogfighting statutes and a half dozen still permitted cockfighting. We lobbied state legislatures, and passed ballot measures against cockfighting in Arizona, Missouri, and Oklahoma, to make cockfighting illegal in every state and dogfighting a felony in every state. We also persuaded the U.S. Congress to upgrade the federal animal fighting statute *four* times in the last 12 years, making it a federal felony to fight animals, possess them for fighting, or to bring a child to an animal fighting spectacle.

- **Ending extreme confinement of farm animals.** In 2008, the vast majority of U.S. veal calves, breeding pigs, and egg-laying hens were kept in crates or cages so small that they couldn't extend their limbs – or sometimes even turn around. We won a ballot measure in California in 2008 to outlaw extreme confinement systems, winning more votes in California than Obama. Ten states now ban some forms of extreme confinement of farm animals. We've worked with more than 60 major food companies – from Costco and Kroger to McDonald's and Subway – to eliminate crate confinement from their pork supply, or cage confinement from their egg supply. And we've recently worked with some of the world's largest food companies – including Compass Group, Nestle, and Starbucks – to implement comprehensive animal welfare sourcing policies.

- **Protecting the oceans for marine animals.** Since The HSUS lobbied for the Marine Mammal Protection Act in 1972, the organization has expanded protections for dolphins, seals, sharks, whales, and other ocean creatures. Our Canadian seal hunt campaign has reduced the number of seal pups slaughtered every year, and recently prompted the European Union to ban the import of seal products. We've worked at the International Whaling Commission to end whaling, and our international affiliate incubated the legal theory that recently led the International Court of Justice to end Japan's Southern Ocean whaling program. We've worked to protect the U.S. dolphin safe tuna program, and to ban the trade in shark fins in nine states, drying up demand for the cruel practice of shark finning.

- **Saving animals from shelter euthanasia.** In 1970, American shelters euthanized about 15 million cats and dogs every year, in large part because most cats and dogs were not spayed and neutered. We ran an aggressive campaign to normalize spay and neuter, promote adoption from shelters, crack down on puppy mills, and help shelters reduce euthanasia numbers. Today, approximately three million adoptable cats and dogs are euthanized in shelters every year, and 87 percent of American cats and dogs are spayed and neutered. Of course, we won't stop until shelters stop euthanizing healthy and adoptable cats and dogs.

We take a mainstream approach and combat the most severe forms of cruelty and abuse. Leaders in the humane movement ranked us the most effective animal organization in the country, in a survey conducted by Guidestar's Philanthropedia. We are approved by the Better Business Bureau's Wise Giving Alliance for all 20 standards for charity accountability, and were named by Worth Magazine as one of the 10 most fiscally responsible charities in America.

HSUS donors expect us to protect all animals – not just to give grants to local shelters – and the results outlined above are the true return on their investment in our work. It is the difference between helping a few million animals in this country, versus helping hundreds of millions or even billions of animals.

The Humane Society of the United States' logo depicts 19 animals in the shape of the United States, making clear that we work for all animals everywhere.

<u>Senator Sullivan</u>:

1) Are you personally opposed to hunting or do you, as the President of the Humane Society of the United States, an organization whose sole focus is animal welfare, have a different position than the organization you lead?

The Humane Society of the United States and I are not opposed to hunting. We are opposed to the most inhumane and unfair sport hunting practices, such as the use of body-gripping traps and snares; bear baiting; the hound hunting of bears, bobcats, mountain lions and wolves; contest killing events; and captive-hunting on fenced properties. We oppose live pigeon shoots and other forms of staged hunting where the animals are bred or stocked simply to be shot at as living targets. We also oppose the trophy hunting of rare or endangered populations and the use of lead ammunition, since less toxic alternatives are workable and available in the marketplace.[31] We routinely work with hunters who agree with us that certain practices are inhumane and unacceptable, and we have hunters in leadership positions in our organization, such as on our National Council.

Our critics use a worn-out strategy to divert attention from the issues by recycling a series of old quotes of questionable provenance that I allegedly made while in college and in my first job out of college. These quotes of course are irrelevant to the issue at hand – whether to enact the Sportsmen's Act of 2015. And none represent my view or the view of the HSUS – it is telling that our opponents do not cite a single quote from me, or anyone at the HSUS, opposing hunting during my 20 years with the organization. But the inclusion of these purported quotes (circa 1990), and similarly misleading statements made during the committee hearing, speak to a larger misrepresentation of our mission. I don't know whether this misrepresentation is due to

[31] *See* HSUS Statement on Wild Animals, *available at* http://www.humanesociety.org/about/policy_statements/statement_wild_animals.html.

disagreements about captive hunting, polar bear trophy hunting, and live pigeon shoots,[32] or due to a simple misapprehension of our mission.

But it is clear that the likely source of these quotes, and the misleading statements made during the committee hearing, is a front group calling itself the Center for Consumer Freedom (CCF). Indeed, the EPW Majority Twitter account has been used in recent weeks to link to a website operated by the CCF, which repeats libelous allegations against our organization.[33] The CCF and its operator, former tobacco lobbyist Rick Berman, have been the subject of repeated exposes by 60 Minutes,[34] The Hill,[35] The New York Times,[36] Bloomberg,[37] and The Boston Globe.[38] Their business model is simple – to tar the reputation of America's most respected charities and agencies on behalf of special interests who want to silence them. The CCF and Mr. Berman have previously attacked the American Medical Association, Mothers Against Drunk Driving, the Centers for Disease Control and Prevention, and even the National Center on Addiction and Substance Abuse.[39] It's no mystery why this group is slandering us – we have dared to take on the puppy mill, horse soring, Canadian seal clubbing, trophy hunting and trapping, factory farming, and animal fighting industries. Our concern is that they misled a member of this Committee into repeating their slanderous allegations.

2) In your testimony you stated that HSUS does not oppose hunting. However, banning all or a vast majority of viable methods of take is the functional equivalent of banning hunting. Please submit for the record a comprehensive list of the methods of take, species and any other kinds of

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[32] *Compare* "Oklahoma Senator Holds Live Pigeon-Shooting Fundraiser – Video," *The Guardian*, Sept. 24, 2014, *available at* http://www.theguardian.com/world/video/2014/sep/24/senator-inhofe-oklahoma-pigeon-shoot-video (video depicting event in Oklahoma, in which participants willfully shoot at live subjugated pigeons, killing, maiming, and mutilating them) *with* 21 Okla. Code §1685 ("Any person who shall willfully … destroy or kill, or … maim or mutilate, any animal in subjugation or captivity, whether wild or tame, and whether belonging to himself or to another … or who shall … engage in, or in any way further any act of cruelty to any animal, or any act tending to produce such cruelty, shall be guilty of a felony and shall be punished by imprisonment in the State Penitentiary not exceeding five (5) years, or by imprisonment in the county jail not exceeding one (1) year, or by a fine not exceeding Five Hundred Dollars ($500.00)").

[33] *See* EPW Majority Twitter Account: "We appreciate @Humane_Watch bringing attention to the flawed practices of the @HumaneSociety: tinyurl.com/psyj2du ," Mar. 26, 2015, *available at* https://mobile.twitter.com/EPWRepublicans/status/581195802695041024.

[34] "Meet Dr. Evil," CBS 60 Minutes, Sept. 16, 2007, *available at* http://www.cbsnews.com/videos/meet-dr-evil/.

[35] Laura Barron-Lopez, "Oil Industry Advised to Play Dirty with Greens," The Hill, Oct. 31, 2014, *available at* http://thehill.com/policy/energy-environment/222421-vet-lobbyist-either-win-ugly-or-lose-pretty-in-fight-with-greens.

[36] Eric Lipton, "Hard-Nosed Advice From Veteran Lobbyist: 'Win Ugly or Lose Pretty'; Richard Berman Energy Industry Talk Secretly Taped," The New York Times, Oct. 30, 2014, *available at* http://www.nytimes.com/2014/10/31/us/politics/pr-executives-western-energy-alliance-speech-taped.html?_r=2.

[37] Mark Drajem and Brian Wingfield, "Union Busting by Profiting From Non-Profit May Breach IRS," Bloomberg, Nov. 2, 2012, *available at* http://www.bloomberg.com/news/2012-11-02/union-busting-by-profiting-from-non-profit-may-breach-irs.html.

[38] Michael Kranish, "Washington's Robust Market for Attacks, Half-Truths," The Boston Globe, May 19, 2013, *available at* http://www.bostonglobe.com/news/politics/2013/05/18/corporations-anonymously-fund-attacks-and-influence-washington-policy-through-nonprofit-groups/qyaJIFcv7yYOsQvya6ykAK/story.html.

[39] William Saletan, "Mad at MADD: Alcohol Merchants Say You Shouldn't Donate to Mothers Against Drunk Driving. Really?" Slate, Aug. 29, 2011, *available at* http://www.slate.com/articles/health_and_science/human_nature/2011/08/mad_at_madd.html.

hunting that HSUS opposes as well as what projected impact it would have on hunting nationally or in a given area if the opposed method is site-specific.

We oppose the most inhumane and unfair sport hunting practices, such as the use of body-gripping traps and snares; bear baiting; the hound hunting of bears, bobcats, mountain lions and wolves; contest killing events; and captive-hunting on fenced properties. We oppose live pigeon shoots and other forms of staged hunting where the animals are bred or stocked simply to be shot at as living targets. We also oppose the trophy hunting of rare or endangered populations and the use of lead ammunition, since less toxic alternatives are workable and widely available.[40]

The primary impact of ending these practices on hunting nationally would be to not allow the broader enterprise of hunting to be tarred by the most unsporting, inhumane, and publicly unacceptable practices. Traditional rank-and-file hunters reject trophy hunting and trapping practices that cause animals to needlessly suffer, devalue animal life, and deplete rare and endangered populations of animals. For instance, the Boone and Crocket Club's hunting ethics statement provides that the hunter must pursue his prey "in a manner that does not give the hunter an improper advantage over such animals."[41] Live pigeon shoots, hunting with GPS-tracked hounds, bear baiting, captive-hunting, and contest killing events all fail that standard.

Indeed, where states have ended particularly inhumane and unsporting trophy hunting practices, the number of traditional hunters has increased. For example, after Colorado banned the baiting and hounding of bears, the number of bear hunters in the state tripled. Similarly when Oregon and Washington banned the baiting and hounding of bears, Oregon bear tag sales tripled and Washington resident license sales shot up by 343 percent. Traditional hunters do not want to compete against trophy hunters operating at an unfair disadvantage or to take part in an activity tarnished by these extreme and unsporting hunting methods.

Ending the use of steel-jawed leghold traps would also protect hunters' dogs, who are often caught in traps, sometimes fatally. For instance, in Minnesota alone, the Department of Natural Resources says 75 dogs have been caught in traps and snares since 2012, and 17 have died.[42] The Ruffed Grouse Society is supporting increased trapping regulations in Minnesota, with a spokesman for the group explaining that "I've heard from many members who say they quit hunting when the trapping season starts," out of fear for their dogs' safety.[43]

Phasing out the use of toxic lead ammunition would have little effect on hunters, other than helping them to conserve public lands and prevent the toxic poisoning of more than 130 species. A single ingested shotgun pellet or bullet fragment is sufficient to cause brain damage in birds, resulting in inhibition of critical neuromuscular, auditory and visual responses.[44] Studies have

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[40] *See* HSUS Statement on Wild Animals, *available at* http://www.humanesociety.org/about/policy_statements/statement_wild_animals.html.
[41] The Boone and Crocket Club, "Fair Chase Statement," *available at* http://www.boone-crockett.org/huntingEthics/ethics_fairchase.asp?area=huntingEthics.
[42] Doug Smith, "Ruffed Grouse Society Supports Minnesota Trapping Bill to Reduce Dog Deaths," Minnesota Star Tribune, Apr. 2, 2015, *available at* http://www.startribune.com/sports/blogs/298486391.html.
[43] *Id*.
[44] MP Dieter and MT Hohman, "∂-Aminolevulinic Acid Dehydratase Enzyme Activity in Blood, Brain, and Liver of Lead-Dosed Ducks," 19 Environ. Res. 127–135 (1979).

shown that hunters could easily transition to the widely available and effective non-lead alternatives. A newly released study comparing lead ammunition and non-lead alternatives in a double-blind field test in mourning dove hunting in central Texas concluded that non-lead ammunition performed at least as well as lead ammunition.[45] It also found that "[h]unters were unable to distinguish the ammunition type being used in the field, and we detected no relationship between ammunition type and level of hunter satisfaction."[46] The U.S. Fish and Wildlife Service prohibited the use of lead ammunition for waterfowl hunting more than 20 years ago, and most hunters look back and say that was the right decision for their sport.

3) What methods of take, species and any other kinds of hunting does HSUS support?

The HSUS only opposes the most inhumane and unfair sport hunting practices and the trophy hunting of rare or endangered populations. The HSUS does not oppose fair chase hunting performed humanely and in line with traditional hunting ethics.

4) Does HSUS believe that wildlife management decisions, such as the setting of hunting seasons and allowable methods of take, are better managed at the ballot box and in state legislatures or wildlife management agencies?

We support wildlife management that is supported by the best available science and traditional conservation ethics. We work closely with wildlife management agencies all across the country to implement those principles and enforce state wildlife laws. Through our poaching rewards program, we and our affiliates have now offered almost $500,000 in rewards for the arrest and conviction of poachers in conjunction with state wildlife agencies.[47]

But we also respect the U.S. Constitution and state constitutions, which establish a system of checks and balances, granting the people and their elected representatives the ultimate authority to direct administrative agencies. Of course, these agencies exist to implement the policy decisions made by the citizens and their elected representatives. We thus work to ensure that these agencies respect the wish of the majority of Americans – including the tens of millions of American who hike and watch wildlife but do not hunt or trap – that all wild animals be treated humanely and with dignity. And we resist efforts by trophy hunting and trapping groups to pack agencies with ideological appointees who have no prior background in wildlife management, and to immunize their decisions from legislative oversight. We believe that the people and their representatives should not cede authority over wildlife management decisions to unaccountable agencies – any more than this Committee would cede authority over environmental management decisions to the EPA.

We therefore also oppose efforts by trophy hunting and trapping groups to rewrite state constitutions to strip citizens of their right to have a democratic say on wildlife issues. We were pleased to work with so many Oklahomans in 2002 to defeat a referendum that sought to do this

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[45] BL Pierce, TA Roster, MC Frisbie, CD Mason, and JA Roberson Pierce, "A Comparison of Lead and Steel Shot Loads for Harvesting Mourning Doves," Wildlife Society Bulletin 39:1, 103–115 (March 2015).
[46] *Id*. at 103.
[47] *See* Humane Society Wildlife Land Trust, "Anti-Poaching Rewards Program," *available at* http://www.hswlt.org/wildlife-abuse/anti-poaching-rewards-program.html

very thing. We can only assume that these groups fear the say of citizens on certain extreme hunting and trapping methods – such as the use of steel-jawed leghold traps and live pigeon shoots – because they know that these methods are publicly indefensible.

5) Your testimony emphasized the human health risks associated with consuming game harvested with traditional ammunition. Please detail, with supporting evidence, all of the documented cases you are aware of where eating game harvested with traditional ammunition has directly caused someone to get lead poisoning.

Thank you for drawing attention to the human health risks associated with the use of lead ammunition in hunting. In 2013, 30 of the nation's, and the world's, leading environmental health and lead scientists issued an evidence-based consensus statement on the human and wildlife health risks directly caused by lead ammunition. They cited significant scientific evidence finding that:

> Lead-based ammunition is a significant source of lead exposure in humans that ingest wild game (Hanning et al., 2003; Levesque et al., 2003; Johansen et al., 2006; Tsuji et al., 2008), and hunters consuming meat shot with lead-based ammunition have been shown to have lead pellets/fragments in their gastrointestinal tract (Carey, 1977; Reddy, 1985).[48]

Based on these findings, these experts – including distinguished scientists at Harvard Medical School, Mount Sinai School of Medicine, Cambridge University, the University of California, and Johns Hopkins University – concluded that:

> We, the undersigned, with scientific expertise in lead and environmental health, endorse the overwhelming scientific evidence on the toxic effects of lead on human and wildlife health. In light of this evidence, we support the reduction and eventual elimination of lead released to the environment through the discharge of lead-based ammunition, in order to protect human and environmental health.[49]

I encourage you to read the full consensus statement, which I have attached to my testimony. This consensus statement by the nation's leading scientists echoes the results of numerous scientific studies, which have documented the human health risks associated with consuming meat from animals killed with lead ammunition. These studies concluded, in part:

- *"Lead ammunition or lead fishing sinkers are commonly implicated as the primary exposure source of elevated [blood lead levels] in Alaska*," according to a 2009 meta-analysis by researchers with the Alaska Department of Health and Social Services, Alaska Native Tribal Health Consortium, and the US Fish and Wildlife Service.[50] The

[48] Health Risks from Lead-Based Ammunition in the Environment—A Consensus Statement of Scientists (2013), *available at* http://escholarship.org/uc/item/6dq3h64x.
[49] *Id.*
[50] LA Verbrugge, SG Wenzel, JE Berner, and AC Matz, "Human Exposure to Lead from Ammunition in the Circumpolar North," Paper presented at "Ingestion of Lead From Spent Ammunition: Implications For Wildlife And Humans," in Boise, Idaho (May 12-15, 2008), at 131 (emphasis added).

study also noted that "it is not surprising that people who consume game shot with lead can also have elevated blood lead levels. Numerous studies at both the population and individual levels have implicated and linked lead ammunition to elevated blood lead levels and clinical symptoms in northern peoples."[51] The study concluded that "use of lead in ammunition comes with risks to humans, especially children, which do not occur with non-lead substitutes," and recommended "education on the dangers of lead from ammunition to both humans and the environment." [52]

- "[P]eople risk exposure to lead from bullet fragments when they eat venison from deer killed with standard lead-based rifle bullets and processed under normal procedures. *At risk in the U.S. are some ten million hunters, their families, and low-income beneficiaries of venison donations*," according to a 2009 study conducted at the Washington Animal Disease Diagnostic Laboratory.[53] In particular, the study found that the levels of lead exposure required to cause human mortality and intellectual impairment "would appear attainable with the repeated consumption of venison possible among deer hunting families, especially those incurring additional exposure from other sources."[54]
- *"[T]he consumption of wild game was significantly associated with an increase in PbB [blood lead levels]*" in a 2008 study by researchers with the U.S. Centers for Disease Control and Prevention of 736 North Dakotans.[55] The highest blood lead levels were found amongst participants who consumed all three game types tracked (venison, birds, and other game). Although the study noted the need for further research, it cautioned that "due to increased rate of lead absorption, children as a whole may potentially be more vulnerable to exposure to lead from wild game consumption."[56]
- "[C]onsuming venison with 21.8 mg/kg (hunter samples) lead every 15 days will result in 90 % of children less than 7 years old having blood lead greater than the 10 µg/dL level of concern," according to a 2008 study by the Wisconsin Department of Health and Family Services. [57] As a comparison point, blood lead levels of just 5-10 µg/dL in 30 month-old children are associated with a reduction in SAT grades later in life.[58] Based on these results, "*DHS recommends the use of non-lead ammunition as the simplest and most effective solution to lead poisoning, in both humans and wildlife, arising from the consumption of deer killed with lead ammunition*. To address this issue, DHFS recommends the eventual transition to non-lead ammunition."[59]

In 2009, *Scientific American* summarized these studies: "New research, however, has shown that eating venison and other game can substantially raise the amounts of lead in human bodies. The

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[51] *Id*. at 130.
[52] *Id*. at 132-33.
[53] WG Hunt, RT Watson, JL Oaks, CN Parish, KK Burnham, RL Tucker, JR Belthoff, and G. Hart, "Lead Bullet Fragments in Venison from Rifle-Killed Deer: Potential For Human Dietary Exposure," PLoS ONE 4(4): e5330 (2009), at 1 (emphasis added).
[54] *Id*. at 7.
[55] S Iqbal, K Loringer, and W Blumenthal, "North Dakota Lead Exposure Study," U.S. Centers for Disease Control and Prevention (Oct. 18, 2008), at 8 (emphasis added).
[56] *Id*. at 11
[57] Wisconsin Department of Health and Family Services, "Health Consultation: The Potential for Ingestion Exposure to Lead Fragments in Venison in Wisconsin" (Nov. 4, 2008), at 5.
[58] DJ Pain, RL Cromie, J Newth, MJ Brown, E Crutcher, et al., "Potential Hazard to Human Health from Exposure to Fragments of Lead Bullets and Shot in the Tissues of Game Animals," PLoS ONE 5(4): e10315 (2010), at 16.
[59] *Supra* note 57, at 7 (emphasis added).

findings have prompted some experts to recommend bans on lead ammunition."[60] Four years later, 15 of the nation's top environmental health scientists wrote in a 2013 editorial in *Environmental Health*: "No rational deliberation about the use of lead-based ammunition can ignore the overwhelming evidence for the toxic effects of lead, or that the discharge of lead bullets and shot into the environment poses significant risks of lead exposure to humans and wildlife."[61]

The fact that politicians would question this weight of scientific evidence shows the importance of letting scientists make decisions about lead ammunition. Unfortunately, the Sportsmen's Act would strip the experts at the EPA of the authority to regulate lead ammunition and lead fishing tackle. It is odd, to say the least, that hunting groups – which normally profess to be guided by science in wildlife management decisions – would support a provision that would stop experts from acting on the best available science on lead ammunition.

6) Would you support hunting if it's done with alternative ammunition that does not contain lead?

We do not oppose traditional sport hunting done with non-lead ammunition. Our opposition is to the inhumane and unfair sporting practices detailed elsewhere in this testimony, and explicitly to the use of lead ammunition, which the nation's leading scientists have found "poses significant health risks to humans and wildlife."[62]

7) Your testimony said HSUS has never opposed hunting for deer, birds and small animals. Yet, you have opposed the hunting of bears, wolves and other species. What is the moral rationale for the Humane Society of the United States being opposed to hunting some species and not others?

