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June 8, 2022

Via Electronic and Certified Mail

The Honorable Deb Haaland Secretary Department of the Interior 1849 C Street, NW Washington, D.C. 20240 exsec@ios.doi.gov	Martha Williams Director United States Fish and Wildlife Service 1849 C Street, NW Washington, D.C. 20240 martha_williams@fws.gov

RE: Petition for Rulemaking to Require Nontoxic Ammunition and Fishing Tackle on National Wildlife Refuges

Dear Secretary Haaland and Director Williams,

Pursuant to the right to petition the government provided in the First Amendment of the U.S. Constitution[1] and the Administrative Procedure Act (APA),[2] and in accordance with the APA's implementing regulations,[3] the Center for Biological Diversity, Texas Physicians for Social Responsibility, and Sierra Club (Petitioners) formally petition the Secretary of the Interior through the U.S. Fish and Wildlife Service (FWS) to phase out use of lead ammunition and tackle across the National Wildlife Refuge System (Refuge System). Over 120 conservation, veterinarian, and hunting groups have called for regulation to require nontoxic ammunition and fishing tackle.[4]

Lead is universally accepted as a highly toxic substance with lethal properties and numerous pathological effects on living organisms. The harmful health effects from lead exposure range from acute, lethal poisoning to subtle, long-term mental impairment. Lead exposure affects many biological functions including reproduction, growth, development, behavior, and survival. Even

[1] "Congress shall make no law . . . abridging . . . the right of the people . . . to petition the Government for a redress of grievances." U.S. Const. Amend. I. The right to "petition for a redress of grievances [is] among the most precious of the liberties safeguarded by the Bill of Rights." *United Mine Workers of Am. Dist. 12 v. Ill. State Bar Ass'n*, 389 U.S. 217, 222 (1967). The Supreme Court has recognized that the right to petition is logically implicit in and fundamental to the very idea of a republican form of government. *United States v. Cruikshank*, 92 U.S. 542, 552 (1875).

[2] 5 U.S.C. § 553(e).

[3] 43 C.F.R. Part 14; 43 C.F.R. §§ 14.2, 14.3, 14.4.

[4] Letter from 121 conservation, hunting, and veterinarian groups to the U.S. Environmental Protection Agency, https://www.biologicaldiversity.org/campaigns/get_the_lead_out/pdfs/Lead_ban_sign-on_letter_of_support.pdf; *see also* American Bird Conservancy et al. 2022, *Phase Out of Lead Ammunition on National Wildlife Refuges* (April 18, 2022) (a letter from 49 conservation and public health groups to U.S. Fish and Wildlife Service).

low levels of exposure to lead can cause neurological damage, and there may be no safe level of lead in the body tissues of the young.

In recent decades the federal government has begun to implement long-overdue regulations to reduce people's exposure to lead in drinking water, paint, gasoline, toys, toxic dumps, and wheel balancing weights. However, lead remains widely distributed in the environment from hunting ammunition and fishing tackle.

In addition to having adverse effects on people, the continued use of lead ammunition and fishing tackle exposes many wildlife species to lead's toxic effects. Particularly susceptible are scavengers that encounter lead shot or bullet fragments in carcasses left in the wild or in gut piles (offal or viscera) from animals cleaned in the wild. Such scavengers include rare and protected raptors, like bald and golden eagles and California condors, and mammals like ocelots, grizzly bears, wolves, and jaguars.

Other significant sources of lead exposure are lost tackle and spent lead shotgun pellets, which accumulate in both aquatic and terrestrial habitats, where migratory birds encounter and ingest them, often mistaking them for food, grit or bone fragments. For example, whooping cranes are known to ingest lead shot and lead weights when foraging for food.

FWS previously established regulations prohibiting toxic lead shot when used in waterfowl hunting.[5] In adopting restrictions on nontoxic shot, FWS stated that the secondary effects of lead shot on migratory birds were a "critical" element in the agency's decision to regulate.[6] The regulations did not cover all hunting, and still allow use of lead ammunition in hunting of upland birds, large game, and other hunting and shooting activities, as well as in lead fishing tackle.

In 2017, FWS ordered a phaseout of all lead ammunition and fishing tackle on the Refuge System.[7] FWS found that "[e]xposure to lead ammunition and fishing tackle has resulted in harmful effects to…wildlife" and that hunting with lead ammunition poses "an ongoing risk to upland or terrestrial migratory birds and other species that ingest spent shot directly from the ground or as a result of predating or scavenging carcasses that have been killed with lead ammunition and left in the field."[8] Despite these findings, that order was later revoked.[9]

Ammunition manufacturers now market a wide variety of nontoxic and less toxic bullets and shotgun pellets as alternatives to lead ammunition. Similarly, nontoxic tackle is widely available across the country. Development of such alternatives has been driven in large part by regulations banning lead ammunition and tackle or encouraging use of nontoxic alternatives. With states like California already implementing prohibitions on lead for hunting, there is no technological or commercial reason why effective, nontoxic alternatives should not be used in the Refuge System.

[5] 50 CFR §§ 20.21(j) (restricting shot to nontoxic materials), 20.108 (establishing nontoxic shot zones), 20.134 (establishing procedures for testing nontoxic shot).
[6] Migratory Bird Hunting: Nationwide Requirement to Use Nontoxic Shot for the Taking of Waterfowl, Coots, and Certain Other Species Beginning in the 1991-92 Hunting, 56 Fed. Reg. 22,100 (May 13, 1991).
[7] FWS 2017, Director's Order No. 219 (Use of Nontoxic Ammunition and Fishing Tackle).
[8] *Id*.
[9] DOI 2017, U.S. Department of the Interior, Order No. 3346 (Mar. 2, 2017) https://www.doi.gov/sites/doi.gov/files/uploads/order_no._3346.pdf.

Petitioners' requested action is necessary because the science overwhelmingly demonstrates that the use of lead ammunition and fishing tackle poses significant threats to the species that rely on the Refuge System, including protected animals like migratory birds and endangered wildlife. Lead ammunition and tackle also pose an unnecessary health threats to hunters and fishers on our Refuge System. Moreover, cost-effective alternatives to toxic ammunition and tackle are readily available.

I. REQUESTED ACTIONS

Petitioners respectfully request the following actions:

1. Issue a Director's Order requiring a phaseout of toxic lead ammunition and tackle on the Refuge System; and
2. Promptly initiate formal rulemaking procedures to require a nationwide phaseout of toxic lead ammunition and tackle on the Refuge System by September 30, 2024.

We further request that while the rulemaking process is ongoing, FWS commit that annual hunt and fish rules require the phaseout of lead ammunition and tackle on individual refuges addressed in those rules.

II. LEGAL AUTHORITY TO PETITION FOR RULEMAKING

Under the APA, agencies must "give an interested person the right to petition for the issuance, amendment, or repeal of a rule."[10] Pursuant to this authority and others, Petitioners request a rule phasing out the use of lead ammunition and fishing tackle.

This Petition supplies the text for the proposed regulation and specific rationale supporting its requests.[11] We request that notice of this Petition be published in the Federal Register for public comment.[12]

Petitioners also request that the Petition be given prompt consideration.[13] The APA requires an agency to "conclude a matter presented to it" "within a reasonable time."[14]

If this Petition is denied, Petitioners may seek judicial review. Agency decisions "that [are] inconsistent with a statutory mandate or that frustrate the congressional policy underlying a

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[10] 5 U.S.C. § 553(e).
[11] 43 C.F.R. § 14.2.
[12] 43 C.F.R. § 14.4.
[13] 43 C.F.R. § 14.3.
[14] 5 U.S.C. § 555(b) ("[W]ithin a reasonable time, each agency shall proceed to conclude a matter presented to it."); *id.* § 706(1) ("The reviewing court shall . . . compel agency action unlawfully withheld or unreasonably delayed."); *id.* § 555(e) ("Prompt notice shall be given of the denial in whole or in part of a written application, petition, or other request of an interested person made in connection with any agency proceeding.").

statute" are impermissible.[15] Judicial review under the APA requires that "the reviewing court shall compel agency action unlawfully withheld or unreasonably delayed."[16]

III. PROPOSED REGULATORY LANGUAGE

Petitioners propose that FWS make the following changes to Title 50 (Wildlife and Fisheries), Chapter 1 (United States Fish and Wildlife Service, Department of the Interior), Subchapter C (The National Wildlife Refuge System), Part 32 (Hunting and Fishing), Subpart A (General Provisions):

* * * * *

50 C.F.R. § 32.2 What are the requirements for hunting on areas of the National Wildlife Refuge System?

…

(k) You may possess only approved nontoxic ~~shot~~ ammunition while in the field~~, which we identify in 50 CFR 20.21(j), while on Waterfowl Production Areas, or on certain other areas of the National Wildlife Refuge System as delineated on maps, leaflets and/or signs, available at each refuge headquarters or posted at each refuge, or as stated in refuge-specific regulations. Where we allow turkey and deer hunting, you may use slugs and shot containing lead to hunt these species unless prohibited by refuge-specific regulations and/or State law~~.

…

50 C.F.R. § 32.5 What are the requirements for sportfishing on areas of the National Wildlife Refuge System?

…

(f) Each person shall possess only approved nontoxic tackle.

…

In addition, several other provisions that effectuate the ban on lead shot for hunting waterfowl should be deleted or revised to reduce unnecessary language. 50 C.F.R. §§ 20.108 (nontoxic shot zones), 20.21(j) (What hunting methods are illegal?), 20.134 (Approval of nontoxic shot types and shot coatings).

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[15] *NLRB v. Brown*, 380 U.S. 278, 291-92 (1965); *see Ocean Advocates v. U.S. Army Corps of Eng'rs*, 402 F.3d 846, 858–59 (9th Cir. 2005).
[16] 5 U.S.C. § 706(1).

IV. WILDLIFE ARE HARMED BY TOXIC AMMUNITION AND TACKLE ON NATIONAL WILDLIFE REFUGES

Importance of the Refuge System

The Refuge System was established in 1903 for the critical purpose of providing sanctuary for threatened and endangered species, migratory birds, and other wildlife. To that end, national wildlife refuges provide habitats for more than 700 species of birds, 220 species of mammals, 250 reptile and amphibian species, more than 200 species of fish, and more than 280 species of threatened or endangered plants and animals.[17] To protect and conserve those species, the Refuge System includes approximately 100 million acres of public lands and waters featuring a diverse array of protected habitat types such as rare and ecologically significant lowland grasslands and wetlands, and 750 million acres of oceans.

According to FWS, "[f]rom one-ton bison to half-ounce warblers, the National Wildlife Refuge System contains a priceless gift—the heritage of a wild America that was, and is."[18] Consequently, FWS must "maintain[] the biological integrity, diversity and environmental health of these natural resources for the benefit of present and future generations of Americans. Caring for fish, wildlife and plant populations and their habitat is the essence of the science of wildlife management as well as the newer disciplines of conservation biology and ecosystem management."[19]

Petitioners and their members strongly agree with these goals and celebrate the Refuge System for providing essential and protected habitats for species that are often in the most danger of disappearing forever.

In addition to the Refuge System's value to wildlife, refuges are also visited by nearly 46 million people each year.[20] According to FWS, visitor spending generates almost $1.7 billion in sales for regional economies.[21] In fact, "[a]s this spending flowed through the economy, nearly 27,000 people were employed and $542.8 million in employment income was generated."[22]

National wildlife refuges are often the closest federal public lands to cities, making them important places for people to recreate and connect with nature. Of the 567 national wildlife refuges in the country, 101 urban national wildlife refuges are within 25 miles of cities with populations over 250,000 — meaning that these refuges can serve the 80% of Americans who live in and around these metro areas.[23]

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[17] FWS, Welcome to the National Wildlife Refuge System, https://www.fws.gov/refuges/about/welcome.html; FWS, Threatened and Endangered Species on National Wildlife Refuges Database, https://www.fws.gov/refuges/databases/ThreatenedEndangeredSpecies/ThreatenedEndangered_Display.cfm.
[18] FWS, Welcome to the National Wildlife Refuge System, https://www.fws.gov/refuges/about/welcome.html.
[19] *Id.*
[20] *Id.*
[21] *Id.*
[22] *Id.*
[23] FWS, Urban National Wildlife Refuges, https://www.fws.gov/urban/wildlifeRefuges.php.

Despite the importance of these public lands for wildlife health and diversity and to the American public, the use of toxic ammunition and tackle on the Refuge System is a commonplace hazard.

Use of Lead Ammunition and Tackle Poisons Wildlife and People

The scientific evidence of the dangers of lead ammunition and tackle on the environment and wildlife is well established in peer-reviewed research, including literature surveys conducted by FWS staff.[24]

Hunting with lead ammunition exposes any animal that preys or scavenges on targeted wildlife to lead's toxic effects. Particularly susceptible are avian and mammalian scavengers that encounter lead in carcasses left in the wild and in gut piles from animals cleaned in the wild. Predators can be exposed when feeding on animals that survive shots and carry lead bullets, shot, or fragments in their bodies.

Eagles and condors are frequently killed by lead poisoning or suffer chronic sub-lethal effects of lead poisoning from scavenging meat containing lead fragments from ammunition, with scientists observing population-level impacts from lead exposure.[25]

Upland game hunting with lead ammunition results in widespread distribution of spent lead, which can accumulate in both terrestrial and seasonally aquatic habitats. And lead tackle like sinkers and jigs can be lost in aquatic environments. This creates a risk of exposure for dozens of species, especially birds that ingest the discarded lead with grit or when foraging.

Copious numbers of scientific studies demonstrate the harm that poisoning from lead ammunition and fishing tackle causes to wildlife that are known to use, visit, or inhabit refuges. In all, more than 130 species of wildlife (including mammals, upland birds, raptors, waterfowl, amphibians and reptiles) have been reported in scientific literature as being exposed or killed by ingesting lead shot, bullets, bullet fragments, or prey contaminated with lead ammunition.

Clean-up costs associated with the remediation of lead in the environment, such as spent lead and lost fishing tackle, can create tremendous costs to government.[26] The remediation efforts themselves can also result in environmental impacts, such as those associated with earth moving and the treatment and storage of remediated lead materials.

Lead also poses significant risks to people who consume game like deer or turkey killed with lead ammunition, or anglers who handle lead tackle.

