Final Version 5.18.20

Teton Raptor Center Position Statement
Lead (Pb) in Ammunition Used for Hunting and Wildlife Management

Background

Lead-based ammunition has been used for centuries and effects to wildlife resulting from inadvertently ingesting lead-based ammunition have been documented since the 1870s [1-3]. Wildlife ingest lead from ammunition in a variety of ways but all avenues can result in acute toxicosis, death, or a variety of secondary effects from low-level exposure and/or bioaccumulation within individuals.

It has been well established from many studies across the globe that bullets used for hunting and wildlife management pose a risk to raptors and other avian scavengers [4]. Both small and large caliber lead-based rifle bullets fragment upon impact with an animal, leaving an average of 38 mg of lead in varmints, 235 small (<2mm diameter) lead fragments in an eviscerated big-game carcass, and 160 lead fragments in the resulting gutpile [5-8]. In Wyoming, the recent five-year (2014-18) mean big-game (antelope, deer, and elk) harvest was 109,870 animals per year [9], not including wounding loss (which can amount to 15-25% each year). Even if 20% of hunters are currently using lead-free ammunition, this equates to >18 million lead fragments from big-game hunting available to scavengers in Wyoming, each year. Using lead stable isotopes, lead found in raptors has been directly linked to these ammunition sources [10-11].

Lead shot used primarily for bird hunting can be directly ingested by birds or secondarily ingested by raptors and scavengers. Spent lead shot in the waterways is ingested by waterfowl, which results in an estimated 1.4 million deaths per year [12]. Lead shot for waterfowl hunting on public lands was phased out in the US in 1991 but is still regularly used for upland game hunting. Ingestion of spent lead shot regularly occurs in upland species such as doves, quail, pheasants, and other species that mistake the lead pellets for seeds and grit [13-16]. An estimated 8.8–15 million doves are estimated to die from lead poisoning each year [17]. Secondary poisoning can occur when raptors and scavengers feed on waterfowl, upland game, or other birds that have either ingested pellets or been wounded and have pellets embedded in their body. In just the Northwest Great Plains ecoregion (eastern MT, northeast WY, western ND, and western SD), there are an estimated 162,000–221,000 shot, unretrieved upland game potentially available to raptors and other scavengers, every year[18]. In Wyoming, the ten-year average harvest of upland game birds (*in order of harvest amounts:* pheasant, mourning dove, sage-grouse, chukar, gray partridge, sharp-tailed

grouse) was 84,716 birds [9]. Assuming a 20% wounding/unretrieved loss rate, that equates to an average of 16,943 birds available to scavengers that likely have spent shot embedded within.

The amount of lead available to raptors and scavengers from varmint shooting is unknown but can have higher risk to populations since much varmint shooting coincides with the nesting season in Wyoming. Shot varmints with embedded lead fragments are fed to growing chicks, which are at higher risk of deleterious effects from lead ingestion [8]. Wyoming is home to white-tail prairie dogs, black-tailed prairie dogs, Wyoming ground squirrels and Uinta ground squirrels. There are no estimates of varmint take in Wyoming, but local-area shooting rates can be extremely high (>100 animals/day/shooter [8]). Data have linked the isotope signatures of lead in nestling golden eagles to the lead isotope ratios of lead ammunition fragments removed from prairie dog carcasses collected from the same areas in northeastern Wyoming (TRC, unpublished data). Varmint shooting occurs for management purposes on private lands and for recreation on both private and public lands. It is common practice for shooters to leave shot animals in the field for scavengers and there is evidence that raptors are at risk of lead ingestion as a result [8,19].

Other sources of lead ingestion in avian scavengers from ammunition sources are from agency and state management actions. Federal aerial gunning programs have killed >20,000 coyotes/year in the western US as part of the USDA Wildlife Service's Wildlife Damage Management Program [20]. These programs typically use lead-based buckshot and the carcasses are left on the landscape. Similarly, state- and county-sponsored predator removal programs, non-agency predator control, and recreational shooting of coyotes all result in shot coyote carcasses across the landscape available for scavenging. The rate at which coyotes and other predators are shot remains unknown. Other state management actions that result in carcasses with lead are due to local law enforcement, wardens, or citizens using lead-based ammunition to euthanize ungulates struck by vehicles with lead ammunition. In Wyoming, an average of >5,000 annual wildlife-vehicle collisions occur across the state [21].