We have long opposed the hunting of animals killed solely for trophies as well as by methods that are inhumane and unsporting. As such, we have opposed the baiting, hounding, and trapping of black bears because all three practices are inhumane, unsporting, and unnecessary. Hunter Ted Williams described bear baiting: "Here's how it works: Your guide or outfitter festoons the woods with garbage, then plants you (often in a folding chair) a few yards from a bait site that's being 'hit.' When the bear shows up, you 'harvest' it…. Once hooked on garbage, bears learn to seek it around human dwellings and campsites."[63] He quotes former Minnesota Governor Jesse Ventura, who said of bear baiting: "Going out there and putting jelly doughnuts down, and Yogi comes up and sits there and thinks he's found the mother lode for five days in a row—and then you back-shoot him from a tree? . . . That ain't sport—that's an assassination."[64]

We have opposed the trophy hunting and trapping of wolves because we oppose the trophy hunting of all rare and endangered populations of animals. Responsible hunters eat what they

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[60] Scott Streater, "Wild Meat Raises Lead Exposure," Scientific American, Sept. 28, 2009, *available at* http://www.scientificamerican.com/article/wild-game-deer-venison-condors-meat-lead-ammunition-ban/.
[61] D Bellinger et al., "Health Risks from Lead-Based Ammunition in the Environment," 121 Environ. Health Perspective 178-179 (2013).
[62] Health Risks from Lead-Based Ammunition in the Environment—A Consensus Statement of Scientists (2013).
[63] Ted Williams, "Bad News Bear Hunters: How Can There Be a "Thrill of The Chase" When There's No Chase?" Audubon Magazine, Sept. 2005, *available at* http://archive.audubonmagazine.org/incite/incite0509.html.
[64] *Id*.

kill, and nobody eats wolves. Wolves are still recovering from near extinction at the hands of trophy hunters and trappers over the last 150 years, and today occupy just five percent of their historic range. Two federal courts recently found that efforts to delist gray wolves from their protections under the Endangered Species Act were not justified by the best available science. We strongly oppose Congressional delisting attempts, which seek to override those court rulings and the science.

In line with our policy, we will continue to oppose the most inhumane and unfair sport hunting practices, the trophy hunting of rare or endangered populations, and the use of lead ammunition. But we have not, do not, and will not oppose hunting in general.

8) Does HSUS support recreational fishing? Are there methods you oppose? If so please detail those methods.

The HSUS has no policy on recreational fishing, and never has had one.

9) In the course of the hearing, you said that your ads have a disclaimer stating that the money will not be used to fund animal shelters. What percentage of your 2014 TV ads explicitly (not implicitly) state that none or only a portion of the funding raised by your ads will be used to support local animal shelters?

We run limited TV ads, all of which state that local humane societies are independent from The HSUS – including 100 percent of our ads in 2014. All of our ads contain images of animals directly helped by our organization, focus exclusively on our programs, and make clear that we use donations to help all animals. The ads also prominently display our logo, which features 19 different animals in the shape of the United States, again emphasizing our comprehensive and national focus. *Our TV ads neither show animal shelters, nor do they have any dialogue about animal shelters – the only reference to shelters is our voluntary mention that they are independent from the HSUS*. This whole issue is a contrivance of the CCF. We urge our critics who repeat the CCF's falsehoods to actually watch our ads, and not conflate them with ads from other organizations.

10) What is the exact language of disclaimers placed on HSUS television ads?

"Local humane societies are independent from The HSUS" or "Local humane societies are independent from HSUS"

11) What percentage of HSUS's television ads running in Oklahoma from 2011 to 2013 had this language?

To underscore precisely our role, we began including that language in our ads in 2011. To the best of our knowledge, that year 98.5 percent of the ads that ran nationally included the language, as have 100 percent of ours ads that have run nationally since.

12) What percentage of the fundraising television ads your organization is running nationally feature that language? What was the percentage in 2013 and 2014?

100 percent. The percentage in 2013 was 100 percent. The percentage in 2014 was also 100 percent.

13) Do you have similar disclaimer language on all of your direct mail solicitations? If not, why do you have it on some television ads but not on fundraising letters?

All of our direct mail solicitations are absolutely clear about the mission and work of our organization. Our direct mail packages feature letters that clearly and consistently describe our mission as a national animal protection charity that works to protect all animals. For example, our direct mail pieces outline our work with law enforcement to rescue animals from dogfights, dog meat farms, cockfights, puppy mills, and hoarders; our education work to encourage people to make humane choices, like adopting animals or choosing responsible breeders; our corporate engagement work to move retailers away from fur, cosmetics tested on animals, and pork and eggs from facilities that use gestation crates and battery cages; and our advocacy work to crack down on egregious cruelty to animals, animal fighting, puppy mills, factory farms, the Canadian seal slaughter and other abusive practices.

In short, our direct mail accurately explains the breadth of work we do every day for all animals. Indeed, it is telling that neither the CCF nor our other adversaries have ever cited a single piece of our direct mail that suggests we run local animal shelters. We are confident that no donor who opens and reads our mail could have any doubt whatsoever about our mission. I have received a number of solicitation letters from U.S. Senators and I have never seen a disclaimer stating that they are not my state senator. We think our direct mail is equally clear about who we are.

14) Do you have similar disclaimer language offered upfront in all of your telephone solicitations? If not, why not?

Our very limited telephone solicitations are also absolutely clear about the mission and work of our organization. Our callers describe actual HSUS programs and ask donors to support them. We are confident that no donor who has a conversation with one of our agents would think we are an organization that runs local animal shelters. Indeed, most of our calls ask for support on specific campaigns we are working on. For instance, our most recent telephone solicitation asked for help with our efforts to rescue dogs from horrific cruelty on South Korean dog meat farms.

15) Do you think having "Humane Society" in your name coupled with ads featuring mostly dogs and cats perpetuates confusion among donors who think HSUS is actually running pet shelters?

The HSUS is absolutely clear about our mission, which remains identical to our mission when we were founded in 1954: to prevent cruelty to all animals, everywhere in the United States. The notion that the HSUS – or the American Humane Association or the American Society of Prevention of Cruelty to Animals for that matter – should focus exclusively on shelter animals misunderstands the history and purpose of the organization. Our name preceded that of many local humane societies, and has always described our work as a society working for the humane treatment of all animals.

The HSUS and its affiliates do directly care for over 100,000 animals every year – more than any other animal group – and run one of the nation's largest animal sanctuaries, horse sanctuaries, and wildlife rehabilitation centers. In terms of animal care, we do it directly – although we give out some grants, we do not rely solely on making grants to local shelters. But we focus on preventing animals from ending up in shelters, sanctuaries, and care centers in the first place.

In that vein, our ads do feature dogs and cats that we rescue from appalling conditions in puppy mills, dog fighting rings, natural disasters, and hoarding situations – and no group does more for animals in these situations than the HSUS and its affiliates. But ours ads also feature cows whose abuse at slaughterhouses we have exposed through undercover investigations, chimpanzees whose retirement from laboratories to sanctuaries we have helped to secure, and so many other animals benefited by our programs. In short, our ads reflect the diversity of our work for all animals. The notion that our television ads are in any way misleading is a fiction invented by political opponents of the HSUS and propagated by the CCF and Mr. Berman.

To our knowledge, no member of this Committee is asking the National Rifle Association whether its donors are confused into thinking that the group only works on rifles. Nor is anyone asking whether the American Farm Bureau or Safari Club International's donors are confused into thinking that the group runs local farms or international safaris. The accusations being made against the HSUS are equally simplistic and overly literal. Frankly, creating a humane society is a much broader concept that includes compassion toward all creatures.

16) Would you be willing to include a clear message in all of your fundraising, advertising and materials that clarifies that HSUS doesn't run pet shelters?

Our messaging focuses on the positive accomplishments of the HSUS and the work we are actively engaged in to help all animals. The notion that we have ever represented ourselves as a foundation for pet shelters is a fabrication invented by groups threatened by our anti-cruelty programs and propagated by the CCF. None of our ads show pet shelters or discuss the work of pet shelters. Instead our materials make clear that we work to help all animals: to stop animal fighting, end the dog meat trade, rescue animals in crisis, crack down on puppy mills, end cruelty on factory farms, prevent cruel and unsporting hunting and trapping practices, end the Canadian seal slaughter, stop horse slaughter and horse soring, and prevent so many other large-scale abuses of animals. If there is any group that should be subject of tough questions, it is the CCF, which masquerades as a non-profit while funneling the majority of its funds to a for-profit PR company wholly owned by its founder.[65]

Moreover, the notion that the government, acting at the behest of groups like the CCF, would try to dictate the content of our materials is alarming. Chief Justice Roberts, writing for the Court,

[65] *See* Mark Drajem and Brian Wingfield, "Union Busting by Profiting From Non-Profit May Breach IRS," Bloomberg, Nov. 2, 2012, *available at* http://www.bloomberg.com/news/2012-11-02/union-busting-by-profiting-from-non-profit-may-breach-irs.html.

recently reaffirmed the "basic First Amendment principle that 'freedom of speech prohibits the government from telling people what they must say.'"[66]

For those people who are genuinely curious and want to learn more about our work, we have information prominently available for them. For example, in the "Frequently Asked Questions" section on our website, the first question is "What does The HSUS do?" and the second question is "How is The HSUS affiliated with my local humane society?"[67] We tell people on this page:

> "Local humane societies and SPCAs are independent entities and are not run by The HSUS or any other national entity. The HSUS works with local humane societies and supports their work through training, evaluations, publications, and other professional services."
>
> "Additionally, The HSUS operates its own network of animal sanctuaries and rescue operations, providing emergency care and homes to more animals than any other organization in the United States."

17) Do you have any reason to believe that your donors are unaware of how little support HSUS gives in direct funding to shelters?

Our donors support the HSUS because they believe in our mission to help all animals. Our donors know this is our mission – a point reinforced by our monthly magazine, entitled *All Animals*, and our logo, which consists of 19 animals in the shape of the United States. The CCF and its allies have been attacking us for a decade, but our support continues to grow. That's the best indication that the public not only understands our mission, but is enthusiastic about it.

Our donors also know that we provide extensive support to local shelters. I'm writing the answers to these questions while at Animal Care Expo, the world's largest conference for animal shelter professionals. We run this conference every year, as well as publishing a magazine, *Animal Sheltering*, and providing extensive training and advocacy work on behalf of local shelters. But our primary focus for companion animals is on preventing animals from ending up in shelters in the first place. Through our innovative Pets for Life program we are working to keep pets in homes, and out of shelters, in some of the most underserved communities across the United States. Through our rural veterinary service programs, we are partnering with veterinarians to provide free and low cost spay and neuter to underserved rural communities. And through our partnership with the Ad Council and Maddie's Fund on the Shelter Pet Project, we've now secured over $240 million in donated media to promote adoption and reduce intakes for local shelters – a program on a scale that local groups could never run on their own. The Shelter Pet Project's most recent advertisements, in partnership with the Walt Disney Company, feature Disney princesses educating children on the importance of adopting from local shelters.

18) Do you believe that your fundraising takes away from local humane societies?

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[66] *Agency for International Development v. Alliance for Open Society Int'l, Inc.*, 570 U.S. ___, slip op. at 6 (2013) (citing *Rumsfeld v. Forum for Academic and Institutional Rights, Inc.*, 547 U. S. 47, 61 (2006); *West Virginia Bd. of Ed.v. Barnette*, 319 U. S. 624, 642 (1943); and *Wooley v. Maynard*, 430 U. S. 705, 717 (1977))

[67] *See* http://www.humanesociety.org/about/contact/frequently_asked_questions.html.

Absolutely not. Americans are charitable people, and their compassion and generosity is not a zero sum game. As we draw attention to the horrific cruelty suffered by too many animals, Americans become more willing to donate to all animal groups, from local shelters to national groups seeking to prevent cruelty. The HSUS' budget accounts for just a fraction of the billions of dollars that compassionate Americans donate every year to animal groups – primarily to local shelters and rescue groups. These local groups understand that the HSUS plays a critical role in preventing cruelty to all animals on a national scale, and in particular in addressing the root causes of the pet overpopulation problem that shelters confront every day. When General Motors does advertising, it helps local car dealerships. When the NRA raises issues, it helps local gun clubs. When a high profile Presidential candidate runs, it helps candidates down the ballot. And when the HSUS advertises and draws attention to animal care issues, it helps local shelters and rescue groups. Our members typically support multiple animal-related charities, in addition to non-animal charities such as their church or other nonprofits.

19) What percentage of the HSUS budget is dedicated to banning methods of hunting vs funding animal shelters?

The HSUS is a charity, not a foundation. As such, we work to prevent cruelty through programs, not through grants. We devote resources both to assisting animal shelters and to opposing cruel and unsporting hunting and trapping practices. In particular, we devote extensive resources to running the Animal Care Expo, publishing *Animal Sheltering* magazine, advocating for the interests of local shelters, shutting down puppy mills that contribute to the pet overpopulation crisis, and running Pets for Life and other programs designed to stem the flow of animals into local shelters. Our guiding principle is that we put our budget to the best use to fight cruelty to animals, regardless of the special interest conducting that cruelty, or the power of their political allies seeking to protect them.

20) Are you aware that polar bear imports under these alleged "carve-outs" have generated almost $1 million dollars for polar bear research and management over the last 10 years, and that S. 659 would generate an additional $40,000 for this purpose?

When a trophy hunter spends $30,000 to $50,000 to shoot a polar bear, the hefty fees prompt over-exploitation of already vulnerable populations of bears. Most of this money is pocketed by commercial guides and outfitters and spent on transportation, hunting gear, and other incidentals—not on conservation. Moreover, this money also does not reach impoverished Inuit communities. The Nunavut newspaper, Nunatsiaq News, concluded in 2005 that "most of the [financial benefits from sport hunts] never reach Inuit hands."

And $40,000 cannot compensate for the harmful conservation effects of encouraging trophy hunters and trappers to kill threatened and endangered species as soon as they are proposed for listing, knowing they will subsequently be able to import the trophies. Congress' willingness to grant "one-time amnesties" for polar bear trophy hunters has encouraged trophy hunters to kill more threatened animals, store more trophies, and lobby more for the next "one-time" amnesty. This cycle needs to stop – Congress needs to send a clear signal that it will not indulge wealthy trophy hunters who come back year after year asking for amnesty.

The hearings convened by pro-trophy hunting politicians to discuss granting polar bear hunters special treatment have already cost the taxpayer far more than $40,000, and the processing of the permits will likely cost the FWS more than $40,000 again. Senator Whitehouse put it well in his statement during the hearing when he called this "probably the largest amount of Congressional attention ever devoted to the smallest issue in the history of Congress." The only reason so much Congressional attention has been devoted to this issue is that the hunters of the polar bear trophies are so wealthy. A special government exception for these wealthy polar bear trophy hunters would be a form of government amnesty for the wealthy that makes corporate welfare look good. This Committee needs to stand up to these special interests and reject their request for another amnesty from federal law.

21) If these alleged "carve-outs" have been detrimental to polar bears, why did the Fish and Wildlife Service for ten years approve imports of polar bears hunted from six populations, finding that Canada had scientifically sound quotas for these populations?

The Bush Administration in January, 2007, published a proposed rule to list the species as threatened after conducting a 262-page status review that rejected this very argument.[68] Thirteen of the fourteen peer reviewers to whom FWS submitted the proposed rule found that it "represented a thorough, clear, and balanced review of the best scientific information available from both published and unpublished sources of the current status of polar bears" and that it "justified the conclusion that polar bears face threats throughout their range."[69] The rule was also supported by the U.S. Geological Survey, which conducted "nine scientific reports that analyze and integrate a series of studies on polar bear population dynamics, range-wide habitat use, and changing sea ice conditions in the Arctic."[70]

Despite this huge volume of scientific evidence, trophy hunting groups led by Safari Club International sued the government to try to undo the rule. The federal district court and the D.C. Circuit Court of Appeals both rejected their arguments.[71] In an echo of how trophy hunting groups have misrepresented my positions, the appellate court noted that several of their arguments "rely on portions of the record taken out of context and blatantly ignore FWS's published explanations."[72] Having lost on the science before the agency and on the law before two courts, these groups are now trying to re-litigate their case in Congress. This Committee should not let them.

22) Are you aware that a Federal judge in California forced the Fish and Wildlife Service to make its listing and the consequent import ban effective immediately, as opposed to at least thirty days after the announcement, as is required by federal law, and most if not all of the polar bear imports at issue here could have been imported in that time?

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[68] *See* 12-Month Petition Finding and Proposed Rule to List the Polar Bear (Ursus maritimus) as Threatened Throughout Its Range, 72 Fed. Reg. 1064 (Jan. 9, 2007).
[69] *See* Determination of Threatened Status for the Polar Bear (Ursus maritimus) Throughout Its Range, 73 Fed. Reg. 28,212, 28,235 (May 15, 2008).
[70] *Id*. at 28,235.
[71] *See In re. Polar Bear Endangered Species Act Listing and § 4(d) Rule Litigation – MDL No. 1993* (DC Cir., Mar. 1, 2013), slip op.
[72] *Id*. at 15.

Senior Federal Judge Claudia Wilken did not act unlawfully in her ruling, as this question implies. In fact, Judge Wilken found that the FWS had allowed trophy hunters *far more time* than the Endangered Species Act required before implementing the import ban. Instead of 30 days' notice, the trophy hunters effectively received 16 months' notice of the impending ban on importing polar bear trophies. The Bush Administration proposed listing polar bears under the Act on January 9, 2007, but the ban only came into force in May, 2008. Judge Wilken concluded that "[t]o allow Defendants more time would violate the mandated listing deadlines under the ESA and congressional intent that time is of the essence in listing threatened species."[73]

Fully 40 of the 41 trophy hunters affected by this provision hunted polar bears in 2008, *more than a year* after the Bush Administration had proposed listing the species as threatened under the Act. They did so in spite of explicit warnings from hunting groups and government agencies not to. For example, in December 2007, the hunting group Conservation Force wrote, "American hunters are asking us whether they should even look at polar bear hunts in light of the current effort by the U.S. Fish & Wildlife Service to list this species as threatened … The bottom line is, no American hunter should be putting hard, non-returnable money down on a polar bear hunt at this point." It is hard to see how an additional 13 days – the import ban only took effect 17 days after the court opinion anyway – would have allowed any more trophy hunters to import their trophies. At the time, the average processing time for import applications was longer than 13 days. Of course, if these 41 trophy hunters had followed the advice of the government and hunting groups they would not now be lobbying Congress for an amnesty from federal law.

[73] *Center for Biological Diversity v. Kempthorne* (N.D. Cal., Apr. 28, 2008), slip op. at 7-8.

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Health Risks from Lead-Based Ammunition in the Environment

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Lead is one of the most studied toxicants, and overwhelming scientific evidence demonstrates that lead is toxic to several physiological systems in vertebrates, including the nervous, renal, cardiovascular, reproductive, immune, and hematologic systems (Health Risks from Lead-Based Ammunition in the Environment—A Consensus Statement of Scientists 2013). Furthermore, there is no level of lead exposure in children known to be without adverse effects [Centers for Disease Control and Prevention (CDC) 2012a, 2012b].

In light of this evidence, there is an urgent need to end a major source of lead for animals and humans: spent lead bullets and shotgun pellets. Notably, production of lead-based ammunition in the United States accounted for > 69,000 metric tons consumed in 2012; this is second only to the amount of lead used to manufacture storage batteries (U.S. Geological Survey 2013). However, there are few regulations regarding the release of lead into the environment through discharge of lead-based ammunition. For other major categories of lead consumption, such as lead batteries and sheet lead/lead pipes, environmental discharge and disposal are regulated. Therefore, lead-based ammunition is likely the greatest largely unregulated source of lead that is knowingly discharged into the environment in the United States. In contrast, the release or distribution of other major sources of environmental lead contamination (e.g., leaded gasoline, lead-based paint, lead solder) have been substantially regulated and reduced since the mid-1970s (Health Risks from Lead-Based Ammunition in the Environment—A Consensus Statement of Scientists 2013).

There is a national discussion—polarized at times—of the health risks posed to humans and wildlife from the discharge of lead-based ammunition. To inform this discussion, a group of 30 nationally and internationally recognized scientists with expertise regarding lead and environmental health recently collaborated to create an evidence-based consensus statement (Health Risks from Lead-Based Ammunition in the Environment—A Consensus Statement of Scientists 2013) supporting the reduction and eventual elimination of lead released to the environment through the discharge of lead-based ammunition.

The discharge of lead bullets and shotgun pellets into the environment poses significant health risks to humans and wildlife. The best available scientific evidence demonstrates that the discharge of lead-based ammunition substantially increases environmental lead levels, especially in areas with higher shooting activity (U.S. Environmetal Protection Agency 2012) and that the discharge of lead-based ammunition poses risks of elevated lead exposure to gun users (National Research Council 2012). When lead-containing bullets are used to shoot wildlife, they can fragment into hundreds of small pieces, many of which are small enough to be easily ingested by scavenging animals or to be retained in meat prepared for human consumption (Hunt et al. 2009; Knott et al. 2010; Pauli and Burkirk 2007). Consequently, lead-based ammunition may be a significant source of lead exposure in humans that regularly ingest wild game (Hanning et al. 2003; Johansen et al. 2006; Levesque et al. 2003; Tsuji et al. 2008). In addition, lead pellets and fragments have been reported in gastrointestinal tracts of hunters who consume meat from animals shot with lead-based ammunition (Carey 1977; Reddy 1985).

The use of lead pellets in shotgun shells for hunting waterfowl posed a serious threat to wetland birds, and secondarily to bald eagles, in the United States, leading to the U.S. Fish and Wildlife Service's 1991 nationwide regulations requiring use of nontoxic shotgun pellets for hunting waterfowl (Anderson 1992). However, lead poisoning from ingestion of spent lead-based ammunition fragments continues to pose a particularly serious health threat for scavenging species. These lead-containing fragments remain the principal source of lead exposure to endangered California condors and continue to prevent the successful recovery of these birds in the wild (Church et al. 2006; Finkelstein et al. 2012; Green et al. 2008; Parish et al. 2009; Rideout et al. 2012; Woods et al. 2007). Other wildlife species, such as golden eagles, bald eagles, ravens, turkey vultures, and pumas, are also exposed to the fragments of spent lead ammunition (Burco et al. 2012; Clark and Scheuhammer 2003; Craighead and Bedrosian 2008; Cruz-Martinez et al. 2012; Fisher et al. 2006; Kelly and Johnson 2011; Stauber et al. 2010; Wayland and Bollinger 1999).

No rational deliberation about the use of lead-based ammunition can ignore the overwhelming evidence for the toxic effects of lead, or that the discharge of lead bullets and shot into the environment poses significant risks of lead exposure to humans and wildlife. Given the availability of non-lead ammunition for shooting and hunting (Thomas 2013), the use of lead-based ammunition that introduces lead into the environment can be reduced and eventually eliminated. This seems to be a reasonable and equitable action to protect the health of humans and wildlife.

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Health Risks from Lead-Based Ammunition in the Environment

A Consensus Statement of Scientists

March 22, 2013

We, the undersigned, with scientific expertise in lead and environmental health, endorse the overwhelming scientific evidence on the toxic effects of lead on human and wildlife health. In light of this evidence, we support the reduction and eventual elimination of lead released to the environment through the discharge of lead-based ammunition, in order to protect human and environmental health.