We have provided a detailed discussion of the science of these impacts in **Appendix 1-Summary of Lead Poisoning in Wildlife** and **Appendix 2-Human Health Risks from Lead**

[24] *E.g.* Golden et al. 2016 and Pain et al. 2019a, b, included in Appendix 1, Summary of Lead Poisoning in Wildlife.
[25] Slabe et al. 2022 and Hanley et al. 2022, Appendix 1.
[26] Kays 2018 and Sauber 2018, Appendix 1.

Ammunition to this Petition. The underlying studies supporting this petition and appendices are also provided.[27]

Regulation of Lead Ammunition and Tackle To Protect Wildlife and People

Because of the significant impacts of toxic lead, FWS enacted prohibitions on the use of lead shot for waterfowl hunting. 50 C.F.R. §§ 20.21(j)(2), 20.134 ("We will not approve as nontoxic any shot type or shot coating with a lead content of 1 percent or more.").

Since then, FWS found that the "[e]xposure to lead ammunition and fishing tackle has resulted in harmful effects to fish and wildlife."[28] FWS further found that hunting with lead ammunition poses "an ongoing risk to upland or terrestrial migratory birds and other species that ingest spent shot directly from the ground or as a result of predating or scavenging carcasses that have been killed with lead ammunition and left in the field." Based on their findings, FWS proposed programs to support nontoxic ammunition and phase out lead ammunition.

Secretary of Interior Ryan Zinke later revoked FWS's Director's Order on the use of nontoxic ammunition and fishing tackle based on the determination that it was "not mandated" and allegedly lacked "coordination with affected stakeholders."[29] But the FWS did not revoke the findings regarding the ongoing dangers of lead ammunition and tackle. Several individual National Wildlife Refuges require the use of non-lead alternatives, but regulations are not consistent across the Refuge System.

In addition, several states have limited the use of lead ammunition and tackle beyond the federal regulations on lead shot for waterfowl hunting:

- California requires the use of nontoxic ammunition "when taking all wildlife, including game mammals, game birds, nongame birds, and nongame mammals, with any firearm."[30]
- Colorado requires the use of nontoxic ammunition when hunting in commercial wildlife parks.[31]
- Wisconsin requires the use of nontoxic ammunition when hunting mourning doves, snipes, rails, moorhens, and coots.[32]
- In Utah, only nontoxic shot can be used when hunting sandhill cranes.[33]
- New York and Vermont prohibit the sale of lead sinkers weighing one-half ounce or less.[34]

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[27] Studies available for download at https://diversity.app.box.com/s/7a2jl0hkx1i6x81fnwaqraw5fve8tncx?sortColumn=name&sortDirection=ASC
[28] FWS 2017, Director's Order No. 219 (Use of Nontoxic Ammunition and Fishing Tackle).
[29] DOI 2017.
[30] Cal. Fish & Game Code § 3004.5(b).
[31] 2 Colo. Code Regs. § 406-5 #502(B)(3).
[32] Wis. Adm. Code NR 10.09(2)(d).
[33] U.A.C. R657-6-7(1).
[34] New York Environmental Conservation Law, ENV § 11-0308; 10 V.S.A. §§ 4606(g), 4615.

- Maine, Massachusetts, and New Hampshire prohibit the sale of lead sinkers weighing one ounce or less.[35]

These federal and state regulations show that phasing out use of lead ammunition and tackle on the Refuge System is a politically feasible, commonsense way to protect wildlife and people.

V. ALTERNATIVES TO LEAD AMMUNITION AND TACKLE

Ammunition with a Maximum of One-Percent Lead Content is Considered Nontoxic

Although the terms "lead-free," "non-lead" and "nontoxic" are often used interchangeably, they are not equivalent. As a result of the manufacturing process, trace levels of lead can exist in any metal projectile, including copper, resulting in ammunition that is not 100% lead-free, but that is functionally nontoxic to wildlife and humans.

Under FWS regulations requiring nontoxic ammunition while hunting for waterfowl, "nontoxic" shot are alloys with less than 1% lead.[36] Steel shot can be coated with metals such as zinc (which always contains lead as an impurity) if the coating does not exceed 1% of the weight of the shot. FWS certifies and approves non-lead shot for use in waterfowl hunting and has currently approved 14 non-lead shot types.[37]

The California Department of Fish and Wildlife (CDFW) also considers lead ammunition to be nontoxic at 1% by weight and certifies nontoxic ammunition.[38] CDFW set a 1% limit on lead content due to scientific consensus that this threshold for lead content will preclude risk from lead to California condors, which are typically more sensitive to lead than other taxa.[39]

Nontoxic Ammunition Performs Better and Costs Less than Lead Ammunition

Non-lead ammunition is available in a large variety of calibers and bullet weights for rifles, shotguns, and muzzleloaders.[40]

Both rifle bullets and .22 caliber rimfire bullets are currently marketed with non-lead alternatives. Non-lead ammunition in .22 rimfire was made available only after California required the use of "nontoxic" .22 ammunition in the range of California condors. Prior to that time, "expert" testimony was presented to the California Fish and Game Commission claiming

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[35] Maine Rev. Stat. Title 12, Conservation § 12664; Mass. Title 321, § 4.00 et seq.; NH Fish & Game Code Title 28, § 211:13-b.
[36] 50 C.F.R. § 20.21(j).
[37] 50 C.F.R. § 20.21(j)(1).
[38] A list of CDFW approved nontoxic ammunitions can be found at https://wildlife.ca.gov/Hunting/Nonlead-Ammunition/Certified.
[39] Fry et al. 2009, Appendix 1.
[40] *See Ballistic Tip® Lead Free*, NOSLER, https://www.nosler.com/products/bullets/product-line/ballistic-tipr-lead-free.html; *Lead Free Hunting*, LAX AMMUNITION, https://www.laxammo.com/lead-free-hunting; *Lead-Free Ammunition*, ABLES, https://www.ableammo.com/catalog/lead-free-hunting-ammo-for-sale-online-discount-prices-c-10480_17468.html; *Lead Free*, HSM, https://hsmammunition.com/lead-free/; *Choose Non-Lead Ammunition*, NYDEC, https://www.dec.ny.gov/outdoor/48420.html.

that non-lead .22 caliber rimfire was impossible to produce. However, commercially available non-lead .22 caliber ammunition became available a mere four months after the Commission decision to ban lead .22 ammunition.

Ammunition manufacturers have not been strictly averse to the use of nontoxic ammunition, and the industry easily met the demand for nontoxic shot in response to FWS's phaseout of lead shot used to hunt waterfowl over 30 years ago. That phaseout recognized industry needs, such as reducing existing lead ammunition inventory and building sufficient supplies of nontoxic shot to supply hunters.

Non-lead bullets generally have equivalent, if not superior, performance when compared to their lead counterparts. Bismuth shot has a density almost equivalent to that of lead, although steel shot is lighter than lead and thus has reduced velocity at greater distances and has been known to damage older shotguns not designed for steel shot. Tungsten alloy shot of several compositions is superior to lead and steel shot, and it can be used in double barreled shotguns and older steel barreled shotguns that are susceptible to damage by steel shot. Copper bullets were originally designed for the "premium" market because of their enhanced ballistic capabilities.

The success of ammunition manufacturers in developing non-lead, expanding-nose centerfire bullets has been well studied.[41] The Barnes Bullet Company succeeded in 1985 in designing copper bullets that demonstrate good expansion without shedding copper particles. They have a proper rotational moment of inertia, are made in traditional bullet weights, and despite the lower density, the over-all loaded cartridge lengths are within specification. These and other factors make copper bullets as capable as traditional lead-cored bullets.

Many varieties of copper bullets are now produced. For example, Barnes produces several X-type bullets, including the X, XLC, and Triple Shock X, in a wide variety of calibers suitable for hunting game such as deer, elk, pigs, and coyotes.[42] To promote proper expansion, Barnes bullets are designed with a hollow point that is fluted so that the tip peels back to form a mushroom upon impact. Barnes bullets have a ballistic coefficient between .220 and .555, depending upon the caliber and cartridge used. Barnes also reports that its bullets retain close to 100% of their weight after hitting most targets. Thus, Barnes bullets are a non-lead alternative ammunition that offers equivalent or superior performance to that of high-quality lead bullets.

In one survey, over 90% of hunters and ranchers approved of the use of copper bullets after trying them out.[43] According to post-hunt survey results in Arizona, 55-89% of hunters would use non-lead ammunition again; in addition, 72% of all hunters said they would recommend the all-copper bullets to other hunters.[44]

Mandating the use of non-lead ammunition for hunting may impose some additional costs on some in the hunting community. However, the incremental cost of alternative ammunition is typically a tiny fraction of the total that hunters spend on their sport. Researchers found that,

[41] Oltrogge, V. 2009, Appendix 1.
[42] Barnes, *The World's Most Effect All-Copper Hunting Bullet*, https://www.barnesbullets.com/
[43] Ritter, J. 2006, Appendix 1.
[44] Seng, P.T. 2006, Appendix 1.

while nontoxic alternatives to lead shot can be more expensive than lead, they represent only a 1–2% increase in the average hunter's yearly expenses.[45] In 2016, ammunition costs made up around 5 percent of total hunting expenses in the U.S.[46]

Moreover, the price of non-lead ammunition has continued to drop over time as demand has risen. The Minnesota Department of Natural Resources in 2009 reported that effective non-lead alternatives to lead shot are available at costs comparable to lead.[47]

On a larger scale, the costs to purchase non-lead ammunition would be more than offset by eliminating the societal costs involved in cleaning up and managing waste from lead ammunition, or in treating health problems associated with lead poisoning. And use of nontoxic ammunition is far cheaper when considering the hidden environmental costs.

Nontoxic Tackle is Widely Available and Cost-Effective

Tackle manufacturers now market a wide variety of nontoxic fishing tackle, and nearly all fishing tackle products are widely available in nontoxic alternative materials such as tin, tungsten, bismuth, steel, and recycled glass.[48] There is no technological or commercial reason why nontoxic fishing tackle with comparable effectiveness should not be substituted for lead.

Tin tackle is widely available and can be reused by anglers many times due to its malleability, but it tends to be more expensive than lead. Steel tackle is known for having fish-attracting qualities because of the noise it makes when bumping along the bottom and is less expensive than other alternatives. Bullet Weights, one of the largest fishing sinker manufacturers in the world, offers two nonlead sinker product lines, Ultra Steel® and Ultra Tin™, and distribute steel and tin sinkers to major outdoor retailers, sporting goods stores, and department stores.[49]

Because its density is comparable to that of lead, tungsten is the preferred alternative for professional anglers. Bismuth tackle is another popular alternative, particularly among anglers who manufacture their own jigs. However, both tungsten and bismuth tackle are currently more expensive than lead tackle. Glass tackle tends to be larger than lead tackle and is more expensive than lead equivalents; however, certain types of glass "glow" after being exposed to light, which can improve fish biting frequency.

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[45] Tranel, M.A. and R.O. Kimmel 2009, Appendix 1.

[46] National Shooting Sports Foundation, *Hunting in America: An Economic Force for Conservation* 1,11 (2018) (ammunitions costs were $1,413,800,000 and total hunting expenses were $27,059,000,000) https://www.fishwildlife.org/application/files/3815/3719/7536/Southwick_Assoc_-_NSSF_Hunting_Econ.pdf.

[47] Tranel, M.A. and R.O. Kimmel 2009, Appendix 1.

[48] MN DNR, *Manufacturers and retailers of lead-free tackle*, https://www.pca.state.mn.us/living-green/manufacturers-and-retailers-lead-free-tackle; Cabela's, *Weights & Sinkers*, https://www.cabelas.com/r/shop/en/fishing-sinkers-and-weights#numberOfResults=32&f[type]=Eco%20Friendly; Bass Pro Shops, *Weights & Sinkers*, https://www.basspro.com/shop/en/fishing-sinkers-and-weights#facet:-7000000000000000201699911132701141051011101001081214&productBeginIndex:0&facetLimit:&orderBy:&pageView:grid&minPrice:&maxPrice:&pageSize:&; Tackle Warehouse, *Brass & Non-Lead Bullet Weights*, https://www.tacklewarehouse.com/Brass__Non-Lead_Bullet_Weights/catpage-TTBO.html.

[49] Bullet Weights, *About*, https://www.bulletweights.com/About.

EPA previously found that the economic cost of banning smaller-sized lead fishing tackle would be minimal.[50] When "Lead-Free Fishing Areas" were proposed for the National Wildlife Refuge System, FWS noted that while nontoxic alternatives could cost more than lead sinkers, any additional cost would not burden anglers because sinkers only make up 3 percent of yearly equipment costs.[51]

Thus, requiring nonlead tackle is feasible because it is widely available and cost-effective.

