

## **Lead Poisoning in Wisconsin's Birds**

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**Summary** – Lead is a highly-toxic elemental metal that historically has been widely used in sporting ammunition and fishing tackle such as sinkers. Lead does not become less toxic over time. Spent lead shotgun shot, bullets, and fishing sinkers in the environment can cause severe illness and death if ingested by birds. Non-toxic alternatives to lead shot, bullets, and sinkers are available at many sporting supply stores and are readily available online.

### **Introduction**

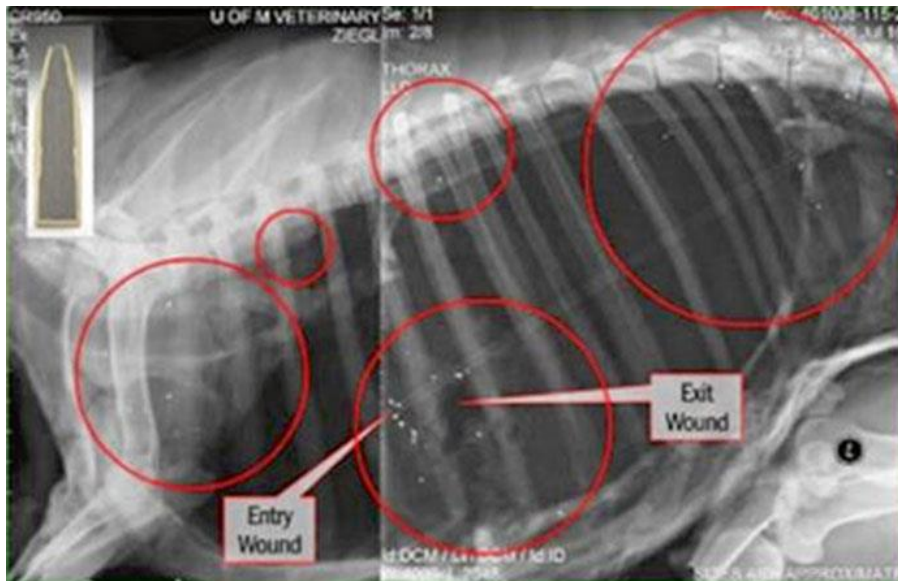
Lead is a highly toxic heavy metal that occurs naturally in mineral deposits and is mined for many human uses. As a result of those uses, lead is then deposited in the environment where it persists because it does not break down into less-toxic compounds. Sources of lead deposition in the environment are many, including lead metals deposited in landfills, lead-based paint, lead tailing deposits from mining activities, and lead from gasoline combustion. Another source of lead deposition in the environment is from ammunition or equipment used in wildlife hunting, fishing, and recreational shooting. Ammunition and other recreational sources of lead deposition can either be directly on the landscape (i.e., lead shot pellets or lost fishing sinkers) or indirectly as lead fragments in animal carcasses and offal piles (gut piles that the hunter deposits on the landscape from large game hunting such as deer). Lead bullets used in ammunition are prone to fragmenting upon impact, and the fragments can spread throughout the body of the targeted animal. Birds scavenging on the carcass or gut piles may ingest the lead fragments. Thus, instead of a single bird ingesting a single bullet, multiple scavenging birds may be poisoned by fragments from a single bullet.

We have a good understanding of lead poisoning in birds because it has been well studied using a variety of bird species in both lab and field settings. Lead poses a risk to wildlife when ingested. Once ingested, it is absorbed into the bloodstream and deposited in soft tissues. Signs of lead poisoning in birds can vary but include lethargy; anorexia; paralysis of the crop, esophagus, proventriculus, gizzard, legs, or wings; vomiting; diarrhea; incoordination or lack of muscle control; convulsions; anemia; and emaciation (starvation/muscle wasting). Mortality due to lead poisoning has been documented in a wide variety of birds. Lead poisoning can also have sub-lethal consequences that compromise avian survival and reproductive success. Lead poisoning in birds has been documented world-wide, and species at greatest risk are those with a likelihood of ingesting lead. For example, scavengers that eat lead-tainted carcasses or offal, waterfowl and other birds that ingest spent lead pellets or fishing sinkers, and ground-feeding songbirds that ingest lead tailings deposited on soil are susceptible to lead poisoning.

