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.

Signed,

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References

Burco, J., Myers, A.M., Schuler, K., and Gillin, C. 2012. Acute lead toxicosis via ingestion of spent ammunition in a free-ranging cougar (*Puma concolor*). J Wildl. Dis. 48(1):216-9.

Carey L.S. 1977. Lead shot appendicitis in northern native people. J. Can. Assoc. Radiol. 28:171–4.

CDC, Response to Advisory Committee on Childhood Lead Poisoning Prevention Recommendations in "Low Level Lead Exposure Harms Children: A Renewed Call of Primary Prevention". June 7, 2012. http://www.cdc.gov/nceh/lead/ACCLPP/CDC_Response_Lead_Exposure_Recs.pdf. ACCLPP, Report of the Advisory Committee on Childhood Lead Poisoning Prevention of the Centers for Disease Control and Prevention. "Low Level Lead Exposure Harms Children: A Renewed Call for Primary Prevention", January 4, 2012. http://www.cdc.gov/nceh/lead/ACCLPP/Final_Document_030712.pdf.

Church, M., Gwiazda, R., Risebrough, R.W., Sorenson, K., Chamberlain, C.P., Aarry, S., Heinrich, W., Rideout, B., Smith, D.R. 2006. Ammunition is the principal source of lead accumulated by California Condors re-introduced to the wild. Environ. Sci. Technol. 40:6143-6150.

Clark, A.J. and Scheuhammer, A.M. 2003. Lead poisoning in upland-foraging birds of prey in Canada. Ecotoxicol. 12:23-30.

Craighead, D. and Bedrosian, B. 2008. Blood lead levels of common ravens with access to big-game offal. J. Wildl. Management 72(1):240-245.

Finkelstein, M.E., Doak, D.F., George, D., Burnett, J., Brandt, J., Church, M., Grantham, J., and Smith, D.R. 2012**.** Lead poisoning and the deceptive recovery of the critically endangered California condor. Proc. Natl. Acad. Sci. U S A. 109(28):11449-54.

Fisher, I.J., Pain, D.J., and Thomas, V.G. 2006. A review of lead poisoning from ammunition sources in terrestrial birds. Biol. Conser. 131(3):421–432.

Green, R. E., Hunt, W. G., Parish, C.N., and Newton, I. 2008. Effectiveness of action to reduce exposure of free-ranging California condors in Arizona and Utah to lead from spent ammunition. PLoS ONE 3(12): e4022.

Hanning, R.M., Sandhu, R., MacMillan, A., Moss, L., Tsuji, L.J.S., and Nieboer, E. 2003. Impact of blood lead levels of maternal and early infant feeding practices of First Nation Cree in the Mushkegowuk Territory of northern Ontario, Canada. J. Environ. Monit. 5:241–5.

Hunt, W.G., Watson, R.T., Oaks, J.L., Parish, C.N., Burnham, K.K., Tucker, R.L., Belthoff, J.R., and Hart, G. 2009. Lead bullet fragments in venison from rifle-killed deer: Potential for human dietary exposure. PLoS ONE 4(4): e5330.

Johansen, P., Pedersen, H.S., Asmund, G., and Riget, F. 2006. Lead shot from hunting as a source of lead in human blood. Environ Pollut. 142:93–7.

Kelly, T.R. and Johnson, C.K. 2011. Lead exposure in free-flying turkey vultures is associated with big game hunting in California. PLoS ONE 6(4): e15350.

Knott, J., Gilbert, J., Hoccom, D., and Green, R. 2010. Implications for wildlife and humans of dietary exposure to lead from fragments of lead rifle bullets in deer shot in the UK. Sci. Total Environ. 409:95–99.

Levesque, B., Duchesne, J.F., Gariepy, C., Rhainds, M., Dumas, P., Scheuhammer, A.M., Proulx, J.F., Déry, S., Muckle, G., Dallaire, F., and Dewailly, E. 2003. Monitoring of umbilical cord blood lead levels and sources assessment among the Inuit. Occup. Environ. Med. 60:693–5.

NRC, 2012. Potential Health Risks to DOD Firing-range Personnel from Recurrent Lead Exposure. National Research Council. National Academies Press, Washington, D.C.

Parish, C. N., Hunt, W. G., Feltes, E., Sieg, R., and Orr, K. 2009. Lead exposure among a reintroduced population of California Condors in northern Arizona and southern Utah.

Ingestion of Lead from Spent Ammunition: Implications for Wildlife and Humans, The Peregrine Fund, Boise, Idaho, USA.
Pauli, J. and Burkirk, S. 2007. Recreational shooting of prairie dogs: A portal for lead entering wildlife food chains. J. Wildl. Management 71(1):103–108.
Reddy, E.R. 1985. Retained lead shot in the appendix. J. Can. Assoc. Radiol.36:47–8.
Rideout, B.A., Stalis, I., Papendick, R., Pessier, A., Puschner, B., Finkelstein, M.E., Smith, D.R., Johnson, M., Mace, M., Stroud, R,, Brandt, J., Burnett, J., Parish, C., Petterson, J., Witte, C., Stringfield, C., Orr, K., Zuba, J., Wallace, M., and Grantham, J. 2012. Patterns of mortality in free-ranging California Condors (*Gymnogyps californianus*). J Wildl. Dis. 48(1):95-112.
Stauber, E., Finch, N., Talcott, P.A., and Gay, J.M. 2010. Lead poisoning of bald (*Haliaeetus leucocephalus*) and golden (*Aquila chrysaetos*) eagles in the U.S. inland Pacific northwest region--an 18-year retrospective study: 1991-2008. J. Avian Med. Surg. 24(4):279-87.
Thomas, V.G. 2013. Lead-free hunting rifle ammunition: Product availability, price, effectiveness, and role in global wildlife conservation. Ambio. Jan 4, DOI: 10.1007/s13280-012-0361-7 [Epub ahead of print].
Tsujia, L.J.S., Wainmanb, B., Martina, I., Sutherland, C., Weberd, J-P., Dumas, P., and Nieboerb, E. 2008. The identification of lead ammunition as a source of lead exposure in First Nations: The use of lead isotope ratios. Sci. Total Environ. 393:291-298.
USGS. Mineral Industry Surveys, Lead. January, 2013; United States Geological Survey, http://minerals.usgs.gov/minerals.
U.S. EPA. Integrated Science Assessment for Lead (Third External Review Draft). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-10/075C, 2012.
Wayland, M. and Bollinger, T. 1999. Lead exposure and poisoning in bald eagles and golden eagles in the Canadian Prairie Provinces. Environ. Poll. 104(3):341–350.
Woods, C. P., Heinrich, W. R., Farry, S.C., Parish, C.N., Osborn, S.A.H., and Cade, T.J. (2007). Survival and reproduction of California Condors released in Arizona. California Condors in the 21st Century. A. Mee and L. S. Hall. Washington, DC, and Cambridge, Massachusetts, USA, American Ornithologists Union, Nuttall Ornithological Club. 2: 57-78.