VI. LEGAL AUTHORITIES THAT AUTHORIZE AND MANDATE PHASEOUT OF LEAD AMMUNITION AND FISHING TACKLE ON NATIONAL WILDLIFE REFUGES

A. Lead Bans Would Protect the Refuge System, as Mandated by the Refuge Act

The National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife System Improvement Act of 1997 (collectively "Refuge Act"), governs the management of national wildlife refuges.[52] The Refuge Act establishes as the mission of the Refuge System "to administer a network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."[53] In crafting the Refuge Act, Congress granted the Secretary of the Interior—acting through FWS—the broad power to promulgate regulations and manage the Refuge System to carry out the purposes of the Act.[54]

Under the Refuge Act, "each refuge shall be managed to fulfill the mission of the system, as well as the specific purposes for which the refuge was established."[55] FWS must prepare a comprehensive conservation plan (CCP) for each refuge, make sure that the CCP is consistent with sound principles of fish and wildlife management and conservation, and revise the plan every 15 years.[56] In establishing the CCP, FWS is supposed to ensure public involvement, and that the "programs" it approves for continued use on a refuge are "compatible" with the purpose of the refuge and the mission of the Refuge System.[57] Such uses must be reevaluated for compatibility when conditions under which the use is permitted change significantly, if there is significant new information regarding the effects of the use, or at least every 10 years.[58]

A "compatible use" is generally a use of a refuge that, based on "sound professional judgment, [] will not materially interfere with or detract from the fulfillment of the mission of the System or

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[50] Lead Fishing Sinkers: Response to Citizens' Petition and Proposed Ban; Proposed Rule, 59 Fed. Reg. 0 (proposed March 9, 1994) (to be codified at 40 CFR pt. 745).
[51] 64 Fed. Reg. 43,834 (Aug. 11, 1999).
[52] 16 U.S.C. § 668dd(a)(1).
[53] *Id*. § 668dd(a)(2).
[54] *Id*. §§ 668dd(a)(1), 668dd(b)(5).
[55] *Id*. § 668dd(a)(3)(A).
[56] *Id*. § 668dd(e)(1)(A), (B).
[57] *Id*. §§ 668dd(d)(1)(A), (d)(3)(A) (FWS "shall not initiate or permit a new use of a refuge or expand, renew, or extend an existing use of a refuge, unless [it] has determined that the use is a compatible use.").
[58] *Id*. § 668dd(d)(3)(B)(vii).

the purposes of the refuge."[59] A compatible use must also contribute to the maintenance of the refuge's biological integrity, diversity, and environmental health.[60] FWS must consider the anticipated impacts of the use on the refuge's purposes and on the mission of the Refuge System.[61]

Impacts that FWS must consider include direct impacts, "indirect impacts associated with the use," and cumulative impacts, including "uses of adjacent lands or waters that may exacerbate the effects of refuge use."[62] This is because, over time, mounting impacts can become quite substantial, threatening the ability of refuges to be protective of wildlife and enjoyed by "present and future generations of Americans."[63]

Uses that are reasonably anticipated "to reduce the quality or quantity or fragment habitats on a national wildlife refuge will not be compatible."[64] When a use is incompatible, FWS must "expeditiously terminate or modify the use to make it compatible."[65] "Under no circumstances (except emergency provisions necessary to protect the health and safety of the public or any fish or wildlife population) may [FWS] authorize any use not determined to be compatible."[66] However, even when a use is compatible, FWS may decline to allow it.[67] FWS has the authority to reevaluate the compatibility of a use "at any time."[68]

The legislative history of the 1997 amendments to the 1966 Refuge Act demonstrates that there is bipartisan support for protecting the Refuge System from threats posed by recreation. For example, in noting that "public use has not always been carried out in a manner that is consistent with the well-being of our refuges and their wildlife," Senator Lindsey Graham (R) acknowledged that secondary activities considered harmful to wildlife resources, including "recreation such as hunting," were occurring on nearly 60 percent of refuges and that a 1991 FWS study found such activities to be harmful to wildlife at 63 percent of refuges.[69] Senator Graham went on to contend that the 1997 amendments were necessary because "[r]efuge managers, despite their best efforts, have often been susceptible to outside pressure to allow these damaging activities because the laws governing the Refuge System are not completely clear."[70] Senator Graham also observed that decisions about what uses are compatible with wildlife conservation were often made improperly, making plain that the purpose of the 1997

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[59] *Id.* § 668ee(1); *see also* 50 C.F.R. § 25.12. Sound professional judgment is limited to mean "a finding, determination, or decision that is consistent with the principles of sound fish and wildlife management and administration, available science and resources, and adherence to the requirements of [the Refuge] Act and other applicable laws." 16 U.S.C. § 668ee(3); *see also* 603 FW 2, § 2.11(A).
[60] 16 U.S.C. § 668dd(a)(4); 601 FW 3, §§ 3.3, 3.7, 3.10, 3.15; 603 FW 2, § 2.5.
[61] 50 C.F.R. § 26.41(a)(8).
[62] 603 FW 2, §§ 2.11(B)(3), 2.12(A)(8)(c).
[63] 16 U.S.C. § 668dd(a)(2).
[64] 603 FW 2, § 2.5(A).
[65] 50 C.F.R. § 26.41(d); *see also* 16 U.S.C. § 668dd(d)(3)(B)(vi).
[66] 603 FW 2, § 2.11(A)(3).
[67] 603 FW 1, § 1.8; 603 FW 2, §§ 2.11(G), 2.15.
[68] 603 FW 2, § 2.11(H)(1); *see also id.* at § 2.11(H)(4),(5).
[69] 143 Cong. Rec. S9092-04, 1997 WL 561070 (statement of Sen. Graham).
[70] *Id.*

amendments was to rein in these harmful activities and refocus agency activities on wildlife conservation.[71]

Further, in signing the 1997 amendments into law, President Clinton emphasized the wildlife-centered mission of the Refuge System, stating that "[w]ildlife conservation is the purpose of the refuges."[72]

These expressions of intent make plain that the Refuge Act allows—and mandates—the actions requested by Petitioners. Use of lead ammunition and tackle does nothing to promote wildlife conservation and causes significant harm to wildlife. While hunting can be a compatible use on some refuges, FWS has used its authority to regulate hunting to ensure that it remains compatible, as it did with the establishment of shooting hours,[73] daily limits,[74] and seasonal limits[75] for migratory bird hunting.

In addition, the National Wildlife Refuge Recreation Act, part of the 1996 Act, allows public recreation "only to the extent" that it is consistent with the primary objectives of wildlife refuges.[76] It requires that the Secretary "shall curtail public recreation use generally or certain types of public recreation use" whenever deemed necessary to meet the purposes of the refuge system and individual refuges.[77] None of the refuges "shall be used… for those forms of recreation that are not directly related to the primary purposes" of the refuge unless the Secretary determines that "recreational use will not interfere with the primary purpose" of that refuge.[78]

Indeed, actions that permit recreation in a degree and manner that interferes with the primary purpose of providing a refuge as a breeding ground for birds and wildlife are inconsistent with the National Wildlife Refuge Recreation Act.[79]

Thus, under this additional authority, FWS can and must ban use of lead ammunition and tackle to allow fulfilment of the primary objectives of the Refuge System and individual refuges.

B. Lead Bans Would Protect Migratory Birds, Eagles, as Required by the Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act

The Migratory Bird Treaty Act

The MBTA is one of the nation's oldest environmental laws and is designed to protect migratory birds in the United States.[80] Over 800 species of birds that migrate across the United States and

[71] *Id.*
[72] The White House, Office of Communications, Presidential Statement on Signing the National Wildlife Refuge System Improvement Act of 1997 (Oct. 9, 1997).
[73] 50 C.F.R § 20.23
[74] *Id*. § 20.24
[75] *Id*. § 20.22
[76] 16 U.S.C. § 460k.
[77] 16 U.S.C. § 460k.
[78] 16 U.S.C. § 460k.
[79] *Defenders of Wildlife v. Andrus*, 455 F. Supp. 446 (D.D.C. 1978).
[80] 16 U.S.C. § 703 *et seq.*

its territories are covered by the protections of the MBTA.[81] The MBTA was originally enacted to recognize international treaties for the protection of migratory birds between the United States and other nations.[82] The MBTA also serves domestic conservation objectives that range from sustainable hunting practices and agricultural protection to the aesthetic importance of wildlife and wartime food-conservation efforts.[83]

The MBTA provides:

> Unless and except as permitted by regulations . . . it shall be unlawful at any time, by any means, or in any manner to pursue, hunt, take, capture, kill, attempt to take, capture, or kill, possess, offer for sale, sell…any migratory bird, any part, nest, or eggs of any such bird, or any product . . . composed in whole or in part, of any such bird or any part, nest, or egg thereof.[84]

FWS had defined "take" broadly under the MBTA to include to "pursue, hunt, shoot, wound, kill, trap, capture, or collect," or attempt any of those activities.[85]

The MBTA requires the development of regulations to control how migratory birds may be taken, killed, or possessed. The Secretary of Interior is "directed" to adopt "suitable regulations" that govern "when, to what extent, if at all, and by what means" migratory birds may be taken, possessed, or killed.[86] The Secretary of Interior is also granted broad authority "to issue such regulations as may be necessary to implement the provisions of the convention[s] between the United States" and Great Britain, Mexico, Japan and Russia to protect migratory birds.[87]

FWS has been delegated authority from the Secretary of Interior to promulgate and administer regulations under the MBTA.[88] Pursuant to its authority under the MBTA, FWS has promulgated regulations which set forth requirements for general take authorization for a range of specific activities including falconry, scientific collecting, conservation education, taxidermy, and sales and hunting of waterfowl.[89]

The MBTA is a broad conservation statute designed to protect migratory birds from a range of threats.[90] FWS has previously established regulations due to the threats emphasized in this Petition in order to limit the take and killing of migratory birds due to toxic lead shot used in

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[81] 50 C.F.R. § 10.13.
[82] *See, e.g.*, 16 U.S.C. § 712; 50 C.F.R. § 10.13.
[83] *See* 55 Cong. Rec. 4402 (1917) (protecting migratory birds against "pothunters"); 55 Cong. Rec. at 4816 (permitting recreational hunting of migratory birds); 56 Cong. Rec. 7360 (1918) (agricultural benefits of migratory birds).
[84] 16 U.S.C. § 703(a).
[85] 50 C.F.R. § 10.12.
[86] 16 U.S.C. § 704(a).
[87] 16 U.S.C. § 712.
[88] 50 C.F.R. Chapter 1.
[89] 50 C.F.R. Parts 13, 20, and 21.
[90] *See Humane Society v. Glickman*, 217 F.3d 882, 885 (D.C. Cir. 2000) (Section 703 of the MBTA "contains broad and unqualified language—'at any time,' 'by any means,' 'in any manner,' 'any migratory bird'"); *United States v. Moon Lake Elec. Ass'n*, 45 F.Supp.2d 1070, 1079 (D. Colo. 1999) (describing the MBTA as "capable of supporting broad interpretations").

waterfowl hunting.[91] In adopting restrictions on nontoxic shot, FWS stated that the secondary effects of lead shot on migratory birds were a "critical" element in the agency's decision to regulate.[92]

Because the regulations did not cover all use of lead, lead from ammunition and tackle continues to be deposited in the environment and absorbed into the terrestrial food chain, creating a persistent and pervasive problem for migratory birds today.

The MBTA Provides Broad Authority to Regulate Hunting

The MBTA provides FWS with statutory authority to regulate hunting to benefit migratory birds. The legislative history of the MBTA demonstrates that Congress intended that FWS regulate recreational and commercial hunting.[93] Even courts that have questioned the reach of liability under the MBTA have recognized that the strict liability provisions apply to hunters and poachers who kill migratory birds.[94]

The MBTA Prohibits the Poisoning of Migratory Birds

The MBTA's current regulations, as well as case law, prohibit the ongoing poisoning of migratory birds. Regulations implementing the MBTA state that "[n]o persons shall take

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[91] 50 CFR §§ 20.21(j) (restricting shot to nontoxic materials), 20.108 (establishing nontoxic shot zones), 20.134 (establishing procedures for testing nontoxic shot).

[92] Migratory Bird Hunting: Nationwide Requirement to Use Nontoxic Shot for the Taking of Waterfowl, Coots, and Certain Other Species Beginning in the 1991-92 Hunting, 56 Fed.Reg. 22100 (May 13, 1991).

[93] *See United States v. Moon Lake Elec. Ass'n, Inc*., 45 F. Supp. 2d 1070, 1080 (D. Colo. 1999) (detailing the MBTA's legislative history); 55 Cong. Rec. 4816 (July 9, 1917) (Statement of Sen. Smith: "Nobody is trying to do anything here except to keep pothunters from killing game out of season, ruining the eggs of nesting birds, and ruining the country by it."); 56 Cong. Rec. 7360 (June 4, 1918) (statement of Rep. Anthony: "[T]he people who are against this bill are the market shooters, who want to go out and kill a lot of birds in the spring, when they ought not to kill them, and some so-called city sportsmen, who want spring shooting just to gratify a lust for slaughter."). *See also* 55 Cong. Rec. 4401 (June 28, 1917) (Statements of Sens. King and McLean: debating the potential conflict between the MBTA and of state game laws); 55 Cong. Rec. 4813 (July 9, 1917) (Statement of Sen. Reed: "[The MBTA] proposes to turn . . . powers over to the Secretary of Agriculture for the creation of zones, to tell white men when and where they can hunt, to make it a crime for a man to shoot game on his own farm . . . ."); 56 Cong. Rec. 7357 (June 4, 1918) (statement of Rep. Fess: annual food losses caused by insects require protection of birds from "the market hunter"); 56 Cong. Rec. 7376 (June 4, 1918) (statement of Rep. Kincheloe: "If you want the pothunters to disregard this solemn treaty we made with Canada and kill these migratory birds and stop their propagation, then you want to vote against this bill."); 56 Cong. Rec. 7447 (June 6, 1918) (statements of Rep. Tillman: "God made woodpeckers, meadow larks, wild ducks, and bobolinks for boys to shoot . . . . It makes better soldiers of them, if they learn to shoot.").

[94] *See United States v. Citgo Petroleum Corp*., 893 F. Supp. 2d 841, 843 (S.D. Tex. 2012) (collecting cases); *Newton County Wildlife Ass'n v. U.S. Forest Serv*., 113 F.3d 110, 115 (8th Cir. 1997) ("[T]he ambiguous terms 'take' and 'kill' in 16 U.S.C. § 703 mean 'physical conduct of the sort engaged in by hunters and poachers, conduct which was undoubtedly a concern at the time of the statute's enactment in 1918.'") (*quoting Seattle Audubon Soc'y v. Evans*, 952 F.2d 297, 303 (9th Cir. 1991); *Mahler v. U.S. Forest Serv*., 927 F. Supp. 1559, 1581 (S.D. Ind. 1996) ("Properly interpreted, the MBTA applies to activities that are intended to harm birds or to exploit harm to birds, such as hunting or trapping, and trafficking in birds and bird parts."); *Citizens Interested in Bull Run, Inc. v. Edrington*, 781 F. Supp. 1502, 1510 (D. Or. 1991) ("I further find that the Act was intended to apply to individual hunters and poachers . . . ."); *United States v. Chevron*, No. 09-CR-0132, 2009 U.S. Dist. LEXIS 102682 (W.D. La. Oct. 30, 2009) ("It is clear and that the provisions of the MTBA were designed to deal with persons who hunt or trap migratory game birds.").

migratory game birds… [w]ith a… poison… or stupefying substance."[95] Courts have also recognized the validity of the MBTA to prohibit the poisoning of migratory birds.[96]

As detailed in this Petition, there are widespread and numerous accounts of lethal and sub-lethal lead poisoning in wildlife, which harms and kills migratory birds. Lead contributes to many physiological, neurological and behavioral changes in animals that diminish the capability of lead-poisoned animals to react normally to outside stimuli. Regulatory prohibition of toxic lead ammunition is thus a logical step to advance the MBTA.