[Photo caption] Fragmentation of spent lead ammunition, copper jacket with lead core and pure copper. Photo courtesy of Institute for Wildlife Studies, P.O. Box 1137 Tres Pinos, California 95075



Radiograph of domestic sheep shot with lead ammunition (rapid expansion behind the scapula. Bullet fragments are visible as bright specks within the *red circles* and are located throughout the thoracic cavity and into the pelvic cavity. Photo courtesy of Minnesota Department of Natural Resources, Farmland Wildlife Populations and Research Group, 35365 800th Ave, Madelia, MN 56062.



## Discussion

The literature on lead poisoning in wildlife is extensive (see “Resources” and “References” below).

Lead poisoning has been documented in waterfowl for over 100 years (Grinnell 1894, Hough 1894, Eisler 2000) across North America, and globally.

Lead poisoning has also been documented in 8 types of scavenging birds including eagles, condors, vultures, hawks, and ravens in the United States (Golden et al. 2015) and has been found at clinical concentrations in ground-feeding passerines (Beyer et al. 2013). Out of 4046 dead eagles submitted to the National Wildlife Health Center for necropsy from 38 states, trauma and poisonings were the leading causes of death with lead accounting for the greatest percentage of poisonings (Russell and Franson 2014)

Causes of mortality in reintroduced critically-endangered California Condors (*Gymnogyps californianus*) in California and Arizona were anthropogenic; lead poisoning was the most important of those causes identified (Rideout et al. 2012).

Studies have found a temporal association with lead exposure and poisoning in birds and timing of hunting seasons (Kramer and Redig 1997, McBride et al. 2007, Hunt et al. 2007, Craighead and Bedrosian 2008, Cruz-Martinez et al. 2012)

In the 1960's, researchers linked lead poisoning in waterfowl and Bald Eagles (*Haliaeetus leucocephalus*) from ammunition sources (spent shot) to population-level effects. At the time, Bald Eagles were federally endangered, and the deaths of some eagles were linked to lead poisoning by feeding on waterfowl carcasses that were shot with lead projectiles and not retrieved (Griffen et al. 1980, Pattee and Hennes 1983). Nationally, lead poisoning of waterfowl and the Bald Eagle resulted in a 1991 federal ban on the use of lead shot for waterfowl and coot hunting.

In 1997, the U. S. Fish & Wildlife Service (USFWS) estimated that the ban on lead shot saved 1.4 million ducks. In Canada, a study showed a 50-70% decrease in lead levels in bone in waterfowl as a result of the ban on lead shot for waterfowl hunting in that country.

Lead ammunition can currently be used for large game hunting (bullets and slugs) and some upland bird hunting (shot-shells), although there have been efforts in some states (CA, MN, WI) to regulate the use of lead shot and lead-based ammunition on all state lands. See an example from Minnesota on the Minnesota Department of Natural Resources web site: Nontoxic shot on farmland wildlife management areas (MNDNR 2016). In 2013 California passed a law that requires the use of non-lead ammunition when taking any wildlife with a firearm in that state. Implementation was phased in with full implementation to occur on July 1, 2019.

Certain lead fishing tackle is banned in NH, ME, NY, VT, Great Britain, the Canadian national parks and national wildlife areas, and in three USFWS wildlife refuges to help

protect birds from lead toxicity

There is increasing concern about possible adverse human and wildlife health effects from the ingestion of fragmented lead or partial-lead bullets in venison. The fragments are not easy to see, except by x-ray, and may be accidentally eaten without the consumer being aware of their presence (WDNR 2016).

### Wisconsin Birds

According to the WDNR Wildlife Health Program, 26 dead Common Loons (*Gavia immer*) were submitted for necropsy between 2006 and 2008. Approximately one-third of those loons were determined to have died of lead poisoning from the remnants of lead fishing tackle recovered from their GI tracts (Strom et al. 2009).

Of 143 Trumpeter Swan (*Cygnus buccinator*) carcasses submitted to the WDNR for post-mortem examination between 1991 and 2007, 36 deaths (~25%) were attributed to lead poisoning (Strom et al. 2009).

The State of Wisconsin wildlife health laboratory processed 583 dead Bald Eagles between 2000 and 2008 with 87 (16 %) diagnosed with lead poisoning (>6 ppm wet weight in liver; Strom *et al.* 2009). This study associated Bald Eagle exposure rates with the hunting season in Wisconsin. Of the remaining admitted eagles, 48 % were diagnosed with trauma; however, lead concentrations were not reported.

