**2011—04**
**Lead Ammunition**

The Minnesota Division of the Izaak Walton League of America in convention at Sandstone Minnesota, April 10, 2011 supports a tiered phase out of lead for hunting and fishing activities in the United States including the following:

1. 5 year phase out of the manufacture of lead bullets, shot, sinkers, jigs

2. 10 year phase out of the commercial sale of lead bullets, shot, sinkers, jigs

3. 15 year phase out of the use of lead bullets, shot, sinkers, jigs

*Submitted by: Walter J. Breckenridge Chapter*

**BACKGROUND:**

**Lead:**
Lead is a dense soft malleable heavy metal with a relatively low melting point. It is found and mined in mineral rich ores of the earths crust around the world. Normally lead does not occur in a pure or refined form in nature. Lead is usually found in ore form with a mixture of copper, zinc, silver, and other minerals. Most ores contain less than 10% lead, with some containing as little as 3% lead. There are several ore/lead mines scattered throughout North America, including Alaska, the contiguous US, Canada, and Mexico. Once mined, a smelting and/or refining process is used to create substantially pure lead for commercial and industrial usage.

**Commercial/Industrial Uses:**
Lead has many uses both past and present. The most common usage for lead is in the construction of lead acid batteries for automobiles. However it is also used for scuba diving weights, as keel ballast for sailboats, and as a protective shield while having x-rays performed on the human body. It is used in PVC plastic that covers electrical cords. Molten lead is sometimes utilized as a coolant for lead cooled nuclear reactors. In years past it was used for water pipes, as solder to connect and seal pipes or to seal cans of food. It is widely used in statues, sculptures, as decorative moldings/motifs and in glass products. Before being banned by the EPA it was an additive in gasoline and paints.

**Fishing and Hunting Uses:**
Anglers may use lead fishing tackle, sinkers, jigs, and weights. Hunters may use lead bullets and shotgun pellets. Because of its low melting point and high density, lead is sometimes used to make bullets and shotgun pellets with inexpensive home equipment.

**Toxicity:**
Lead is a poisonous/toxic material. Lead poisoning is one of the oldest known hazards. The Romans were aware that lead could cause serious health problems, even madness and death. However, they were so fond of its diverse uses that they minimized the hazards it posed. Romans of yesteryear, like Americans of today, equated limited exposure to lead with limited risk. What they did not realize was that their everyday low-level exposure to the metal rendered them vulnerable to chronic lead poisoning, even while it spared them the full horrors of acute lead poisoning (from US EPA website).

The small amount of lead necessary to cause harm was not understood until the latter half of the 20th century. No safe threshold for lead exposure has been discovered. Even small amounts of lead may cause harm. In 1991 the US EPA revised the drinking water standard for lead to 15 parts per billion (ppb). The previous standard was 50 ppb, but the standard was revised to reflect concerns about lead accumulating in standing water in pipes and plumbing.

**Human Health Affects:**
Lead may be absorbed into the human body by eating fragments or particles in meat, breathing lead dust or fumes, or absorption of lead dust/solution by touch. The ingestion of lead may cause temporary detrimental affects and sometimes permanent damage. Some of these affects include; damage to the brain/nervous system, cardiovascular

system, digestive system, reproductive system, bones and teeth, kidneys, and various internal organs. Some of the affects of lead poisoning in adults are reversible. Young children, infants and the unborn may be particularly vulnerable to the affects of lead and may suffer lifelong ill affects including cognitive impairment of an individual.

**Wildlife Health Affects:**
The ingestion of lead (from lead shot, bullets, fishing tackle, or other sources) has been documented at elevated levels or having caused mortality in several bird species, including: California condors, bald eagles, golden eagles, ravens, red tailed hawks, northern goshawks, great horned owls, ring necked pheasants, wild turkey, ruffed grouse, mourning doves, and sandhill cranes. Water fowl species with elevated lead levels or mortality caused by lead include the common loon (Minnesota state bird), trumpeter swans, tundra swans, ducks, and geese, wood ducks, and mergansers. Elevated lead levels have been documented in several mammals near shooting ranges (where lead shot and bullets accumulate over time) such as; shrews, mice, voles, squirrels, hares, opossums, and raccoons. It does not tend to accumulate in fish, but does in some shellfish, such as mussels. See Appendix 2.

**Plant Health Affects:**
In general, plants do not absorb or accumulate lead (in soils testing high in lead, it is possible for some lead to be taken up). There is more concern about lead contamination (to humans), from lead contained in the soil on unwashed produce than from actual uptake into the plant itself.

**Ground Water Affects:**
A study in 2003 was conducted by Dania Soeder and Cherie Miller regarding lead shot at the Prime Hook National Wildlife Refuge (Delaware) in coastal lowland near Delaware Bay. For 37 years, the Broadkiln Sportsman's Club (adjacent to the refuge) operated a trap-shooting range, with the clay-target launchers oriented so that the expended lead shot from the range dropped into forested wetland areas on the refuge property. Investigators have estimated that up to 58,000 shotgun pellets per square foot are present in locations on the refuge where the lead shot fell to the ground. As part of the environmental risk assessment for the site, the U.S. Geological Survey (USGS) investigated the potential for lead contamination in ground water.