Further, there are several studies that have documented a link between the local-area hunting seasons and lead ingestion in raptors and other scavengers [7,22-25]. Lead concentrations in bald eagles during the hunting seasons increase, on average, 7.6 times compared to the non-hunting season [25]. The magnitude of lead-induced mortality remains unknown for most species. In the midwest, 26% of 1,277 bald eagles admitted into a raptor rehabilitation facility from 1996-2009 had elevated lead levels [26]. In Wyoming, 98% of bald eagles during the 2005-2010 hunting seasons had elevated lead levels [23]. That study also found 43% of eagles tested had clinical or acute poisoning levels, while no eagles exhibited those levels during the non-hunting season. The mean annual lead levels in eagles and ravens is directly correlated to the number of big-game annually harvested [23,27].

In raptors and other avian scavengers, ingested lead can result in depression, anemia, vomiting, diarrhea, ataxia, blindness, and seizures [14]. Lead is known to affect the neurologic, ocular, gastrointestinal and/or respiratory systems in raptors [28]. Sub-lethal doses of lead have been shown to reduce cognitive abilities and impair the nervous system of birds, resulting in less food acquisition, poor coordination, and decreased ability to learn [29-30]. Therefore, lead ingestion can result in direct mortality or secondary mortality from a variety of reasons generally not directly attributed to lead (starvation, collisions, etc.).

Bald eagle populations across the US have been increasing, with the possible exception of the Northern Rocky Mountains [31]. The total number of bald eagles that succumb to lead poisoning remains unknown but it does not appear to be significantly impacting the US population as a whole. From 1998–2008, 50% of bald eagles admitted into rehabilitation centers in the Pacific Northwest had elevated levels of lead [26]. That, coupled with the 93% of wild eagles with elevated lead levels across the entire year in Wyoming [23], suggest that lead affects many individual eagles. Golden eagle populations breeding in the western conterminous US appear to be stable-to-declining [31]. Migratory golden eagle populations may be significantly declining in the West [18]. Estimates of mortality have been derived from a sample of 97 known-fate golden eagles tracked from 1997–2013 and estimated 160 golden eagles (3% of all mortalities) die from lead toxicosis [31]. However, it is likely that sub-lethal lead toxicosis or accumulation was a contributing factor in some of the other proximate causes of death [e.g., starvation, electrocution, collisions (which account for 40% of mortalities)].

There are similar lead deposition rates in small mammals shot with both expanding and non-expanding bullets and lead-free small caliber bullets incapacitate small mammals at a similar rate to lead bullets [32]. Use of lead-free ammunition has been documented to significantly reduce lead exposure in eagles. In California, lead exposure significantly declined in golden eagles and vultures following the ban of lead ammunition within the range of the condor at that time [33]. In Wyoming, bald eagle lead levels dropped directly proportional to the number of hunters voluntarily using lead-free ammunition [23].

Lead-free rifle bullets have been found to have similar wound channels and maximum cross-sectional wound areas to lead-based bullets, indicating similar effectiveness between bullet types [34]. The availability and price of lead-free ammunition is a function of consumer demand, because full lines of frangible and non-frangible lead-free bullets are now available [35]. However, widespread use of lead-free ammunition is still considered to be fairly low and estimates of hunters using lead-free ammunition remain unknown.

There are several examples of efforts to reduce lead ammunition across the globe. In California, all forms of lead ammunition were banned within the range of the California condor (at that time) in 2008 and statewide in 2019. In 2000/01, lead ammunition for big-game hunting was banned in Japan. Regional efforts in Arizona and Wyoming have been implemented for voluntary lead-free ammunition use with incentive programs. Several US national parks have eliminated the use of lead-based ammunition for big game hunting. While the initial year of a partial ban in California indicated lower lead levels in golden eagles and vultures [22], the effectiveness of the state-wide ban remains unknown. Even though lead for big-game hunting has been banned for 20 years in Japan, the endangered Stellar's sea eagles still struggle with lead poisoning [10]. A voluntary, incentive lead-free program in the range of the California condor in Arizona has resulted in up to 90% of hunters taking measures to reduce lead availability to scavengers (using lead-free ammunition or removing gutpiles) [36]. In a modest two-year incentive program in Wyoming, up to one-third of hunters switched to lead-free ammunition[23].

Findings:

Given the preponderance of evidence in the scientific literature, Teton Raptor Center concurs that lead from ammunition does result in mortality, sub-lethal and secondary effects, and reduced fecundity in raptors and other avian scavengers. There is little evidence to suggest that lead-based ammunition use for target shooting, shooting sports, and other similar shooting affects raptors and other scavenging wildlife when the target is not an animal. Teton Raptor Center also finds that voluntary, incentive, and educational programs are highly effective at reducing lead ammunition use for hunting and are preferred over regulatory mechanisms.

Hunting is a vital component to the North American Model of Wildlife Conservation. Hunters provide valuable resources for wildlife conservation. The leading support of individual hunters and the hunting community is critical to the implementation of any lead-free ammunition program and the resulting reduction of lead toxicosis in raptors and other avian scavengers.