A WDNR study found that some American Woodcock (*Scolopax minor*) in WI are accumulating unusually high levels of lead in their wing bones. The exact source of the lead is unknown at this time, but data suggest a local and dietary source (Strom et al. 2005).

In 1992, at least 200-300 Canada Geese (*Branta canadensis*) died as a result of acute lead poisoning from ingesting lead shot on a former trap and skeet shooting range near Lake Geneva in Walworth County, WI. The US Environmental Protection Agency reportedly spent ~\$1.88 million on a Superfund cleanup of the site, removing ~28,000 tons of lead-contaminated soils. The most recent large-scale lead poisoning event in Wisconsin occurred when ~200 Canada Geese were collected in 1999 and again in 2000 from a location in Outagamie Co.

1,227 very sick Bald Eagles were admitted to a raptor rehabilitation center in Minnesota from 1996 to 2009, with 331 (27 %) of the birds having blood lead concentrations above background levels (>0.2 ppm) (Cruz-Martinez et al. 2012). Over 90 % of these eagles were from Minnesota, Iowa, and Wisconsin. The chance of elevated lead concentrations increased based on hunting season, deer hunting zones, and the bird's age. Metal objects were visible by radiograph in the stomachs of 34 eagles with lead levels above background (10 with shot, 24 with metallic shrapnel)

An investigation conducted by the USFWS found that 35 of the livers from the 58 (60 %) dead Bald Eagles found between 2009 and 2012 in Iowa, Minnesota, and Wisconsin had detectable concentrations of lead. 22 of these eagles (37.9 %) had concentrations consistent with clinical lead poisoning (>6 ppm wet weight in liver; Warner et al. 2014).

Warner et al. (2014) also observed lead fragmentation in hunter-killed White-tailed Deer (*Odocoileus virginianus*) shot with different firearm types (12 and 20 gauge shotgun, muzzleloader rifle). Of 25 offal piles examined by radiography, 36% contained lead fragments, ranging from 1 to 107 fragments per pile.

### Non-toxic Ammunition and Fishing Sinkers

There are a variety of approved non-toxic alternatives to lead for ammunition that are suitable and effective for hunting use (U.S. Fish and Wildlife Service, <https://www.fws.gov/birds/bird-enthusiasts/hunting/nontoxic.php>). Research studies have found no adverse effects on waterfowl from ingesting shot made from bismuth-tin, steel, tungsten-iron, tungsten-polymer (Sanderson et al. 1997, Kelley et al. 1998, Ringelman et al. 1993). Other studies found no adverse effect on raptors from ingesting tungsten-tin-bismuth (Risebrough 2001, Krone et al. 2009). And multiple studies have found birds tolerant of ingested metallic copper (Bellrose 1965, Irby 1967, Locke et al. 1967, Bannon et al. 2011, Franson et al. 2012).

While some hunters have expressed concern about cost, effectiveness, and availability of lead-free substitutes, Thomas (2013) reported “Lead-free bullets are made in 35 calibers and 51 rifle cartridge designations. Thirty-seven companies distribute internationally ammunition made with lead-free bullets. There is no major difference in the retail price of equivalent lead-free and lead-core ammunition for most popular calibers. Lead-free ammunition has set bench-mark [*sic*] standards for accuracy, lethality, and safety.”

Fishing sinkers and jigs made from non-toxic materials such as tin, bismuth, steel, stone, ceramic, glass, and tungsten-nickel alloy are readily available at many local sporting supply stores and online.

### **Recommended Actions**

- Instead of lead, use fishing sinkers and jigs made from nontoxic materials such as tin, bismuth, stainless steel, ceramic, and tungsten-nickel alloy.
- Instead of lead, use non-toxic rifle and shotgun ammunition. Non-toxic ammunition is widely available at many locations where lead ammunition is sold, and online.
  - California-Certified Non-lead Ammunition - Where to buy:  
<https://www.wildlife.ca.gov/Hunting/Nonlead-Ammunition/Certified>
- Ask your local bait and tackle shop and your ammunition dealer to carry a variety of non-lead products if they don't already carry them.
- Dispose of unwanted lead sinkers, jigs, bullets and shot properly. Turn these items in at your local hazardous waste collection site or a local metals recycling company. **Keep lead out of the reach of children while you are awaiting proper disposal.**

- Spread the word. Tell others about the problem and encourage them to switch to non-lead fishing tackle and ammunition.