1) Lead is one of the most well-studied of all anthropogenic toxins and there is overwhelming scientific evidence that demonstrates:
   a) Lead is toxic to multiple physiological systems in vertebrate organisms, including the central and peripheral nervous, renal, cardiovascular, reproductive, immune, and hematologic systems. Lead is also potentially carcinogenic; lead is officially recognized as a carcinogen and reproductive toxin in California, and the International Agency for Research on Cancer, the National Toxicology Program, and the US Environmental Protection Agency have identified lead as likely to be carcinogenic to humans.
   b) There is no level of lead exposure to children known to be without deleterious effects (CDC, 2012). Exposure in childhood to even slightly elevated levels of lead produce lasting neurological deficits in intelligence and behavior.
   c) Lead is also known to be toxic across different vertebrate organisms, including mammalian and avian species.

2) Lead-based ammunition is likely the greatest, largely unregulated source of lead knowingly discharged into the environment in the United States. In contrast, other significant sources of lead in the environment, such as leaded gasoline, lead-based paint, and lead-based solder, are recognized as harmful and have been significantly reduced or eliminated over the past 50 years.
   a) Lead-based ammunition production is the second largest annual use of lead in the United States, accounting for over 60,000 metric tons consumed in 2012, second only to the consumption of lead in the manufacture of storage batteries (USGS, 2013).
   b) The release of toxic lead into the environment via the discharge of lead-based ammunition is largely unregulated. Other major categories of lead consumption, such as leaded batteries and sheet lead/lead pipes, are regulated in their environmental discharge/disposal.

3) The discharge of lead-based ammunition and accumulation of spent lead-based ammunition in the environment poses significant health risks to humans and wildlife. The best available scientific evidence demonstrates:
   a) The discharge of lead-based ammunition substantially increases environmental lead levels, especially in areas of concentrated shooting activity (USEPA ISA for Lead draft report, 2012).
   b) The discharge of lead-based ammunition is known to pose risks of elevated lead exposure to gun users (NRC, 2012).
   c) Lead-based bullets used to shoot wildlife can fragment into hundreds of small pieces, with a large proportion being sufficiently small to be easily ingested by scavenging animals or incorporated into processed meat for human consumption (Pauli and Burkirk, 2007; Hunt *et al*., 2009; Knott *et al*., 2010).

d) Lead-based ammunition is a significant source of lead exposure in humans that ingest wild game (Hanning *et al*., 2003; Levesque *et al*., 2003; Johansen *et al*., 2006; Tsuji *et al*., 2008), and hunters consuming meat shot with lead-based ammunition have been shown to have lead pellets/fragments in their gastrointestinal tract (Carey, 1977; Reddy, 1985).
e) Lead poisoning from ingestion of spent lead-based ammunition fragments poses a serious and significant threat to California wildlife.
   i. Spent lead-based ammunition is the principal source of lead exposure to the endangered California condor, and lead poisoning in condors is preventing their successful recovery in the wild (Church *et al*., 2006; Woods *et al*., 2007; Green *et al*., 2008; Parish *et al*., 2009; Rideout *et al*., 2012; Finkelstein *et al*., 2012).
   ii. Many other wild scavenging species, such as golden eagles, bald eagles, ravens, turkey vultures, and pumas are known to be exposed to and affected by lead (Wayland and Bollinger, 1999; Clark and Scheuhammer, 2003; Fisher *et al*., 2006; Craighead and Bedrosian, 2008; Stauber *et al*., 2010; Kelly and Johnson, 2011; Burco *et al*., 2012).

Based on overwhelming evidence for the toxic effects of lead in humans and wildlife, even at very low exposure levels, convincing data that the discharge of lead-based ammunition into the environment poses significant risks of lead exposure to humans and wildlife, and the availability of non-lead alternative products for hunting (Thomas, 2013), we support reducing and eventually eliminating the introduction of lead into the environment from lead-based ammunition.

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HUMAN EXPOSURE TO LEAD FROM AMMUNITION IN THE CIRCUMPOLAR NORTH

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ABSTRACT.—Circumpolar subsistence cultures use firearms, including shotguns and rifles, for hunting game for consumption. Lead shot is still used for waterfowl and seabird hunting in many subsistence areas (despite lead shot bans) because it is inexpensive, readily available, and more familiar than non-toxic or steel shot, which shoot differently. Here we review published literature on lead concentrations and lead isotope patterns from subsistence users in the circumpolar North, indicating that elevated lead exposure is associated with use of lead ammunition. Mechanisms of exposure include ingestion of lead dust, ammunition fragments, and shot pellets in harvested meat, and inhalation of lead dust during ammunition reloading. In Alaska, ammunition-related lead exposures have also been attributed to the use of certain indoor firing ranges, and the melting and casting of lead to make bullets. Since there is no safe lead exposure limit, especially for children, use of lead shot and bullets in subsistence cultures results in unnecessary and potentially harmful lead exposure. In order for lead ammunition to be feasibly phased out, alternatives must be affordable and readily available to subsistence hunters. Community outreach, including describing the harmful effects of even small amounts of lead, especially in children and women of child-bearing age, and training on the different shot patterns, velocities, and distances inherent in using shot and bullet materials other than lead, will also be necessary to promote acceptance of alternatives to lead ammunition. *Received 15 September 2008, accepted 3 October 2008.*

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HUMANS IN THE NORTH have been exposed to lead from many of the same sources as in temperate regions. In the 20th century, the greatest exposure was inhalation of atmospherically transported lead produced from leaded gasoline. Other atmospheric sources included combustion of other fossil fuels, particularly coal, non-ferrous metal production (mining, smelting), and waste incineration (AMAP

[3] The findings and conclusions in this document are those of the author(s) and do not necessarily represent the views of the US Fish and Wildlife Service.

2004, AMAP 2002). Lead leachate from lead solder used in food cans may have poisoned the crews of *Erebus* and *Terror*, the ships of the 1850s Franklin expedition to the North Pole (Bayliss 2002). Interestingly, lead solder for canning wasn't banned in the United States until 1995 (Federal Register 60(123): 33106-9), and may still be used elsewhere. Ingestion of lead-based paint chips by children remains an issue worldwide, although in abatement with regulation of leaded paint.

With control of these lead sources, however, blood lead levels in humans have dropped over the past few decades. A phase-out of leaded gas beginning in the 1980s, for example, resulted in a substantial decline in lead levels in humans in North America (Pirkle et al. 1994) and Greenland (Hansen et al. 1991), as well as in snow from Greenland (Robinson 1981) and in the Arctic ice pack. The prevalence of blood lead levels ≥10 µg/dL dropped from over 80% before 1980 to less than 10% in the 1990s (Pirkle et al.1998).

Still, some northern populations, especially indigenous peoples dependent upon subsistence foods, continue to have elevated blood lead levels. A primary source is thought to be lead from ammunition, by ingestion of lead fragments in game shot with lead, inhalation of fumes from home production of shot or sinkers (as in rural areas in Russia; AMAP 2004), and inhalation of dust or particles during prolonged shooting. In fact, the Arctic Monitoring and Assessment Programme stated:

Lead levels in Arctic indigenous peoples have declined since the implementation of controls on lead emissions. Concentrations of lead in blood currently reported are below a level of concern, however, continued monitoring is warranted because of the potent effects of lead on neurological development in the fetus and children (AMAP 1998).

This is still valid. In addition, recent data have shown that lead shot can be a significant source of human exposure (AMAP 2003).

Lead is exceptionally dense, making it ideal for projectiles. It is also relatively soft, which allows it to be formed, even in home environments, into a variety of bullet and shot gauges. This malleability also results in fracturing of the shot and bullets. The latter can leave macro- and microscopic traces of lead on average 15 cm from bullet pathways in meat (Hunt et al. 2006) and spread over an average of 24 cm and up to 45 cm apart (Hunt et al. 2009). Therefore, even if game is carefully cleaned and damaged meat discarded, embedded and invisible fragments of lead may still contaminate the meat (Stroud and Hunt 2009, Hunt et al. 2009).

In this paper we review data on lead concentrations in people living in the circumpolar north and evaluate lead from ammunition as an important source for current lead exposure. We conclude that exposure to lead from ammunition is unnecessary and potentially harmful to Arctic indigenous populations.

REVIEW OF LEAD TOXICOLOGY

Absorption.—Lead can enter the human body through three main routes of exposure: eating, breathing, or being shot. The third route has obvious health consequences and will not be discussed further.

People can ingest lead that is present in their immediate environment, such as dust, or that is in food or water. Leachate from lead solder use in canned foods has already been discussed. Wild game that has been shot with lead ammunition can contain lead fragments, particles or dust that is consumed along with the meat. Lead can also be ingested if people handle lead products such as fishing sinkers, and then fail to wash their hands before eating food. Children often ingest lead when they mouth lead-containing toys or objects, or suck their fingers after touching lead objects or lead-containing dust or soil.

In humans, the percentage of lead that is absorbed into the bloodstream after oral ingestion is influenced by several factors, including age. Gastrointestinal absorption of water-soluble lead appears to be higher in children than in adults (ATSDR 2007). Estimates derived from dietary balance studies indicate that children (ages two weeks to eight years) absorb approximately 40–50% of ingested water-soluble lead, while non-fasting adults absorb only 3–10% of ingested water-soluble lead (ATSDR

2007). Nutritional status also affects gastrointestinal absorption of lead; fasting status increases lead absorption. The presence of food in the gastrointestinal tract lowers lead absorption, especially if calcium or phosphate is present in the meal. Children who have calcium or iron deficiencies have a higher absorption of lead from the gastrointestinal tract (ATSDR 2007).

Exposure to lead through inhalation can occur in a variety of ways. When lead is melted to make fishing sinkers, ammunition or other products, especially in a home environment, dangerous levels of lead fumes can be produced and inhaled. Lead can also be inhaled on dust particles, contaminated soils, or via occupational exposure in manufacturing and mining. When leaded gasoline is combusted, tetraalkyl lead is an inhalable byproduct.

Amounts and patterns of deposition of particulate aerosols in the respiratory tract are affected by the size of the inhaled particles, age-related factors that determine breathing patterns (e.g., nose vs. mouth breathing), airway geometry, and airstream velocity within the respiratory tract (ATSDR 2007). Absorption of deposited lead is influenced by particle size and solubility. Larger particles (>2.5 microns) that are deposited in the upper airways can be transferred by mucociliary transport into the esophagus and swallowed. Smaller particles (<1 micron) can be deposited deeper into the lungs including the alveolar region, where intimate contact with the bloodstream enhances absorption (ATSDR 2007).

Distribution and Excretion.—The excretory half-life of lead in blood is approximately 30 days for adult humans (ATSDR 2007). Lead that is retained by the body is mostly stored in bone, where it is assimilated due to its chemical similarity to calcium (AMAP 2002). Lead can be mobilized from bone and released into the bloodstream during the process of bone resorption. Mobilization of bone lead can occur during pregnancy and lactation, and after menopause due to osteoporosis (ATSDR 2007). Lead in a pregnant mother's blood is effectively transferred to the fetus, and maternal lead can also be transferred to infants during breastfeeding (ATSDR 2007).

Toxicity.—Lead poses a greater risk to children than to adults for several reasons. Lead is more toxic to children than to adults because the nervous system of children is still developing. Also, children absorb a greater percentage of the lead they are exposed to (ATSDR 2007), and children are often exposed to more lead than adults. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. The crawling and mouthing behaviors of older infants and young toddlers place them at particular risk for exposure; blood lead levels (BLLs) in children typically peak at the age of two years for this reason (American Academy of Pediatrics 2005). Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Children's brains are developing rapidly during the first six years of life, which is why exposure to a chemical like lead that targets the brain is most devastating at that critical time.

Lead can delay or impair brain development in children and adversely affect IQ, and impair a child's ability to learn. Lead can also cause anemia and impaired metabolism of vitamin D. The Centers for Disease Control and Prevention (1997) recognized BLLs of ≥10 μg/dL in children aged ≤6 years as levels of concern, and based on studies since then, the CDC now recognizes that 10 μg/dL does not define a lower threshold for the harmful effects of lead (Brown 2007). Multiple studies have shown that as blood lead concentrations increase, IQ decreases, for example, by 7.4 points as blood lead increased from 1 to 10 μg/dL in children up to five years old (Canfield et al. 2003), and with significantly higher rates of intellectual decrement in children with maximal BLL <7.5 μg/dL than ≥7.5 μg/dL (Lanphear et al. 2005). Thus, BLLs less than 10 μg/dL are clearly harmful, and there is growing consensus that there is no "safe" level of lead exposure. Other adverse health effects associated with relatively low BLLs in children include delayed sexual maturation, increased blood pressure, depressed renal glomerular filtration rate, and inhibition of pathways in heme synthesis (ATSDR 2007).

As BLLs rise in children, the harmful health effects of lead become more severe. A child exposed to a large amount of lead may develop anemia, kidney damage, colic, muscle weakness, and brain damage, which can ultimately kill the child (ATSDR 2007). Such symptoms of clinical lead poisoning are commonly observed in children with BLLs of 45 µg/dL or higher; children with BLLs of 70 µg/dL or higher should be hospitalized immediately for treatment (Centers for Disease Control and Prevention 2002).

Studies have reported adverse health effects in adults with blood lead levels between 25–40 µg/dL, including hypertension, subtle or sub-clinical central nervous system deficits, and adverse reproductive outcomes (Centers for Disease Control and Prevention 2002). Lead exposure is clearly related to elevated blood pressure, and may also cause negative clinical cardiovascular outcomes and impaired performance on cardiovascular function tests (Navas-Acien et al. 2007). Cardiovascular and renal effects have been seen in adults chronically exposed to lead at levels <5 µg/dL in blood, and no lower threshold has been established for any lead-cardiovascular association (Navas-Acien et al. 2007).

At high levels of lead exposure, the brain and kidney in adults or children can be severely damaged, and death can result. High levels of lead exposure may also cause miscarriage in pregnant women, and affect testicular hormones in men. Other symptoms of lead poisoning in adults include colic, anemia, and muscle weakness. Clinical symptoms of lead poisoning can occur in adults with BLLs above 40 µg/dL (ATSDR 2007).

HUMAN EXPOSURE TO LEAD IN THE ARCTIC

Research on human lead exposure in the Arctic in the last decade has linked elevated lead exposure to use of lead shot or bullets for hunting. Other lead exposures of prior importance have largely been controlled, such as lead-based paints, lead in drinking water, and lead from gasoline. Leaded gasoline was phased out from North American use in the 1980s, with subsequent declines in environmental levels, including blood lead in humans (AMAP 1998, AMAP 2003, Van Oostdam et al. 2003). The exception may be in northern Russia, where industrial contamination from mining and smelting of lead ores, and use of lead-containing gasoline, continues (AMAP 2003). However, populations in Russia who practice subsistence hunting, such as people on the Kola Peninsula, are probably also exposed to lead from ammunition (AMAP 2003, Odland et al. 1999).

Specific studies of lead exposure from lead shot began decades ago with documentation of residual (embedded or ingested) lead in waterfowl. Embedded lead shot were found in 18–45% of waterfowl, depending upon the species, tested in the USA, Canada, and Western Europe in the 1950s (Elder 1955). In Canada in the 1980s, 15% of 227 pooled breast muscle samples from waterfowl harvested with lead shot had lead concentrations >0.5 mg/kg (Canadian Wildlife Service unpublished data, cited in Scheuhammer and Norris 1995), and Frank (1986) found lead concentrations, some >100 µg/kg, in tissues of waterfowl harvested with lead shot. These fragments, confirmed by radiographs and ranging in size from dust to 1–2 mm, resulted from collision of shot with bone. In the mid-1990s, Hicklin and Barrow (2004) used fluoroscopy on live Canada Geese (*Branta canadensis*), American Black Ducks (*Anas rubripes*), Mallards (*A. platyrhynchos*) and Common Eiders (*Somateria millissima*) from eastern Canada. Twenty-five percent of 1,624 birds had embedded shot, most of which was assumed to be lead. From 15–29%, depending upon age, of over 700 Common Eiders collected in western Greenland after colliding with boats or drowning in fishing nets had embedded lead shot in them (Merkel et al. 2006). It is clear that both micro- and macroscopic lead particles remain in avian meat that has been shot with lead pellets (Scheuhammer et al. 1998) and in large mammals shot with lead-based rifle bullets (Hunt et al. 2006). Therefore, lead from ammunition is a potential public health concern for indigenous peoples (Tsuji et al. 1999) and others who depend on wild game for food.

In a study specifically designed to examine the link between lead shot use for subsistence hunting of birds and potential human exposure, Johansen et al. (2001) x-rayed 50 Thick-billed Murre (*Uria lomvia*) carcasses bought from hunters in Greenland. The birds had been harvested with lead shot, and

had an average of 3.7 lead pellets per carcass (range 0–12). There was no correlation between the number of pellets and the lead concentration in meat, which ranged from 0.0074–1.63 ppm wet weight, although most lead found in the breast meat was from pellets that had gone through the meat and left fragments. The authors concluded that even after pellets were removed, lead shot fragmented to fine dust upon collision with bone, resulting in substantially greater (although variable) lead concentrations in murres shot with lead compared to those shot with steel. They estimated a potential dose of 50 µg of lead from eating one bird. An estimated 200,000 murres are harvested annually in Greenland, in addition to other seabirds and waterfowl. The authors concluded that using lead shot to hunt birds could be a significant public health concern (Johansen et al. 2001).

A variety of raptor species have been exposed to or poisoned by lead from predating or scavenging lead-shot game (Hunt et al. 2006) and waterfowl (Pattee and Hennes 1983, Elliott et al. 1992, Pain et al. 1993, Kendall et al. 1996, Miller et al. 1998, Mateo et al. 1999, Samour and Naldo 2002, Pain et al. 2009). Therefore, it is not surprising that people who consume game shot with lead can also have elevated blood lead levels. Numerous studies at both the population and individual levels have implicated and linked lead ammunition to elevated blood lead levels and clinical symptoms in northern peoples.

For example, blood lead levels were monitored in 50 male hunters in Greenland before, during, and after the bird-hunting season in order to establish the association between bird consumption and blood lead concentrations (Johansen et al. 2006). Frequency of reported bird consumption was strongly associated with measured BLLs in the hunters, and eider meals were more important than murre meals as a lead source in the blood. Mean BLLs (12.8 µg/dL) were more than eight times higher in the group reporting more than 30 bird meals per month than in the group reporting no bird consumption (1.5 µg/dL).

At the population level, the Dene/Métis and bird-hunting Inuit in Canada averaged from 3.1–5.0 µg/dL of lead in maternal blood, compared to 1.9–2.2 µg/dL among Caucasians and other Inuit (Van Oostdam et al. 2003). However, 3.4% and 2.2% of the blood samples from the Inuit and Dene/Métis women, respectively, exceeded the 10.0 µg/dL Canadian Action Level (Walker et al. 2001). In Greenland, blood lead levels in Inuit mothers averaged 3.1–5.0 µg/dL, similar to the Canadian Inuit and Dene/Métis (AMAP 2003). In Siberia, indigenous women had average blood lead levels of 2.1–3.2 µg/dL, while non-indigenous women, who presumably obtained a smaller proportion, if any, of their food from hunting, averaged 0.02–0.04 µg/dL (AMAP 2003). In Nunavik (Arctic Quebec), adult Inuit blood lead levels were elevated and were related to age, smoking and, in particular, daily consumption of waterfowl (Dewailly et al. 2001). Blood lead, adjusted for age and sex, was associated with seabird consumption in Greenland (Bjerregaard et al. 2004). In that study, Greenlanders who reported consuming sea birds several times a week had a blood lead level >50% higher than those who reported eating sea birds only a few times a month or less.

Lead shot exposure and effects have also been documented at the individual level in northern humans. For example, Madsen et al. (1988) noted that lead shot in the appendix were often seen in lower abdominal x-rays in Denmark, and those with lead in the appendix had greater blood lead concentrations. Of 132 randomly selected radiographic charts from a hospital serving six native Cree communities in Northern Ontario (1990–1995), 15% showed lead shot in the gastrointestinal system (Tsuji and Nieboer 1997). Sixty-two patients in one Newfoundland hospital had from 1–200 lead shot in their appendices (Reddy 1985), and Hillman (1967), Greensher et al. (1974), Durlach et al. (1986), and Gustavsson and Gerhardsson (2005) all documented clinical symptoms resulting from lead shot in human appendices. In the USA in 2005, Cox and Pesola (2005) published a radiograph from an Alaska Native elder with an appendix full of shot, and stated "buckshot is commonly seen in Alaskan natives."

Using lead isotopes to identify the source of lead when blood lead is elevated combines population and individual assessments. This method was used by Tsuji et al. (2008) to definitively document lead

from ammunition—both shot and bullets—as a source of lead in First Nations Cree in northern Ontario. Lead isotope signatures of southern Ontario urban dwellers were different from those of northern First Nations people, who depended upon subsistence foods. Lead from ammunition had a separate signature from that found on lichens and, significantly, isotope signatures of First Nations people overlapped with that of lead from ammunition. Levesque et al. (2003) used a similar approach to identify the source of lead in cord blood of Nunavik Inuit infants born from 1993–96. Although mobilization of maternal bone lead resulted in less definite signatures than those documented by Tsuji et al. (2008), there was still a strong suggestion that the source of elevated cord blood lead, found in approximately 7% of Inuit newborns, was lead from ammunition. There were also signature differences between Inuit infants from Nunavik in northern Quebec, and Caucasian infants from southern Quebec. In Alaska, recent lead isotope data from blood of Alaska Natives from Bethel on the Yukon-Kuskokwim Delta and Barrow on the North Slope, regions where subsistence waterfowl hunts occur, showed signatures that overlapped with those of shot (Alaska Native Tribal Health Consortium, unpubl. data).

Blood Lead Surveillance in Alaska.—Alaska regulations require laboratories and health care providers to report all blood lead test results ≥10 µg/dL to the Alaska Division of Public Health, Section of Epidemiology; however, most laboratories report all BLL results (Section of Epidemiology 2008b). The Section of Epidemiology maintains a blood lead surveillance database of all reported blood lead levels from Alaskans (>26,000 records as of August 2008), and conducts individual case follow-up activities for all elevated BLLs.

In Alaska, the majority of adults with BLLs ≥25 µg/dL were males who worked in the metal ore mining industry (State of Alaska 2008a). Across all age groups, the majority (81%) of known non-occupational elevated lead exposures involved people exposed on indoor firing ranges, followed by children who were born or adopted from abroad (10%), and people casting lead as a hobby (3.4%) (State of Alaska 2008b).

Major lead sources for children aged <6 years in the contiguous United States are lead-contaminated dust and soil and deteriorated lead-based paint (Brown 2007), but these exposure sources are not frequently encountered in Alaska. The majority of Alaska children aged <6 years with elevated BLLs obtained their lead exposures abroad (State of Alaska 2008b). Many of the other sources of non-occupational lead exposure in Alaskans reflect the hunting and fishing, outdoor lifestyle of Alaska. Lead ammunition or lead fishing sinkers are commonly implicated as the primary exposure source of elevated BLLs in Alaska.