**Ground Water Affects (continued):**
Results from 19 shallow wells indicate that elevated levels of dissolved lead are present in ground water at the site. The lead and associated metals, such as antimony and arsenic (common shotgun pellet alloys), are being transported along shallow ground-water flowpaths toward an open-water slough in the forested wetland adjacent to the downrange target area. Water samples from wells located along the bank of the slough contained dissolved lead concentrations higher than 400 micrograms per liter, and as high as 1 milligram per liter. In contrast, a natural background concentration of lead from ground water in a well up-gradient from the site is about 1 microgram per liter. See: http://pubs.usgs.gov/wri/wri02-4282/wri02-4282.pdf

**Lead Phase Out/Ban**:

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| US | Phase out lead in gasoline: ~1973 – 1986 |
| US | Standards limiting lead in water systems/pipes/fixtures: ~1986 |
| Minnesota | Lead Battery Land Disposal Ban: ~1989 |
| US | Phase out/ban of lead shot for water fowl hunting: ~1991 |
| US | Lead Paint Exposure Reduction Act: ~1992 |
| US | Lead solder banned for canned food: ~1995 |
| US | Lead foil caps on wine bottles ban: ~1996 |
| Canada | Partial ban small lead sinkers in Parks/Wildlife Areas: ~1997 |
| Canada | Phase out of lead shot for migratory game birds: ~1999 |
| US | Lead in candle wicks banned: ~2001 |
| US | Yellowstone Park banned small lead fishing tackle and weights |
| New Hampshire | Phase out/ban small lead sinkers and jigs: ~2000 - 2006 |
| Maine | Bans small lead sinkers and jigs: ~2001 |
| New York | Ban small lead sinkers and jigs: ~ 2004 |
| Vermont | Ban small lead sinkers and jigs: ~2007 |
| 23 States | Nontoxic shot regulations: dove, crane, quail, pheasant ~2006 |
| California | Lead bullets/shot ban hunting in Condor range: ~2007 - 2008 |
| US | Lead toy recall and banned from children's toys: ~2007-2008 |
| US | Lead automobile wheel balancing weights ban: ~2009-2011 |

**Alternatives**:

There are several less toxic materials that are currently being used to make lead free bullets, shot, sinkers, jigs, and weights. For example: copper, steel, tungsten, tin, bismuth, bronze, nickel, iron, tin, plastics, putty, carbon steel, pewter, glass. Nontoxic shot, however, is not currently available in all calibers (yet). Some of these materials are more expensive than lead. See Appendix 3.

**Izaak Walton League of America – Current Conservation Policy:**

## Chapter IX

OUTDOOR ETHICS AND RECREATION

The Izaak Walton League inspires all types of outdoor enthusiasts to take personal responsibility for protecting the outdoors. League chapters promote outdoor ethics and provide various outdoor recreational opportunities. Chapters offer programs focused on educating and supporting ethical behavior among all outdoor users, particularly gun owners and hunters, to ensure the safety of others, protect the environment, and conserve fish and wildlife for future generations.

**Section D) Firearms Rights**

1) The League supports the constitutional right of law-abiding citizens to own and use firearms.

2) The League opposes legislation or other action that would require the general registration of firearms.

**Section J) Non-Toxic Shot and Fishing Weights**

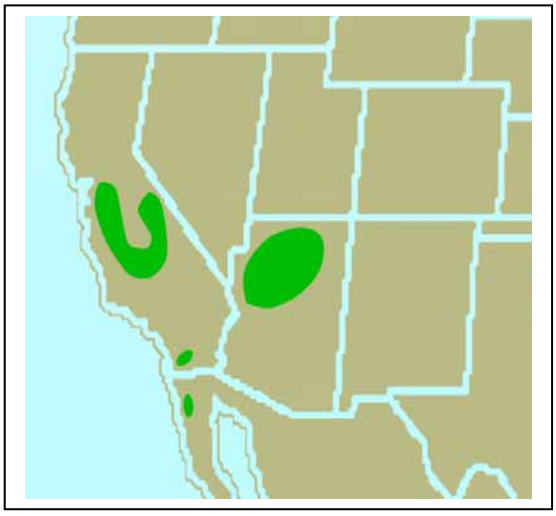
1) Because of the serious problem of lead shot poisoning of waterfowl and secondary poisoning of bald eagles, the League has supported a phased conversion to nontoxic shot for hunting migratory waterfowl. Similarly, the League encourages the use of nontoxic fishing weights in areas where lead can cause a problem.

**Izaak Walton League of America:**

The Izaak Walton League's motto is: 'Defenders of Soil, Air, Woods, Waters and Wildlife'. Unlike many, if not most other outdoor organizations, the IWLA membership is composed of a diversity of viewpoints, including those of hunters, anglers, outdoor recreationalists, and environmentalists. Consequently the IWLA is distinctly positioned to take a leadership role in advocating for a phased transition from lead bullets, shot, sinkers, and jigs to nontoxic materials.

**Appendix 1:**

**The California Condor** (*Gymnogyps californianus*): One of the largest birds in North America with a wing span of up to 9 feet. It inhabits areas around the Grand Canyon, Zion National Park, Central California, and Northern Baja California. The Condor is a scavenger which eats large amounts of carrion. It is one of the longest living birds in the world with a life span of up to 50 years. Condor numbers declined in the 20th century with 22 condors living in the wild in 1987. They were captured and subsequently bred at the San Diego Wild Animal Park and the Los Angeles Zoo. Starting in 1991, condors have been reintroduced into the wild. As of November 2010 there are 381 condors living, including 192 in the wild.



California Condor Range

The California Condor and other birds such as the Golden Eagle, Bald Eagle, Ravens, and Turkey Vultures may scavenge gut piles or other animal remains that have been left with lead bullet fragments or lead pellets.

## Appendix 2:

*** Of 110 Trumpeter Swan carcasses submitted to the WDNR for post-mortem examination between 1991 and 2004, 34 deaths (~31%) were attributed to lead poisoning. Of 559 Bald Eagle carcasses submitted to the WDNR between 1994 and 2003, 68 (~12%) of those deaths were attributed to lead poisoning. Lead poisoning has been reported in at least 37 species of birds beyond waterfowl.
See: http://www.dnr.state.wi.us/org/land/wildlife/hunt/nontoxshot.pdf

*** Historically, bald eagles were becoming secondarily lead poisoned by scavenging on lead poisoned or lead shot-crippled waterfowl. The Raptor Center's (TRC) research on lead poisoning in bald eagles back then along with collaborative work with the Minnesota Department of Natural Resources, built an important portion of the cumulative data that led to the passing of a 1991 Federal law banning the use of lead ammunition for waterfowl hunting.