The Strict Liability Nature of the Statute Confers Liability for Intentional and Unintentional Take

The broad reach of the MBTA is further supported by the structure of the statute, which provides for strict liability misdemeanor offenses, meaning that no intent is required for the actor to be culpable of violating the MBTA.[97] "Violations of § 703 are strict liability offenses, requiring no proof of specific intent to commit the crime."[98] Federal appellate courts considering the issue have upheld the strict liability nature of the MBTA's misdemeanor provisions.[99]

The Congressional history and statutory structure separating misdemeanor and felony offenses make clear that misdemeanor violations of the MBTA are strict liability offenses. In 1986, Congress added "knowingly" to section 707(b) because of concerns about the constitutionality of strict liability felony offenses.[100] However, it retained the strict liability provision in section 707(a) related to misdemeanor offenses, as noted in the legislative history: "Nothing in this amendment is intended to alter the 'strict liability' standard for misdemeanor prosecutions under 16 U.S.C. [§] 707(a), a standard which has been upheld in many Federal court decisions."[101]

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[95] 50 CFR § 20.21(a).

[96] *See, e.g.*, *United States v. Halcomb*, No. 1:08-CR-00046-R, 2010 U.S. Dist. LEXIS 48274, *9-12 (W.D. Ky. 2010) (upholding conviction under MBTA for poisoning and remanding to magistrate judge for sentencing). Federal appellate courts considering the issue have repeatedly held that the MBTA prohibits poisoning of migratory birds. *See United States v. FMC Corp.*, 572 F.2d 902 (2d Cir. 1978) (violation due to accidental release of pesticides in holding tanks by pesticide manufacturer); *United States v. Van Fossan*, 899 F.2d 636, 637 (7th Cir. 1990) (upholding defendant's conviction for inadvertently poisoning migratory birds, stating that "[a]lthough neither [the common grackle nor the mourning dove] seems to need protection, each is 'migratory' and the regulations under the Migratory Bird Treaty Act do not allow people to poison them ...."); *United States v. Corbin Farm Serv.*, 444 F. Supp. 510, 532 (E.D. Cal. 1978) *aff'd on other grounds*, 578 F.2d 259 (9th Cir. 1978) (interpreting the language and construction of the statute and legislative history to uphold the MBTA's prohibition on poisoning migratory birds); *United States v. Carpenter*, 933 F.2d 748 (9th Cir. Cal. 1991) (upholding conviction for poisoning under MBTA and remanding for proper sentencing; reversed on other grounds).

[97] 16 U.S.C. §§ 703, 707(a).

[98] *United States v. Stephens*, 142 Fed. Appx. 821, 822 (5th Cir. 2005).

[99] *United States v. FMC Corp*., 572 F.2d 902, 908 (2d Cir. 1978); *United States v. Engler*, 806 F.2d 425, 432 (3d Cir. 1986); *United States v. Boynton*, 63 F.3d 337, 343 (4th Cir. 1995); *United States v. Morgan*, 311 F.3d 611, 616 (5th Cir. 2002); *United States v. Wulff*, 758 F.2d 1121, 1124 (6th Cir. 1985); *United States v. Smith*, 29 F.3d 270, 273 (7th Cir. 1994); *Rogers v. United States*, 367 F.2d 998, 1001 (8th Cir. 1966); *United States v. Wood*, 437 F.2d 91 (9th Cir. 1971); *United States v. Corrow*, 119 F.3d 796, 805 (10th Cir. 1997).

[100] S. Rep. No. 99-445, at 16 (1986), reprinted in 1986 U.S.C.C.A.N. 6113, 6128.

[101] *Id*.

The strict liability nature of the statute provides FWS with rigid authority to regulate lead poisoning regardless of the intent or indirect action of the actor.[102]

Hunting and Fishing with Lead is a Hazardous Activity that is a Proximate Cause of Injury and Death of Migratory Birds and Thus Can be Subject to Regulation under the MBTA

The inherently hazardous nature of hunting and fishing with toxic lead and the reasonably foreseeable outcome of poisoning of migratory birds supports the regulation of lead ammunition and tackle under the MBTA. Several courts have looked to other areas of law to support the statutory basis of the MBTA's strict liability for unintentional take of migratory birds. Judicially adopted theories of MBTA liability based in tort law also support the regulation of toxic lead ammunition and tackle.

The toxic nature of lead makes both hunting with lead ammunition and fishing with lead tackle inherently dangerous. In supporting the strict liability nature of the MBTA, the Second Circuit analyzed the manufacture of a highly toxic substance that caused the poisoning of migratory birds.[103] The highly toxic pesticide, carbofuran, was being washed into a wastewater pond on the manufacturer's property, which attracted migratory birds and led to their death.[104] The Second Circuit noted that the manufacture of the highly toxic product was an abnormally dangerous activity that carried with it liability for the resulting harm, which was well established in common law tort theories.[105]

Hunting with lead ammunition is a similar type of hazardous activity that should be treated as a strict liability violation, as lead is an inherently toxic material. The highly dangerous nature of use of lead ammunition supports greater restrictions on its use for hunting and fishing.

Indeed, as this Petition establishes, lead is a highly toxic chemical that can cause a range of problems for people and wildlife even at extremely low doses. Hunting with lead ammunition deposits tons of lead each year into the environment, including in animals and gut piles that attract scavengers including migratory birds. Furthermore, it contaminates game meat consumed by human beings. When lead tackle gets lost in waterways, it can get inadvertently swallowed by migratory birds. If fish ingest lead tackle, migratory birds such as eagles can end up eating contaminated fish.

The overt act of hunting and fishing with toxic lead ammunition is the proximate cause of the deaths of innumerable migratory birds each year. Proximate cause is an important feature of the MBTA, and "liability would attach where the injury 'might be reasonably anticipated or foreseen as a natural consequence of the wrongful act.'"[106]

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[102] *See, e.g.*, *North Slope Borough v. Andrus*, 486 F.Supp. 332, 362 (D.C. C. 1980) (citing section 703 to prohibit the killing of migratory birds "even if the killing was not intentional"); *see also United States v. Moon Lake Elec. Ass'n, Inc.*, 45 F. Supp. 2d 1070, 1079 (D. Co. 1999) (concluding that the statutory language of "kill" in the MBTA does not limit "kill" to the product of an intentional act).
[103] *United States v. FMC Corp.*, 572 F.2d 902, 907 (2d Cir. 1978).
[104] *Id*. at 904-905.
[105] *Id*. at 907.
[106] *United States v. Apollo Energies, Inc.*, 611 F.3d 679, 690 (10th Cir. 2010) (*citing United States v. Moon Lake Elec. Ass 'n, Inc.*, 45 F. Supp. 2d 1070 (D. Colo. 1999)). Violators of the MBTA are culpable, in part, when it is

The highly toxic effects of lead are well known, and it is reasonably foreseeable that the overt act of putting lead into the environment such that it could be consumed by wildlife and people makes the actor culpable and compels FWS to explicitly prohibit this activity.

The Bald and Golden Eagle Protection Act Authorizes the Phaseout of Lead Ammunition

The Bald and Golden Eagle Protection Act is one of the cornerstones of our nation's efforts to protect and preserve bald and golden eagles.[107] Congress enacted the original Bald Eagle Protection Act to protect the bald eagle from extinction due to its national symbolic value of "American ideals of freedom," as well as its "biological interest."[108] The golden eagle was later included in the Eagle Act due to severe declines in its population and its agricultural value in controlling rodent populations.[109]

The BGEPA, modeled after the MBTA, prohibits the take, possession, purchase, barter, sale, or transport of any bald or golden eagle, or part, nest, or egg thereof.[110] Like the MBTA, the BGEPA broadly proscribes the taking or killing of eagles "at any time or in any manner."[111] The United States Supreme Court has described the BGEPA's prohibitions as "exhaustive" and "consistently framed to encompass a full catalog of prohibited acts."[112]

The BGEPA articulates a non-exhaustive list of possible meanings for its take prohibition, including "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest or disturb."[113] The definitions of "take" under the BGEPA and the Endangered Species Act also provide prohibitions on habitat modification,[114] with limited exceptions that are not appropriate for hunting on refuges.[115]

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reasonably foreseeable that their actions will result in deaths to migratory birds. *United States v. Apollo Energies, Inc*., 611 F.3d 679, 690 (10th Cir. 2010); *United States v. Citgo Petroleum Corp*., 893 F. Supp. 2d 841, 848 (S.D. Tex. 2012).

107 *United States v. Wilgus*, 638 F.3d 1274, 1277-1278 (10th Cir. 2011); *see generally* 16 U.S.C. § 668.

108 Enacting Clause, June 8, 1940, c. 278, § 1 (Statement of Sen. Gruening: "Whereas the Continental Congress in 1782 adopted the bald eagle as the national symbol; and […] became the symbolic representation of a new nation under a new government in a new world; and […]the bald eagle is no longer a mere bird of biological interest but a symbol of the American ideals of freedom; …").

109 *See* Joint resolution to provide protection for the golden eagle. Pub. L. No. 87-884, 76 Stat. 1246 (1962), https://www.govinfo.gov/content/pkg/STATUTE-76/pdf/STATUTE-76-Pg1246.pdf.

110 16 U.S.C. § 668(a).

111 16 U.S.C. § 668(a); 16 U.S.C. § 703(a).

112 *Andrus v. Allard*, 444 U.S. 51, 56-59 (1979).

113 16 U.S.C. § 668c; 50 C.F.R. § 22.3.

114 *Contoski v. Scarlett*, No. 05-2528 (JRT/RLE), 2006 U.S. Dist. LEXIS 56345 at *6-7 (D. Minn. 2006); Protection of Eagles; Definition of Disturb, 72 Fed. Reg. 31132, 31134 (June 5, 2007) (to be codified at 50 CFR pt. 22) (explaining that the FWS's definition of disturb would "protect eagles from certain effects to the eagles themselves that are likely to occur as the result of various activities, including some habitat manipulation").

115 Exceptions to prohibitions under the BGEPA are allowed, among other things, for scientific, exhibition, and religious purposes if a permit is granted by the Secretary of Interior. 16 U.S.C. § 668a. FWS has adopted regulations that authorize limited eagle take for otherwise lawful activities. 50 C.F.R. pts. 13 and 22; *see* Eagle Permits; Take Necessary to Protect Interests in Particular Localities, 74 Fed. Reg. 46836 (Sept. 11, 2009) (to be codified at 50 C.F.R. pts 13 and 22) (accounting for "programmatic take").

After the bald eagle was delisted under the Endangered Species Act, FWS added a regulatory definition of disturb, which

> means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, (1) injury to an eagle, (2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.[116]

FWS revised the definition, in part, so that it may apply to future take or disturbance and not simply past harm.[117]

Both civil and criminal liability can result from violations of the BGEPA.[118] "[C]ivil violations are subject to strict liability standards."[119] Criminal liability under the BGEPA requires that individuals engaging in prohibited conduct must do so "knowingly, or with wanton disregard for the consequences" of their actions.[120] Generally, the "defendant 'must be conscious from his knowledge of surrounding circumstances and conditions that conduct will naturally and probably result in injury' to a protected bird."[121]

The 1972 amendments of the BGEPA sought to reduce the level of specific intent required to convict a defendant under the BGEPA. As stated in a Senate Report, under the 1972 amendments, the "word 'knowingly' means that the offender knew what he was about to do and, with such knowledge, proceeded to do the act."[122] In order to violate the BGEPA a defendant does not need to *know* the bird harmed was an eagle, but that the defendant "deliberately" and "intentionally" caused the act that led to the harm.[123]

> The additional words "with wanton disregard for the consequences of his act" were also added to lessen the degree [of] knowledge required to be proved in order to obtain a conviction under the Act. The evidence would have to show more than mere negligence; while there is no intent to injure, the person must be conscious from his knowledge of surrounding circumstances and conditions that his conduct will naturally and probably result in injury.[124]

FWS has interpreted "wanton disregard" as a negligence standard for individuals who are not acting in good faith.[125]

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[116] 50 C.F.R. § 22.3.
[117] 72 Fed. Reg. at 31,134 (definition was modified "to make clear that it encompasses impacts to eagles that cause 'or are likely to cause' injury, decreased productivity or nest abandonment.")
[118] 16 U.S.C. §§ 668(a),(b), 668b.
[119] 72 Fed. Reg. at 31134; 16 U.S.C. § 668(b).
[120] 16 U.S.C. § 668(a).
[121] *United States v. Moon Lake Elec. Ass'n, Inc.*, 45 F. Supp. 2d 1070, 1074 (D. Colo. 1999) *citing* S. Rep. No. 92-1159, at 5, reprinted in 1972 U.S.C.C.A.N. 4285, 4289.
[122] *United States v. Corbin Farm Service*, 444 F. Supp. 510, 535 (E.D. Cal. 1978) *citing* S. Rep. No. 92-1159.
[123] *United States v. Zak*, 486 F. Supp. 2d 208, 219 (D. Mass. 2007).
[124] *United States v. Corbin Farm Service*, 444 F. Supp. 510, 535 (E.D. Cal. 1978) *citing* S. Rep. No. 92-1159.
[125] 72 Fed. Reg. at 31134.

In enacting the 1972 amendments to the BGEPA, Congress intended to provide a low threshold for harm to eagles as a result of poisoning, and to reduce the requisite level of intent for poisoning.[126] "Congress reduced the scienter requirement and, 'through an abundance of caution,' also amended the definition of 'take' in section 668c to include the word 'poison' even though it was not clear that the latter change was necessary."[127] As the former Director of the FWS[128] explained, "if the person using the poison knows that the poison has the capability to kill wildlife, and is using it with negligent disregard for the consequences of his act, it makes our enforcement position much stronger."[129]

Violations of the BGEPA carry serious civil and criminal penalties. Civil penalties can result in fines up to $5,000, and criminal violators may face one year imprisonment.[130] Repeat criminal violators can face up to $10,000 in fines and two years of imprisonment.[131] With harsh civil penalties and criminal penalties even more severe than those imposed under the MBTA, it is evident that Congress intended to demonstrate the importance of protecting bald and golden eagles.[132]

FWS's existing regulations on lead shot were put in place, in part, to protect bald eagles by "eliminat[ing] lead poisoning as a major mortality factor in waterfowl, bald eagles, and certain other migratory birds."[133] Since then, researchers have published additional studies demonstrating population-level, harmful impacts of lead on bald and golden eagles.[134]

Therefore, the BGEPA authorizes the phaseout of lead ammunition to protect bald and golden eagles and prevent further lead poisoning.

FWS's Mandatory Obligations to Protect Migratory Birds and Eagles from Lead

FWS will be abrogating its duties to protect migratory birds if there is continued inaction on the regulation of lead ammunition and tackle. It is well recognized that "migratory birds are one of [FWS's] primary trust resources."[135] In its role as trustee for the nation's wildlife, FWS has fiduciary obligations to advance the protection of migratory birds as public trust resources.