Elevated BLLs have been attributed to use of indoor firing ranges in Alaska (Lynn et al. 2005, Verbrugge 2007). Students shooting on high school rifle teams that used the problematic indoor shooting ranges were among the persons with elevated BLLs. Inadequate ventilation systems and improper maintenance practices at indoor firing ranges were documented at several ranges with lead exposure problems. The cleaning practice of dry sweeping is particularly hazardous, and should never be performed in indoor ranges. Elevated lead exposures have also occurred among Alaskans who hand reload ammunition, and among sportsmen who melt lead to cast their own bullets (State of Alaska 2008b). In June 2001 an adult Alaskan male suffered acute lead poisoning as a result of inhaling lead dust and fumes while melting and casting lead to make fishing sinkers (State of Alaska 2001). The patient had a BLL of 133 µg/dL and exhibited symptoms of fatigue, stomach pain with gastric upset for several months, and a fever of 102ºF for 10 days. The patient was hospitalized and received chelation therapy, and his BLL subsequently declined. The State of Alaska has not yet investigated whether consumption of game shot with lead may also be causing elevated lead exposures in Alaska, although this has recently been added to the list of potential risk factors under consideration during follow-ups for elevated BLLs.

REDUCING LEAD EXPOSURE IN CIRCUMPOLAR PEOPLE

In the circumpolar north, many indigenous peoples and other rural inhabitants depend on wild game for subsistence. In Alaska and elsewhere, scientists

have documented the nutritional value of traditional foods such as fish, marine and terrestrial mammals, wild birds, and plants (Egeland et al. 1998, Nobmann et al. 1992). In many rural northern communities, wage-paying jobs are limited and market food is not available or is expensive. Further, wild foods are often nutritionally superior to market foods, which have high levels of processed sugars and fats. Subsistence food gathering is essential if people are to have enough healthy food. Traditional foods represent not just a critical food source, but also an integral part of Native culture and a way of life that has existed for many generations. Risk reduction strategies for lead exposure from ammunition must account for the need for inexpensive shot that is easy to use for subsistence hunting—a niche that is still being filled by purchased and reloaded lead shot in much of the North.

Risk reduction strategies that have been suggested for reducing lead exposure from use of lead shot include culture-specific outreach (see Tsuji 1998) to lead shot users and sellers, with the goal of voluntary behavior changes; capacity-building, which trains community members in outreach regarding lead shot risks and non-lead shot shooting techniques; and regulation, both from within and outside of subsistence communities (Tsuji 1999, AMAP 2003). Some are more successful than others; for example, regulation is often most effective if it is community-generated. Enforcement from outside the community, especially with the large distances and relatively low human population densities in Arctic regions, can be inefficient on broad scales.

After Inuit from Nunavik were found to have high cord blood lead levels, lead shot bans (Dallaire et al. 2003) and public health intervention (Levesque et al. 2003) resulted in "marked" and "significant" decreases in cord blood lead concentrations, from an average of 0.20 µmol/L before the ban in 1999 to 0.12 µmol/L after the ban (Dallaire et al. 2003). In the Mushkegowuk Territory of northern Ontario, collaborative health education outreach with direct community involvement was essential to changing attitudes about the safety of lead shot and inspiring behavioral change (Tsuji et al. 1999). In Alaska, outreach to food preparers, school-age children, and hunters about the risk of lead exposure from lead shot to human and bird health, resulted in two community-generated injunctions on the use of lead shot in areas covering 83 million acres (2.4 million ha) and numerous subsistence communities on the North Slope and Yukon-Kuskokwim Delta.

Reducing lead exposure from other sources, which may not be as widespread as the use of lead ammunition, could respond well to targeted outreach and regulation. For example, as the Alaskan examples illustrate, lead should not be melted and formed into shot or sinkers in home environments. In indoor shooting ranges, ventilation systems must be built correctly and correctly maintained, dry sweeping should be prohibited, and blood lead testing for regular users such as rifle teams should be performed at the beginning and end of each shooting season.

CONCLUSION

Since bans on lead in gasoline, instituted primarily in the 1980s and 1990s, lead levels in northern hemisphere humans have generally declined. A notable exception is the blood lead levels of Arctic indigenous peoples who rely on subsistence foods. In many cases, elevated blood lead levels in the Arctic have been associated with ingestion of lead from spent ammunition, primarily shot, although lead from fragmented bullets in big game may have been overlooked as a source until recently (Hunt et al. 2006, Tsuji et al. 2008, Hunt et al. 2009, Titus et al. 2009). Other cases of harmful lead exposure have resulted indirectly from use of lead in ammunition or for fishing (indoor firing ranges, home melting and manufacture of lead sinkers, shot, or bullets, and home reloading). Because subsistence populations by definition hunt much of their food, and because this food is important economically, nutritionally, and socially (Titus et al. 2009), an inexpensive source of ammunition is required. Lead is relatively inexpensive, but use of lead in ammunition comes with risks to humans, especially children, which do not occur with non-lead substitutes. Many approaches to reducing lead exposure have been proposed or implemented. For example, human health agencies can work with ammunition manufacturers and sellers to reduce the availability of lead ammunition, facilitate the availability of inexpensive non-toxic alternatives, and offer training

on the different shot patterns, velocities, and distances inherent in using materials other than lead. The most effective means of reducing lead exposure have included community-based outreach and education on the dangers of lead from ammunition to both humans and the environment. These approaches have achieved positive behavioral changes, and may result in subsistence hunters and their families choosing to use non-toxic shot and bullets for their subsistence needs.

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Date: October 14, 2008

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Division of Environmental Hazards and Health Effects (DEHHE)

National Center of Environmental Health (NCEH)

Subject: Epi-AID Trip Report: Assessment of human health risk from consumption of wild game meat with possible lead contamination among the residents of the State of North Dakota.

To: Douglas H. Hamilton, MD, PhD

Director, Epidemic Intelligence Service

Office of Workforce and Career Development (OWCD)

Through: Sharunda D Buchanan, PhD, MS, Director, Division of Emergency and Environmental Health Services (DEEHS), NCEH

Mary Jean Brown, ScD, RN, Chief, Lead poisoning and Prevention Branch, DEEHS, NCEH

Introduction

Large game hunting plays a significant role in the state economy of North Dakota and is a popular tourist attraction. During hunting season and throughout the year, a substantial proportion of families in ND consume wild game, especially venison. A large proportion of venison (around 17,000 lbs every year) is also donated to local food pantries and serves as an important source of protein for low income families.

Recently, a local physician notified the North Dakota Department of Health (NDDoH) that in 53 of 95 packets of ground venison donated to several food pantries, x-ray analysis revealed evidence of metal fragments. Further analysis identified these fragments as lead, and found the levels were much higher than expected. The bullets used to kill wild game are the most likely source of this lead. The discovery of lead fragments prompted a recommendation from the NDDOH to stop distributing the remaining donated venison. NDDoH also released a public notification to advise people of the unknown risk of lead exposure associated with the consumption of large animals killed by lead bullets. NDDoH then requested assistance from CDC to investigate the human health risk associated with consumption of wild game, with an emphasis on venison, and to assist in the development of scientifically sound recommendations for the safe processing and consumption of wild game killed by lead bullets. The findings of this investigation also have great impact on the surrounding states as large game hunting and the consumption of wild game is highly prevalent in this region of the country.

On May 13, 2008, a CDC team consisting of Epidemic Intelligence Service Officers (EISO) Shahed Iqbal, PhD, MBBS, Kelly Loringer, ND, MPH and epidemiologist Wendy Blumenthal, MPH deployed in North Dakota to conduct a study on lead exposure from wild game consumption. Drs. Chinaro Kennedy, DrPH, MPH, and Fuyuen Yip, PhD, MPH supervised the study.

Objectives

1. To determine whether an increase in blood lead levels (PbB) is associated with consumption of wild game.
2. To identify population subgroups by age, race, sex, and other socio-demographic characteristics who might be at risk of having increased lead levels due to wild game consumption.

Methods

A retrospective cohort study was conducted to determine the association between consumption of wild game and PbB. Exposure to wild game was defined based on self-reported consumption or on levels of consumption of wild game meat that included venison, other wild game (e.g., elk, moose), and birds (excluding water fowl). Participants were eligible for inclusion if they were

a) ≥2 years of age,

b) residents of North Dakota,

c) had sufficient knowledge and understanding of the English language for participation, and

d) agreed to provide blood samples.

Following an NDDoH press release announcing the study, participants were recruited through a convenience sampling approach at local public health clinics in six different cities, namely, Bismarck, Fargo, Grand Forks, Minot, Jamestown, and Dickinson (Figure 1). Participants were also recruited from two additional sites in Bismarck. From 5/16/2008 to 5/30/2008, data were collected via face-to-face interview. Data collection took place over a 2-week period, but was not conducted simultaneously in all cities.

Before enrolling in to the study, all participants signed a consent form. For any children <18 years of age, parental consent and child assent were obtained. Data were then collected on demographic and housing characteristics (e.g., age of housing, duration of residence in the same household, renovation, visible peeling of paint), current and previous lead-related hobbies (e.g., hunting, lead soldering, car/boat repair) and occupations (e.g., welding, construction, working in lead smelter, refinery, or lead mines), other possible sources of lead exposure (e.g., use of herbal medicine or make up, residence near a lead smelter/mine, use of South/Central American pottery, living in or travelling to South/Central America), and consumption of wild game. Information on frequency, duration, meat processing methods, and average serving size by type of wild game was also collected. Trained phlebotomists, using aseptic precautions, collected venous blood samples from all participants.

Blood samples were shipped, refrigerated with pre-frozen ice packs, to the CDC National Center for Environmental Health, Division of Laboratory Sciences in Atlanta, GA. Blood lead was measured using whole blood and inductively coupled plasma mass spectrometry. The minimum detection level for blood lead was 0.25µg/dl. For persons with no detectable levels of blood lead (n = 5), a value calculated as the detection limit divided by the square root of 2 was assigned (National Center for Environmental Health 2001).

Statistical analysis

Frequencies and proportions were reported for all variables, including socio-demographic and housing characteristics, lead-related occupations and hobbies, and wild game consumption including type, frequency, and average serving size. Both mean and geometric mean lead levels and frequency for PbB ≥ 5 µg/dl were reported. Generalized Estimating Equation (GEE) methods were used to determine unadjusted and adjusted associations between PbB and other

variables using SAS software (version 9.1, Copyright © SAS Institute, Inc., 2002-2003, Cary, NC). Separate GEE models were developed by types of wild game (i.e., venison, other game, birds) to determine the association between frequency, duration, average food serving size, and PbB. Only significant variables in unadjusted models were included in the multivariate model. Race and income, commonly reported predictors of elevated PbB, were included in the multivariate model regardless of their significance in the unadjusted models. Parameter estimates with 95% confidence intervals and significance levels were reported for all models. Multivariate models with two-way interactions with the exposure variable (e.g., consumption of wild game) were considered. Missing values were reported for all frequencies. Some variables were not reported due to unilateral response (e.g., use of herbal medicine, residence near a lead smelter/mine, use of South/Central American pottery, previous blood lead test), ambiguity (e.g., travel to South or Central America), or a high number of missing values (e.g., additional exposure questions for children <6 years of age and pregnant women).

Results

Study population

A total of 742 participants were recruited from the six different cities in North Dakota. Two persons were found to be residents of the neighboring state of Minnesota and were excluded from all analyses (N = 740). The distribution of participants, by location, is provided in Table 1. Capillary blood samples were collected from two children as their parents refused venous blood draw. The results of these tests were included in the analysis. Additionally, one child refused blood draw, and blood draw was incomplete for two children and one adult. Blood samples from 736 persons were therefore included in the final analysis.

Almost half of the participants (48.1%) were ≥ 55 years of age. Participation among males (54.5%) was higher than among females (Table 2). Participants were predominantly white (98.2%) and non-Hispanic (96.4%). The majority of the study participants (65.7%) had graduated from college or had higher education. For most participants (73.5%), annual household income was ≥ $40,000.

Approximately 31.0% of participants shared the same household with at least one other participant (Table 3). Most of the residences were built in or after 1950 (83.1%). More than half of the participants reported living in the same household for >10 years (53.5%) and had some renovation done on the home while they were living there (53.7%). Most participants did not observe any peeling paint inside or outside their homes (85.5%).

With respect to other potential lead exposures, approximately 13.0% of the study participants reported they were currently engaged in at least one lead-related occupation, while 36.5% reported a previous lead-related occupation (Table 4). Most of the participants (63.9%) reported currently having at least one lead-related hobby, and 55.9% reported previously having lead-related hobbies.

Wild game consumption

Approximately 80.8% (N = 598) of the participants reported consuming at least one type of wild game (i.e., venison, other game, birds), while 86.5% (N = 517) reported consuming more than one type (Table 5). Among those who consumed wild game, almost all reported consuming venison (98.8%), and 64.5% and 84.4% reported consuming other game and birds, respectively. Study participants indicated that they primarily hunted the wild game they consumed, or it was hunted by family members or by friends (98.8%). Most of these participants (81.9%) reported processing their own meat or had family members process the meat. Among them, 92.1%

reported cleaning the meat around the wound channel. The remainder of the participants reported having their meat processed by meat packers/lockers (31.6%) and local butchers (9.2%).

With respect to frequency of consumption, most participants consumed venison throughout the year (80.5%). Nearly half reported consuming other game (49.2%) or birds (52.0%) occasionally or only during the hunting season (Table 6). In a given month, 62.2% of participants reported consuming venison at least once a week; they also reported consuming other game (69.2%) and birds (77.2%) at a frequency of less than once a week. Within the past month preceding the survey, 82.6% of participants had consumed venison; by comparison, only 45.3% and 40.4% had consumed other game and birds, respectively. Most of the participants reported grinding their venison (57.9%) but did not grind other game meat (57.0%) or birds (96.6%). When asked about approximate serving size, participants predominantly reported consuming an average of ≥ 2 oz. of venison, of other game, and birds per serving. Most of the participants reported consuming all three types of wild game for >10 years.

Laboratory results

A total of 734 blood samples—excluding two locally tested capillary samples—were sent to the NCEH laboratory for PbB analysis. Among all participants, the geometric mean PbB was 1.17µg/dl (Table 7); 1.1% had PbB ≥5 µg/dl. None of the participants had PbB above the CDC recommended threshold of ≥ 10µg/dl—the level at which CDC recommends case management.

Generalized Estimating Equation (GEE) analysis

In unadjusted Generalized Estimating Equations (GEE) models, variables including age, sex, education, age of housing, amount of time in the household, renovation, current and previous lead related occupations, current lead related hobbies, family members with lead-related

occupations or hobbies, and consumption of wild game were significantly associated with PbB (Table 8). In a multivariate-adjusted GEE model, age, sex, age of housing, current lead-related hobbies, and wild game consumption were significantly associated with PbB.

Specifically, compared with other age categories, participants aged ≥65 years had the highest geometric mean PbB (Table 8). After adjusting for all other confounding effects, participants 2–5 years of age, 6–24 years of age, 25–44 years of age, and 45–65 years of age, respectively, had 0.84µg/dl, 1.10µg/dl, 1.10µg/dl, 0.44µg/dl lower PbB than those ≥65 years of age (Table 8). Males had PbB that were 0.28µg/dl higher than female participants. Participants living in residences built between 1950 and 1977 or before 1950 had higher PbB (0.19µg/dl and 0.43 µg/dl, respectively) compared with participants living in residences built after 1977. Currently having lead-related hobbies were associated with higher PbB compared with those who did not report lead-related hobbies.

Participants who consumed wild game had 0.30 µg/dl higher PbB in comparison with those who did not consume wild game (Table 8). The multivariate model did not improve significantly when all two-way interactions between wild game consumption and other variables were considered in the model (data not shown). Participants who did not consume wild game within a month before data collection had significantly lower PbB for all game types (Table 9). Among those who reported consuming other game, a 0.40 µg/dl increase in PbB was associated with having an average serving size of ≥ 2 oz. compared with those who consumed a lesser amount.

Discussion

In this study, the consumption of wild game was significantly associated with an increase in PbB. This increase could not, however, be attributed to one single game type: a substantial

overlap occurred in the types of wild game the participants consumed. Also, no linear increase in PbB was observed with an increase in the number of wild game types consumed. Nevertheless, after adjusting for other factors, the associated increase in PbB was highest among participants who consumed all three game types (i.e., venison, other game, birds) (data not shown).

Recent consumption of wild game and amount consumed per serving were also significant factors associated with PbB. For all game types, participants who reported consuming wild game within a month prior to data collection had significantly higher PbB in comparison with those who did not consume wild game within a month of the study. This could be explained by the fact that blood lead is an indicator of more recent exposure and supports the finding of a positive association between wild game consumption and PbB; in adults, the excretory half life of lead is approximately 30 days (ATSDR 2007; Rabinowitz et al. 1976). Among participants who reported consuming other wild game, an increase in PbB was also, after adjusting for other factors, associated with a larger average serving size (≥2 oz.).

While this study suggests that consumption of wild game meat can adversely affect PbB, no participant had PbB higher than the CDC recommended threshold of 10µg/dl—the level at which CDC recommends case management; and the geometric mean PbB among this study population (1.17µg/dl) was lower than the overall population geometric mean PbB in the United States (1.60 µg/dl) (CDC 2005). The clinical significance of low PbB in this sample population and the small quantitative increase of 0.30µg/dl in PbB associated with wild game consumption should be interpreted in the context of naturally occurring PbB. Despite the decline in PbB in recent decades, the mean PbB in the population is several orders of magnitude higher than the levels of preindustrial human societies (0.016 µg/dl) and the natural background of PbB in humans (Flegal and Smith 1992; Bellinger 2004). Among adults, increased risk of myocardial and stroke mortality have been observed to be associated with PbB ≥2µg/dl (Menke et al. 2006).

Furthermore, studies have consistently reported adverse neurocognitive effects in children at PbB <10µg/dl (Canfield et al. 2003; Lanphear et al. 2005; Tellez-Rojo et al. 2006; Kordas et al. 2006). Due to increased absorption and an under-developed blood brain barrier, children <6 years of age are considered to be more susceptible to the adverse effects of lead exposures (ATSDR 2007).

Most lead in adults is stored in the bones, and the concentration of lead increases with age. In comparison with 8 mg in children <16 years of age, the body burden of lead is estimated at approximately 200 mg in adults 60–70 years of age (ATSDR 2007; Barry 1975). Lead released from bone storage can therefore contribute to PbB (ATSDR 2007; O'Flaherty et al. 1982). For all game types, participants aged ≥ 65 years frequently reported consuming wild game for more than a decade (data not shown). This long-term cumulative exposure may have resulted in the observed increase in PbB in this age group compared with younger age groups.

Age of housing, male sex, and current lead-related hobbies were other significant factors associated with an increase in PbB. Increased PbB was associated with increase in housing age, which is consistent with our knowledge of environmental exposure to lead (CDC 2005). Higher PbB in males can be explained by the fact that males were almost four times more likely to report consuming wild game compared with females (data not shown). Hunting (53.5%), target shooting (32.0%), home remodeling or painting (18.6%), and reloading (15.7%) were most commonly reported lead-related hobbies and may have substantially contributed to the observed association with PbB.

Limitations

Findings from this study have limited generalizability. The study cohort was predominantly white, educated, and had higher incomes, and did not include persons who

received donated wild game meat from food pantries or other charitable organizations. As high levels of lead were detected in the meat packs donated to local food pantries in North Dakota and the surrounding states (Smith 2008), this group may have greater exposure to lead-contaminated wild game meat.

This study also included a small number of children <6 years of age; however, all of them reported consuming wild game meat. And due to increased rate of lead absorption, children as a whole may potentially be more vulnerable to exposure to lead from wild game consumption. In any event, further research is needed to determine the magnitude of the risk associated with wild game consumption among children and among the population who receives donated meat.

Additionally, most of the data collected were self-reported and may therefore, have been subject to information bias due to misclassification. Although the direction of the bias could not be ascertained, it is unlikely that the findings of the study were qualitatively impacted.

Conclusion

Among those who consumed wild game, most reported hunting as their source. Most participants reported processing the meat themselves and also reported cleaning the meat around the wound channel. Despite these precautions and despite the fact that a wide range of potential confounders were controlled for in the analyses, participants who consumed wild game had higher PbB in comparison with those who did not consume wild game. Careful review of cleaning practices and monitoring of meat packing processes may mitigate the risk of increased PbB from consumption of wild game shot with lead bullets.