The Policy of Teton Raptor Center is to:

- Recognize that lead-based ammunition used for shooting game, varmint, and other animals can result in mortality, sub-lethal and secondary effects, and reduced fecundity in raptors and other avian scavengers.

- Promote the use of lead-free ammunition for hunting and shooting wildlife or removal of gutpiles/carcasses from the ecosystem that have been shot with lead-based ammunition.

- Actively participate in and advocate for educational/voluntary lead-free ammunition programs.

- Do not participate in or partner with federal or state legislation and/or litigation aimed at reducing lead use.

- Recognize that hunting remains the foundation of the North American Model of Wildlife Conservation. Hunting is a critical tool for both wildlife conservation and funding. Proactive, collaborative conservation efforts led by and in cooperation with hunters and hunting organizations will be the foundation of reducing lead ammunition in the United States.

- Promote and encourage the best management practices for shooting sports relevant to non-animal shooting, recognizing that lead-based ammunition use for these purposes has little to no effect on raptors or other scavengers.

Literature Cited

[1] Grinnell, G.B. 1894. Lead poisoning. Forest and Stream 42: 117–118.

[2] Hough, B. 1894. Lead-poisoned ducks. Forest and Stream 42: 117.

[3] Grinnell, G.B. 1901. American Duck Shooting. Forest and Stream Publishing Company, New York, USA

[4] Pain, D.J., R. Mateo, and R.E. Green. 2019. Effects of lead from ammunition on birds and other wildlife: A review and update. Ambio. 48:935-953.

[5] Pauli J.N. and S.W. Buskirk. 2007. Recreational shooting of prairie dogs: a portal for lead entering wildlife food chains. Journal of Wildlife Management. 71:103-108.

[6] Hunt W.G., Burnham W., Parish C.N., Burnham K.K., Mutch B. and Oaks J.L. 2006. Bullet fragments in deer remains: implications for lead exposure in avian scavengers. Wildlife Society Bulletin. 34:167–170.

[7] Craighead, D. and B. Bedrosian. 2008. Blood Lead Levels of Common Ravens with Access to Big-Game Offal. Journal of Wildlife Management 72, 240-245

[8] Herring, G., Eagles-Smith, C. A., & Wagner, M. T. 2016. Ground Squirrel Shooting and Potential Lead Exposure in Breeding Avian Scavengers. PloS one, 11(12), e0167926.

[9] Wyoming Big and Trophy Game Harvest Reports. https://wgfd.wyo.gov/Hunting/Harvest-Reports

[10] Ishii, C.A. , S.M.M. Nakayama, Y. Ikenaka, H. Nakata, K. Saito, Y. Watanabe, H. Mizukawa, S. Tanabe, K. Nomiyama, T. Hayashi, and M. Ishizuka. 2017. Lead exposure in raptors from Japan and source idensification using Pb stable isotope ratios. Chemosphere. 186:367-373.

[11] Church, M.E., Gwiazda, R., Risebrough, R.W., Sorenson, K., Chamberlain, C.P., Farry, S., Heinrich, W., Rideout, B.A., Smith, D.R., 2006. Ammunition is the principal source of lead accumulated by California condors re-introduced to the wild. Environ. Sci. Technol. 40, 6143e6150

[12] Anderson, W. L., S. P. Havera, and B. W. Zercher. 2000. Ingestion of lead and nontoxic shotgun pellets by ducks in the Mississippi Flyway. Journal of Wildlife Management 64:848-857.

[13] Schulz, J. H., J. J. Millspaugh, A. J. Bermudez, X. Gao, T. W. Bonnot, L. G. Brit, and M. Paine. 2006a. Lead toxicosis in mourning doves. Journal of Wildlife Management 70:413-421.

[14] Friend, M., J. C. Franson, and W. L. Anderson. 2009. Biological and societal dimensions of lead poisoning in birds in the USA. In Watson, R.T., 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. DOI 10.4080/ilsa.2009.0104

[15] Fisher, I. J., D. J. Pain, and V. G. Reynolds. 2006. A review of lead poisoning from ammunition sources in terrestrial birds. Biological Conservation 131:421-432.

[16] Watson, R.T., M. Fuller, M. Pokras, and W.G. Hunt. 2009. Ingestion of Lead from Spent Ammunition: Implications for Wildlife and Humans. Conference Proceedings, The Peregrine Fund, Boise, Idaho.

[17] Schulz, J. H., P. I. Padding, and J. J. Millspaugh. 2006b. Will mourning dove crippling rates increase with nontoxic-shot regulations? Wildlife Society Bulletin 34:861-865.