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[126] *United States v. Moon Lake Elec. Ass'n, Inc.*, 45 F. Supp. 2d 1070, 1087 (D. Colo. 1999) (discussing prosecution of eagle poisoning becoming much easier after amendment).
[127] *United States v. Corbin Farm Service*, 444 F. Supp. 510, 532 (E.D. Cal. 1978).
[128] Spencer H. Smith was Director from 1970 to 1973 of the Bureau of Sport Fisheries and Wildlife, which is a predecessor to the present-day FWS.
[129] *United States v. Moon Lake Elec. Ass'n, Inc.*, 45 F. Supp. 2d 1070, 1087 (D. Colo. 1999) (*citing* Bald Eagle Protection Act: Hearings on S. 2547, H.R. 12186, and H.R. 14731 Before the Subcomm. on the Environment of the Senate Comm. on Commerce, 92nd Cong. 22-24, Serial No. 92-63 (June 29, 1972)).
[130] 16 U.S.C. § 668(a)-(b).
[131] *Id.* § (b).
[132] *Corbin Farm Service*, 444 F. Supp. at 534-35.
[133] Migratory Bird Hunting; Criteria and Schedule for Implementing Nontoxic Shot Zones for 1987-88 and Subsequent Waterfowl Hunting Seasons, 51 Fed. Reg. 23444 (June 27, 1986) (to be codified at 50 CFR pt 20).
[134] *E.g.* Slabe, V.A. et al. 2022, Appendix 1.
[135] Service Responsibilities to Protect Migratory Birds, 720 FW 2 (2004); *see also* Responsibilities of Federal Agencies to Protect Migratory Birds, Exec. Order No. 13186 (2001) (ordering enhanced coordination of federal agencies with FWS to benefit migratory birds).

Moreover, federal agency action that authorizes or causes take of migratory birds—in the absence of a specific mechanism provided for in the MBTA or BGEPA—is itself a violation of the law.[136] FWS is equally subject to those take prohibitions and is also required to fully implement statutes protecting bird species.

FWS is also under an affirmative obligation to fully implement the MBTA and BGEPA and implement protections for birds covered by the statutes. FWS's failure to develop regulations to prohibit take of covered species violates the law.[137]

Injury, death, and poisoning from lead ammunition and tackle, which results from hunting and fishing, is exactly the type of take of migratory birds prohibited under the MBTA and BGEPA.[138] FWS has not issued take permits or regulations that would allow the current take of migratory birds and eagles. By continuing to allow lead ammunition for hunting and fishing, FWS is arbitrarily authorizing incidental take in violation of the MBTA and BGEPA.

C. Lead Bans Would Protect Endangered Species and Other Wildlife, as Required by the Endangered Species Act and Fish and Wildlife Act

The Endangered Species Act provides a means and program to conserve endangered and threatened species and their ecosystems.[139] To this end, it imposes mandatory duties on FWS to conserve wildlife.

Specifically, Congress established that "all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance" of the Endangered Species Act.[140] The Secretary of the Interior "shall review" programs administered by the Interior Department and utilize those programs in furtherance of the purposes conserving threatened and endangered species.[141]

With more than 500 ESA-protected species living on refuges, the Refuge System is critical to the preservation of imperiled wildlife and essential to biodiversity. Thus, allowing the use of toxic lead ammunition and tackle on refuges runs counter to endangered wildlife conservation. Under the authority and mandates of the ESA, FWS should phase out the use of lead that harms ESA-protected species living on refuges including, but not limited to, the jaguar, the condor, the crested caracara, and the whooping crane.

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[136] *See Humane Society v. Glickman*, 217 F.3d 882 (D.C. Cir 2000) (Department of Agriculture was prohibited from implementing a goose management plan by taking and killing Canada geese without an MBTA permit); *Center for Biological Diversity v. Pirie*, 191 F. Supp. 2d 161, 174 (D.D.C. 2002) (prohibiting MBTA take by military without permit but superseded by statute to exempt take for military purposes only).

[137] *See Hill v. Norton*, 275 F.3d 98, 106 (D.C. Cir. 2001) (superseded by statute) (holding that the Department of Interior's failure to issue regulation that included Canadian mute swans in the list of protected migratory birds led to take and constituted a violation of the MBTA).

[138] 16 U.S.C. § 703(a) (prohibiting take of migratory birds "by any means, or in any manner"); 16 U.S.C. §§ 668(a), 668c (prohibiting take or poisoning of bald or golden eagles poisoning in any manner).

[139] 16 U.S.C. § 1531.

[140] *Id.* § 1531(c)(1).

[141] *Id.* § 1536(a)(1).

Moreover, pursuant to the Fish and Wildlife Act, the Secretary of Interior shall "take such steps as may be required for the development, advancement, management, conservation, and protection of fish and wildlife resources."[142] Like the ESA, the Fish and Wildlife Act charges FWS with the duty of conservation. And with that duty, FWS is obligated to protect fish and wildlife resources from the harmful effects of lead. A phaseout of the use of lead in the Refuge System is the most efficient, expeditious, and cost-effective way to fulfill this duty.

In summary, through the enactment of several wildlife conservation statutes mentioned above, Congress has tasked FWS with a broad duty to protect wildlife. The use of toxic lead on the Refuge System harms imperils wildlife and runs counter to the purpose and requirements of these conservation statutes. Therefore, FWS has not only the statutory authority to phase out lead ammunition and tackle on the Refuge System, but also has legal obligation to do so.

VII. PETITIONERS

The Center for Biological Diversity is a nonprofit conservation organization with more than 1.7 million members and supporters dedicated to the preservation, protection, and restoration of biodiversity and ecosystems throughout the world. The Center works to ensure the long-term health and viability of animal and plant species across the United States and elsewhere, and to protect the habitats these species need to survive. For more information, visit www.biologicaldiversity.org

Texas Physicians for Social Responsibility is the Texas chapter of Physicians for Social Responsibility; physicians, nurses, and concerned citizens committed to a safe environment and healthier Texas. Guided by medical and public health expertise, Texas PSR works in partnership with national PSR and other PSR chapters to protect human life from the gravest threats to health and survival through outreach, education, and advocacy. For more information, visit www.texaspsr.org

The Sierra Club is America's largest and most influential grassroots environmental organization, with millions of members and supporters. In addition to protecting every person's right to get outdoors and access the healing power of nature, the Sierra Club works to promote clean energy, safeguard the health of our communities, protect wildlife, and preserve our remaining wild places through grassroots activism, public education, lobbying, and legal action. For more information, visit www.sierraclub.org

VIII. CONCLUSION

The mission of the Refuge System is clear: "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."[143] The Refuge System cannot achieve its mission if the use of toxic lead ammunition and tackle continue to harm fish and wildlife populations and public health.

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[142] 16 U.S.C. § 742f(a)(4).
[143] *Id.* § 668dd(a)(2).

Therefore, Petitioners respectfully request that Secretary of the Interior, through the FWS, grant this Petition and phase out use of lead ammunition and tackle across the Refuge System. FWS has the authority to do so under several federal conservation statutes such as the Refuge Act, the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act, the Endangered Species Act, and the Fish and Wildlife Act. The requested actions are necessary because lead use in the Refuge System presents an unacceptable risk to species health and diversity that diminishes the biological integrity of these public lands. Granting this Petition will be in service of our public lands, wildlife, and environmental health.

In accordance with the APA, Petitioners request that FWS expeditiously respond to this Petition.

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Appendix 1.
Summary of Lead Poisoning in Wildlife

Below we have compiled a survey of important scientific studies demonstrating the significant impacts of lead ammunition.

Between 1975 and 2016, there was a sizeable increase in the number of peer-reviewed papers covering lead ammunition and related impacts. When searching databases like Web of Science using 11 different query combinations of the key words "lead, lead-free, non-lead, non-toxic, ammunition, hunting, poisoning, shot, meat, game, raptor, waterfowl, and upland game," researchers located 570 relevant peer-reviewed papers published from 1975 to August 2016, with a sharp increase in the rate of papers published as time went on (Arnemo et al. 2016).

Sources and Quantities of Lead in the Environment from Hunting and Shooting Sports

The density of spent lead shot in wetlands and fields relates to hunting intensity. Prior to the national requirement for non-lead shot for waterfowl hunting, densities of spent shot reported in waterfowl hunting areas ranged from about 50,000 pellets to over 2 million pellets per acre (Bellrose 1959; Pain 1992; Rocke et al. 1997). Areas with regular hunting from fixed-position blinds or pits resulted in significant accumulation of spent lead. Prior to the lead shot ban for waterfowl hunting, an estimated 2,721 metric tons of spent lead shot were deposited in U.S. wetlands each year (Pain 1992). Spent shot accumulated near the surface of sediments in aquatic settings, increasing the amount of lead shot available to waterfowl over time (Pain 1992). The depth of lead fragments in soil and their availability are influenced by land management practices such as cultivation, and lead shot and bullets can persist for decades to hundreds of years (Fredrickson et al. 1977; Jørgensen and Willems 1987; Kendall et al. 1996).

Despite the ban on lead shot for waterfowl hunting, significant lead shot deposition continues in upland fields used for hunting, where densities of spent lead shot can reach over 400,000 pellets per acre (Schulz et al. 2002). Castrale (1989) estimated densities of approximately 11,000 pellets per acre in a field managed for dove hunting in Indiana. Lewis and Legler (1968) estimated approximately 43,600 pellets per acre in a field managed for dove hunting in Tennessee. Esslinger and Klimstra (1983) estimated approximately 44,000 pellets per acre in a field managed for goose hunting in Illinois. Fredrickson et al. (1977) estimated approximately 122,800 pellets per acre in uncultivated fields near duck blinds in Missouri. Best et al. (1992a, b) estimated approximately 344,000 pellets per acre in an area frequented by dove and quail hunters in New Mexico. The Washington Fish and Wildlife Nontoxic Shot Working Group (WFGA 2001) estimated densities of approximately 188,000 and 344,000 pellets per acre respectively at two pheasant release sites in Washington.

The hunting of big game, upland species, and furbearers also continues to deposit large quantities of spent lead ammunition in the environment. Predator control activities similarly contribute to dangerous and widespread lead deposition (Scheuhammer and Norris 1995; Schulz et al. 2002). Lead from shot, bullets and bullet fragments in tissue or entrails of wounded or dead animals has been increasingly recognized as a threat to many scavenging species (Jannsen et al. 1986; Hunt et al. 2006; Knopper et al. 2006).

To give an idea of the number of potentially lead-tainted carcasses available to scavengers, Fry and Maurer (2003) quantified hunter-shot carcasses available to condors in their California range before the California lead ammunition ban went into effect and concluded that gut piles and whole carcasses left in the field by hunters were a highly significant source of lead within the condor range. From hunting survey data for the eight counties encompassing the condor range in California at that time, it was estimated that an annual average of 36,000 big game animals (17,000 wild pigs, 11,000 coyotes and 8,000 deer) were taken each year by sport hunters in this area (*Id*.). The researchers assumed that only a very few gut piles are actually buried, hidden successfully, or removed from the field (*Id*.). Deer and pigs are generally field dressed and gut piles discarded in the field; coyotes are generally left in the field intact. The Fry and Maurer (2003) figures do not account for poaching, which likely significantly increases the number of deer carcasses available. The data also do not account for the thousands of pigs and deer shot by ranchers under depredation permits, or for small game such as ground squirrels shot by varmint hunters. The carcasses of large animals left in the field are the primary source of hunter-shot food for condors, although condors and other scavengers will eat smaller animals as well. The carcasses of almost 28,000 tree squirrels, rabbits, and ground squirrels are estimated to be left in the field within the condor range annually (*Id*.). Even animals as small as ground squirrels shot with .22 caliber bullets can contain lead fragments at biologically relevant levels that may constitute a hazard for scavenging birds of prey (Harmata 2011; Knopper et al. 2006).

Sources of Lead in the Environment from Fishing

Waterbirds are lead poisoned from ingesting lead fishing sinkers or jigs lost by anglers on the bottom of water bodies. Sport anglers attach lead weights to fishing lines to sink the hook, bait, or lure into the water. Some anglers use lead-weighted hooks called jigs. A sinker or jig can accidentally detach from a line and fall into the water, or the hook or line may become tangled and the line may break or be cut. Aquatic birds may ingest lead objects while collecting gizzard stones or by preying on live bait or escaped fish with attached fishing gear. Many ducks and other water birds forage for food in the mud at the bottom of lakes. Most of these birds also swallow small stones and grit that aid in grinding up their food. Some of the grit may contain lead from fishing tackle. The hazards of and alternatives to lead fishing tackle are well known (Grade et al. 2019; MPCA 1; MPCA 2; MDNR 2019; Schroeder 2010).

Since birds do not generally ingest lead fishing weights greater than 2 ounces, the greatest hazard to water birds from lead fishing tackle seems to be the smaller weights used by sport anglers (Scheuhammer and Norris 1995). However, Franson et al. (2003) found a pyramid sinker weighing 2.75 ounces in a common loon and 5 sinkers greater than 25 mm in diameter in other water birds. Observed sizes of lead objects in the gizzards of waterfowl may be somewhat smaller at necropsy than at the time they were first ingested, due to the grinding action of the gizzard and the presence of small stones against which lead objects are abraded. Birds such as loons may ingest fishing weights while ingesting bait attached to tackle (USEPA 1994). Once ingested, lead objects retained within a bird's ventriculus will be abraded and partially dissolved by acid in the digestive tract, and then absorbed into the blood with potentially toxic effects (IPCS 1989; Scheuhammer and Norris 1995, 1996; NCM 2003).

Lead fishing sinkers and jigs are documented to cause lead poisoning in numerous species of water birds and wading birds, and the problem is particularly acute for mute swans (*Cygnus olor*), trumpeter swans (*Cygnus buccinator*), sandhill cranes (*Grus canadensis,*), and common loons (*Gavia immer*) (Windingstad et al. 1984; Pain 1992; USEPA 1994; Scheuhammer and Norris 1995, 1996; Rattner et al. 2009; Friend 1999; Martin 2019). The U.S. Environmental Protection Agency believes that over 75 individual species are potentially at risk from exposure to lead- and zinc-containing fishing sinkers based on their feeding habits and sources of food. (USEPA 1994).