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Figure 1: North Dakota study locations

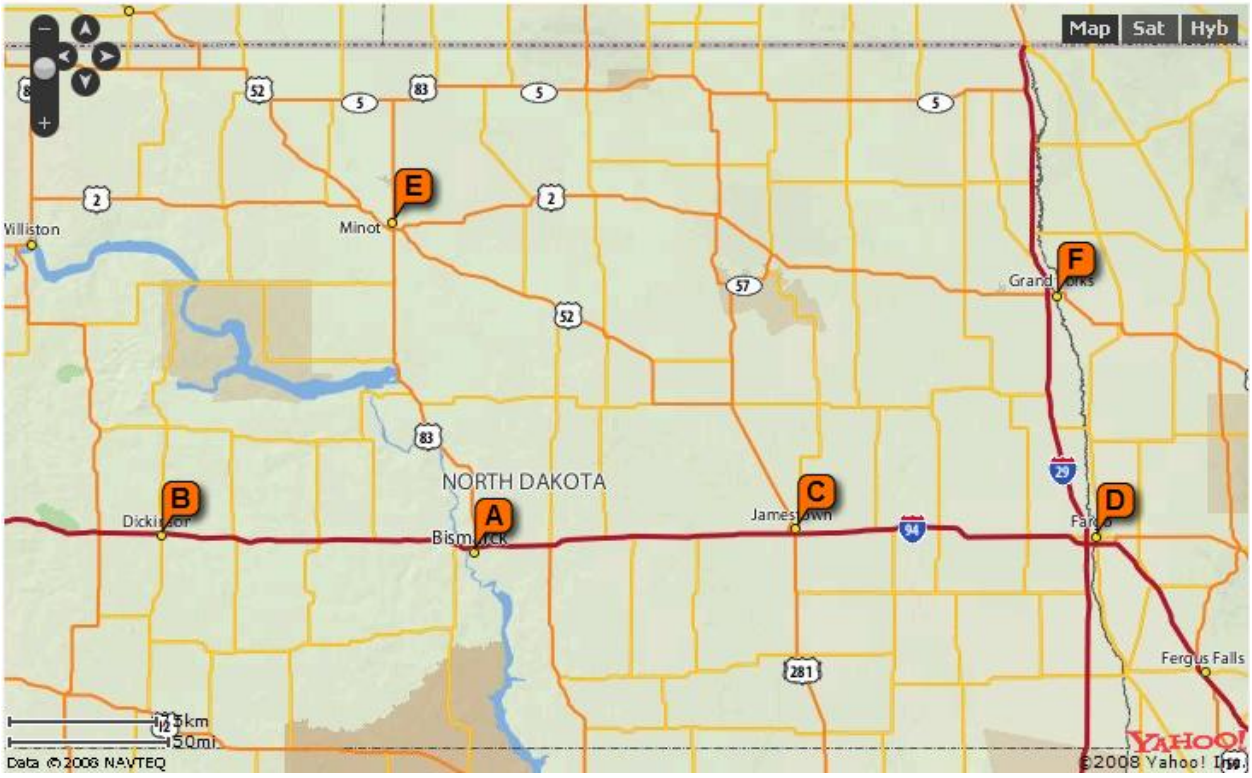

Table 1: Geographical distribution of recruitment of study participants (N=740)

Geographical unit	n(%)
Bismarck	229 (30.9)
Dickinson	70 (9.5)
Fargo	91 (12.3)
Grand Forks	96 (13.0)
Jamestown	126 (17.0)
Minot	128 (17.3)

Table 2: Demographic characteristics of the study participants (N=740)

Variables	n (%)
Age	
2 – 5 yrs	7 (0.9)
6 – 14 yrs	12 (1.6)
15 – 24 yrs	21 (2.8)
25 – 34 yrs	78 (10.5)
35 – 44 yrs	89 (12.0)
45 – 54 yrs	177 (23.9)
55 – 64 yrs	203 (27.4)
65 yrs or more	153 (20.7)
Sex	
Male	403 (54.5)
Female	337 (45.6)
Ethnicity	
Hispanic or Latino	7 (0.9)
Non-Hispanic or Latino	713 (96.4)
Missing (n=19) or Refused (n=1)	*20 (2.7)*
Race	
White	727 (98.2)
Other	12 (1.6)
Asian (n=4)	
Native Hawaiian/Pacific Islander (n=1)	
American Indian/Alaskan native (n=2)	
Other race (incl. multiracial) (n=5)	
Refused	*1 (0.1)*
Education	
Less than high school	12 (1.6)
High school graduate or equivalent	75 (10.1)
Some college	167 (22.6)
College grad or more	486 (65.7)
Income	
Less than $15,000	10 (1.4)
$15,000 - $24,999	38 (5.1)
$25,000 - $39,999	104 (14.1)
$40,000 or more	544 (73.5)
Refused	*27 (3.6)*
Don't know	*6 (0.8)*
Missing	*11 (1.5)*

Table 3: Housing characteristics of the study participants (N=740)

Variable	n(%)
Participants from same household	
One person	511 (69.0)
More than 1 person	229 (31.0)
House construction year	
1949 or before	119 (16.1)
1950 to 1977	297 (40.1)
1978 or after	318 (43.0)
Don't know	*6 (0.8)*
Living in the household	
2 months or less	7 (0.9)
3 months to a year	37 (5.0)
>=1 yr to 5 yrs	164 (22.2)
>=5 yrs to 10 yrs	135 (18.2)
>10 yrs	396 (53.5)
Missing	*1 (0.1)*
House Renovation/remodeling	
Currently undergoing renovation	42 (5.7)
Done within the last 12 months	76 (10.3)
Done beyond the last 12 months	279 (37.7)
No renovation done	338 (45.7)
Don't know (n=4) or missing (n=1)	*5 (0.7)*
Peeling paint or paint chips	
None	633 (85.5)
Yes	104 (14.1)
Inside	59 (8.0)
Outside	71 (9.6)
Don't know (n=2) or missing (n=1)	*3 (0.4)*

Table 4: Study participants' lead-related occupation[1] (N=717) and hobbies[2] (N=740)

	Currently n(%)	**Previously n(%)**
Lead-related occupations (any)	93 (13.0)	262 (36.5)
Lead-related occupations (more than one)	22 (3.1)	117 (16.3)
Lead-related hobbies (any)	473 (63.9)	414 (55.9)
Lead-related hobbies (more than one)	334 (45.1)	217 (29.3)
Household member ever having a lead-related occupation	166 (22.4)	
Household member ever having lead-related hobbies	411 (55.5)	

[1]Auto repair, battery manufacture/repair, construction, home construction/painting, working in lead smelter/refinery/mine, plumbing or pipe fitting, radiator repair, welding, working in brass/copper foundry, gas station attendant, military/police officer, etc.
[2]Car/boad repair, casting (bullets, fishing weights, etc.), casting lead figures (toys, soldiers), furniture finishing, home remodeling/paint job, hunting, jewelry making, lead soldering, pottery/stained glass making, reloading, target shooting, welding, etc.

Table 5: Wild game consumption by type, source, processing, and cleaning methods

Variables	n (%)
Wild game consumption	**598 (80.8)**
Venison	591 (98.8)
Other wild game	386 (64.5)
Birds	505 (84.4)
Number of types of wild games consumed (N=598)	
One	81 (13.5)
Two	150 (25.1)
Three	367 (61.4)
Source of wild game	
Food pantries or similar	1 (0.2)
Hunting	591 (98.8)
Other sources	8 (1.3)
Missing	*3 (0.5)*
Meat processing	
Self/family members	490 (81.9)
Meat packers/processors/lockers	189 (31.6)
Butcher	55 (9.2)
Don't know (n=7) or missing (n=4)	*11 (1.8)*
Cleans wound channel (N=490)	
Yes	451 (92.1)
No	9 (1.8)
Don't know (n=25) or missing (n=5)	*30 (6.1)*

Table 6: Wild game consumption frequency, recent consumption, meat processing method, average serving size, and duration

Variable	Venison (N=591)	Other game (N=386)	Birds (N=505)
Consumption in a year			
Occasionally	101 (17.1)	163 (42.2)	180 (35.6)
Hunting season only	11 (1.9)	27 (7.0)	83 (16.4)
Year round	476 (80.5)	192 (49.7)	240 (47.5)
Don't know or missing	*3 (0.5)*	*4 (1.0)*	*2 (0.4)*
Consumption in a given month			
<1 time/wk	222 (37.6)	267 (69.2)	390 (77.2)
1-3 times/wk	278 (47.0)	84 (21.8)	90 (17.8)
>3 times/wk	90 (15.2)	30 (7.8)	20 (4.0)
Don't know or missing	*1 (0.2)*	*5 (1.3)*	*5 (1.0)*
Last time consumed wild game			
<1 month ago	488 (82.6)	175 (45.3)	204 (40.4)
1-6 months	68 (11.5)	104 (26.9)	191 (37.8)
>6 month ago	33 (5.6)	104 (26.9)	107 (21.2)
Don't know or missing	*2 (0.3)*	*3 (0.8)*	*3 (0.6)*
Meat processing method			
Ground	342 (57.9)	107 (27.7)	11 (2.2)
Not ground	91 (15.4)	220 (57.0)	488 (96.6)
Both	157 (26.6)	57 (14.8)	3 (0.6)
Don't know or missing	*1 (0.2)*	*2 (0.6)*	*3 (0.6)*
Portion size in average serving			
<2 oz	57 (9.6)	34 (8.8)	50 (9.9)
>= 2 oz	523 (88.5)	342 (88.6)	446 (88.3)
Don't know or missing	*11 (1.9)*	*10 (2.6)*	*9 (1.8)*
Duration of consumption (years)			
< 1 year	3 (0.5)	10 (2.6)	5 (1.0)
1-3 year	17 (2.9)	14 (3.6)	19 (3.8)
4-10 year	50 (8.5)	34 (8.8)	43 (8.5)
>10 year	514 (87.0)	321 (83.2)	431 (85.3)
Don't know or missing	*7 (1.2)*	*7 (1.8)*	*7 (1.4)*

Table 7: Description of blood lead results (N=736)

Descriptive statistics (µg/dl)	
Mean	1.46
Median	1.19
Standard deviation	1.09
Geometric mean	1.17
Minimum	0.18
Maximum	9.82
Frequency of ≥5µg/dl	**8 (1.1%)**

Table 8: Geometric mean (µg/dl) and unadjusted and multivariate-adjusted associations between PbB and other variables in Generalized Estimating Equations (GEE) models (N = 736)

Variables	Geometric mean PbB (µg/dl)	Unadjusted Parameter estimates (95% CI)	Adjusted Parameter estimates (95% CI)
Age			
2 – 5 yrs	0.88	-1.021 (-1.251, -0.790) ††	-0.843 (-1.122, -0.563) ††
6 – 24 yrs	0.60	-1.234 (-1.532, -0.936) ††	-1.110 (-1.515, -0.705) ††
25 – 44 yrs	0.75	-1.062 (-1.283, -0.841) ††	-1.051 (-1.298, -0.804) ††
45 – 65 yrs	1.29	-0.457 (-0.672, -0.241) ††	-0.440 (-0.677, -0.203) †
65 yrs or more	1.77	Ref.	Ref.
Sex			
Male	1.49	0.610 (0.472, 0.748) ††	0.281 (0.078, 0.484)*
Female	0.89	Ref.	Ref.
Race			
White	1.18	Ref.	Ref.
Other	0.98	-0.291 (-0.832, 0.249)	0.274 (-0.245, 0.792)
Education			
Less than high school	1.95	Ref.	Ref.
High school graduate or equivalent	1.57	-0.189 (-0.867, 0.489)	0.434 (-0.209, 1.078)
Some college	1.23	-0.703 (-1.328, -0.078)*	-0.001 (-0.593, 0.590)
College grad or more	1.10	-0.811 (-1.431, -0.190)*	-0.023 (-0.615, 0.569)
Income			
Less than $15,000	0.99	Ref.	Ref.
$15,000 - $24,999	1.43	0.436 (-0.084, 0.957)	0.120 (-0.375, 0.614)
$25,000 - $39,999	1.03	0.071 (-0.392, 0.534)	0.113 (-0.340, 0.566)
$40,000 or more	1.19	0.308 (-0.137, 0.753)	0.395 (-0.073, 0.862)
House construction year			
1978 or after	1.00	Ref.	Ref.
1950 to 1977	1.31	0.334 (0.168, 500) ††	0.191 (0.017, 0.365)*
1949 or before	1.39	0.461 (0.201, 0.721) †	0.428 (0.155, 0.702)*
Living in the household			
Less than a year	0.74	Ref.	Ref.
1 to 5 years	1.05	0.332 (-0.221, 0.884)	-0.068 (-0.617, 0.483)

6 to 10 years	0.99	0.300 (-0.266, 0.867)	-0.030 (-0.085, 0.256)
More than 10 years	1.31	0.613 (0.064, 1.163)*	-0.250 (-0.917, 0.218)
House renovation/remodeling			
No renovation done	1.10	Ref.	Ref.
Currently undergoing renovation	1.01	- 0.134 (-0.401, 0.134)	-0.216 (-0.470, 0.037)
Done within the last 12 months	1.37	0.409 (0.033, 0.786)*	0.178 (-0.168, 0.525)
Done beyond the last 12 months	1.26	0.202 (0.033, 0.371)*	-0.046 (-0.209, 0.118)
Peeling paint or paint chips			
None	1.18	Ref.	
Yes	1.15	0.054 (-0.214, 0.322)	
Current lead-related occupation			
No	1.16	Ref.	Ref.
Yes	1.45	0.412 (0.159, 0.665)*	0.215 (-0.020, 0.450)
Previous lead-related occupation			
No	1.11	Ref.	Ref.
Yes	1.36	0.250 (0.093, 0.407)*	-0.149 (-0.324, 0.026)
Current lead-related hobbies			
No	0.88	Ref.	Ref.
Yes	1.38	0.611 (0.484, 0.738) ††	0.338 (0.172, 0.504) ††
Previous lead-related hobbies			
No	1.13	Ref.	
Yes	1.21	-0.037 (-0.120, 0.120)	
Household members with lead-related occupations			
No	1.02	Ref.	Ref.
Yes	1.22	0.241 (0.061, 0.421)*	-0.074 (-0.239, 0.091)
Household members with lead-related hobbies			
No	1.09	Ref.	Ref.
Yes	1.29	0.292 (0.128, 0.456) †	0.151 (-0.021, 0.324)
Consumes wild game			
No	0.84	Ref.	Ref.
Yes	1.27	0.428 (0.313, 0.543) ††	0.300 (0.157, 0.443) ††

Ref. – Reference category; *p-value <0.05; †p-value <0.001; ††p-value <0.0001

Table 9: Multivariate- adjusted association between PbB and frequency, proportion, and duration of wild game consumption by game type[1]

Variables	Venison (N=584) Parameter estimates (95% CI)	Other game (N=378) Parameter estimates (95% CI)	Birds (N=494) Parameter estimates (95% CI)
Consumption in a given year			
Occasionally	Ref.	Ref.	Ref.
Hunting season only	-0.012 (-0.536, 0.512)	0.072 (-0.276, 0.419)	0.156 (-0.064, 0.376)
All year round	0.005 (-0.267, 0.278)	-0.010 (-0.331, 0.312)	0.151 (-0.116, 0.418)
Consumption in a given month			
<1 time /week	Ref.	Ref.	Ref.
1-3 times/week	0.079 (-0.143, 0.301)	-0.074 (-0.381, 0.234)	0.053 (-0.213, 0.319)
> 3 times/week	0.148 (-0.133, 0.429)	-0.191 (-0.705, 0.323)	0.015 (-0.643, 0.672)
Most recent consumption			
<1 month ago	Ref.	Ref.	Ref.
1-6 months ago	-0.184 (-0.481, 0.112)	-0.461 (-0.790, -0.133)*	-0.279 (-0.516, -0.042)*
>6 months ago	-0.336 (-0.663, -0.009)*	-0.380 (-0.727, -0.032)*	-0.362 (-0.64, -0.081)*
Most often processed			
Ground	Ref.	Ref.	Ref.
Not ground	0.045 (-0.207, 0.296)	0.124 (-0.137, 0.385)	0.136 (-0.354, 0.625)
Both	-0.026 (-0.219, 0.166)	0.083 (-0.249, 0.414)	0.081 (-0.611, 0.772)
Average serving			
<2 oz	Ref.	Ref.	Ref.
≥2 oz	0.099 (-0.146, 0.345)	0.403 (0.068, 0.738)*	0.234 (-0.013, 0.480)
Years of consumption			
< 1 year	Ref.	Ref.	Ref.
1-3 years	-0.075 (-0.948, 0.797)	0.514 (-0.129, 1.158)	0.021 (-0.500, 0.542)
4-10 years	-0.070 (-0.992, 0.853)	0.130 (-0.378, 0.649)	0.176 (-0.403, 0.754)
>10 years	-0.114 (-1.023, 0.794)	0.145 (-0.272, 0.562)	0.182 (-0.283, 0.646)

Ref. – Reference category; *p-value <0.05; †p-value <0.001; ††p-value <0.0001;
[1]After adjusting for age, sex, race, age of housing, current and previous lead-related hobbies, current and previous lead related occupations, household member's with lead-related hobbies or occupation

Appendix 1:

North Dakota Lead Exposure Study

General instruction to interviewers

- Make sure to conduct this face to face interview at a time and place convenient to the participant.
- Read all the questions distinctly. If the participant has difficulty in understanding the question, repeat the question or try to explain it with provided definitions, if available. Try to avoid giving your own interpretation of the question.
- Use a proxy respondent for any participant under the age of 18 years. A proxy respondent can be a parent, primary caregiver, grandparent, sibling or any other family member 18 years of age or older.
- Try to obtain any contact information in case the interview is incomplete or in case you need to call back for more information.
- *Italic* fonts are used for instruction purposes only. Do not read them aloud.
- **Bold** fonts are headers/sub-headers. Do not read them aloud.
- CAPITAL fonts are used for definitions/explanations. Read these if the participant has trouble understanding any term or context.
- Assign a participant ID (e.g. NDXXXX) after they have signed an informed consent. Parents or primary caregivers should also sign consent form if the participant is 18 years or younger.
- Provide a copy of the informed consent to the participant.
- Read out **participant's name** where it says 'Participant'.

Interviewer Name: _____ Interview Date: _ _ /_ _/ _ _

Interview status: 1 ☐ Completed [date:_ _/_ _/_ _] 2 ☐ Not Completed

Participant Name:_____

Address _____: _____

City:_____ Zip:_____ Phone: (1)_____(2)_____

Interviewee relationship to the participant: _____

Start Survey:

"Thank you for agreeing to be in our study. I would like to ask you a few questions regarding your /participant's consumption of wild game such as deer, pheasant, elk, and other hunted animals, your/ participant's housing, your occupation and issues that can assist us in this lead exposure investigation. This survey will not take more than 15-20 minutes. I will ask you a question and give you some options to choose from. If you have any questions or don't understand what is being asked, please feel free to stop me. You can choose not to answer any question in this survey. All the information you give including your name, address, and your lead results will be kept confidential. Do you have any questions before we start?

(*If 'no'*) I would like to start by asking you about yourself."

Section 1: Demographic information

Q1. What is your/ participant's sex? 1 ☐ Male 2 ☐ Female

Q2. What is your/participant's age?

_____Years _____Months *99 ☐ Don't know* *77☐ Refused*

(If answer is 'Don't know' or 'Refused', ask Q3, otherwise skip to Q4)

Q3. You can also choose from the following categories:

1 ☐ 2 to 5 years 2 ☐ 6 to 14 years 3 ☐ 15 to 24 years

4 ☐ 25 to 34 years 5 ☐ 35 to 44 years 6 ☐ 45 to 54 years

7 ☐ 55 to 64 years 8 ☐ 65 years or more

99 ☐ Don't know *77 ☐ Refused*

Q4. Do you consider yourself/participant to be of Hispanic or Latino origin?

1 ☐ Hispanic or Latino 2 ☐ Not Hispanic or Latino

99 ☐ Don't know *77☐ Refused*

Q5. What race best describes you/participant?

1 ☐ White 2 ☐ Black or African American

3 ☐ Asian 4 ☐ Native Hawaiian or other Pacific Islander

5 ☐ American Indian or Alaskan native 6 ☐ Other: _____

99 ☐ Don't know *77 ☐ Refused*

Q6. What is your highest level of education (*List education level of proxy if participant <18 years of age)*?

1 ☐ Less than HS graduate 2 ☐ HS graduate or equivalent 3 ☐ Some college

4 ☐ College grad or more *99 ☐ Don't know* *77 ☐ Refused*

Q7. What is your/participant's annual household income?

1 ☐ less than $15,000 2 ☐ $15-$24,999 3 ☐ $25-$39,000

4 ☐ $40,000 or more *99 ☐ Don't know* *77 ☐ Refused*

NOTES TO INTERVIEWER

Has any other member(s) of the participant's household already completed this survey?

1 ☐ Yes (ID of any at least one participating household member: ND_ _ _ _)

2 ☐ No

(If 'yes', go to section 3, p.4. Otherwise continue with section 2)

Section 2: Housing information

”Now I will ask you a few questions about the house that you/participant live in or consider to be your primary residence.”

PRIMARY RESIDENCE: PRIMARY RESIDENCE IS THE PLACE WHERE THE YOU/PARTICIPANT SPEND AT LEAST FOUR NIGHTS A WEEK.

Q8. Do you know what year that house/apartment was built?

Year of construction |___|___|___|___| ***(Skip to Q10)***

99 ☐ Don’t know ***(Continue to Q9)***

Q9. Which of the following categories do you think most closely matches the year of construction?

1 ☐ 1978 and after 2 ☐ 1950 to 1977 3 ☐ Before 1949

99 ☐ Don’t know 77 ☐ Refused

Q10. How long have you/participant been living in this house/apartment?

Number |___|___|

1 ☐ Years

2 ☐ Months *(record 1 month if it has been less than a month)*

99 ☐ Don’t know 77 ☐ Refused

Q11. Has this house/apartment undergone renovation or is it currently undergoing renovation or remodeling? Renovation and remodeling can include the removal of walls, replacement of windows, or paint removal, etc.

1 ☐ Currently undergoing renovation/remodeling

2 ☐ Renovation/remodeling done within the last twelve months

3 ☐ Renovation/remodeling done more than twelve months ago

4 ☐ Never been renovated/remodeled

99 ☐ Don’t know 77 ☐ Refused

Q12. Is there any peeling paint or paint chips in this house/apartment? *(Check all that apply)*

1 ☐ No 2 ☐ Yes, interior 3 ☐ Yes, exterior

99 ☐ Don’t know 77 ☐ Refused

Q13. Is this house/apartment near a lead smelter, lead mine, battery recycling plant, or any other industry that is likely to release lead in to the environment?

1 ☐ No 2 ☐ Yes, within 1 mile 3 ☐ Yes, within 1-5 miles

4 ☐ Yes, but more than 5 miles away *99 ☐ Don’t know 77☐ Refused*

Section 3: Blood lead test history

Q14. Have you/participant ever had a blood test for lead?

1 ☐ Yes 2 ☐ No *99 ☐ Don't know* *77☐ Refused*

(If 'yes', ask Q15 and Q16. Otherwise, skip to section 4)

Q15. Have you/participant ever been told that you have high or elevated blood lead levels that can be harmful for your/participant's health?

1 ☐ Yes 2 ☐ No *99 ☐ Don't know* *77☐ Refused*

Q16. Do you/participant know the results from your/ participant's most recent blood lead test?

1 ☐ Yes 2 ☐ No *77☐ Refused*

(If 'yes') Levels: _____ Unit: _____ Date tested: _ _ / _ _ / _ _ or _____ months ago

Section 4: Exposure history

(Ask Q17 if the study participant is 18 years of age or older, otherwise, go to Q18)

Q17. Were you/participant ever engaged in any of the occupations listed on this card?

(Present participant with the occupation card and choose one answer option)

1 ☐ Yes, now 2 ☐ Yes, previously 3 ☐ No *99 ☐ Don't know* *77☐ Refused*

Occupation	Answer (write #)	Occupation	Answer (write #)
1. Auto repair		9. Lead smelter, refinery, mine	
2. Battery manufacture/repair		10. Military/Police officer	
3. Brass/copper foundry		11. Plastic, glass, ceramic, or rubber industry	
4. Chemical industry		12. Plumbing, pipe fitting	
5. Computer printing		13. Radiator repair	
6. Construction		14. Welding	
7. Gas station attendant		88. Other: _____	
8. Home construction/painting			

Q18. Has anyone else in the household ever been engaged in any of the occupations listed on the card?

1 ☐ Yes 2 ☐ No *99 ☐ Don't know* *77☐ Refused*

Section 4: Contd.

Q19. Have you/participant ever had any of the hobbies listed on this card?