In 1997, TRC undertook another study to evaluate if banning of lead shot for waterfowl hunting had reduced the number of lead-poisoned eagles. Surprisingly, it showed the prevalence of poisoned eagles didn't change even with good hunter compliance. This suggested that eagles were being poisoned from another source of lead, deer gutpiles left in the field by hunters.

Therefore, TRC's conducted a 13-year (1996-2009) retrospective study of lead poisoning in bald eagles (Haliaeetus leucocephalus) to test the hypothesis that spent lead from ammunition, present in the carcasses and gutpiles of white-tailed deer, represents an important source of lead exposure.

We analyzed four epidemiological parameters: 1) seasonal prevalence and relationship with deer hunting season onset in Minnesota, Wisconsin and Iowa; 2) correlation of the animal recovery location with deer hunting zones; 3) lead isotope ratio analysis of metal fragments recovered from the gastrointestinal tract of lead-poisoned bald eagles and of whole blood; and, 4) comparison of kidney copper concentration from lead-exposed vs. non-exposed eagles.

A statistically significant seasonal and geographical association ($p<0.01$) was established between deer hunting season onset and hunting zones, with the incidence of eagle poisoning. The majority of cases occurred during late fall and early winter, with significantly higher number of poisoned bald eagles recovered from the deer hunting rifle zone. The lead isotope ratio analysis revealed: 1) most of the paired blood-fragment samples have a closely matched isotopic signature; and, 2) the majority of the blood and fragment samples from lead exposed eagles were within the isotope ratio from ammunition samples reported by Church et al (2006). The kidney copper concentration was significantly higher in lead exposed eagles ($p=0.002$) implying the ingestion of fragments from copper-jacketed lead bullets.

The results from these four epidemiological parameters strongly support the hypothesis that spent lead from ammunition is an important source of lead exposure for bald eagles.
See: http://www.cvm.umn.edu/raptor/news/healthtopics/leadpoisoning/home.html

*** Terrestrial bird species reported with ingested spent lead shot include mourning doves, ring-necked pheasants, northern bobwhite quail, wild turkey, and chukars. These species may consume lead shot as they feed on seeds on the ground or when they ingest small stones as grit, especially in heavily hunted areas. In areas managed for mourning dove hunting, biologists have found that about 3–5 percent of birds consume spent shot.
See: http://www.nwhc.usgs.gov/publications/fact_sheets/pdfs/lead_poisoning_wild_birds_2009.pdf

*** The primary obstacle for the recovery of the critically endangered California condor is reported to be lead poisoning from the ingestion of lead from spent ammunition. In the 1980s, before all wild California condors were brought into captivity, scientists determined that condors were dying from lead poisoning and the problem continues today, within the recovering wild population of about 150 birds. Lead from mines in different geographic areas contains varying proportions of the four natural lead isotopes; thus, an object made from lead from a certain mine or region can often be identified by an isotope "fingerprint." Research has shown that California condors with low concentrations of lead in their blood had lead isotope fingerprints similar to lead fingerprints in food items in their diet. However, condors with elevated blood lead concentrations had lead fingerprints in their blood similar to lead from a sample of ammunition purchased in southern California, suggesting that the source of lead exposure was from ammunition.
See: http://www.nwhc.usgs.gov/publications/fact_sheets/pdfs/lead_poisoning_wild_birds_2009.pdf

*** The Wildlife Health Program of the Wisconsin Department of Natural Resources has monitored lead (Pb) exposure in numerous avian species including Bald Eagles (*Haliaeetus leucocephalus*), Trumpeter Swans (*Cygnus buccinator*), Common Loons (*Gavia immer*), and American Woodcock (*Scolopax inor*). A comprehensive review of Trumpeter Swan health data indicated approximately 25% of rumpeter Swan fatalities were attributed to lead toxicity.

Similarly, approximately 15% of live-sampled Trumpeter Swans had blood lead levels above background concentrations (20 µg/dL). A similar review of necropsy data for Bald Eagles revealed approximately 15% of all Bald Eagle deaths in Wisconsin were attributed to lead toxicity. A noticeable increase in the percent of fatalities attributed to lead toxicity began in October and peaked in December. This pattern overlapped with the hunting seasons in Wisconsin suggesting
lead ammunition could be a major source of lead exposure in eagles.
See; http://dnr.wi.gov/fish/documents/PbExposureinWIBirds.pdf

*** Biologists have studied the effects of lead sinkers and jigs on water birds and birds of prey since the 1970s. In areas where loons breed, lead poisoning from sinkers or jigs may account for up to 50 percent of the dead adult loons found by researchers. Between 1980 and 1996, the Raptor Center reported lead poisoning in 138 of 650 eagles they treated. From 1996-99, 43 additional eagles were affected by lead toxicity. Most times the source of the lead cannot be detected, as the birds have cast the material out of their system. The Raptor Center reports there has been no reduction in lead poisoning of bald eagles despite recent restrictions on lead gun shot for hunting waterfowl.
See: http://www.dnr.state.mn.us/eco/nongame/projects/leadout.html

*** Lead poisoning mortality, through the ingestion of spent shot, is long established in waterfowl, and more recently in raptors and other avian taxa. Raptors (vultures, hawks, falcons, eagles and owls) are exposed to lead from spent ammunition (shot, bullets, or fragments from either) while feeding on game species, and other avian taxa are exposed when feeding in shot-over areas, including shooting ranges. Here we review the published literature on ingestion of and poisoning by lead from ammunition in terrestrial birds. We briefly discuss methods of evaluating exposure to and poisoning from ammunition sources of lead, and the use of lead isotopes for confirming the source of lead. Documented cases include 33 raptor species and 30 species from *Gruiformes*, *Galliformes* and various other avian taxa, including ten Globally Threatened or Near Threatened species. Lead poisoning is of particular conservation concern in long-lived slow breeding species, especially those with initially small populations such as the five Globally Threatened and one Near Threatened raptor species reported as poisoned by lead ammunition in the wild. Lead poisoning in raptors and other terrestrial species will not be eliminated until all lead gunshot and rifle bullets are replaced by non-toxic alternatives. Received 29 May 2008, accepted 24 July 2008.
See: http://www.nps.gov/pinn/naturescience/upload/0108%20Pain.pdf