[18] Bedrosian, B.E., Z. Wallace, G. Bedrosian, B. Woodbridge, and J. Dunk. 2019. Northwestern Plains Golden Eagle Conservation Strategy. Unpublished report prepared for the U.S. Fish and Wildlife Service Western Golden Eagle Team by Teton Raptor Center. Available online at https://ecos.fws.gov/ServCat/Reference/Profile/98141

[19] McTee, M., B. Hiller, and P. Ramsey. 2019. Free lunch, may contain lead: Scavenging shot small mammals. Journal of Wildlife Management. 83:1466-1473.

[20] Herring, G., C.A. Eagles-Smith, J. Buck. 2017. Characterizing golden eagle risk to lead and anticoagulant rodenticide exposure: A review. Journal of Raptor Research. 51:273-292.

[21] Riginos, C, H. Copeland, C. Smith, H. Sawyer, K. Krasnow, and T. Hart. 2016. Planning-Support for Mitigation of Wildlife-Vehicle Collisions and Highway Impacts on Migration Routes in Wyoming. Final Report. FHWA-WY-16/10F. http://www.corinnariginos.com/resources/WVC_and_migration_final_report.pdf

[22] Kelly, T.R., P.H. Bloom, S.G. Torres, Y.Z. Hernandez, R.H. Poppenga, W.M. Boyce, and C.K. Johnson. 2011. Impact of the California lead ammunition ban on reducing lead exposure in Golden Eagles and Turkey Vultures. PLOS ONE 6:e17656.

[23] Bedrosian, B., D. Craighead, and R. Crandall. 2012. Lead exposure in Bald Eagles from big game hunting, the continental implications and successful mitigation efforts. PLoS ONE 7:e51978.

[24] Cruz-Martinez, L., P.T. Redig, and J. Deen. 2012. Lead from spent ammunition: a source of exposure and poisoning in Bald Eagles. Human–Wildlife Interactions 6:94–104.

[25] Legagneux, P., P. Suffice, J.S. Messier, F. Lelievre, J.A. Tremblay, and C. Maisonneuve. 2014. High risk of lead contamination for scavengers in an area with high moose hunting success. PLoS ONE 9:e111546.

[26] Stauber, E., N. Finch, P.A. Talcott, and J.M. Gay. 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. Journal of Avian Medicine and Surgery 24:279–287.

[27] Manning, L.K., A. Wunschmann, A.G. Armien, M. Willette, K. MacAulay, J.B. Bender, J.P. Buchweitz, and P. Redig. 2019. Lead intoxication in free-ranging bald eagles (Haliaeetus leuocephalus). Veterinary Pathology. 56:289-299.

[28] Burger, J. and M. Gochfeld. 1994. Behavioral impairments of lead-injected young Herring Gulls in nature. Fundamental and Applied Toxicology 23:553–561.

[29] Burger, J. and M. Gochfeld. 2005. Effects of lead on Herring Gulls: an avian wildlife model for neurobehavioral deficits. Neurotoxicology 26:615–624

[30] U.S. Fish and Wildlife Service. 2016. Bald and Golden Eagles: Population demographics and estimation of sustainable take in the United States, 2016 update. Division of Migratory Bird Management, Washington D.C., USA.

[31] McTee, M., M. Young, A. Umansky, and P. Ramsey. 2017. Better bullets to shoot small mammals without poisoning scavengers. Wildlife Society Bulletin. 41:736-742.

[32] Craighead, D. and B. Bedrosian. 2009. A relationship between blood lead levels of Common Ravens and the hunting season in the Southern Yellowstone Ecosystem. Pp. 202-205 in 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

[33] Kelly T.R., Bloom P.H., Torres S.G., Hernandez Y.Z., Poppenga R.H., Boyce W.M., et al. 2011. Impact of the California Lead Ammunition Ban on Reducing Lead Exposure in Golden Eagles and Turkey Vultures. PLoS ONE 6(4): e17656.

[34] Trinogga, A., Fritsch, G., Hofer, H., Krone, O., 2013. Are lead-free hunting rifle bullets as effective at killing wildlife as conventional lead bullets? A comparison based on wound size and morphology. Sci. Total Environ. 443, 226e232.

[35] Thomas, V.G., 2013. Lead-free hunting rifle ammunition: product availability, price, effectiveness, and role in global wildlife conservation. Ambio 42, 737e745. http://dx.doi.org/10.1007/s13280-012-0361-7.

[36] Chase L., Rabe M.J. 2015. Reducing Lead on the Landscape: Anticipating Hunter Behavior in Absence of a Free Nonlead Ammunition Program. PLoS ONE 10(6): e0128355.