(Present participant with the hobbies card and choose one answer option)

1 ☐ Yes, now 2 ☐ Yes, previously 3 ☐ No *99 ☐ Don't know 77☐ Refused*

Hobbies	Answer (write one)	Hobbies	Answer (write one)
1. Car/boat repair		8. Lead soldering	
2. Casting (bullets, fishing weights, etc.)		9. Pottery/stained glass making	
3. Casting lead figures (toys, soldiers)		10. Reloading	
4. Furniture finishing		11. Target shooting	
5. Home remodeling/paint job		12. Welding	
6. Hunting		88. Other: _____	
7. Jewelry making			

Q20.Has anyone else in the household ever been engaged in any of the hobbies listed on the card?

1 ☐ Yes 2 ☐ No *99 ☐ Don't know 77☐ Refused*

Q21. Do you/participant use any traditional Asian cosmetics, for example: Surma, Kohl, Sindoor?

1 ☐ Yes 2 ☐ No *99 ☐ Don't know 77☐ Refused*

Q22. Do you/participant use any herbal or folk remedies, for example: greta, azarcon, pay-loo-ah, ayurvedic products?

1 ☐ Yes 2 ☐ No *99 ☐ Don't know 77☐ Refused*

Q23. Have you/participant ever traveled to or lived in South or Central America or Mexico?

1 ☐ Yes 2 ☐ No *99 ☐ Don't know 77☐ Refused*

Q24. Do you/participant use ceramic or glazed pottery made in South or Central America or Mexico for cooking, eating, or drinking?

1 ☐ Yes 2 ☐ No *99 ☐ Don't know 77☐ Refused*

Q25. Do you/participant eat venison or other game meat or birds (other than water fowl) that are hunted using firearms? *(Check all that apply)*

1 ☐ Venison 2 ☐ Other game meat 3 ☐ Birds (other than water fowl)

4 ☐ No *99 ☐ Don't know 77☐ Refused*

(if 'No', 'Don't know' or 'Refused' then go to Section 5, otherwise continue)

Section 4: Contd.

Question	Venison	Other game meat	Birds(other than water fowl)
Q26. In a given year, how often do you/participant eat these kinds of meat?	1 □ Occasionally 2 □ Hunting season only 3 □ Year round *99 □ Don't know* *77 □ Refused*	1 □ Occasionally 2 □ Hunting season only 3 □ Year round *99 □ Don't know* *77 □ Refused*	1 □ Occasionally 2 □ Hunting season only 3 □ Year round *99 □ Don't know* *77 □ Refused*
Q27. How often do you/participant eat these kinds of meat in a given month?	1 □ <1/wk 2 □ 1-3 times/wk 3 □ > 3 times/wk *99 □ Don't know* *77 □ Refused*	1 □ <1/wk 2 □ 1-3 times/wk 3 □ > 3 times/wk *99 □ Don't know* *77 □ Refused*	1 □ <1/wk 2 □ 1-3 times/wk 3 □ > 3 times/wk *99 □ Don't know* *77 □ Refused*
Q28. When was the last time you/ participant ate these kinds of meat?	1 □ <1 a month ago 2 □ 1-6 months ago 3 □ > 6 months ago *99 □ Don't know* *77 □ Refused*	1 □ <1 a month ago 2 □ 1-6 months ago 3 □ > 6 months ago *99 □ Don't know* *77 □ Refused*	1 □ <1 a month ago 2 □ 1-6 months ago 3 □ > 6 months ago *99 □ Don't know* *77 □ Refused*
Q29. How is the meat most often processed?	1 □ Ground 2 □ Not ground *99 □ Don't know* *77 □ Refused*	1 □ Ground 2 □ Not ground *99 □ Don't know* *77 □ Refused*	1 □ Ground 2 □ Not ground *99 □ Don't know* *77 □ Refused*
Q30. How do you/family most often cook your meat?	1 □ Stew 2 □ Barbecue/grill 3 □ Bake/roast 4 □ Fry 5 □ Other *99 □ Don't know* *77 □ Refused*	1 □ Stew 2 □ Barbecue/grill 3 □ Bake/roast 4 □ Fry 5 □ Other *99 □ Don't know* *77 □ Refused*	1 □ Stew 2 □ Barbecue/grill 3 □ Bake/roast 4 □ Fry 5 □ Other *99 □ Don't know* *77 □ Refused*
Q31. In an average serving, how much meat do you/participant eat?	1 □ < 2 oz. 2 □ ≥2 oz. *99 □ Don't know* *77 □ Refused*	1 □ < 2 oz. 2 □ ≥2 oz. *99 □ Don't know* *77 □ Refused*	1 □ < 2 oz. 2 □ ≥2 oz. *99 □ Don't know* *77 □ Refused*
(2 oz. IS EQUIVALENT TO HALF OF A QUARTER POUNDER HAMBURGER FROM McDonalds)			
Q32. How many years have you/participant been eating these kinds of meat?	1 □ < 1 year 2 □ 1-3 years 3 □ 4-10 years 4 □ > 10 years *99 □ Don't know* *77 □ Refused*	1 □ < 1 year 2 □ 1-3 years 3 □ 4-10 years 4 □ > 10 years *99 □ Don't know* *77 □ Refused*	1 □ < 1 year 2 □ 1-3 years 3 □ 4-10 years 4 □ > 10 years *99 □ Don't know* *77 □ Refused*

Q33. Where do you get your wild game meat? *(Check all that apply)*

1 □ Food Pantries or similar 2 □ Hunting (self/family/friends) 3 □ Other sources

99 □ Don't know *77 □ Refused*

(If answer to Q33 is 'Hunting' or 'Other sources' then ask Q34, else go to the next section)

Q34.Who processes your meat? *(Check all that apply)*

1 □ Self or family member 2 □ Meat packers/processors/lockers 3 □ Butcher

99 □ Don't know *77 □ Refused*

Section 4: Contd.

(If answer to Q34 is 'Self or family member' then ask Q35, else go to the next section)

Q35. Do you/family member remove the meat around the wound channel before cooking the meat?

1 ☐ Yes 2 ☐ No *99 ☐ Don't know* *77☐ Refused*

Section 5: Child section *(Ask only if the child is <6 years of age; otherwise go to Section 6)*

Q36. Does the child frequently visit (2 or more times a week) a home or a building (second home, relatives, school, or day care) built before 1978?

1 ☐ Yes 2 ☐ No *99 ☐ Don't know* *77☐ Refused*

(If 'yes', then ask Q37, otherwise skip to Q38)

Q37. Has that home or building recently been, or is currently being renovated or remodeled?

1 ☐ Yes 2 ☐ No *99 ☐ Don't know* *77☐ Refused*

Q38. Does the child frequently visit, or temporarily live with, a person who has/had any of the above mentioned hobbies or occupation? *(Present the occupation and hobbies cards again)*

1 ☐ Yes 2 ☐ No *99 ☐ Don't know* *77☐ Refused*

(If 'yes', then list all that apply) 1 ☐ Hobby (#s): _____2 ☐ Occupation (#s): _____

Q39. Does the child often pick up things from the ground and put them in his/her mouth?

1 ☐ Yes 2 ☐ No *99 ☐ Don't know* *77☐ Refused*

Section 6: Assessment of pregnant participants *(For female respondents between 18-45 years of age; otherwise end survey and read "End Script")*

Q40. Are you currently pregnant?

1 ☐ Yes 2 ☐ No *77☐ Refused*

(If 'no', end survey and read 'End script')

Q41. People sometimes consume non-food items during pregnancy. Have you consumed non-food items such as clay, chalk, dirt, etc. during your pregnancy?

1 ☐ Yes 2 ☐ No *99 ☐ Don't know* *77☐ Refused*

Q42. During your pregnancy, have you been told that you are anemic (low number of red blood cells)?

1 ☐ Yes 2 ☐ No *99 ☐ Don't know* *77☐ Refused*

End Script:

"Thank you again for your time and participation. The information you have given is very important and will help us answer our very important question regarding lead and wild game consumption. As we mentioned earlier, we will now draw a little blood from you/participant. The result of this blood draw and the investigation will be communicated to you as soon as possible. If you have any questions about today's survey, please contact Dr. Kirby Kruger at the State Health Department at 701.328.2378.

Comments:

(List anything you found to be relevant to the investigation during the whole encounter)

Health Consultation

THE POTENTIAL FOR INGESTION EXPOSURE
TO LEAD FRAGMENTS IN VENISON IN WISCONSIN

NOVEMBER 4, 2008

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

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HEALTH CONSULTATION

THE POTENTIAL FOR INGESTION EXPOSURE TO LEAD FRAGMENTS IN VENISON IN WISCONSIN

Prepared By:

Wisconsin Department of Health and Family Services
Under cooperative agreement with the
Agency for Toxic Substances and Disease Registry

Table of Contents

Summary and Statement of Issues

Bullet fragments in rifle-killed deer have led to concerns about risks of lead exposure associated with human consumption of venison. The presence of lead bullet fragments in venison intended for human consumption has been confirmed, and indicates a completed exposure pathway for the ingestion of lead-contaminated meat. A modeled exposure estimate, based on currently available field data, suggests a significant risk of elevated lead levels in blood among children consuming venison shot with lead ammunition. Because elevated blood lead has not been confirmed among consumers of venison, and because the measured lead content in venison varies greatly, there is an *indeterminate public health hazard* among those consumers. The Wisconsin Department of Health Services (DHS) recommends the use of non-lead ammunition as the simplest and most effective solution to lead poisoning, in both humans and wildlife, arising from the consumption of deer killed with lead ammunition. In addition, food pantries and their clients should be made aware of possible lead fragments in venison; processors of deer should use best practices to avoid lead exposure from venison.

The presence of lead in venison is a topic that has implications for deer hunters and their families, food pantries and their clients, meat processors, and others with a public or private interest in hunting. The purpose of this report is to determine the health implications of eating lead-contaminated venison, based upon laboratory analysis of venison samples and a modeled exposure assessment.

Background

Wisconsin ranks near the top of all states in the popularity and economic importance of White-tailed deer hunting (WDNR 1998, 2007). Deer hunting is an important part of Wisconsin recreation and tourism, and is a long-held tradition in many families. In addition, the large size of the state's deer population has effects such as crop damage and road vehicle accidents that demand population management. Most of that management is conducted via hunting, traditionally with rifle and shotgun using lead ammunition, as well as bow and arrow.

The issue of human exposure to lead ammunition fragments in venison came to the attention of Public Health indirectly. Hunt *et al.* (2006), concerned about reports of lead poisoned avian scavengers, investigated hunter-shot deer for the presence of lead, hypothesizing that eagles and other birds consumed lead from deer killed but unrecovered, or from discarded entrails. They reported that tiny metal fragments were prevalent in the wounds of these deer, particularly those shot with copper-jacketed and hollow point bullets. Subsequently, concerns were raised in North Dakota, South Dakota, Iowa, Minnesota, and Wisconsin about the potential for human exposure to lead among those consuming venison. North Dakota was the state taking the earliest public health position (NDDOH 2008):

> "Earlier this year, Dr. William Cornatzer, a Bismarck physician and hunter, contacted the Department of Health with concerns about the potential of lead fragments from bullets in ground venison. Dr. Cornatzer collected 95 packages of ground venison donated for food pantries. Of those, X-rays detected the presence

> of metal in 53 packages. The Department of Health recently took five samples targeting the metal pieces, all five of which tested strongly positive for lead….The Department of Agriculture sent a letter to all state- and federal-inspected meat processing plants in North Dakota informing them about the situation, and the Department of Health sent a letter to food pantries with recommendations for disposing of the meat. Additional studies concerning lead in wild game and lead levels in children are being planned by the Department of Health. In addition, the Game and Fish, Health, and Agriculture departments are working to develop guidance about how to properly clean and dress wild game to reduce the chances of lead in meat."

Venison donated to charity food pantries is a particular concern, as this program is an important outlet for harvested deer while also serving a population having a greater than average exposure to lead in the home. In Wisconsin, food pantry venison is not regulated, unlike commercial and retail meats, which must be inspected before and after processing. The 2006 Wisconsin deer harvest was approximately 500,000 deer (WDNR 2007). From these, about 400,000 pounds of venison were donated to food pantries via 126 meat processors participating in the Department of Natural Resources (WDNR) program.

The Wisconsin Department of Health Services (DHS, formerly Dept. Health and Family Services) has a comprehensive *Childhood Lead Poisoning Prevention Program* devoted to identifying those at risk and interrupting all sources of lead exposure (DHFS 2008). Metallic lead in food is not a new issue. Lead solder in canned foods and lead leachate from ceramic and glass vessels were important sources that were addressed starting in the 1970s. Consumers of wild game are familiar with lead pellets, bullets, and slugs to be avoided in meat. However, the presence of nearly invisible lead fragments in wild game, to our knowledge, had not been widely considered.

Because this issue has implications for an important food distribution program, on April 11, 2008 the DHS asked food pantries to hold venison pending the analysis of venison samples from food pantries (Appendix 1). As the analysis proceeded (see below), DHS concluded that due to the prevalence and concentration of lead seen in venison samples, the frozen venison held in food pantries and other facilities should not be released without further screening. This was conveyed in a second letter to food pantries (Appendix 2). In cooperation with the WDNR, an appeal was made to local veterinarians throughout the state (Appendix 3) for their assistance in screening the venison using their X-ray facilities.

Venison sampling. In Wisconsin, the Departments of Natural Resources and Health Services cooperated to sample and analyze lead in venison from around the state. One hundred eighty three (183) nominal one-pound ground venison samples were collected from freezer stocks of 5 food pantries and 6 meat processors located around the state ("pantry samples"). The samples were screened radiographically by WDNR staff. Of these, 46 samples with radiopaque fragments were submitted to the Wisconsin State Laboratory of Hygiene (WSLH) for lead analysis. Each of the 46 packages was subdivided into nominal ¼ lb "portions" for chemical analysis. Each ¼ lb sample (approx. 0.113 kilograms) was digested in KOH. Any metal fragments recovered following digestion were dissolved in acid and analyzed for Pb (See USDA

2004 for method). The lab reported lead concentration as milligrams Pb per kilogram fresh meat (mg/kg). Means ± standard deviation are reported in terms of the ¼ pound samples. Reported prevalence was calculated from ¼ pound samples normalized to the 1 pound x-ray screened package size.

One hundred fourteen (114) additional samples of ground and whole cut venison were solicited from WDNR employees in order to more directly sample the hunter population ("hunter samples"). These were screened and analyzed as above. Sixteen of the 114 hunter samples were identified by the submitter as "commercially processed." Therefore, for the purpose of calculating averages, these sixteen were grouped with the pantry samples, for an adjusted total of 199 pantry (or commercially processed) samples and 98 self-processed samples (from hunters).

Results. Lead was ultimately detected in 30 of 199 commercially processed samples, a prevalence of 15% (Table 1). The mean lead concentration found among those pantry samples positive for lead was 15.9 mg/kg ± 32.5 std. dev. The mean lead concentration found among *all* pantry samples was 2.4 mg/kg ± 13.8 std. dev.

Lead was detected in 8 of 98 hunter samples, a prevalence of 8%. Seven of the eight positives were from ground meat; one was from a whole cut. The mean lead concentration found among those hunter samples positive for lead was 21.8 mg/kg ± 67.1 std. dev. The mean lead concentration found among *all* hunter samples was 1.8 mg/kg ± 19.8 std. dev.

Table 1. Summary of lead content analysis in Wisconsin hunter-killed deer.

Sample group	***Number of samples****	***Mean lead conc., lead-positive samples mg/kg ±std. dev.***	***Mean lead conc., all samples mg/kg ±std. dev.***	***Prevalence of lead-positive samples***
Commercial processor	*199*	*15.9 ± 32.5*	*2.4 mg/kg ± 13.8*	*15%*
Hunter processed	*98*	*21.8 ± 67.1*	*1.8 mg/kg ± 19.8*	*8%*

*Each sample represents a nominal 1 pound package.

Discussion

Venison sampling. The presence of quantified lead bullet fragments in venison intended for human consumption indicates that a completed exposure pathway exists for the ingestion of lead-contaminated meat. To date, there has been no corresponding sampling of blood lead among consumers of venison in Wisconsin. This work represents an initial assessment of the risks of lead in venison.

This health consultation emphasizes the implications of lead found in donated venison. However, it is noteworthy that donated venison represents approximately 2% of the total deer harvest in Wisconsin. The potential exposed population extends well beyond clients of food pantries. Changes in practices that result in lower lead concentrations in venison will have positive effects in the broader population.

The analytical results of lead in venison conducted to date in Wisconsin are characterized by high variability. Each hunter-killed deer is a unique interaction of the anatomical placement of the shot, the type of ammunition used, the ballistics of the individual shot, and details of the processing method. Each of these variables affects the passage of the bullet through the wound, the degree of fragmentation, and ultimately the concentration of lead. As more data is gathered from deer carcasses and processed meat, it may later be possible to state the prevalence of lead in venison killed in a particular way, and to predict whether there are exposure risks to a processed lot of meat based upon samples taken from that lot. Despite these limitations, it is clear that many venison samples contained unhealthy levels of lead.

U.S. Food and Drug Administration regulatory position. There is no single standard for permissible amounts of lead in food. Furthermore, FDA regulatory standards and guidelines for lead in food are complicated by the relatively recent recognition (ATSDR 2007, EPA 2008) of lead as a probable human carcinogen.

Health and environmental agencies rely on several standards and guidelines, including FDA guidelines for tolerable levels of daily dietary lead intake, and FDA guidance suggesting specific limits for lead in certain foods such as shellfish and candy (ATSDR 2007, FDA 2007).

For meat and fat products, an international consensus standard of 0.05 mg/kg is under discussion (FDA 2000). While there is no known endogenous role for lead, and no known level of exposure that is without effect, the variety of standards and guidelines acknowledges that some exposure to lead is unavoidable. The FDA's *provisional total tolerable intake levels* provide the following limits on daily lead intake: for adults, 75 µg/day; for pregnant women, 25 µg/day; and for children age five and under, 6 µg/day (FDA 1998).

Exposure analysis. Blood lead levels that could result from ingesting Pb-contaminated venison were predicted using the U.S. EPA *Integrated Exposure Uptake Biokinetic Model* (IEUBK, EPA 2007). The model has 100 input parameters that account for the various sources of ingested and inhaled lead in the environment. Default inputs and assumptions were used for all parameters save dietary consumption of Pb-contaminated game meats as a percentage of total meat consumption. The model was run using inputs for game meats at the mean concentrations observed in Wisconsin (Table 1), at an ingestion frequency of either once (3.5%) or twice (7.0%) per month. The ingestion frequency assumes one meat meal per day. The model was also run using the maximum concentrations found in venison (Table 2). Running the model at these maximum concentrations and at the once- or twice-per-month consumption frequency resulted in a model error, and were therefore calculated using a lower exposure frequency.

Table 2. Childhood blood lead concentrations predicted from consuming venison containing lead fragments at concentrations found in Wisconsin. [1]

Exposure scenario	*Pb conc. in venison mg/kg*	*Consumption frequency (meals/month)*	*% children with blood Pb above 10 µg/dL*	*Average blood lead (geometric mean, µg/dL)*
maximum	*265*[3]	*1 per 2 months*	*100%*	*34*[2]
maximum	*265*	*1 per 4 months*	*96%*	*23*
maximum	*169*[4]	*1 per 2 months*	*98%*	*27*
medium	*21.8*[5]	*2 per month*	*90%*	*18*
medium	*21.8*	*1 per month*	*65%*	*12*
medium	*15.9*[6]	*2 per month*	*81%*	*15*
medium	*15.9*	*1 per month*	*50%*	*10*
low	*2.4*[7]	*2 per month*	*11%*	*6*
low	*2.4*	*1 per month*	*5%*	*5*
low	*1.8*[8]	*2 per month*	*8%*	*5*
low	*1.8*	*1 per month*	*4%*	*4*
standard	*0.05*[9]	*2 per month*	*1%*	*3.5*

Shaded area is "medium" exposure scenario. See uncertainty discussion.
mg/kg: milligram lead per kilogram fresh venison. µg/dL: micrograms lead per deciliter of blood.
[1]*Predictions modeled using U.S. EPA Integrated Exposure Uptake Biokinetic Model (EPA 2007).*
[2]*Exposures associated with blood lead levels above 30 µg/dL are above the range of values calibrated and validated for the model.*
[3]*Maximum lead concentration found in hunter samples.*
[4]*Maximum lead concentration found in pantry samples.*
[5]*Average lead concentration among hunter samples that were positive for lead, n=8.*
[6]*Average lead concentration among pantry samples that were positive for lead, n=30.*
[7]*Average lead concentration among all pantry samples, n=199.*
[8]*Average lead concentration among all hunter samples, n=98.*
[9]*International consensus standard for lead in meat (FDA 2000).*

Results. As shown in Table 2., the model predicts that consuming venison with 21.8 mg/kg (hunter samples) lead every 15 days will result in 90 % of children less that 7 years old having blood lead greater than the 10 µg/dL level of concern. If the ingestion frequency is reduced to once every 30 days, the predicted percentage of children with blood lead >10 µg/dL is 65%. A comparable statement for adult blood lead is not included, as the model is designed only for the pharmacokinetic fate of lead in children.

At the mean lead concentration found in pantry samples, the model predicts that consuming venison with 6.2 mg/kg lead every 15 days will result in 80 % of children less that 7 years old having blood lead greater than 10 µg/dL level of concern. If the ingestion frequency is reduced to once every 30 days, the predicted percentage of children with blood lead >10 µg/dL is 50%.

Uncertainty. The conditions used in the modeled predictions (Table 2) were chosen to reflect a range of risk levels among the wide variation in prevalence and concentration of lead in venison samples. The assumed ingestion frequency may over- or underestimate any particular child. The overall means would tend to underestimate exposures to those consuming venison from pantries and processors having a high prevalence of lead in meat samples. The venison Pb concentrations used in the model are means of only those samples that were positive for lead and are not overall means. However, these averages were 10-42 fold lower than the maximum concentrations of lead seen in some samples (maximum 169 mg/kg in pantry samples; 265 mg/kg in hunter samples). Calculated lead exposure to those children consuming venison with the highest levels of lead measured was at or near 100%, even with a lower frequency of consumption (Table 2). At the lowest calculated lead levels, using the same 15 and 30 day exposure frequencies, the model predicts that most children would have measurable increases in blood lead that are *below* 10 ug/dL. However, this lower estimate is skewed away from the possibility of ingesting venison having very high lead levels. For the purpose of this exposure estimate, it is assumed that a realistic exposure, or the calculated averages of 21.8 and 15.9 mg/kg Pb in venison, lies somewhere between the minimum and the maximum permitted by our data.