*** We studied randomly selected ground venison packages donated to the Community Action Food Centers of North Dakota by the Hunters For The Hungry Association. These packages were studied by high resolution computerized tomography imaging and x-ray fluoroscopy for qualitative detection of metal fragments. Quantitative measurements of lead levels in both randomly selected and fluoroscopic image guided site-specific subsamples from packages were performed. This study documented a health risk from lead exposure to humans consuming venison. Received 30 July 2008, accepted 30 October 2008.
See: http://www.nps.gov/pinn/naturescience/upload/0111%20Cornatzer.pdf

*** Loons and other waterbirds can die from lead poisoning after swallowing lead fishing sinkers and jigs lost by anglers. According to the Loon Preservation Committee, poisoning from lead fishing tackle accounts for 52 percent of mortalities among adult and immature loons from 1976 through 2000, by far the largest single cause of adult loon mortality in New Hampshire. State law prohibits the use of lead sinkers and jigs in all fresh water in New Hampshire, including lakes, ponds, rivers and streams. The ban prohibits the use of lead sinkers weighing 1 ounce or less and lead jigs less than 1 inch long along their longest axis. The law also prohibits the sale in New Hampshire of lead sinkers weighing 1 ounce or less and lead jigs less than 1 inch long along their longest axis.
See: http://www.wildlife.state.nh.us/Fishing/get_the_lead_out.htm

*** Wildlife rehabilitators across the state of Iowa began gathering lead poisoning information on Bald Eagles (*Haliaeetus leucocephalus*) in January 2004 for this ongoing project. Blood, liver, or bone samples were analyzed for lead levels from 62 of the 82 eagles currently in the database. Thirty-nine eagles showed lead levels in their blood above 0.2 ppm or lead levels in their liver above 6 ppm, which could be lethal poisoning without chelation treatment. Seven eagles showed exposure levels of lead (between 0.1 ppm and 0.2 ppm in blood samples, between 1 ppm and 6 ppm in liver samples, and between 10 ppm and 20 ppm in bone). Several of the eagles admitted with traumatic injuries showed underlying lead exposure or poisoning. Over fifty percent of the eagles being admitted to Iowa wildlife rehabilitators have ingested lead. Behavioral observations, time-of-year data analysis, and x-ray information point to lead shrapnel left in slug-shot White-tailed Deer (*Odocoileus virginianus*) carcasses to be a source of this ingested lead. With thousands of Bald Eagles spending the winter in Iowa (up to one fifth of the lower 48 states population), this poisoning mortality could be significant and is preventable. Educational efforts are being directed at encouraging deer hunters to switch from lead to non-toxic (copper) slugs and bullets. Received 30 May2008, accepted 4 September 2008.
See: http://www.peregrinefund.org/lead_conference/pdf/0119%20neumann.pdf

*** Recently, we discovered a significant amount of lead ingestion in Common Ravens (*Corvus corax*) from the southern Yellowstone Ecosystem during the large-game hunting seasons (Craighead and Bedrosian 2008). Our results provided further evidence that hunter discarded viscera of large-game animals is a source of lead in the ecosystem. However, there are many species that feed on hunter provided offal (Wilmers et al. 2003, Hunt et al. 2006) and are thus potentially exposed to lead throughout the duration of the hunting season (mid-September through December)…… These results confirmed that both Bald and Golden Eagles are ingesting large amounts of lead during the hunting season in the southern Yellowstone Ecosystem. Further, the magnitude of lead in the blood of many eagles is extremely high and likely results in the death of some individuals (Pattee et al. 1981). While it is clear that eagles are ingesting large amounts of lead during the hunting season, the long-term, cumulative impacts of annual exposure are uninvestigated. Received 24 June 2008, accepted 12 August 2008.
See: http://www.biologicaldiversity.org/campaigns/get_the_lead_out/pdfs/Bedrosian_and_Craighead_2009.pdf

*** We recently found evidence to support the supposition that Common Ravens (*Corvus corax*) were ingesting lead from hunter-provided offal in the southern Yellowstone Ecosystem. Since those data were analyzed, we have collected an additional 237 samples from ravens in the same study area spanning an additional two hunting seasons. In total, we collected 153 individual blood samples during the hunting seasons of 2006/07 and 2007/08. Those new samples exhibited a median level of 10.0 µg/dL with a range of 2.7–51.7 µg/dL. We also collected 84 additional samples during the non-hunting season which exhibit a median blood lead level of 2.2 µg/dL with a range of 0.0–19.3 µg/dL. Comparatively, 50% of the hunting season sample exhibited blood lead levels >10µg/dL, while only 3% were greater than 10µg/dL during the
non-hunt. We combine this new data with previous data collected to further understand the link between ingested lead and Common Ravens. Received 24 June 2008, accepted 20 August 2008.
See: http://www.biologicaldiversity.org/campaigns/get_the_lead_out/pdfs/Craighead_and_Bedrosian_2009.pdf