In a survey of the current state of knowledge about species lead poisoning through the ingestion of fishing gear, researchers found a significant need to improve the development, marketing, adoption, and regulatory approaches for nontoxic fishing gear (Grade et al. 2019). Anglers should be educated on the dangers of lead fishing gear to human and animal health, the availability and costs of non-toxic alternatives to lead fishing gear, and the fact that non-lead fishing gear is suitable for their angling goals (Grade et al. 2019).

Pathways of Lead Exposure for Wildlife

Recent research supports the existing conclusion that lead poisoning of birds is likely to occur wherever lead ammunition is used and a pathway of exposure exists (Pain et al. 2019a, b). Lead from shot, bullets and fragments in heavily hunted fields and shooting areas can be directly ingested or solubilized and biologically incorporated into food items (Ma 1989; Stansley and Roscoe 1996; Hui 2002). Soil, discharge, subsurface, and groundwater lead concentrations can be high in areas where spent lead is deposited into the environment (Pain et al. 2019b; Mariussen et al. 2017a). Lead contamination from spent lead ammunition can put soil biota, small mammals and aquatic organisms including fish at risk (Heier et al. 2009; Mariussen et al. 2017b).

There is extensive documentation of direct ingestion of lead shot and bullet fragments by dabbling and diving ducks, swans, loons, and other water birds. Other marsh birds feeding in wetland areas that are hunted with lead ammunition can also ingest spent lead, such as flamingoes, rails, shorebirds, terns, and herons (Artmann and Martin 1975; Kaiser et al. 1980; Maedgen et al. 1982; Custer and Mulhern 1983; Hall and Fisher 1985; Locke et al. 1991; Beck 1997; Mateo et al. 1999). Numerous species of birds are at risk of lead poisoning from ingesting spent lead shot, as they often mistake shot pellets for food, grit or bone fragments.

Significant lead exposures and effects are due to direct ingestion of spent lead shot and bullet fragments by waterfowl (Sanderson and Bellrose 1986) and certain upland game species (Kendall et al. 1996, Schulz et al. 2006). Wounded or dead prey contaminated with lead ammunition pose a significant threat of toxic lead exposure to predatory and scavenging birds. Secondary poisoning caused by consumption of contaminated prey or gut piles is particularly deadly to bald eagles and California condors (Kramer and Redig 1997; Meretsky et al. 2000; Church et al. 2006; Hunt et al. 2006; Pauli and Buskirk 2007). The use of stable lead isotope ratios has provided evidence that ammunition sources are responsible for lead exposure in wild birds (Scheuhammer and Templeton 1998; Church et al. 2006; Finkelstein et al. 2010).

Granivorous (seed-eating) bird species are known to ingest lead shot, perhaps because they mistake shot for grit or berries, which may be similar in appearance to lead shot after drying and falling (Calvert 1876; Campbell 1950; Hunter and Rosen 1965; Fimreite 1984; Best et al. 1992a, b; Scheuhammer et al. 1999; Lewis et al. 2001; Potts 2004; Butler 2005a, b; Rodrigue et al. 2005). Significant lead exposure has been documented in doves foraging at intensive hunting or target-shooting areas (Fisher et al. 2006; Schulz et al. 2002). Species that forage primarily on seeds on the ground may have a higher risk of exposure, but even bird species with very different foraging strategies, such as woodpeckers, can acquire lead (Mörner and Petersson 1999). In a survey of birds and mammals examined in an outdoor firearm shooting range area, approximately 33% were found to have elevated lead tissue levels and 17% to have potential subclinical or clinical lead exposure (Lewis et al. 2001). Deer are thought to ingest lead fragments on the ground at shooting ranges because of the taste of lead salts on oxidized bullet fragment surfaces (*Id.*).

Animals that scavenge hunter-killed carcasses are at the highest risk of encountering severely toxic concentrations of lead. Studies by Hunt et al. (2006, 2009) evaluated radiographic evidence of lead fragments in 38 deer killed by licensed hunters using center fire rifles with lead-based copper jacketed, soft point bullets in Arizona from 2002 to 2004. 94% of samples of deer killed with lead-based bullets contained fragments and 18 out of 20 (90%) offal piles contained lead fragments (*Id.*). Metal fragments were found to be broadly distributed along wound channels (*Id.*). The authors concluded that the data demonstrated a high potential for scavenger exposure to lead (*Id.*).

Reports from experimental and field observations conclude that all bird species are susceptible to lead poisoning after ingesting and retaining shot in the gastrointestinal system (Fisher et al. 2006). A study on vultures found that lead contamination is a threat in every geographic area where vultures are present (Plaza and Lambertucci 2019). Raptor and scavenger species that feed on animals killed with lead ammunition are at high risk for exposure to lead in this way. Animals that consume lead particles that have fragmented in hunter-killed carcasses may be at particular risk because the small size and irregular shape of fragments make them more absorbable (Fisher et al. 2006).

Fisher et al. (2006) listed 59 terrestrial bird species worldwide that have been poisoned to lead from ammunition sources, including raptors, galliformes, gruiformes, columbiformes, and gulls. Vyas et al. (2000, 2001) identified lead in songbirds residing on a shotgun trap and skeet range. Fisher et al. (2006) reviewed published literature on lead poisoning of 32 species of wild birds in the United States from spent lead ammunition. Documented cases of ingestion and poisoning by lead from ammunition in terrestrial birds globally include 33 raptor species and 30 species from *Gruiformes*, *Galliformes* and various other avian taxa, including ten globally threatened or near threatened species (Pain et al. 2009).

Lead poisoning is of particular conservation concern in long-lived slow breeding species, especially those with initially small populations. A review by the Minnesota Department of Natural Resources (2019) found that over 130 species of animals (including upland birds, raptors, waterfowl, and reptiles) have been reported in scientific literature as being exposed to or killed by ingesting lead shot, bullets, bullet fragments or prey contaminated with lead ammunition (Tranel and Kimmel 2009). Kendall et al. (1996) found that upland game birds ingest substantial amounts of lead shotgun pellets and deduced that raptors must incur secondary ingestion of pellets because their prey ingested it. Rifle-shot prairie dogs and ground squirrels may contain fragmented lead particles that can be ingested by scavengers or raptors (Knopper et al. 2006; Pauli and Buskirk 2007). Kramer and Redig (1997) compiled data on more than 2,000 bald eagles which demonstrated that lead shot pellets, likely from crippled waterfowl and lead fragments in offal and unrecovered deer carcasses, were responsible for elevated lead levels in more than 98% of birds admitted to a veterinary hospital and raptor center.

Terrestrial birds are exposed to lead mainly through ingestion. Galliforms and doves probably ingest spent shot as grit, which is retained in their gizzards (Schulz et al. 2002, 2006). Approximately 2.5% of the hunter-shot doves that were examined contained lead shot in their digestive system, giving a rough estimate of the proportion of doves that ingest shot (Schulz et al. 2002). Predators and scavengers that feed on poisoned doves can also die of lead poisoning.

Raptors and other scavenging birds are also poisoned by ingesting lead shot or bullet fragments lodged in dead or injured prey or gut piles (Friend 1987; Kendall et al. 1996). Common ravens have been shown to have elevated blood lead levels during hunting season due to ingestion of lead in rifle-shot big game offal piles (Hatch 2006; Craighead and Bedrosian 2008, 2009). In Canada, upland game birds and mammals, the primary food source of many raptors, are now more likely to contain lead shot than waterfowl, as lead shot is prohibited for waterfowl hunting (Clark and Scheuhammer 2003). Studies have definitively linked isotopically labeled lead in California condors with rifle bullets sold in the same region, substantiating that condors are regularly ingesting lead from hunting sources and that lead bullet fragments are the principal cause of condor lead poisoning deaths and sublethal complications (or injuries etc) (Church et al. 2006; Chesley et al. 2009; Finkelstein et al. 2010).

Toxic Effects of Lead on Wildlife

Lead has long been recognized as a poison to wildlife (Grinnell 1894; Engstad 1932; Horton 1933). Lead was highlighted as an important cause of mortality in wildlife populations in the late 1950s, when ingestion of spent hunting lead pellets was recognized as causing death in a wide range of wild waterfowl (Bellrose 1959). Reports of poisoned wildlife have continued frequently since that time (e.g. Bates et al. 1968; Irwin and Karstad 1972; Sanderson and Bellrose 1986; Kramer and Redig 1997; Schulz et al. 2006).

Lead fragments can be absorbed from the gastrointestinal tract of birds and mammals, cause damage in various organs, and result in behavioral changes, significant illness, and even death, depending on the amount ingested (Reiser and Temple 1981; Kramer and Redig 1997; Fisher et al. 2006).

Lead fragments or pellets ingested by birds may be rapidly regurgitated (in the pellets of raptors, for example), retained for varying periods, or completely dissolved, with the resulting lead salts absorbed into the bloodstream. The likelihood of a bird becoming poisoned is related to the retention time of lead items, frequency and history of exposure to lead, and factors such as nutritional status and environmental stress (Pattee and Pain 2003). A proportion of exposed birds will die, and mortality can occur following the ingestion of just one pellet of lead shot (Pain and Rattner 1988). Ingestion of lead particles usually results in some absorption, and in cases where sufficient lead is absorbed, poisoning ensues. Lead concentrations are generally highest in the blood directly after absorption, and in liver and kidneys for days to months after absorption. Lead deposited in bone can remain for years and reflects lifetime exposure (Pain 1996). Even extremely low concentrations of lead affect the activity of blood enzymes and cause physiological harm. Other than in cases of point source contamination, high concentrations of lead in the tissues of birds result primarily from the ingestion of lead ammunition and fishing weights.

Various authors have attempted to define tissue concentrations in birds indicative of excessive lead exposure, sub-lethal poisoning, and acute poisoning (Franson et al. 1996; Friend 1987, 1999; Franson et al. 1996; Pain 1996; Pattee and Pain 2003), but there is no definitive consensus on “background” lead levels for wild birds. Environmental sources of lead are almost exclusively anthropogenic, Wildlife can get low-level exposure to lead from unknown sources, including accumulation in plants and ingestion by herbivores, as well as deposition by leaded gasoline exhaust, although this is now attenuated due to regulation. “Baseline” lead concentrations in wildlife can vary between taxa, and the diagnosis of poisoning is usually based on signs of poisoning in combination with blood lead levels in live birds and on tissue concentrations, sometimes in combination with evidence of exposure to lead in dead birds. For example, Pattee et al. (1990) defined background levels as <20 μg/dL. For condors, blood lead levels above 10 μg/dl, rather than 20 μg/dl, could have detrimental effects on condors and ought to be considered the beginning of toxic exposure (Fry et al. 2009). The background levels of 20ug/dl are now understood to indicate significant exposure, because animals held in captivity usually have background levels of 5 μg/dl or less (Walters et al. 2010).

A threshold toxic level for wildlife is difficult to measure because the effects on the nervous system at low doses can be subtle and difficult to detect without specific quantifiable behaviors. In addition, predisposition and susceptibility to lead can vary between individuals within a species (Pattee et al. 1981, Carpenter et al. 2003). Even a minor decrease in the fitness of a bird surviving in a hostile and competitive environment caused by small amounts of lead ingestion may result in death from other causes. In long-lived bird species such as condors, eagles, and ravens, this has the potential to skew the normal age structure toward younger and non-breeding birds and negatively influence long-term population viability. As the duration of periodic and chronic exposure increases in the condor population, so does the likelihood of death by lead poisoning. It is unknown whether wildlife species sustain sublethal effects on coordination and cognitive behaviors similar to those demonstrated in humans (Canfield et al. 2003; Lanphear et al. 2003; Ris et al. 2004), but it is likely that repetitive sub-lethal exposures to lead will cause permanent neurological and behavioral decrements in all species of wildlife.

Lead is a non-specific poison affecting all body systems. Birds can suffer from both acute and chronic lead poisoning (Bellrose 1959; Redig 1985; Sanderson and Bellrose 1986; Eisler 1988; Scheuhammer and Norris 1996). Birds with acute lead poisoning may experience massive tissue destruction and die within a few days, despite appearing perfectly healthy (Sanderson and Bellrose 1986). Birds with chronic lead poisoning may develop appetite loss, anemia, anorexia, reproductive or neurological impairment, immune suppression, weakness, and susceptibility to predation, disease, and starvation (Grandy et al. 1968; Finley and Deiter 1978; Hohman et al. 1995; Scheuhammer and Norris 1996).

The effects of lead toxicosis in birds commonly include distension of the proventriculus, green watery feces, weight loss, anemia, and drooping posture (Hanzlik 1923; Quortrup and Shillinger 1941; Redig et al. 1980; Reiser and Temple 1981; Franson et al. 1983; Sanderson and Bellrose 1986; Mateo 1998). Sub-lethal toxic effects are exerted on the nervous system, kidneys, and circulatory system, resulting in physiological, biochemical, and behavioral changes (Scheuhammer 1987). Vitamin metabolism can be affected (Baksi and Kenny 1978) and birds can go blind (Pattee et al. 1981). Lead toxicosis depresses the activity of certain blood enzymes, such as delta aminolevulinic acid dehydratase, which is essential for cellular energy and hemoglobin production, and may impair immune function (Redig et al. 1991; Grasman and Scanlon 1995). Over longer periods, hematocrit and hemoglobin levels are often reduced. Finkelstein et al. (2010) found that sub-lethal concentrations of lead in blood (20 µg/dL) resulted in a 60% decrease in the levels of aminolevulinic acid dehydratase in condors.

As a result of physiological and behavioral changes, birds may become increasingly susceptible to predation, starvation and infection by disease, increasing the probability of death from other causes (Scheuhammer and Norris 1996). Lead can also affect reproductive success (Cheatum and Benson 1945; Elder 1954; Buerger 1984; Buerger et al. 1986; Williams et al. 2017). Grandjean (1976) showed a correlation between thin eggshells and high concentrations of lead in European kestrels (*Falco tinnunculus*). Lead poisoning significantly decreased egg production in captive Japanese quail, *Coturnix japonica* (Edens and Garlich 1983). In ringed turtle doves (*Streptopelia risoria*), significant testicular degeneration has been reported in adults following shot ingestion and seminiferous tubules may be devoid of sperm (Kendall and Scanlon 1981; Veit et al. 1982). Experimental studies on Cooper's hawks (*Accipiter cooperii*) showed detectable amounts of lead in eggs when adults had high levels in their blood (Snyder et al. 1973). In nestlings of altricial species, such as the American kestrel (*Falco sparverius*), body length, brain, liver and kidney weights can be depressed (Hoffman et al. 1985a). Other adverse effects include reduced survival and disrupted brain, liver and kidney function (Hoffman et al. 1985b).