Toxicological effects expected from lead fragments in venison. Lead is a well-established developmental neurotoxin, and also affects the kidneys, blood formation, reproduction, humoral immunity, and the peripheral nervous system. Due to variation in lead uptake among individuals and among the various chemical forms of lead, the toxicity of lead exposure is usually expressed in terms of its resulting concentration in blood (PbB), and the toxic endpoints corresponding to those blood concentrations. Ten micrograms per deciliter of blood (10µg/dL) is commonly cited as the level of concern in children (CDC 1991). However, numerous studies (*e.g.* Finkelstein *et al.* 1998; Fels *et al.* 1994) report subtle biochemical, nephric, neuromotor, and cognitive effects in children (and in some studies, adults) chronically exposed to lead corresponding to blood lead levels as low as 2 µg/dL.

Although we know of no formal studies of lead poisoning resulting from ingestion of lead bullet fragments in large game animals, the presence of lead in game birds is well established (Tsuji *et al.* 1999) and some studies (*e.g.* Johansen *et al*. 2006) have measured elevated blood lead (>10 µg/dL in adults) among subsistence hunters who regularly consume waterfowl shot with lead pellets. Several reports have demonstrated clinical lead poisoning among adults retaining two or more lead shot in the appendix (Madsen *et al.* 1988, Hilman 1967). Other reports (*e.g*. Mowad *et al.* 1998) have documented cases in which medical intervention was required for children who intentionally ingested lead fishing sinkers or other metallic lead objects. A recent Minnesota case resulted in a fatality (CDC 2006).

A variety of effects of lead in children and adults correspond to various blood lead levels (see Appendix 4, from ATSDR 2006). Within the limitations of modeled blood lead predictions presented here, some of these effects can be reasonably expected among children and adults consuming venison contaminated with lead fragments.

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

Developing fetuses and young children are particularly vulnerable to the effects of lead (ATSDR 2006). Children are more sensitive to the effects of lead than adults, have absorb more ingested lead into the body than adults, and no safe blood lead level in children has been determined (see Appendix 5, for a child-specific public health statement).

Conclusions

- The quantified presence of lead bullet fragments in venison intended for human consumption indicates that a completed exposure pathway exists for the ingestion of lead-contaminated meat.
- The modeled exposure estimates, based on currently available field data, indicate that even at the lowest exposure scenario, there is predicted risk of elevated lead levels in blood among children consuming venison shot with lead ammunition.
- Because elevated blood lead has not been confirmed among consumers of venison, and because the measured lead content in venison varies greatly, there is an *indeterminate public health hazard* among those consumers.

Recommendations

- Food pantries and their clients should be made aware of possible lead fragments in venison, to include consumption recommendations to protect young children and fetuses from lead exposure.
- Identifying and discarding those portions of the deer carcass most likely to contain bullet fragments is one way to avoid lead exposure from venison. Best practices for butchering deer should be provided to commercial processors and to hunters.
- Future venison donations to charity food pantries should be from processors using methods shown to minimize bullet fragments in meat.
- DHS recommends the use of non-lead ammunition as the simplest and most effective solution to lead poisoning, in both humans and wildlife, arising from the consumption of deer killed with lead ammunition. To address this issue, DHFS recommends the eventual transition to non-lead ammunition.

Public Health Action Plan

- Advice to hunters for minimizing the amount of lead in venison has been included in the WDNR 2008 Deer Regulations.
- To verify the effect of revised meat processing recommendations, DHS, in cooperation with WDNR, DATCP, and local and state health agencies, will analyze ground venison samples for the presence of lead following the 2008 deer hunting season.
- DHS will continue to work with state and local health and environmental agencies, with the hunting community, and with food relief programs in providing education on this topic.
- DHS will work with state agencies to encourage the public's awareness of and availability to non-lead hunting ammunition.

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Appendix 1. Venison and lead information distributed to local health officers and posted to the Wisconsin Health Alert [Internet] Network

TO: Local and Tribal Health Officers, DPH Regional Office Directors

FROM: Chuck Warzecha, Bureau of Environmental and Occupational Health

RE: Possible lead contamination in processed venison at food pantries.

DATE: April 11, 2008

Please forward this alert to food pantries in your jurisdictions.

By now you may have heard or seen news out of North Dakota or Minnesota related to lead contamination in venison donated to food pantries in those states. Wisconsin has been in contact with those states and we are also conducting sampling of venison from processors in this state. We are taking the reports from the other states seriously. There have been no reports of illness associated with lead in venison. But, as a precaution we have advised that food pantries with donated venison on their shelves hold any remaining product until we have more information.

The concern stems from studies that show bullet fragments (particularly from high velocity rifles) dispersing widely in the meat, and then incorporated into the ground meat from processors. We are working with the DNR and DATCP to better understand the issue and formulate clearer advice for the public. We are testing venison to determine if bullet particles in wild game pose a health issue. If we get similar results to what Minnesota has received, it is possible we will recommend disposal of the remaining venison at food pantries.

Because of the extensive blood lead surveillance we have done, we are confident that the primary source of lead poisoning in the state comes from chipping and peeling lead paint. Eating venison has not been identified as a concern from this surveillance. However, we are unable to rule this issue out as a possible source of unsafe lead exposure.

We have sent messages to the food pantries in the TEFAP program (The Emergency Food Assistance Program). However, that does not include all food pantries. Please pass this advisory on to other food pantries in your area.

Please address any questions on this matter to Chuck Warzecha (608/264-9880) in the Bureau of Environmental and Occupational Health. Thank you.

Appendix 2. DHS (formerly DHFS) letter to food pantry managers.

TO: Food Pantry Managers

Local and Tribal Health Officers
DPH Regional Office Directors
Please forward this alert to food pantries in your jurisdictions.

FROM: Chuck Warzecha, Rob Thiboldeaux,

Bureau of Environmental and Occupational Health

SUBJECT: Health Concerns about Lead in Venison

June 20, 2008

Thank you for your patience while the Department of Health and Family Services works with the Department of Natural Resources, the Department of Agriculture, Trade, and Consumer Protection, and neighboring states to develop recommendations regarding lead in venison.

At this time, processing guidelines are being established so that food pantries and meat processors can continue their involvement in venison donation programs when hunting season opens again in the fall.

In addition, based on what we currently know about the health implications of eating venison containing lead, we recommend that remaining venison from food pantries not be consumed or distributed unless the meat has been tested. If it is not possible to test the meat, pantries have the discretion to discard it.

Using X-ray equipment and lab tests, we have analyzed more than 200 venison samples from food pantries and meat processors throughout the state. The number of samples with lead present was fairly low, about 4%, but not low enough to eliminate the potential for exposure under the right set of circumstances.

Resources are not available for screening all remaining venison stocks. If a food pantry has access to X-ray equipment through a local veterinarian, it may be possible for them to screen their remaining venison and still release uncontaminated meat. A plan to offer this screening is underway, but may take several months to implement.

Although lead in venison does not rival lead paint in older homes as a health risk for Wisconsin children, the risk is not low enough to ignore. Wisconsin's health and environmental agencies continue to study this concern to determine the actual risk.

We do know that pregnant women and children less than six years old are most at risk. These two groups in particular should avoid consuming venison shot with lead bullets or slugs, or

venison from an unknown source. Lead poisoning can cause health symptoms that may not immediately be noticed by a casual observer. Lead exposure in young children is known to affect brain development and cause reduced IQ and attention span, impaired growth, reading and learning disabilities, hearing loss, and a range of other health and behavioral effects.

We again thank you for patience while DHFS, DNR, and DATCP work to understand this issue. If you have questions please call Chuck Warzecha 608/264-9880 or Rob Thiboldeaux 608/267-6844.

Appendix 3. DHS (formerly DHFS)/DNR letter to Wisconsin Veterinarians.

TO: Wisconsin Veterinarians

FROM: Department of Health and Family Services

SUBJECT: Radiographic Screening for Lead in Food Pantry Venison

July 1, 2008

Dear Wisconsin Veterinarian,

The Wisconsin Division of Public Health (DHFS) and the Department of Natural Resources (DNR) request your assistance with an issue of public health concern. Recent studies have shown a prevalence of tiny lead fragments in venison shot with lead ammunition. These are typically too small to be seen or removed during meat processing, and can disperse far from the wound channel. This first came to light from studies investigating the potential for eagles to be poisoned by feeding on deer carcasses.1 More recently, preliminary investigations in Minnesota and Wisconsin, using X-ray screening followed by chemical analysis, have found lead in processed venison stored at charity food pantries and from hunter's home freezers.

Venison to be distributed from charity food pantries is of particular concern to state health and environmental agencies. Based on what we currently know about the health implications of eating venison containing lead, we recommend that venison currently remaining in food pantries not be consumed or distributed *unless the meat has been screened radiographically.* DHFS and DNR do not currently have the resources to screen all the venison remaining at state food pantries from the last season. In order to allow food pantries to confidently release donated venison to the needy, *we seek to enlist the voluntary services of local vets willing to offer their X-ray services to screen packaged meat.*

The lead fragments occur with relatively low incidence (4-20% of 1 lb. meat samples in preliminary work), but often at a high concentration (up to 169 milligrams per kilogram , compared to a FDA-recommended 0.05 mg/kg in meat products). Because this source of lead exposure has not been considered until recently, we do not understand all of its health implications. Most current examples of human lead poisoning involve exposure to lead paint. We do know that subsistence hunters that regularly consume waterfowl from areas where lead shot is used are at high risk lead poisoning, both from ingestion of lead pellets and from meat tainted by pellets in the gizzard.2 We have little information about the effects of infrequent lead

1 Hunt GW, Burnham W, Parish CN, Burnham KK, Mutch B, Oaks JL. 2006. Bullet Fragments in Deer Remains: Implications for Lead Exposure in Avian Scavengers. *Wildlife Soc. Bull. 34(1):* 167-70.

2 Johansen P, Pedersen HS, Asmund G, Riget F. 2006. Lead shot from hunting as a source of lead in human blood. *Environ. Polution 142:* 93-97.

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exposure at the concentrations we see in venison, but our best information is that there is a level of concern, and that the exposure is to be avoided, especially by those most sensitive.

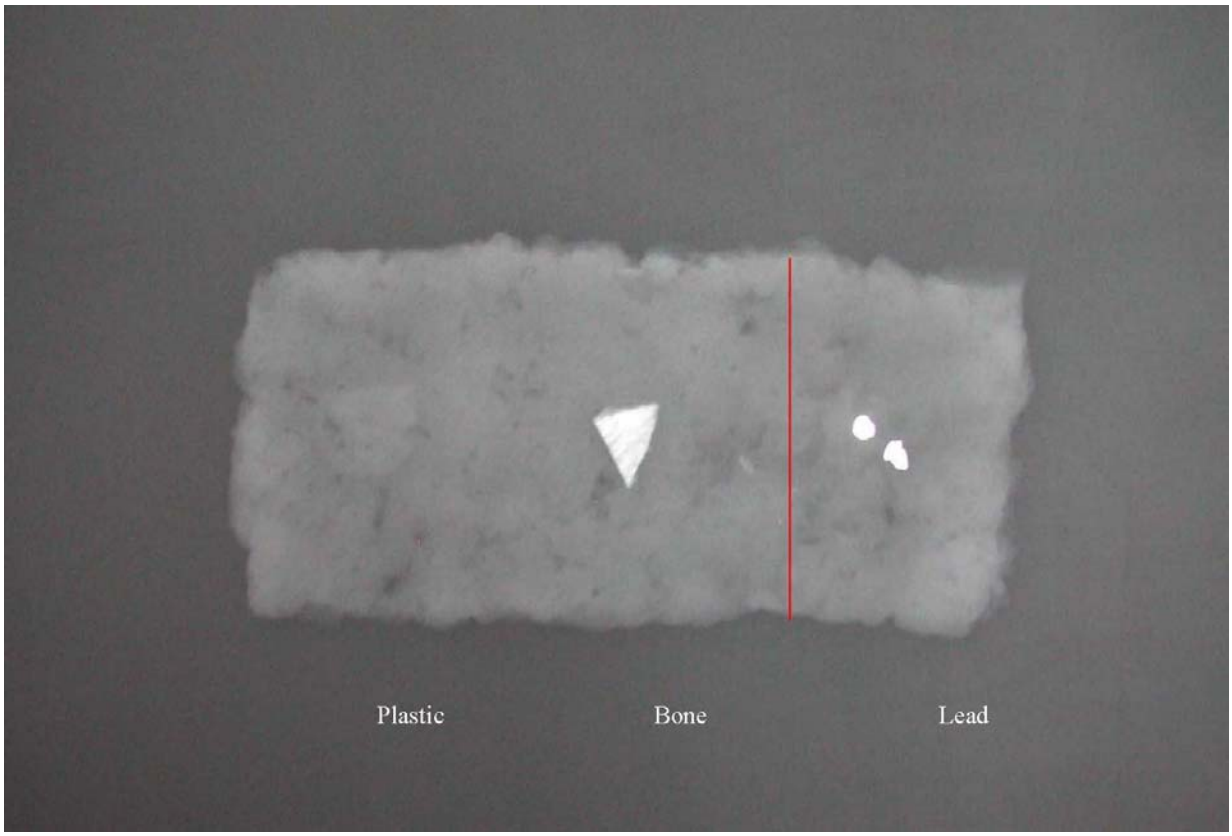
In order to prevent this source of lead exposure, DHFS is working with the DNR, the Department of Agriculture, Trade, and Consumer Protection (DATCP), and neighboring states to develop recommendations regarding lead in venison. Processing guidelines are being established so that food pantries and meat processors can continue with the venison program when hunting season opens in the fall. New processing guidelines should avoid the need for future X-ray screening.

We hope that food pantries who are interested in having their current stores of venison screened for lead will be able to find a veterinary clinic in the community that is willing to provide radiography services. This request for assistance would apply only to the period prior to the 2008 deer season. For the upcoming season, we are working on a separate plan that will include recommendations to meat processors, along with spot checks by the state lab of hygiene to see how well processing techniques are able to eliminate lead from venison.

Screening guidelines. Based on preliminary work by the DNR, radiography of the wrapped frozen packages of venison is a simple process. Lining up several packages on a large cassette works well, as long as identification of the individual packages is recorded on the film, so that those containing fragments can be later identified. The exposure technique will vary with different equipment, but since the goal is to differentiate metal from soft tissue, details of the exposure technique are not critical. As an aid to interpreting X-ray images, this letter includes a "radiographic scale" demonstrating the appearance of small fragments of plastic, bone, and lead-containing bullets on a background of ground venison.

The goal of the venison radiography is to identify those packages with ANY fragments compatible with lead. These packages should be separated and identified as possibly containing lead when results are communicated to the food pantry. Using this information, *it will be the pantry's responsibility to decide which packages are distributed for consumption and which are discarded.* DHFS recommends that all packages possibly containing lead be discarded.

Thank you for considering helping your local food pantry and your community by participating in this program. In closing, please note that DHFS and DNR make no presumption of commitment from individual veterinarians. The choice is yours, as you will not be reimbursed for your donated time and resources. Nonetheless, if you do choose to provide this support to local food pantries, we are very interested in learning the results of your screening. There is still much to learn on this issue, and your experience will add to our understanding. If you have questions about the program or your clinic's role, please contact Robert Thiboldeaux, PhD, Department of Health and Family Services (Robert.Thiboldeaux@wi.gov; 608-267-6844). If you have questions about the radiographic screening techniques, please contact Julie Langenberg, VMD, Department of Natural Resources (Julia.Langenberg@wisconsin.gov; 608-266-3143).



Radiography scale illustrating opacities of plastic, bone, and lead fragments in ground venison. Venison containing any objects with an opacity similar to that of lead (to the right of the red line) should be discarded.

Appendix 4. Blood Lead Concentrations Corresponding to Adverse Health Effects

From: **Agency for Toxic Substances and Disease Registry/Division of Toxicology and Environmental Medicine. 2006. Lead ToxFAQs: /Chemical Agent Briefing Sheet.**

Blood Lead Concentrations Corresponding to Adverse Health Effects		
Life Stage	**Effect**	**Blood lead (µg/dL)**
Children	Depressed ALAD* activity	< 5
	Neurodevelopmental effects	<10
	Sexual maturation	<10
	Depressed vitamin D	>15
	Elevated EP**	>15
	Depressed NCV***	>30
	Depressed hemoglobin	>40
	Colic	>60
Adult	Depressed ALAD*	< 5
	Depressed GFR****	<10
	Elevated blood pressure	<10
	Elevated EP (females)	>20
	Enzymuria/proteinuria	>30
	Peripheral neuropathy	>40
	Neurobehavioral effects	>40
	Altered thyroid hormone	>40

	Reduced fertility	>40
	Depressed hemoglobin	>50
Elderly Adult	Neurobehavioral effects	> 4

*aminolevulinic acid dehydratase (ALAD)
**erythrocyte porphyrin (EP)
***nerve conduction velocity (NCV)
****glomerular filtration rate (GFR)
Source: ATSDR Toxicological Profile for Lead (Draft for Public Comment), 2005.

Appendix 5. How can lead affect children?

A public health statement from the Agency for Toxic Substances and Disease Registry's *Toxicological Profile for Lead* (ATSDR 2007).

1.6 HOW CAN LEAD AFFECT CHILDREN?

This section discusses potential health effects in humans from exposures during the period from conception to maturity at 18 years of age. Studies carried out by the Centers for Disease Control and Prevention (CDC) show that the levels of lead in the blood of U.S. children have been getting lower and lower. This result is because lead is banned from gasoline, residential paint, and solder used for food cans and water pipes. However, about 310,000 U.S. children between the ages of 1 and 5 years are believed to have blood
lead levels equal or greater than 10 μg/dL, the level targeted for elimination among young children in the Unites States by 2010.

Children are more vulnerable to lead poisoning than adults. Children are exposed to lead all through their lives. They can be exposed to lead in the womb if their mothers have lead in their bodies. Babies can swallow lead when they breast feed, or eat other foods, and drink water that contains lead. Babies and children can swallow and breathe lead in dirt, dust, or sand while they play on the floor or ground. These activities make it easier for children to be exposed to lead than adults. The dirt or dust on their hands, toys, and other items may have lead particles in it. In some cases, children swallow nonfood items such as paint chips; these may contain very large amounts of lead, particularly in and around older houses that were painted with lead-based paint. The paint in these houses often chips off and mixes with dust and dirt. Some old paint contains as much as 50% lead. Also, compared with adults, a bigger proportion of the amount of lead swallowed will enter the blood in children.

Children are more sensitive to the health effects of lead than adults. No safe blood lead level in children has been determined. Lead affects children in different ways depending on how much lead a child swallows. A child who swallows large amounts of lead may develop anemia, kidney damage, colic (severe "stomach ache"), muscle weakness, and brain damage, which ultimately can kill the child. In some cases, the amount of lead in the child's body can be lowered by giving the child certain drugs that help eliminate lead from the body. If a child swallows smaller amounts of lead, such as dust containing lead from paint, much less severe but still important effects on blood, development, and behavior may occur. In this case, recovery is likely once the child is removed from the source of lead exposure, but there is no guarantee that the child will completely avoid all long-term consequences of lead exposure. At still lower levels of exposure, lead can affect a child's mental and physical growth. Fetuses exposed to lead in the womb, because their mothers had a lot of lead in their bodies, may be born prematurely and have lower weights at birth. Exposure in the womb, in infancy, or in early childhood also may slow mental development and cause lower intelligence later in childhood. There is evidence that these effects may persist beyond childhood. Children with high blood lead levels do not have specific symptoms. However, health workers can find out whether a child may have been exposed to harmful levels of lead by taking a blood sample. They can also find out how much lead is in a child's bones by taking a special type of x-ray of the finger, knee, or elbow. This type of test, however, is not routine.

CERTIFICATION

This Health Consultation was prepared by the Wisconsin Department of Health Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun. Editorial review was completed by the Cooperative Agreement partner.

Jennifer Freed
Technical Project Officer
CAT, CAPEB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation and concurs with its findings.

Alan Yarbrough
Team Lead
CAT, CAPEB, DHAC, ATSDR

LEAD BULLET FRAGMENTS IN VENISON FROM RIFLE-KILLED DEER: POTENTIAL FOR HUMAN DIETARY EXPOSURE

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ABSTRACT.—Human consumers of wildlife killed with lead ammunition may be exposed to health risks associated with lead ingestion. This hypothesis is based on published studies showing elevated blood lead concentrations in subsistence hunter populations, retention of ammunition residues in the tissues of hunter-killed animals, and systemic, cognitive, and behavioral disorders associated with human lead body burdens once considered safe. Our objective was to determine the incidence and bioavailability of lead bullet fragments in hunter-killed venison, a widely-eaten food among hunters and their families. We radiographed 30 eviscerated carcasses of White-tailed Deer (*Odocoileus virginianus*) shot by hunters with standard lead-core, copper-jacketed bullets under normal hunting conditions. All carcasses showed metal fragments (geometric mean = 136 fragments, range = 15–409) and widespread fragment dispersion. We took each carcass to a separate meat processor and fluoroscopically scanned the resulting meat packages; fluoroscopy revealed metal fragments in the ground meat packages of 24 (80%) of the 30 deer; 32% of 234 ground meat packages contained at least one fragment. Fragments were identified as lead by ICP in 93% of 27 samples. Isotope ratios of lead in meat matched the ratios of bullets, and differed from background lead in bone. We fed fragment-containing venison to four pigs to test bioavailability; four controls received venison without fragments from the same deer. Mean blood lead concentrations in pigs peaked at 2.29 µg/dL (maximum 3.8 µg/dL) 2 days following ingestion of fragment-containing venison, significantly higher than the 0.63 µg/dL averaged by controls. We conclude that people risk exposure to lead from bullet fragments when they eat venison from deer killed with standard lead-based rifle bullets and processed under normal procedures. At risk in the U.S. are some ten million hunters, their families, and low-income beneficiaries of venison donations. *Reproduced with permission from PLoS ONE 4(4): e5330.*[6]

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[6]Reproduced in accordance with the Creative Commons Attribution License with permission of the authors from: Hunt, W. G., R. T. Watson, J. L. Oaks, C. N. Parish, K. K. Burnham, R. L. Tucker, J. R. Belthoff, and G. Hart. 2009. Lead bullet fragments in venison from rifle-killed deer: potential for human dietary exposure. PLoS ONE 4(4): e5330. doi: 10.1371/journal.pone.0005330.

HUNT, W. G., R. T. WATSON, J. L. OAKS, C. N. PARISH, K. K. BURNHAM, R. L. TUCKER, J. R. BELTHOFF, AND G. HART. 2009. Lead bullet fragments in venison from rifle-killed deer: potential for human dietary exposure. Reproduced *in* R. T. Watson, M. Fuller, M. Pokras, and W. G. Hunt (Eds.). Ingestion of Lead from Spent Ammunition: Implications for Wildlife and Humans. The Peregrine Fund, Boise, Idaho, USA. DOI 10.4080\ilsa.2009.0112

Key words: Bullet fragmentation, bush meat, game meat, lead, lead exposure, venison.