*** Lead has long been documented as a serious environmental hazard to eagles and other predatory and scavenging avian species (Redig et al. 1984, Kramer and Redig 1997). The use of lead shotgun pellets for waterfowl hunting on federal and state lands was banned in 1991 due to lead poisoning in Bald Eagles (*Haliaeetus leucocephalus*), Golden Eagles (*Aquila chrysaetos*) and numerous waterfowl species. Spring migrating eagles sampled in west-central Montana between 1983 and 1985 showed elevated blood-lead levels in 85% of 86 Golden Eagles and 97% of 37 Bald Eagles (Harmata and Restani 1995). The authors suggested shot from waterfowl hunting and fragmented lead-core rifle bullets in ground squirrels (*Spermophilus spp*.) as a possible lead source. More recently, lead poisoning from spent ammunition has been identified as the leading cause of death in California Condors (*Gymnogyps californianus*), prompting the recent ban of lead ammunition within the "California Condor Recovery Zone" (Hunt et al. 2006, Cade 2007). Another study on Common Ravens (*Corvus corax*) in Wyoming has shown a direct correlation between elevated bloodlead levels and the onset of rifle hunting season (Craighead and Bedrosian pers. comm.) We sampled blood from 42 Golden Eagles captured on migration during the fall of 2006 and 2007 to quantify a suite of possible heavy metal contaminants, with an emphasis on lead. Eagles were trapped using traditional ridgeline trapping techniques with bow nets, and using a harnessed Rock Dove (*Columbia livia*) for a lure (Bloom 1987). Small blood samples (2 ml) were taken from the brachial vein, and whole blood samples (1 ml) were frozen for later analysis using Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) following hot acid digestion. We employed a portable field instrument (ESA LeadCare II®, Biosciences Inc.) to analyze lead in a subset of 20 samples. Our data suggest that both methods produce equivalent results. Total lead concentrations ranged from <0.5 to 481 µg/dL with a median value of 13.6 µg/dL. When separated into four exposure stages (Redig 1984), our results were as follows: 18 eagles contained *background* levels of 0–10 µg/dL, 19 eagles were considered *sub-clinically exposed* at 10–60 µg/dL, two birds were *clinically exposed* (60–100 µg/dL), and three exhibited *acute exposure* of >100 µg/dL. In all, we found that 58% of the 42 fall migrant Golden Eagles sampled had elevated blood-lead levels. We speculate that the five birds (12%) showing at least clinical exposure levels (≥60 µg/dL) had recently ingested lead-tainted carcasses and/or offal piles, likely during migration. Eagles with lower,
but detectable blood lead levels may have had earlier exposure with the majority of the lead already deposited in other organs and bone. We surmise the use of lead-core ammunition for hunting is the major source for lead exposure in Golden Eagles, though we cannot identify a particular source species or region, in part because of the overlapping timing of hunting seasons for various game species in different regions of the Rocky Mountains and the - DOMENECH AND LANGNER - 2 very large area visited by Golden Eagles during migration season. We are uncertain whether our preliminary numbers represent the northern migratory population of Golden Eagles as a whole, but a serious threat to the welfare of the species on a landscape level appears plausible. We believe an intensive educational outreach campaign and a switch away from lead-containing hunting ammunition to alternative, less toxic materials are appropriate ways to protect these and other scavenging species, as well as human consumers of gun-killed animals. Received 5 September 2008, accepted 17 November 2008.
See: http://www.biologicaldiversity.org/campaigns/get_the_lead_out/pdfs/Domenich_and_Langler_2009.pdf

*** Although use of lead shot in waterfowl hunting has been banned in the United States since 1991, lead concentrations with possible population-level effects continue to be documented in waterfowl breeding in Alaska, including threatened Spectacled Eiders (*Somateria fischeri)*. The presumed source is ingested lead shot, which waterfowl consume intentionally or incidentally while feeding in wetlands containing spent shot. Lead shot is still used in many parts of rural Alaska for subsistence waterfowl hunting. Further, legal use of lead shot for upland game hunting may occur in waterfowl breeding habitats. Availability of spent shot may be prolonged by permafrost, which frequently underlies wetlands used for breeding and retards the sinking of shot beyond the reach of feeding waterfowl. Exposure to lead from shot can be documented using radiographs or dissection, but these methods are cumbersome or applicable only post mortem, respectively. Analysis of blood for total lead and lead isotope ratios (e.g., 206 Pb /207Pb) is a simpler and more efficient technique. Lead isotope ratios vary geographically, and lead products such as shot can have distinct, ore-specific signatures. We compared lead isotope ratios from shot and breeding and wintering area sediments to those in blood from Spectacled, King (*S. spectabilis*), and Common Eiders (*S. mollissima*) and Long-tailed Ducks (*Clangula hyemalis*). Birds were sampled on the Yukon-Kuskokwim Delta and the North Slope of Alaska. We also analyzed bird blood for total lead concentrations. Isotopic signatures from birds with relatively high blood lead concentrations were most similar to the isotopic signatures of lead shot, while signatures from birds with low blood lead concentrations closely matched those of local sediments. Further, lead concentrations in sediment samples were very low making sediments an unlikely source for high blood concentrations. Therefore, spent lead shot is available and consumed by breeding waterfowl in Alaska. Although exposure may result from previously used shot, current lead shot use combined with the persistence of lead shot in Alaskan wetlands mandates that management, including outreach and law enforcement, be directed at entirely eliminating the use of lead shot for subsistence hunting. MATZ, A., AND P. FLINT. 2009. Lead isotopes indicate lead shot exposure in Alaska-breeding waterfowl. Abstract *in* R.T. Watson, M. Fuller, M. Pokras, and W.G. Hunt (Eds.).
See: http://www.biologicaldiversity.org/campaigns/get_the_lead_out/pdfs/Matz_and_Flint_2009.pdf