Under some circumstances, there may be sex differences in the probability of exposure to poisoning by lead. In a study of western marsh-harriers (Circus aeruginosis), Pain et al. (1993) found that significantly more females than males trapped had elevated lead concentrations, for unexplained reasons. Lead exposure may also reduce the likelihood of birds returning to an area to breed (Mateo et al. 1999). Locke and Friend (1992) concluded from their wide-ranging study that all bird species are susceptible to lead poisoning after ingesting and retaining shot. All raptor species that feed on game may potentially be exposed at some time to lead ingestion, with the likelihood varying according to the proportion of game in the diet, the size of game taken, the season, and the local hunting intensity.

In experimentally fed turkey vultures (*Cathares aura*) and bald eagles (*Haliaeetus luecocephalus*), lead ingestion decreased weight and muscle mass and caused blindness (Pattee et al. 1981, 2003). Blood pressure increases and renal damage have also been observed in rodents after experimental lead exposure (Victery 1988; Staessen et al. 1994). Bagchi and Preuss (2005) found that acute lead exposure has lasting effects in laboratory rats, including lowered bone density and increased blood pressure one year after exposure.

In spite of the abundance of evidence that lead is toxic to wildlife, poisoning rates are not well understood. While massive die-offs are readily visible, daily losses of individual animals are more difficult to detect. This is because sick animals will often isolate themselves and then are quickly predated upon after death. In one study, observers were given 30 minutes to discover 100 placed carcasses and only found 6 (Stutzenbaker et al. 1983). In another study in which researchers planted carcasses, over 60% of the carcasses were gone within 3 days and over 90% were gone within 8 days (Humburg et al. 1983; Stutzenbaker et al. 1983).

Lead contamination of carcasses across the landscape remains a serious threat to the health and sustainability of scavenging birds. Transdisciplinary science-based approaches have been used to manage lead exposure in California condors and to explore non-lead ammunition in California (Johnson et al. 2013).

Sub-lethal lead poisoning may weaken raptors and leave them unable to hunt, or make them more susceptible to mortality from vehicles, power lines, and steel traps (Redig et al. 1980; Fry and Maurer 2003). Recent research has found that sub-lethal doses of lead in birds can cause detectable toxicities in multiple organ systems, with harmful reproductive and developmental effects being of increased concern (Williams et al. 2017). It has also been suggested that raptors intoxicated with lead may suffer impaired hunting ability and may scavenge to a greater extent or be less selective in their choice of prey. Sampling methods to determine the exposure to lead intoxication in wildlife have inherent biases, as does any wildlife health assessment in the field.

Long-lived species are particularly susceptible to bioaccumulation of lead in bone tissues, and repeated lead ingestion and accumulation in long-lived species can reduce bone mineralization, which may signal an increase in bone fragility (Gangoso et al. 2009). Gangoso et al. (2009) found an unusually high level of frequency of fractures and even leg amputations in an Egyptian vulture (*Neophron percnopterus*) population with high exposure to ingestion of lead ammunition.

Lead poisoning due to ingestion of spent shot or bullet fragments has had population-level effects for some bird species with low recruitment rates, depressed populations, or that are in recovery, such as the California condor, bald eagle, trumpeter swan, sandhill crane, and spectacled eider (Hennes 1985; Grand et al. 1998; Church et al. 2006, Slabe et al. 2022).

Lead poisoning of raptors poses a threat to raptor populations in North America and beyond (Garvin et al. 2020; Haig et al. 2014). Some progress has been made on a regional scale, but raptors do not subscribe to political borders. Therefore, large-scale regulations, on a national or continent-level, would be more effective than regional regulations (Krone 2018). Reducing the sources and scale of lead poisoning will allow long-term co-occurrence of raptor populations with human populations (Garvin et al. 2020).

Bald Eagles (*Haliaeetus leucocephala*) and Golden Eagles (*Aquila chrysaetos*)

Bald eagles share some demographic and ecological factors with free-ranging condors that make them vulnerable to lead: they scavenge on carcasses, they are long-lived, they have low recruitment rates, and their numbers have been reduced in recent decades (Pattee et al. 1990). Bald eagles that ingest lead shot embedded in the tissues or the intestinal tract of waterfowl often demonstrate acute and chronic symptoms of lead poisoning (Hoffman et al. 1981). In an experiment in which bald eagles were intoxicated with lead shot, Pattee et al. (1981) found that the eagles died within 10 to 133 days. The range of time for lead shot retention in the stomach varied between 0.5 and 48 days. Mean lead levels in dead animals were 16.6 ppm (wet weight) in liver and 6.0 ppm (wet weight) in kidney (Pattee et al. 1981). In a complementary study, Hoffmann et al. (1981) reported mean blood lead levels in eagles dosed with 10 #4 lead shot (0.21g each) to be 80 µg/dl after 24 hours and 280 µg/dl after 72 hours. Mean blood lead levels as high as 270 µg/dl have been detected in apparently healthy free-ranging bald eagles but subclinical effects may be difficult to document (Reiser and Temple 1981). Foreign bodies, including lead fragments, may be regurgitated by eagles so that fragments may not be detected in the gastrointestinal tract at the time of capture or blood tests, even if the fragments contributed substantially to elevated lead exposure levels prior to being ejected. Mateo et al. (2003) recognized the importance of accounting for this unique physiology in raptors and recommend collecting regurgitated pellets at raptor roosting sites to study the presence, frequency, seasonality, and prey associated with the ingestion of lead shot.

The secondary poisoning of bald eagles by lead shot in crippled waterfowl was part of the impetus for the final decision to ban the use of lead for hunting waterfowl (Kendall et al. 1996; Kramer et al. 1997). In one study, 97% of bald eagles and 86% of golden eagles tested had elevated blood levels of lead (Harmata and Restani 1995).

According to the Wisconsin Department of Natural Resources, about 15 to 20 percent of all bald eagle deaths in that state are due to lead poisoning (Eisele 2008; Strom et al. 2009), usually from eating animals that were wounded with lead ammunition or from scavenging gut piles during and after the deer hunting season. It has been observed that Wisconsin lead poisoning cases in bald eagles begin to increase in October, peak in December, and tail off in late winter, which coincides exactly with Wisconsin's deer hunting seasons, suggesting hunter-crippled game and lead contaminated offal are the cause.

A 16-year review of lead levels in bald and golden eagles in Minnesota and Wisconsin by Kramer and Redig (1997) found that observed blood lead concentrations in both species declined following the ban on lead shot in waterfowl hunting, but there was no change in the prevalence of lead poisoning, attributable in part to continued availability of gut piles from hunter-killed deer. In that study, 21% (138/654) of eagles admitted to treatment centers had evidence of lead poisoning, and only one had radiographic evidence of lead fragments in the gastro-intestinal tract (Kramer and Redig 1997). Other potential sources of lead, such as fish contaminated with lead fishing sinkers and hunting activities not included in the lead shot ban, were suggested as causes for the substantial number of cases reported during this time period. Clark and Scheuhammer (2003) found, not surprisingly, that upland game birds and mammals, the primary foods for many raptors, were more likely to contain lead shot than waterfowl 12 years after the ban on lead shot for waterfowl hunting. Lead shot from upland game hunting and lead bullet fragments from big game hunting and "varmint" shooting are significant causes of continued lead toxicity for bald and golden eagles (Harmata and Restani 1995; Fisher et al. 2006; Hunt et al. 2006; Pauli and Buskirk 2007).

Golden and bald eagle feeding ecology and behaviors may expose them to some of the same factors that predispose condors to lead. In a study by Pattee et al. (1990) on the lead hazards within the California condor range, golden eagles were suggested as a model species to assess lead exposure in California condors because they are abundant in the condor range and have been observed feeding on the same carcasses as condors. Between 1985 and 1986, 36% of the 162 golden eagles evaluated within the California condor range had elevated blood lead levels, and 2.5% had levels greater than 100ug/dl, indicative of clinical lead poisoning. This study also reported seasonal trends in lead levels in tissues of golden eagles within the California condor range, which coincided with the deer hunting season (Pattee et al. 1990).

Wildlife rehabilitators in Iowa began gathering lead poisoning information on bald eagles in 2004, analyzing blood, liver, and bone samples for 62 eagles (Neumann 2009). Thirty-nine eagles showed lead levels in their blood above 0.2 ppm or lead levels in their liver above 6 ppm, which can be lethal 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 half of the eagles 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 as a source of this ingested lead (*Id*.). Thousands of bald eagles winter in Iowa, up to one fifth of the population in the lower 48 states.

Samples from spring migrating eagles gathered 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, with the source thought to be shot from waterfowl hunting and fragmented lead-core rifle bullets in ground squirrels (Harmata and Restani 1995). Domenech and Langner (2009) sampled blood from 42 golden eagles in Montana captured during migration during the fall of 2006 and 2007 and found that 58% had elevated blood-lead levels, attributed to ingestion of lead-tainted carcasses or offal piles. Of the eagles evaluated by Domenech and Langner (2009), 18 contained background lead levels of 0–10 µg/dL, 19 were considered sub-clinically exposed at 10–60 µg/dL, two were clinically exposed (60–100 µg/dL), and three exhibited acute exposure of >100 µg/dL. Eagles with lower but still detectable blood lead levels may have had earlier exposure with the majority of the lead already deposited in other organs and bone.

Bedrosian and Craighead (2009) measured blood lead levels of 47 bald eagles and 16 golden eagles in the southern Yellowstone Ecosystem around Grand Teton National Park, Wyoming during and after large-game hunts for two years. They found a median blood lead level of 41.0 µg/dL (range = 3.2–523 µg/dL). 75% of all birds tested exhibited elevated lead levels (>20 µg/dL), and 14.3% exhibited levels associated with clinical poisoning (>100 µg/dL). The median blood lead levels for eagles during the hunting season was significantly higher than during the non-hunting season (56.0 vs. 27.7 µg/dL, respectively; $P = 0.01$). The magnitude of lead in the blood of Wyoming eagles is extremely high and likely results in deaths (Bedrosian and Craighead 2009).

Following the ban on lead shot for waterfowl hunting, bald eagles continue to acquire elevated levels of lead from hunter-shot deer. Spent lead from ammunition is present in field residue of white-tailed deer (*Odocoileus virginianus*) (Cruz-Martinez et al. 2012). Cruz-Martinez et al. (2012) evaluated data from 1,277 bald eagles admitted for rehabilitation in Minnesota from January 1996 through December 2009. They found that 334 bald eagles (26%) had elevated lead levels, and detected significantly increased odds for elevated lead levels based on season (late fall and early winter) and in hunting zones.

Bedrosian et al. (2012) investigated the incidence of lead exposure in bald eagles in Wyoming during the big game hunting season and found that eagles had significantly higher lead levels during the hunt. They found that 24% of eagles tested had levels indicating at least clinical exposure (>60 ug/dL) during the hunt, while no birds did during the non-hunting seasons.

Franson and Russell (2014) evaluated demographic and pathologic characteristics in 484 bald eagles and 68 golden eagles diagnosed with lead poisoning at the U.S. Geological Survey National Wildlife Health Center in Wisconsin. They detected a distinct temporal trend in the collection date of lead-poisoned bald eagle carcasses, corresponding with greater frequency during hunting season in late autumn and winter than in spring and summer. Lead poisoning effects on eagles included emaciation, evidence of bile stasis, myocardial degeneration and necrosis, and renal tubular nephrosis and necrosis (*Id*.). Franson and Russell (2014) additionally found ingested lead ammunition or fragments in 14.2% of bald eagles and 11.8% of golden eagles.

Ecke et al. (2017) correlated lead levels in the blood of golden eagles in Sweden with progression of the moose hunting season. Based on analyses of tracking data, they found that even sublethal lead concentrations in blood can likely negatively affect golden eagle movement behavior (flight height and movement rate). Lead levels in the livers of recovered post-mortem analyzed eagles also suggest that sublethal exposure increases the risk of mortality in eagles (Id.).

Yaw et al. (2017) assessed 11 years (2004–2014) of bald eagle data from four wildlife rehabilitators in Iowa for the prevalence of elevated lead levels in blood or tissue samples. They found the highest blood lead levels in eagles during hunting season (October–January).

Brasic et al. (2021) studied the bald eagle population in the Great Lakes region and found that the primary source of ingested lead in bald eagles was unretrieved carrion that had been contaminated with lead. Brasic et al. (2021) also conducted a sensitivity analysis which showed that bald eagles in the Great Lakes region were dependent on the rate of entry of contaminated carrion in the environment, more so than on retrieval or on the rate of treatment of eagles.

Slabe et al. (2022) studied lead exposure in 1,210 bald and golden eagles from 38 states across the United States and found unexpectedly high frequencies of acute and chronic lead poisoning. The study reported that 46-47% of bald and golden eagles evaluated suffered from chronic lead poisoning, and that 27-33% of bald eagles and 7-35% of golden eagles evaluated suffered from acute lead poisoning (*Id*.). Continent-wide demographic modeling suggests that poisoning at this level suppresses population growth rates for bald eagles by 3.8% and for golden eagles by 0.8% (Id.).

Hanley et al. (2022) found that mortalities from the ingestion of lead have likely reduced the long-term growth rate and resiliency of bald eagles in the northeast United States over the last 3 decades. Deaths from acute lead poisoning were associated with a reduction in the annual survival performance of hatchlings and reproductive females as well as a reduction in resilience for hatchling and breeding female eagles (*Id*.).

Lethal effects from ingestion of lead shot by predatory and scavenging raptors feeding on hunter-killed carcasses have also been documented in red-tailed hawks (*Buteo jamaicensis*), northern goshawks (*Accipiter gentilis*), and great horned owls (*Bubo virginianus*).

Bobwhite, Quail, Doves, and Other Game Birds

Lead exposure and poisoning from ingesting spent lead shot has been documented in many species of upland game birds such as chukar (*Alectoris chukar*), grey partridge (*Perdix perdix*), ring-necked pheasant (*Phasianus colchicus*), wild turkey (*Meleagris gallopavo*), scaled quail (*Callipepla squamata*), northern bobwhite (*Colinus virginianus*), American woodcock (*Scolopax minor*), ruffed grouse (*Bonasa umbellus*), mourning dove (*Zenaida macroura*), and others (Campbell 1950; Damron and Wilson 1975; Best et al. 1992a, b; Yamamoto et al. 1993; Kendall et al. 1996; Akoshegyi 1997; Keel et al. 2002; Battaglia et al. 2005; Butler 2005b; Fisher et al. 2006, Schulz et al. 2006).