LEAD HAS BEEN IMPACTING the health of humankind since the Romans began mining it 2500 years ago, and despite early knowledge of its harmful effects, exposure to lead from a wide variety of sources persists to this day (Warren 2000). Government-based guidelines for acceptable degrees of exposure prior to the 1970s were based upon thresholds of overt toxicity and on apparent acceptance that norms in lead concentrations in a society enveloped in lead-permeated exhaust fumes and lead paint must somehow reflect organic tolerance. Medical science has since concluded that virtually no level of lead exposure can be considered harmless in consideration of its many sublethal, debilitating, and often irreversible effects (Needleman 2004). Lead quantities formerly regarded as trivial are associated with permanent cognitive damage in children (Lanphear et al. 2005), including those prenatally exposed (Schnaas et al. 2006). Lead is associated with impaired motor function (Cecil et al. 2008), attentional dysfunction (Braun et al. 2006), and even criminal behavior (Needleman et al. 2002, Wright et al. 2008). Release of lead stores from bone exposes fetuses during pregnancy (Tellez-Rojo et al. 2004), and adults late in life (Schwartz and Stewart 2007, Shih et al. 2007). Lead is implicated in reduced somatic growth (Hauser et al. 2008), decreased brain volume (Cecil et al. 2008), spontaneous abortion (Borja-Aburto et al. 1999), nephropathy (Ekong et al. 2006), cancer, and cardiovascular disease (Menke et al. 2006, Lustberg and Silbergeld 2002).

Ingested residues of lead ammunition are a recently identified pathway of lead exposure to human consumers of gun-killed game animals. An analysis of North Dakota residents showed that recent (≤ 1 mo) consumers of game meat had higher covariate-adjusted blood lead concentrations than those with a longer interval (> 6 mo) since last consumption (Iqbal 2008). Studies have linked elevated blood lead concentrations of subsistence hunters in northern Canada, Alaska, Greenland, and elsewhere to consumption of shotgun-killed birds (Hanning et al. 2003, Levesque et al. 2003, Johansen et al. 2004, 2006, Bjerregaard et al. 2004, Tsuji et al. 2008a, 2008b, 2008c; see Burger et al.1998, Mateo et al. 2007). The hypothesis that rifle bullet fragments are an additional source of human lead exposure is suggested by radiographic studies of deer killed with standard lead-based bullets, which show hundreds of small metal fragments widely dispersed around wound channels (Hunt et al. 2006, Dobrowolska and Melosic 2008, Krone et al. 2009). The possibility of inadvertent lead contamination in prepared meat consumed by hunters and their families is noteworthy, considering the millions of people who hunt big game in the USA (USFWS and USCB 2006) and the thousands of deer annually donated to food pantries for the poor (Cornatzer et al. 2009, Avery and Watson 2009). In this report, we test two hypotheses: (1) that fragments of lead from rifle-bullets remain in commercially processed venison obtained under normal hunting conditions in the USA, and (2) humans absorb lead when they eat venison containing bullet fragments.

MATERIALS AND METHODS

Ethics Statement.—Nine licensed hunters provided the deer carcasses analyzed in this study, and obtained them during the established hunting season and in accordance with normal practices as permitted under the authority of the Wyoming Game and Fish Commission, Cheyenne, Wyoming. The latter institution also granted permission to the authors to convey the processed meat from each carcass to the Washington Animal Disease Diagnostic Laboratory at Washington State University, Pullman, for analysis. The Washington State University Institutional Animal Care and Use Committee approved the lead bioavailability experiment involving eight swine.

Deer Collection.—Hunters used conventional center-fire hunting rifles to kill 30 White-tailed Deer (*Odocoileus virginianus*) under normal hunting conditions in Sheridan County, Wyoming in November 2007. All bullets were of 7-mm Remington Magnum caliber and of identical mass (150 grains, 9720 mg); cartridges were of a single brand reported in local mass-market vendor interviews as the most widely sold to deer hunters. Bullets consisted of a lead core (68% of mass) and a copper jacket (32%); lead was exposed only at the 1.7-mm-diameter tip of the bullet. Reported shot distances averaged 116 m (range = 25–172 m). All deer were eviscerated according to the hunters' normal practice. Weights of 29 eviscerated deer averaged 33.8 kg (SD = 7.1). We recorded the positions of bullet entry and exit wounds; 26 deer (87%) were shot in the thorax, and some portion of the projectile exited the animal in 92% of shots. We removed the skin and head, and we excised from each animal a ≥4 cm section of tibia for isotope analyses and a ≥30 g sample of muscle (shank) along the tibia to determine background lead levels in each deer.

Carcass Radiography.—We radiographed with conventional veterinary equipment the area of the wound channel (lateral view) of eviscerated deer and adjusted exposures to maximize contrast. We included along the margin of each radiograph a strip of clear plastic tape containing arrayed samples of lead bullet fragments (obtained by shooting through light plastic jugs filled with water), comparably-sized samples of bone fragments, and locally-obtained sand and gravel; only the lead fragments were clearly visible in the radiographs at the applied settings. We scanned radiographs into digital format and counted unambiguous metal fragments under 400% magnification. We did not attempt to distinguish between copper and lead in fragment counts.

Commercial Processing.—We transported each deer carcass to a different commercial meat processing plant in 22 towns throughout Wyoming and requested normal processing into boneless steaks and ground meat in 2-pound (0.91 kg) packages; we retrieved the processed, frozen, and packaged meat usually within 4 days.

Radiography of Processed Meat.—We used digital radiography (EDR6 Digital Radiography, Eklin Medical Systems, Santa Clara, California) and fluoroscopy (MD3 Digital Fluoroscopy, Philips Medical Systems, Best, Netherlands) to scan all the thawed ground meat packages (N = 234); we scanned an additional 49 loin steak packages from 16 carcasses in which radiography had revealed fragments near the spine. We unwrapped every package showing visible radiodense fragments in a subsample of 13 deer, flattened the meat to c. 1-cm thickness on a light plastic plate, and rescanned. We marked the vicinity of each visible fragment with a stainless steel needle and then used a 2.8-cm diameter plastic tube as a "cookie-cutter" to obtain samples of meat with radiodense fragments.

Analysis of Metal Samples.—Each of the fragment-containing meat samples was weighed and then divided into approximately 5-g subsamples, each of which was completely digested in a known volume of concentrated nitric acid. Inductively coupled plasma (ICP) analysis was then used to measure the concentrations of lead and copper in each subsample. The lower detection limit for both metals was 2 µg/g. The analysis was performed commercially by the Analytical Sciences Laboratory, University of Idaho, Moscow, where quality management conforms with applicable Federal Good Laboratory Practices (40 CFR Part 160); the Laboratory is accredited through the American Association of Veterinary Laboratory Diagnosticians, which stipulates ISO 17025 quality assurance measures.

Lead Isotope Analysis.—We analyzed bullet, bone, and meat samples for lead isotope compositions. Bullet fragments were cleaned in dilute (1M) HCl, leached with 2 ml of 7M HNO_3, and then removed from the acid leachate. The leachate was then dried and treated with 2 drops of 14M HNO_3. Bone and meat samples were digested in 14M HNO_3, dried and treated with 2 drops of 14M HNO_3. Lead was separated using standard HBr and HCl on an anion-exchange column (Bio Rad, AG 1X8). Isotope compositions were determined with a ThermoFinnigan Neptune MC-ICPMS at the Washington State University GeoAnalytical Laboratory. Reproducibility of the lead standard (NBS-981), run before, during, and after the samples, was <0.012% (2 SE, n = 4) for Pb^{206}/Pb^{204}, and <0.018% for Pb^{208}/Pb^{204}.

Lead concentrations in the procedural blanks were negligibly small.

Bioavailability Experiment.—We tested the bioavailability of ingested bullet fragments by feeding processed venison known by radiography to contain radiodense fragments to pigs. The latter were considered a good model for the absorption of lead from the human gastrointestinal tract (USEPA 2007). We used eight female Yorkshire/Landrace and Berkshire/Duroc cross-bred pigs, 70–82 days of age and weighing 28.2–32.7 kg (mean 30.3 kg) at the termination of the experiment. All were initially fed 1.36 kg of standard pelleted pig grower ration divided into two meals per day, then acclimated for 7 days to consuming cooked ground commercial beef patties mixed with the pellet ration. We gradually increased the amount of ground meat from 113 g per meal to 500 g, as pellet amounts were correspondingly decreased. We withheld all food for 24 hours prior to the venison feeding trial.

Ground venison and venison steaks from four deer were used in the feeding trial. Each of the eight pigs consumed 1.26–1.54 kg of meat over two feedings 24 hours apart on days 0 and 1 of the experiment; no pig consumed meat from more than one deer. Four pigs received venison containing fluoroscopically visible metal fragments. The total amount of lead fed to each pig was unknown, but quantitative analysis of similar packages from other deer in the study showed 0.2–168 mg (median 4.2 mg) of lead. The four control pigs were simultaneously fed equivalent amounts of venison with no fluoroscopically visible fragments from the same four deer. We assessed background levels of lead in each deer from shank meat, collected well away from any potential bullet contamination. All venison for the test and control pigs was either already ground, or finely chopped if steaks, and cooked in a microwave oven until brown. For feeding, we mixed the cooked venison in a bowl with small amounts of pig ration to improve palatability. We verified that all meat was eaten, and we monitored the pigs for signs of illness.

We collected anticoagulated blood samples (2 ml whole blood in EDTA) from each pig at 1 hour prior to feeding venison on day 0, and on days 1, 2, 3, 4, 7 and 9 after feeding venison, and stored the samples at 4°C until testing. Lead levels were determined by inductively coupled plasma mass spectrometry (ICP-MS) with a lower detection limit of 0.5 µg/dL; we assigned all values below the detection limits as 0.5 µg/dL. We compared mean blood lead concentrations between control pigs and test pigs on days 0 through 9 using 2-way ANOVA with repeated measures and restricted maximum likelihood (REML) estimation; we performed linear group contrasts for each day. A single outlier datum among control pigs on day 4 (6.8 µg/dL) was an order of magnitude higher than a retest of the same sample (0.54 µg/dL); the latter was consistent with all other control samples. We omitted both results from statistical analysis, resulting in a sample of three rather than four control pigs on day 4. We used JMP (SAS Institute, Cary, NC, USA, Vers. 7.0.1) for all statistical analyses.

RESULTS

Bullet Fragments in Venison.—Wound radiographs of all 30 eviscerated deer showed metal fragments (median = 136 fragments, range = 15–409) and offered a measure of fragment dispersion, albeit two-dimensional. Extreme distance between fragment clusters in standard radiographs averaged 24 cm (range ± SD = 5–43 ± 9 cm), and maximum single fragment separation was 45 cm. Radiography revealed visible metal fragments in the ground meat of 24 (80%) of the 30 deer. At least one fragment was visible in radiographs of 74 (32%) of 234 packages of ground meat; 160 (68%) revealed no fragments, 46 (20%) had one, 16 (7%) had two, and 12 (5%) showed 3-8 fragments. An average of 32% of ground meat packages (N = 3–15 packages, mean 7.8) per deer showed metal fragments (range = 0–100% of packages). The ground meat derived from one deer showed more fragments (N = 42) than counted in the radiograph of the carcass (N = 31), and two ground meat packages (2 deer) each contained a single shotgun pellet which had not been detected on the carcass radiographs. No relationship was apparent between the number of metal fragments counted in carcasses and those subsequently counted in ground meat from the same individual (correlation coefficient 0.06). In the aggregate, we observed 155 metal particles in the ground meat packages, 3.1% of the 5074 we counted in the carcasses. Of 16 deer carcasses with metal frag-

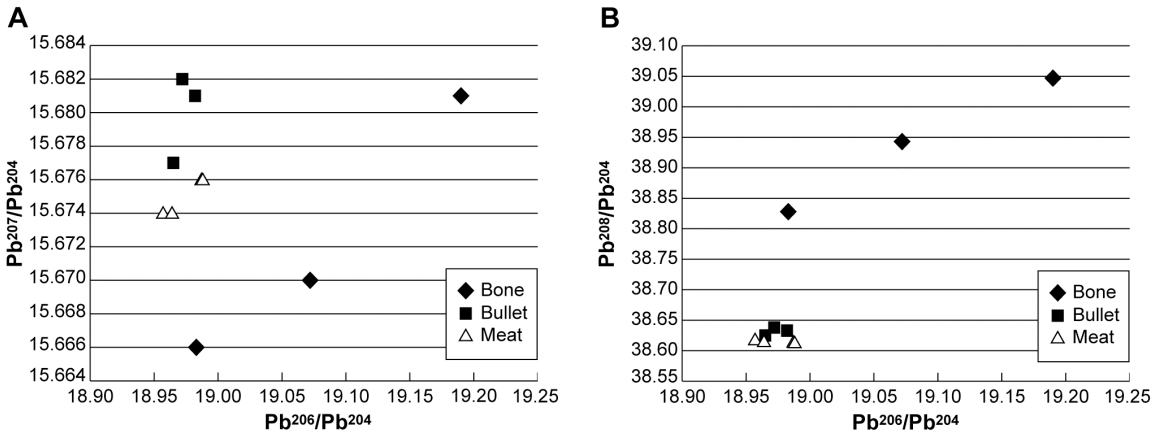

Figure 1. Plots of lead isotope ratios in ground meat samples containing radiodense fragments from four deer. Ratios from lead-in-meat samples clustered with those of unfired bullets but were distinct from bone lead ratios. Note that there are four meat data points (open triangles) in each graph, but two have almost identical positions and are superimposed.

ments near the spine, four (25% of selected deer, 8% of 49 packages) showed fragments in processed loin steaks (1–9 fragments). Additional fragments may have occurred in 220 unscanned packages of steaks derived from all animals.

ICP analysis of radiodense fragments excised from ground meat packages from 13 deer identified lead in 25 (93%) of 27 samples; aggregate lead fragment mass per package averaged 17.2 mg (range ± SD = 0.2–168 ± 39.8 mg) or 0.03% of the lead component of bullet mass. Nine samples contained copper at levels above background values, including the two samples with no detectable lead. Lead concentrations in unprocessed muscle tissue collected from the shank and well away from the bullet path of the same 13 deer were all below the detection limit of 2.0 µg/g and served as internal controls for measures of lead in ground meat.

The ratio of lead isotopes 206/204 plotted against 207/204 ratios (Figure 1a) and 208/204 ratios (Figure 1b) showed that meat samples with elevated lead levels from four deer, and lead from bullets from the same boxes (N = 3) supplying the bullets used to kill those deer, formed tight clusters distinct from ratios of background lead in tibial bone. Variation in the bone ratios apparent in Figure 1 likely represent long term, cumulative lead exposure encompassing varied sources of natural and anthropogenic lead.

Bioavailability Experiment.—All the pigs consumed all the venison provided to them within 2 hours. None of the experimental animals showed any signs of lead toxicosis or other illness for the duration of the experiment; none exhibited vomiting or diarrhea which might have affected gastrointestinal physiology or retention times in the stomach or intestines.

Blood lead concentrations in the four control pigs ranged from below the level of ICP-MS detection (0.5 µg/dL) to 1.2 µg/dL throughout the experiment (mean ± SD = 0.63 ± 0.19 µg/dL; Figure 2). Blood lead concentrations in pigs fed metal fragment-containing venison ranged from below the level of detection to 1.4 µg/dL on day 0, immediately prior to feeding venison. The 2-way ANOVA revealed a significant interaction between treatment (feeding venison either with fragments or no fragments) and day ($F_{6,35.32}$ = 3.413, P = 0.009; Figure 2). Mean blood lead concentrations in the pigs fed fragment-containing venison were significantly elevated above those of control pigs on days 1, 2 and 3 post-exposure (linear contrast: $F_{1,39.79}$ = 10.39, P = 0.003, $F_{1,39.79}$ = 17.76, P = 0.0001, and $F_{1,39.79}$ = 14.71, P = 0.0004, respectively; Figure 2); the maximum observed value was 3.8 µg/dL. Blood lead concentrations did not differ (P >0.05) between the control pigs and exposed pigs on days 0, 4, 7 and 9 (Figure 2).

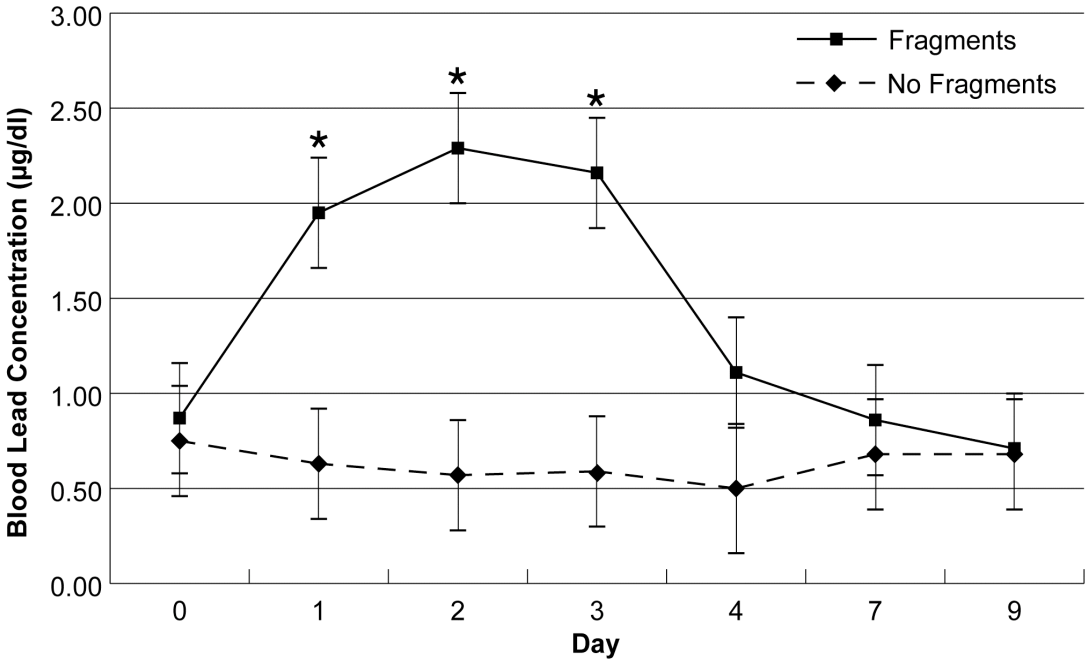

Figure 2. Mean blood lead concentrations observed during swine feeding experiment. Mean (± SE) blood lead concentrations (μg/dL) in four pigs fed venison containing radiographically dense fragments (Fragments) compared with four control pigs fed venison without visible fragments (No Fragments) on days 0 and 1. Asterisks indicate days when means differed significantly between test and control groups.

DISCUSSION

Our findings show that people risk exposure to lead when they eat venison from deer killed with standard lead-based rifle bullets and processed under normal commercial procedures. Evidence includes a high proportion (80%) of deer showing at least one bullet fragment in one or more ground meat packages, a substantial frequency of contamination (32% of all ground meat packages), a majority (93%) of assayed fragments identified as lead, isotopic homogeneity of bullet lead with that found in the meat, and increased blood lead concentrations in swine fed fragment-containing venison. Considering that all the carcasses we brought to the processors contained fragments (15-409 fragments counted in radiographs), the high rate of removal evident in the ground meat implies meticulous care on the part of the processors to avoid contamination, but an apparent inability of 80% of them to do so entirely. We conclude that, in a majority of cases, one or more consumers of a hunter-killed, commercially-processed deer will consume bullet lead.

We interpret the absorption of lead into the bloodstream of all four test pigs as clear evidence of the bioavailability of lead from ingested bullet fragments (Figure 2), and we infer that human consumption of venison processed under prevailing standards of commerce results in increased blood lead concentrations. The rate of bioavailability cannot be calculated from our experiment because the exact amounts of lead in the meat packages were unknown. Rather, we directed our test at the condition experienced by human consumers of venison from rifle-killed deer of variable amounts of lead patchily distributed as fragments in ground meat or steak.

Depuration of lead in blood does not imply its excretion, but rather the sequestration of a substantial proportion in soft tissues and ultimately in bone from which it may eventually be mobilized, as dur-

ing pregnancy (Tellez-Rojo et al. 2004) or in old age (Schwartz and Stewart 2007). The observed elevations in blood lead concentrations, while not considered overtly toxic, would nevertheless contribute to cumulative lead burdens, and would be additive with further meals of contaminated venison. Observed blood lead concentrations of up to 3.8 µg/dL, and daily means of 2.3 and 2.2 µg/dL in the experimental animals, do approach what is considered significant with respect to adverse effects in humans by contemporary assessments (Gilbert and Weiss 2006, Levin et al. 2008). Whereas the CDC advisory level for intervention in individual children is 10 µg/dL in blood (CDC 1991), studies now associate as little as 2 µg/dL with increased risk of cardiovascular mortality in adults (Menke et al. 2006) and impaired cognitive function in children (Jusko et al. 2008). Hauser et al. (2008) detected an impact threshold of 5 µg/dL on male maturation rates, and Lanphear et al. (2005) concluded that "…lead exposure in children who have maximal blood lead concentrations <7.5 µg/dL is associated with intellectual deficits." These latter values would appear attainable with the repeated consumption of venison possible among deer hunting families, especially those incurring additional exposure from other sources.

Factors that may influence dietary lead exposure from spent lead bullets include the frequency and amount of venison consumption, degree of bullet fragmentation, anatomical path of the bullet, the care with which meat surrounding the bullet wound is removed, and any acidic treatments of the meat that would dissolve lead, i.e., coating the hanging carcass with vinegar or the use of acidic marinades in cooking. Exposure to lead from spent bullets is easily preventable if health-minded hunters use lead-free copper bullets now widely available and generally regarded as fully comparable to lead-based bullets for use in hunting (Carter 2007). The potential for toxic exposure to copper from these bullets is presumably insignificant because little or no fragmentation occurs (Hunt et al. 2006), and there is no meat wastage from having to discard tissue suspected of contamination.

Fragmenting lead bullets have been in use for hunting since the early 1900s (Stroud and Hunt 2009). Although hunter numbers have diminished slightly in recent years, there were 10.7 million big game hunters in the United States in 2006, the majority of whom still use lead-based bullets (USFWS 2006, Watson and Avery 2009). Many state wildlife agencies annually issue multiple deer harvest permits to individuals, effectively offering venison as a year-round protein staple for some families; game meat is the principal source of protein for a considerable proportion of Alaska's population (Titus et al. 2009). Hunter-donated venison to food pantries and shelters for low income families in most states produced an estimated minimum of 9 million venison meals associated with the 2007/08 hunting season (Avery and Watson 2009). With these concerns, we anticipate that health sciences will further examine the bioavailability of lead from bullets and shot, the epidemiology of exposure, and the possible consequences among hunters, their families, and others who consume venison.

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