WBCI encourages research aimed at understanding the extent of the problem of lead poisoning in birds in Wisconsin, and efforts to inform hunters and anglers in Wisconsin of alternatives to lead ammunition and fishing tackle and encourage their use instead of lead. Suspected cases of lead poisoning in birds should be reported to your local WDNR Warden or Wildlife Manager (WDNR Call Center: 1-888-WDNRINFO (1-888-936-7463)) and a licensed wildlife rehabilitator (<http://dnr.wi.gov/topic/wildlifehabitat/directory.html> or call the WDNR Call Center at 1-888-936-7463).

## Conclusions

Lead is highly toxic to humans, wildlife, and domestic animals. For decades, lead has been banned from paint and gasoline for environmental and human health reasons, yet efforts to eliminate the use of lead in sport fishing gear and in hunting ammunition continue to be met with resistance.

It is clear that lead deposited in the environment from lead-containing bullets and shot used for hunting, and from small, lost lead sinkers and jigs used in recreational fishing have caused, and unless their use is stopped, will continue to cause significant and needless illness, suffering, and death for many birds in Wisconsin. Especially at risk are Bald Eagles, waterfowl, and Common Loons.

Non-toxic hunting ammunition and fishing sinkers and jigs are widely available from many sources online and are becoming increasingly available at many local sporting supply stores. We urge hunters and anglers to switch from using toxic lead-containing ammunition, sinkers, and jigs to lead-free alternatives.

## Web Resources

Hawkwatch International: <https://hawkwatch.org/learn/threats-to-raptors>

Tufts Cummings School of Veterinary Medicine - Lead Poisoning in Loons and Alternatives to Lead Fishing Gear: <http://vet.tufts.edu/wildlife-medicine-program/research-2/lead-poisoning/>

Michigan Department of Natural Resources – Lead Poisoning  
[http://www.michigan.gov/dnr/0,4570,7-153-10370\\_12150\\_12220-26676--,00.html](http://www.michigan.gov/dnr/0,4570,7-153-10370_12150_12220-26676--,00.html)

Minnesota Pollution Control Agency - Non-toxic tackle: Let's get the lead out:  
<https://www.pca.state.mn.us/living-green/nontoxic-tackle-lets-get-lead-out>

National Wildlife Health Center - Concerns Rise Over Known and Potential Impacts of Lead on Wildlife (Also contains some related links.)  
[http://www.nwhc.usgs.gov/disease\\_information/lead\\_poisoning/index.jsp](http://www.nwhc.usgs.gov/disease_information/lead_poisoning/index.jsp)

LoonWatch - Get the Lead Out:

<https://www.northland.edu/sustainability/soei/loonwatch/protect-loons/#lead-out>

Loon Preservation Committee – Causes of Mortality and Nest Failure

<http://www.loon.org/mortality.php>

Minnesota DNR - Non-toxic shot on farmland WMAs:

<http://dnr.state.mn.us/hunting/nts/index.html>

Minnesota Public Radio – Environmental Threat: Lead Sinkers (a still effective re-telling of this information) [http://news.minnesota.publicradio.org/features/200005/09\\_engerl\\_fish-m/index.shtml](http://news.minnesota.publicradio.org/features/200005/09_engerl_fish-m/index.shtml)

The Wildlife Society - Final Position Statement: Lead in Ammunition and Fishing Tackle.