*** Although lead shot has been banned for waterfowl hunting in North America, some predators continue to exhibit elevated lead burdens, which has been attributed to ingesting metallic lead from other projectiles. Few studies have investigated residual lead fragments in hunted upland animals. Therefore, specific portals for lead entering wildlife food chains remain largely unknown. Prairie dogs (Cynomys spp.) are shot for recreation with minimal regulation in western North America. Because recreational shooters mostly use expanding bullets and rarely remove or bury carcasses, shot prairie dogs could make lead accessible to predators and scavengers. To determine whether and to what degree shot prairie dogs carry lead fragments, we analyzed carcasses shot by recreational shooters with 2 bullet types. Bullet type influenced the probability of bullet fragments being retained in carcasses; 87% of prairie dogs shot with expanding bullets contained bullet fragments, whereas 7% of carcasses shot with non-expanding bullets did. The amount of bullet fragments per carcass also differed between bullet types; carcasses shot with expanding bullets contained a mean of 228.4 mg of the lead-containing bullet core and 74.4 mg of the copper-alloy jacket, whereas carcasses shot with non-expanding bullets averaged only 19.8 mg of the core and 23.2 mg of the jacket. Lead fragments in carcasses shot with expanding bullets were small in size; 73% of all lead mass in each carcass was from fragments that weighed ,25 mg each, small enough to be easily ingested and absorbed by secondary consumers. The amount of lead in a single prairie dog carcass shot with an expanding bullet is potentially sufficient to acutely poison scavengers or predators. Therefore, shot prairie dogs may provide an important portal for lead entering wildlife food chains and may pose risks to raptors and carnivores. Managers should consider measures, such as using non-expanding or lead-free ammunition, to reduce the likelihood of lead consumption and poisoning in upland wildlife. (JOURNAL OF WILDLIFE MANAGEMENT 71(1):103–108; 2007)
See: http://www.biologicaldiversity.org/campaigns/get_the_lead_out/pdfs/Pauli_and_Buskirk_2007.pdf

*** Ingestion of lead from spent ammunition is a potential challenge to the conservation of large carnivores and scavengers. Evidence suggests large carnivores such as Black Bears (*Ursus americanus*), Grizzly Bears (*U. arctos)*, Wolves (*Canis lupis),* and Coyotes (*C. latrans)* scavenge to varying degrees on ungulate offal piles abandoned by hunters (Wilmers et al. 2003). Other top carnivores, such as Cougars (*Puma concolor),* may be less attracted to offal piles and thus less dependent on them, but may periodically still be exposed to lead at biologically significant levels because of the tendency to occasionally scavenge. Grizzly Bears alter their movement patterns outside of Yellowstone National Park during the fall hunting season to take advantage of unrecovered offal and wounded Elk (*Cervus canadensis*) left by hunters (Ruth et al. 2003, Haroldson et al. 2004). The Southern Yellowstone Ecosystem is host to one of the densest Elk populations in North America as well as a complete large carnivore guild. An annual big game hunt results in an abundant harvest and provides an ideal situation to test for the occurrence among predators and scavengers of lead ingestion from spent rifle bullets. We have begun collecting samples of liver, hair, blood, and feces from Black and Grizzly Bears, Wolves, Coyotes, and Cougars, and tested samples for the presence of lead using inductively coupled plasma mass spectroscopy to determine if there is a seasonal correlation of lead ingestion during the hunting season. We also hope to determine if carnivores, such as Grizzly Bears, that scavenge to a greater extent on offal piles or on the unretrieved carcasses of animals mortally wounded by hunters, exhibit higher levels of lead ingestion than do species with lesser tendency to scavenge, such as Wolves and Cougars. In a pilot study, blood samples from live captured Grizzly Bears were the most abundant sample type we were able to obtain, though limited

samples of other material were also obtained. During the nonhunting season (March–August), no Grizzly Bear blood samples (n = 11) exhibited lead exposure (>10 µg/dL). However, during the hunting season (September–November), 46% of 13 samples showed exposure with blood lead levels >10 µg/dL. Of six liver samples collected from Wolves during the non-hunting season, none have shown signs of lead exposure. This preliminary evidence suggests mammalian carnivores in areas of high hunting density may exhibit the same temporal pattern of lead exposure from ingestion of rifle bullet fragments during the hunting season as avian scavengers (Cade 2007, Craighead and Bedrosian 2008, Parish et al. 2009, this volume). This study will continue as a master's thesis by Tom Rogers in the fall of 2008 at the University of Montana. Received 12 June 2008, accepted 24 July 2008. See:
http://www.biologicaldiversity.org/campaigns/get_the_lead_out/pdfs/Rogers_et_al_2009.pdf

*** Shooting and using poison baits (e.g., strychnine, zinc phosphide) are current management options for controlling Richardson's ground squirrels (Spermophilus richardsonii ; RGS). Bullets used for shooting RGS contain lead, fragment upon impact, and RGS carcasses are not usually recovered after being shot. For these reasons, we hypothesized that scavenging birds of prey may be at risk of lead poisoning. To test this, we took radiographs of 15 shot RGS and analyzed the area around the path of the bullet for lead. Lead levels ranged from 0.01 to 17.21 mg/carcass (median ¼ 3.23 mg), and fragments appeared as dust. Two common scavenging hawks (Swainson's and ferruginous hawks [ Buteo swainsonii, B. regalis]) consume eviscerated RGS carcasses and would consequently ingest this amount of lead per feeding. In a previous study, an estimated 5.71 mg/kg of lead, eroded in vivo from ingested lead shot, was lethal to bald eagles ( Haliaeetus leukocephalus). Fitting the residue values to a normal distribution and based on the mass of an average raptor, we determined that roughly 1 in 5 RGS carcasses had lead levels that exceeded this value. Based on the average amount of lead in carcasses, and assuming that uptake of lead from the carcass is as high as that of eroded lead, we suggest that hawks would have to eat roughly 6.5 carcasses, taking an average of 23 days of feeding on an uninterrupted supply of shot carcasses, to attain a lethal dose of lead. Uncertainties remain, but shot RGS carcasses appear to be an appreciable source of lead that could prove fatal to scavenging hawks. This hazard could be avoided with the collection and disposal of shot
carcasses and with the use of (green) ammunition. (JOURNAL OF WILDLIFE MANAGEMENT 70(1):295–299; 2006)
See: http://www.biologicaldiversity.org/species/birds/California_condor/pdfs/Knopper-et-al-2006.pdf