Mourning doves are particularly at risk for lead poisoning because they frequent and feed at high-risk habitats in terms of high concentrations of spent lead shot (Lewis and Legler 1968; Kendall and Scanlon 1979a, b; Buerger et al. 1983; Carrington and Mirarchi 1989; Castrale 1989; Best et al. 1992b; Kendall et al. 1996; Burger et al. 1997; Schulz et al. 2002). Spent shot concentrations on managed dove fields as high as 348,000 pellets per acre have been documented (Best et al. 1992b). Portions of the dove populations feeding on these sites ingest lead pellets, and shot ingestion by doves increases during the hunting season (Kendall et al. 1996; Franson et al. 2009). Virtually all doves that ingest lead pellets succumb to the direct or indirect effects of lead poisoning (Schulz et al. 2006; Schulz et al. 2007).

Sampling and evaluation of lead exposure of hunter-harvested doves is the usual source for estimating lead ingestion (Schulz et al. 2002, 2006) with 2.5 to 45.3% of doves sampled having lead shotgun pellets in their digestive tracts. Schulz et al. (2009) suggested that doves feeding in fields hunted with lead shot that ingest multiple lead pellets may die quickly of acute lead toxicosis and become unavailable to harvest, resulting in underestimates of lead shot ingestion rates. This has been exemplified in studies finding relatively few doves with ingested lead shot despite feeding in areas with high lead shot availability. Schulz et al. (2007, 2009) administered lead shot to captive doves and confirmed rapid and acute lead toxicosis.

Franson et al. (2009) evaluated lead exposure in 4,884 hunter-harvested mourning doves from Arizona, Georgia, Missouri, Oklahoma, Pennsylvania, South Carolina, and Tennessee. The frequency of ingested lead pellets in gizzards of doves on hunting areas where the use of lead shot was permitted was 2.5%. On areas where non-lead shot was required, 2.4% of mourning doves had ingested steel shot. Doves without ingested lead pellets had lower bone lead concentrations in areas requiring the use of non-lead shot than in areas allowing the use of lead shot. Schulz et al. (2006) comparing hunting statistics and population estimates, calculated that nearly as many doves are poisoned lethally by ingesting lead shotgun pellets (8.8 million to15 million per year) as are shot by sport hunters on an annual basis. The number of mourning doves harvested in the U.S. is approximately 20 million birds annually.

Bingham et al. (2009) documented ingestion of lead pellets by hunter-harvested chukars in four counties in western Utah and found ingested lead pellets in 8.74% of gizzards from 286 birds. Toxicology results show elevated concentrations of lead (>0.5 ppm, ranging from 0.7 to 42.6 ppm) in 50 bird livers (14%). The arid, rocky, and alkaline nature of chukar habitat reduces pellet settlement and dissolution, and the similar appearance of lead pellets to chukar food sources leads to ingestion of lead pellets by chukars.

American woodcocks are exposed to lead on their breeding grounds in Wisconsin, resulting in high accumulations of lead in bone tissue (Strom et al. 2009). Bone lead concentrations considered to be toxic in waterfowl were observed in all age classes of woodcock; although the source of the lead could not be conclusively identified from a stable isotope analysis of the bone samples, the data suggest a local and dietary source (*Id.*).

Cranes and Rails

Many gruiformes have been shown to ingest lead shot, including cranes, coots, and rails (Jones 1939; Kennedy et al. 1977; Windingstad et al. 1984; Franson and Hereford 1994; Windingstad 1988; Fisher et al. 2006). For example, according to a study by the U.S. Environmental Protection Agency, cranes "wade in shallow areas of inland and coastal aquatic habitats searching for prey . . . dig[ging] into the sediment with their bills to extract food . . . and may incidently ingest lead fishing sinkers" (EPA 1994).

Indeed, endangered whooping cranes (*Grus americana*) have been documented to ingest lead pellets during their migration across Canada and the U.S. One study examined a whooping crane whose gizzard contained "890 tiny lead particles" that researchers thought derived from a "small plastic encased battery or fishing sinker" (Snyder et al. 1992). The consequences of poisoning incidents for the critically endangered Mississippi sandhill crane (*Grus canadensis pulla*) may be considerable, given a population that has only recently grown to about 100 individuals (Johnsgard 1983; Hall 1995). Numerous studies discuss the presence of lead fishing tackle in a variety of bird species with similar feeding and behavioral patterns as whooping cranes and Mississippi sandhill cranes (Franson and Hereford 1994; Franson et al. 2003; Martin 2019; Rattner 2009).

Corvids

Scientists tested blood lead levels in 302 ravens that scavenged on hunter-killed large ungulates and their offal in and around Grand Teton National Park, Wyoming in 2004 and 2005 (Craighead and Bedrosian 2008, 2009). Blood lead levels of ravens increased dramatically during hunting season, roughly five times higher than the rest of the year, likely due to ravens consuming lead bullet fragments left behind in gut piles of hunted elk, deer and moose. Blood samples were taken during a 15-month period spanning two hunting seasons, from mid-September 2004 to mid-December 2005. 47% of the ravens tested during the hunting season exhibited elevated blood lead levels (≥10 µg/dL), while only 2% tested during the non-hunting season exhibited elevated lead levels. Offal is the primary food source of ravens during the time of exposure. Craighead and Bedrosian (2008) also identified unretrieved offal piles of hunter-killed game as a point source for lead contamination in the area. These substantial increases in blood-lead levels correspond almost exactly with the open and close of hunting season. Just after the start of hunting season, blood lead levels begin to rise. Shortly after the end of hunting season, they return to normal. Blood lead levels spike again in the late spring, when melting snow uncovers gut piles left from the previous hunting season.

Craighead and Bedrosian (2009) collected an additional 237 blood samples from ravens in the same study area spanning an additional two hunting seasons. The samples had a median blood lead level of 10.0 µg/dL with a range of 2.7–51.7 µg/dL. The median blood lead level of 84 additional samples collected during the non-hunting season was only 2.2 µg/dL, with a range of 0.0–19.3 µg/dL. 50% of the hunting season samples had blood lead levels >10µg/dL, while only 3% were greater than 10µg/dL during the non-hunting season.

Craighead and Bedrosian (2009) also documented that the blood lead levels of ravens around Grand Teton dropped as use of non-lead ammunition by hunters on the National Elk Refuge and in Grand Teton National Park increased. In fall 2009, researchers distributed 194 boxes of copper bullets to hunters with permits for the park and the refuge (Hatch 2010). They also captured 46 ravens (which typically scavenge the discarded gut piles) during hunting season and tested their blood for lead. An estimated 24% of hunters in the area used copper bullets in 2009, and there was a corresponding 28% drop in blood lead levels in ravens compared with what would have been expected (Hatch 2010).

Median blood lead concentrations of ravens captured during hunting season in northern California were almost six-fold higher than those of birds captured during the non-hunting season (West et al. 2017).

Songbirds

Lead poisoning from ingested spent lead ammunition has been documented in several songbird species in the United States, including white-throated sparrows (*Zonotrichia albicollis*), dark-eyed juncos (*Junco hyemalis*), brown-headed cowbirds (*Molothrus atar*), yellow-rumped warblers (*Dendroica coronata*), brown thrashers (*Toxostoma rufum*), and blue-headed vireos (*Vireo solitarius*) (Vyas et al. 2000, 2001; Lewis et al. 2001).

Grizzly Bears, Black Bears, and Other Mammals

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. Cougars (*Puma concolor*) may periodically be exposed to lead at biologically significant levels because of their tendency to occasionally scavenge. Rogers et al. (2009) collected samples of liver, hair, blood, and feces from black and grizzly bears, wolves, coyotes, and cougars in Grand Teton, Wyoming, and tested the samples for the presence of lead. The researchers documented elevated blood lead levels in grizzly bears during hunting season, when grizzlies scavenge the remains of big game (*Id*.). Preliminary data showed that of 13 Grand Teton grizzly bears sampled during hunting season, 46% showed elevated blood lead levels above 10 µg/dl, while 11 bears sampled outside of hunting season had undetectable lead in their blood (*Id*.).

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Appendix 2
Human Health Risks from Lead Ammunition

Human exposure to lead in the United States has dramatically decreased as lead has been phased out or reduced in gasoline, plumbing, paint and toys. Public health agencies regulate lead in industrial activities and consumer products, and have to varying degrees begun to address lead exposure at shooting ranges. But less attention has been focused on hunting or fishing activities that may cause harmful lead exposure.

Lead has long been the primary metal used for ammunition because of its mass and malleability, but lead is an extraordinarily toxic element. The chemical properties of lead and its harmful effects on humans have been known for thousands of years (Lessler 1988; Needleman 1999; Hernberg 2000; Tong et al. 2000; Nriagu 2009).

Recent research shows that lead is toxic at very low levels. Several studies demonstrate effects on children with blood lead levels less than 10 µg/dL (Wu et al. 2003; Denham et al. 2005; Lanphear et al. 2005; NTP 2012). The Centers for Disease Control and Prevention uses a blood lead reference value (BLRV) of 3.5 micrograms per deciliter (µg/dL) to identify children with blood lead levels that are higher than most children's levels (CDC 2021).

When lead is ingested, it attacks organs and many different body systems. Lead poisoning can damage the brain, central nervous system, and reproductive system and cause kidney disease, cancer, high blood pressure, anemia, impotence, birth defects, miscarriage, nerve disorders, memory and concentration problems, and a host of other health disorders. (Goyer & Clarkson 1996; Borja-Aburto et al. 1999; Lustberg and Silbergeld 2002; Ekong et al. 2006; Khan et al. 2018). In large enough doses, lead can cause brain damage leading to seizures, coma and death. (ATSDR 2020). Even very low levels of lead exposure can decrease IQ and cause learning disabilities and behavioral problems in children or increase the probability of dying from a heart attack or stroke in adults (Needleman et al. 1990; Needleman et al. 2002; Canfield et al. 2003; Needleman 2004; Lanphear et al. 2005; Braun et al. 2006; Menke et al. 2006; Schnaas et al. 2006; Cecil et al. 2008; Wright et al. 2008).

Lead is especially dangerous to fetuses and young children, for whom poisoning is even more pronounced because lead is absorbed faster and disrupts development, causing slow growth, developmental defects, and damage to the brain and nervous system (Schnaas et al. 2006; Hauser et al. 2008). Some studies link elevated bone or blood lead levels with aggression, delinquent behavior, attention deficit hyperactivity disorder, and criminal behavior (Nevin 2000; Needleman et al. 2002; Needleman 2004; Braun et al. 2006; Wright et al. 2008). The consensus among medical researchers is that there is no safe level of lead exposure in young children (CDC 2005).

Hunters who use lead bullets or shot, and their families, are at risk of lead poisoning in several ways: ingesting lead shot pellets, bullet fragments, or residues in game meat; ingesting lead residue from handling lead bullets; or inhaling airborne lead during ammunition reloading or at shooting ranges (Scheuhammer and Norris 1995; Tsuji et al. 1997; Tsuji et al. 1999; Scheuhammer et al. 1998; Johansen et al. 2001, 2004, 2006; Bjerregaard et al. 2004; Khan et al. 2018; Mateo et al. 2007). The handling and use of lead tackle can also cause dangerous human exposure to lead (Grade et al. 2019, OHA, CCHA).

Elevated blood lead levels and resulting health effects and disease have been well documented for people who frequent or work at indoor and outdoor firing ranges (Fischbein et al. 1979; Novotny et al. 1987; Valway et al. 1989; Peddicord and LaKind 2000; Gulson et al. 2002; Laidlaw et al. 2017).

Unsurprisingly, many studies show harmful levels of lead exposure and elevated blood lead levels in subsistence hunters who regularly eat game meat harvested with lead ammunition (Carey 1977; Tsuji and Nieboer 1997; Tsuji et al. 1997; Scheuhammer et al. 1998; Tsuji et al. 1999; Johansen et al. 2001; Johansen et al. 2004; Bjerregaard et al. 2004; Johansen et al. 2006; Mateo et al. 2007; Tranel and Kimmel 2009; Verbrugge et al. 2009; Kosnett 2009) and in people from hunting communities (Dewailley et al. 2001; Lévesque et al. 2003).

An increasing number of studies are directly measuring high lead concentrations in game meat—from visible lead particles and fragments to very fine dust and residues only visible by radiograph—of waterfowl, squirrels, deer, pigs, game birds, and sheep killed by lead bullets or shotgun pellets (Frank 1986; Knopper et al. 2006; Hunt et al. 2009; Cornicelli and Grund 2009; Pain et al. 2010). The meat of game birds killed with lead shot can have high lead levels even after lead pellets are removed and the birds are cooked (Pain et al. 2010). Lead bullets tend to shatter into fragments upon impact with bone, leaving shards and imperceptible dust-sized particles of lead (Frank 1986; Bjerregaard et al. 2004). This lead can infect game meat up to a foot and a half away from a bullet wound when fired from a high-powered rifle, and even lead shot can leave particles, dust and residues in game meat (Tsuji et al. 1999; Hunt et al. 2009). Copper bullets leave no lead and rarely fragment (Hunt et al. 2009).

The Centers for Disease Control and Prevention found that those consuming wild game in North Dakota have 50% more lead in their bloodstream than non-game-eaters (Iqbal et al. 2009). Several scientific studies have shown that venison packets donated by hunters to feed the hungry, processed from deer shot with lead ammunition, are contaminated with toxic lead (Cornicelli and Grund 2008; Hunt et al. 2009; Cornatzer et al. et al. 2009). Taking game to a processor is not a solution: research shows that in a majority of cases, one or more consumers of a hunter-killed, commercially-processed deer will consume toxic lead derived from bullets (Hunt et al. 2009). The Minnesota Department of Agriculture found lead bullet fragments in 26% of ground venison packages from commercial processors, and for some investigated processors the contamination rate was more than 70% (MDA 2008). Based on these studies, state health and wildlife agencies (see for example North Dakota and Minnesota) recommend that women and children do not eat any game harvested with lead ammunition. Food banks and shelters have had to pull lead-tainted venison meat from their shelves (MDA 2008). More than 2.5 million pounds of game meat (approximately 10 million meals), most of it shot with lead ammunition, is donated annually in the United States and four Canadian provinces (Avery and Watson 2009).

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