[http://wildlife.org/wp-content/uploads/2016/04/PS\\_LeadinAmmunitionandFishingTackle.pdf](http://wildlife.org/wp-content/uploads/2016/04/PS_LeadinAmmunitionandFishingTackle.pdf)

U.S. Fish and Wildlife Service - Non-toxic shot regulations for hunting waterfowl and coots in the U.S.: <https://www.fws.gov/birds/bird-enthusiasts/hunting/nontoxic.php>

The Humane Society of the United States – Lead Ammunition: Toxic to Wildlife, People and the Environment: [http://www.humanesociety.org/issues/campaigns/wildlife\\_abuse/toxic-lead-ammunition-poisoning-wildlife.html](http://www.humanesociety.org/issues/campaigns/wildlife_abuse/toxic-lead-ammunition-poisoning-wildlife.html)

U.S. Fish and Wildlife Service – Contaminants: <http://www.fws.gov/ecological-services/habitat-conservation/toxic-metals.html>

Cornell Lab of Ornithology – Get the lead out: The Poisoning Threat From Tainted Hunting Carcasses: <https://www.allaboutbirds.org/get-the-lead-out-the-poisoning-threat-from-tainted-hunting-carcasses/>

Center for Biological Diversity – Get The Lead Out:

[http://www.biologicaldiversity.org/campaigns/get\\_the\\_lead\\_out/index.html](http://www.biologicaldiversity.org/campaigns/get_the_lead_out/index.html)

California Department of Fish and Wildlife – Non-lead Ammunition in California:

<https://www.wildlife.ca.gov/Hunting/Nonlead-Ammunition>

New York Times – Get the Lead Out of Hunting:

[http://www.nytimes.com/2010/12/16/opinion/16prieto.html?\\_r=0](http://www.nytimes.com/2010/12/16/opinion/16prieto.html?_r=0)

## References

Bannon DI, Parsons PJ, Centeno JA, Lal S, Xu H, Rosencrance AB, Dennis WE, Johnson MS (2011) Lead and copper in pigeons (*Columbia livia*) exposed to a small arms–range soil. Arch Environ Contam Toxicol 60:351–360

Bellrose FC (1965) Wasted waterfowl. Final report. Exhibit F. Mississippi Flyway Council

Planning Committee, Mississippi, p 72

Beyer WN, Franson JC, French JB, May T, Rattner BA, Shearn-Bochsler VI, Warner SE, Weber J, Mosby M (2013) Toxic exposure of songbirds to lead in the Southeast Missouri Lead Mining District. *Arch Environ Contam Toxicol* 65:598–610. doi: 10.1007/s00244-013-9923-3

Clark, AJ, Scheuhammer AM. 2003. Lead poisoning of upland foraging birds of prey in Canada. *Ecotoxicology* 12:23-30.

Craighead D, Bedrosian B (2008) Blood lead levels of common ravens with access to big-game offal. *J Wildl Manage* 72:240–245

Cruz-Martinez L, Redig PT, Deen J (2012) Lead from spent ammunition: a source of exposure and poisoning in bald eagles. *Hum Wildl Interact* 6:94–104

Franson JC, Lahner LL, Meteyer CU, Rattner BA (2012) Copper pellets simulating oral exposure to copper ammunition: absence of toxicity in American kestrels ( *Falco sparverius* ). *Arch Environ Contam Toxicol* 62:145–153

Golden NH, SE Warner, MJ Coffee (2015) A Review and Assessment of Spent Lead Ammunition and Its Exposure and Effects to Scavenging Birds in the United States. *Reviews of Environmental Contamination and Toxicology*. Vol 237. DOI 10.1007/978-3-319-23573-8\_6

Hunt WG, Parish CN, Farry SC, Lord TG, Sieg R (2007) Movements of introduced California condors in Arizona in relations to lead exposure. In: Mee A, Hall L (eds) *California condors in the 21st Century*. Series in Ornithology No. 2, Nuttall Ornithological Club and the American Ornithologists' Union, pp 79–96

Irby HD, Locke LN, Bagley GE (1967) Relative toxicity of lead and selected substitute shot types to game farm mallards. *J Wildl Manage* 31:253–257

Kelly ME, Fitzgerald SD, Aulerich RJ, Balander RJ, Powell DC, Stickle RL, Stevens W, Cray C, Tempelman RJ, Bursian SJ (1998) Acute effects of lead, steel, tungsten, iron, and tungsten-polymer shot administered to game farm mallards. *J Wildl Dis* 34:673–687

Kramer JL, Redig PT (1997) Sixteen years of lead poisoning in eagles, 1980–95: an epizootiologic view. *J Raptor Res* 31:327–332