*** The California Condor (*Gymnogyps californianus*) is the largest bird species in North America. Prior to the 20th century these birds were abundant along the western coast of the U.S. However, losses of habitat, natural predation, shooting, and environmental contamination have all been thought to contribute to a precipitous population decline. Early studies suggested that the demise of the condor population was in part the result of incidental Pb poisoning from either direct ingestion of lead fragments from hunter-killed game or indirectly as the result of biologically incorporated Pb from the environment. A recent article for the National Rifle Association (Wright and Peddicord 2007) suggested that although condors are most likely adversely affected by elevated lead in their tissues and lead ammunition is used in condor range,
there is little scientific evidence of actual ingestion of lead ammunition by condors, and there is little scientific evidence that the lead in the tissues of condors can be traced to ammunition. Condors in Arizona were periodically captured and monitored for blood Pb concentrations; subsets of these blood samples were analyzed for Pb isotopic ratios. To date, Pb isotopic ratios have been measured in blood in 47 birds over 3 years. Multiple measurements have been undertaken on 18 birds, including metal fragments collected at the same time from two different birds. Birds with elevated blood Pb levels were isolated, x-rayed and the excrement monitored for metal fragments. Twelve fragments were collected from 6 different birds. Analyses of the metal fragments from these birds determined that the fragments were Pb, Cu, Fe-Cr alloy and Pb-Sn alloy. We present Pb isotopic evidence that directly links ingested Pb fragments to Pb in the blood of condors.

One condor was found to have metal fragments in both 2004 and 2007 and had differing blood Pb isotopic ratios, which were within analytical error of the fragments collected at the same time. In addition to identifying the possible source(s) of Pb in the blood of condors, lead isotopic measurements can be used to discern if the condor has undergone a significant poisoning event between blood collection periods and provide insight into the number of Pb toxicity events over the lifetime of a bird. These results support the hypothesis that bullet fragments are causing increased blood lead levels in condors. CHESLEY, J., P. REINTHAL, C. PARISH, K. SULLIVAN, AND R. SIEG. 2009. Evidence for the source of lead contamination within the California Condor. Abstract *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.2009.0219
See: http://www.biologicaldiversity.org/species/birds/California_condor/pdfs/Chesley_et_al_2009.pdf

*** See: http://www.nwhc.usgs.gov/publications/documents/92JCF.CLE01.pdf

## ABSTRACT

Summarized are necropsy results from 222 carcasses of Common Loons (Gavia immer) submitted to the National Wildlife Health Research Center from 1976 through 1991. The carcasses were from 18 states, and 10 or more birds each were from Minnesota, Florida, Virginia, Michigan, Wisconsin, Maine, and North Carolina. Seventy-three (33%) carcasses were emaciated, and in some of these birds emaciation was thought to be related to exposure to mercury. Over 40% of these emaciated birds were from Florida. Trauma, including blunt trauma of unknown origin, outboard motor propeller wounds, and shooting caused the deaths of 49 (22%) loons, 30 of which were from Minnesota. Diseases, primarily avian botulism type E and aspergillosis, accounted for 39 (18%) mortalities and lead poisoning for 14 (6%), 11 of which had fishing sinkers in their stomachs. Most of the avian botulism type E cases occurred during two outbreaks on Lake Michigan. Seven of the 14 lead-poisoned birds were from Minnesota. Nine (4%) birds died of miscellaneous causes and 9 (4%) of drowning, primarily from entanglement in nets. No diagnosis could be reached for 29 (13%) carcasses. Sample bias precludes interpretation of these data to represent actual proportional causes of mortality in the loon population. However, the sample size is sufficient to clearly identify major causes of mortality.


*** A new study suggests that the U.S. Fish and Wildlife Service's 1991 nationwide ban on the use of lead shot for waterfowl hunting has had remarkable success, preventing the premature deaths of millions of waterfowl from lead poisoning.

The study, "Ingestion of Lead and Nontoxic Shotgun Pellets by Ducks in the Mississippi Flyway," was funded in part by the Service's Great Lakes and Southeast Regional offices and published this summer in the Journal of Wildlife Management. In order to gauge the effect of the ban on lead shot, researchers examined thousands of ducks harvested in the Mississippi Flyway during the 1996 and 1997 waterfowl seasons, the fifth and sixth seasons after the 1991 ban on lead shot.

Based on the survey's findings, researchers William L. Anderson of the Illinois Department of Natural Resources and Stephen P. Havera and Bradley W. Zercher of the Illinois Natural History Survey estimate that the ban on lead shot reduced lead poisoning deaths of Mississippi Flyway mallards by 64 percent, while overall ingestion of toxic pellets declined by 78 percent over previous levels.

The report concludes that by significantly reducing lead shot ingestion in waterfowl, the ban prevented the lead poisoning deaths of approximately 1.4 million ducks in the 1997 fall flight of 90 million ducks. In addition, the researchers state that approximately 462,000 to 615,000 acres of breeding habitat would have been required to produce the same number of birds that potentially were saved by nontoxic shot regulations that year. With the ban now entering its ninth year, ingestion of lead shot has probably continued to decline from the levels documented in the study, preventing an increasing number of lead poisoning deaths.

"The results of this important report suggest that the ban on lead shot has been a resounding success for the health of waterfowl populations, and has almost certainly contributed to the record numbers of waterfowl we have seen in recent years. I'm proud that the Service took the initiative in phasing out lead shot for waterfowl hunting, and continues to expedite the approval of nontoxic alternatives to lead shot for hunters," said Service
See: http://www.fws.gov/pacific/news/2000/2000-177.htm
*** Deer harvested with lead bullets have been shown to have tiny lead particles or fragments remaining in the processed meat. These are often too small to be seen and can disperse far from the wound channel. Although lead in venison does not rival lead paint in older homes as a health risk for the public, the risk is not low enough to ignore. Children under 6 years and pregnant women are at the greatest risk from lead exposure. The amount of lead found in a small percentage of venison samples suggests that long term effects of lead consumption could occur in people who regularly eat venison shot with lead ammunition. However, there is currently no known evidence linking human consumption of venison to lead poisoning. See: http://dnr.wi.gov/org/land/wildlife/lead.htm