Krone O, Kenntner N, Trinogga A, Nadjafzadeh M, Scholz F, Sulawa J, Totschek K, Schuckwersig P, Zieschank R (2009) Lead poisoning in white-tailed sea eagles: causes and approaches to solutions in Germany. In: Watson RT, Fuller M, Pokras M, Hunt G (eds) *Ingestion of lead from spent ammunition: implications for wildlife and humans*. The Peregrine Fund, Boise, ID, pp 1–13, <https://www.peregrinefund.org/subsites/conference-lead/PDF/0207%20Krone.pdf>

Locke LN, Bagley GE (1967) Lead poisoning in a sample of Maryland mourning doves. *J Wildl*



Manage 31:515–518

McBride TJ, Smith JP, Gross HP, Hopper MJ (2004) Blood-lead and ALAD activity levels of Cooper's hawks (*Accipiter cooperii*) migrating through the southern Rocky Mountains. *J Raptor Res* 38:118–124

Pattee OH, Hennes SK (1983) Bald eagles and waterfowl: the lead shot connection. *Trans 48th N Am Wildl Nat Resour Conf* 48:230–237

Rideout BA, Stalis I, Papendick R, Pesser A, Puschner B, Finkelstein ME, Smith DR, Johnson M, Mace M, Stroud R, Brandt J, Burnett J, Parish C, Petterson J, Witte C, Stringfield C, Orr K, Zuba J, Wallace M, Grantham J (2012) Patterns of mortality in free-ranging California condors (*Gymnogyps californianus*). *J Wildl Dis* 48:95–112

Risebrough RW (2001) Absence of demonstrable toxicity to turkey vultures. *Cathartes aura* of copper and tungsten-tin-bismuth-composite pellets. Final report. U.S. Fish and Wildlife Service, California Condor Recovery Program, Ventura, CA

Ringelman JK, Miller MW, Andelt WF (1993) Effects of ingested tungsten-bismuth-tin shot on captive mallards. *J Wildl Manage* 57:725–732

Russell RE, Franson JC (2014) Causes of mortality in eagles submitted to the National Wildlife Health Center 1975–2013. *Wildl Soc Bull* 38:697–704

Sanderson GC, Anderson WL, Foley GL, Skowron LM, Brawn JD, Seets JW (1997) Acute toxicity of ingested bismuth alloy shot in game-farm mallards. *Ill Nat Hist Surv Bull* 35:183–215

Scheuhammer AM and Norris SL (1995) A review of the environmental impacts of lead shotshell ammunition and lead fishing weights in Canada. Occasional Paper 88. Canadian Wildlife Service, Ottawa.

Scheuhammer AM, Money SL, Kirk DA, and Donaldson G (2003) Lead fishing sinkers and jigs in Canada: Review of their use patterns and toxic impacts on wildlife. Occasional Paper 108. Canadian Wildlife Service, Ottawa.

Strom SM, Patnode K, Langenberg J, Bodenstein B, Scheuhammer T, and Beard B (2004) Determination of the extent and source of lead contamination in woodcock (*Scolopax minor*) from Wisconsin. Wisconsin Department of Natural Resources Final Report. Technical Review Committee on Lead in the Environment. 2008. Sources and implications of lead ammunition and fishing tackle on natural resources. Technical Review 08-01. The Wildlife Society. 68p.

Strom SM, Langenberg JA, Businga NK, and Batten JK (2009) Lead exposure in Wisconsin birds. Pg. 194-201. *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, ID.

[http://www.peregrinefund.org/Lead\\_conference/PDF/0205%20Strom.pdf](http://www.peregrinefund.org/Lead_conference/PDF/0205%20Strom.pdf)

Thomas VG (2013) Lead-Free Hunting Rifle Ammunition: Product Availability, Price, Effectiveness, and Role in Global Wildlife Conservation. *Ambio* 42(6): 737–745.  
DOI 10.1007/s13280-012-0361-7

Warner SE, Britton EE, Becker DN, Coffey MJ (2014) Bald eagles lead exposure in the upper Midwest. *J Fish Wildl Manag* 5:208–216

Watson RT, M Fuller, M Pokras, and WG Hunt (Eds.) 2009. Ingestion of lead from spent ammunition: Implications for wildlife and humans. The Peregrine Fund, Boise, Idaho, USA.

WDNR 2016. Wisconsin Department of Natural Resources web page, “Precautions for Using Lead Ammunition (<http://dnr.wi.gov/topic/hunt/lead.html>).

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