*** Lead toxicity has been identified as the leading cause of death in condors in the Arizona reintroduction program. Eight confirmed and two suspected condor deaths have been caused by lead poisoning, the most recent occurring in March of 2006. Condors in Arizona are trapped twice a year to have their blood tested for lead. Biologists have seen 211 instances of lead exposure in condors since testing began in 1999. A total of 49 condors have been exposed to lead,

most multiple times, with 31 birds requiring treatment (chelation) to reverse dangerously high blood lead levels (data current as of March 2006). Without these treatments more condors might have died.
Although there may be many potential sources of lead, an ongoing scientific study funded by the Arizona Game and Fish Department has determined that lead from spent ammunition is a major source of lead in exposed condors and that lead from the local environment does not appear to be a factor. An additional study has determined that condor lead exposure rates are highest during the fall hunting season in northern Arizona. This study also concludes that during this same time, condors spend the most time foraging on the Kaibab Plateau. The Arizona Game and Fish Department is committed to reducing the amount of lead available to condors by encouraging sportsmen to take lead reduction actions when hunting in condor range. See: http://www.azgfd.gov/w_c/california_condor_lead.shtml

*** Statement of Scientific Agreement July 10, 2007 We, the undersigned, endorse the scientific chain of evidence linking lead ammunition to lead exposure in the endangered California condor as sufficiently strong to support a ban of lead ammunition in condor country. This conclusion flows from a robust chain of evidence, namely: (1) California condors are obligate scavengers on mammal carcasses, including deer and other big game; (2) large numbers of deer are killed with lead ammunition in condor country; (3) free-flying condors frequently have elevated levels of lead in their blood, and these levels peak during the fall deer hunting season; and, (4) isotopic analysis of lead in the blood of pre-release and free-flying condors in California strongly supports the link between lead ammunition and lead exposure. Lead exposure is the major, preventable obstacle to the success of condor reintroduction: all wild condors must be captured for lead testing, held for emergency treatment when suffering acute toxicity, and, for fear of lead exposure, offered lead-free food at artificial feeding stations. Untreated, lead exposure affects all major organs, interferes with digestion, hinders normal behaviors, and can cause death. Due to the preponderance of evidence, we believe that any reduction in lead ammunition in condor country will significantly increase the success of reintroduction efforts of California condors.
See: http://www.biologicaldiversity.org/swcbd/SPECIES/condor/condor-lead-science.pdf

*** PICATINNY ARSENAL, N.J. (June 23, 2010) -- The Army announced today it has begun shipping its new 5.56mm cartridge, the M855A1 Enhanced Performance Round, to support warfighters in Afghanistan. The new M855A1 round is sometimes referred to as "green ammo." … The Enhanced Performance Round contains an environmentally-friendly projectile that eliminates up to 2,000 tons of lead from the manufacturing process each year in direct support of Army commitment to environmental stewardship.
See: http://www.army.mil/-news/2010/06/23/41283-army-begins-shipping-improved-556mm-cartridge/

*** ARLINGTON, Va. — The Army has developed a deadlier and more effective round of ammunition, which is lead-free and environmentally friendly. The M855-A1 cartridge, also known as the green bullet, uses a 24.3 gram copper projectile instead of lead, said Jerry Mazza, the program manager for ammunition, Marine Corps Systems Command, Marine Corps Base Quantico, Va. The U.S. military upgraded the 5.56mm round before and it was a huge improvement, said Army Lt. Col. Jeffrey K. Woods, products program manager for the Product Executive Office of Ammunition in Picatinny Arsenal, N.J. This is a chance for another big improvement.
See: http://www.marines.mil/unit/hqmc/Pages/Goodfortheenvironment,badfortheenemy.aspx

## Appendix 3:

See: http://www.dfg.ca.gov/wildlife/hunting/condor/certifiedammo.html

| Certified Nonlead Ammunition Information | | |
|---|---|---|
| **Name** | **Date Application Received** | **Date Application Approved** |
| Ammo Brothers | September 22, 2008 | September 25, 2008 |
| Barnes Bullets, Inc. | April 16, 2008 | April 28, 2008 |
| Black Hills Ammunition | June 10, 2008 | July 2, 2008 |
| CCI | April 15, 2008 | April 28, 2008 |
| Cutting Edge Bullets | February 26, 2010 | April 12, 2010 |
| Custom Cartridge, Inc. | March 14, 2008 | April 28, 2008 |
| Dakota Ammo (COR-BON/Glaser) | April 16, 2008 | April 28, 2008 |
| D Dupleks Ltd. | March 2, 2010 | March 16, 2010 |
| Dynamic Research Technologies (DRT) | July 29, 2009 | September 8, 2009 |
| Federal Cartridge Company | April 15, 2008 | April 28, 2008 |
| Hornady Mfg. Co | December 8, 2008 | December 29, 2008 |
| International Cartridge Company | August 12, 2008 | September 4, 2008 |
| Magtech Ammunition Company | September 11, 2008 | October 20, 2008 |
| Miwall Corporation | September 23, 2008 | October 20, 2008 |
| North Fork Bullets | January, 27 2009 | February 23, 2009 |
| Nosler, Inc. | March 25, 2008 | April 28, 2008 |
| P-Bar Co., LLC | November 30, 2009 | January 4, 2010 |
| Remington Arms Co., Inc. | March 25, 2008 | April 28, 2008 |
| Sinterfire, Inc | May 29, 2008 | July 2, 2008 |
| Snake River Ammunition | August 31, 2009 | September 14, 2009 |
| Stars & Stripes Ammunition | August 15, 2008 | September 11, 2008 |
| TomBob Outdoors, LLC | March 15, 2010 | April 21, 2010 |
| Weatherby, Inc. | May 29, 2008 | July 2, 2008 |
| Winchester Ammunition | April 7, 2008 | April 28, 2008 |