SETAC SCIENCE BRIEF

LEAD TOXICITY IN WILDLIFE

Lead, represented by the symbol Pb, is a naturally occurring element with qualities well suited for use in numerous chemical, industrial, commercial and sporting applications. In fact, due to its widespread distribution, abundance in the Earth's crust, physico-chemical properties – it is dense, soft and malleable – easy handling and low transformation cost, lead has been used in multiple applications since ancient times. Exposure to lead has been shown to have negative effects on human health and wildlife, including anemia, neurological disorders and immune diseases. Therefore, even though lead has characteristics beneficial to many applications, lead use should be carefully controlled and regulated because of its potential for toxic effects.

Lead exposure and effects on wildlife

For centuries, lead has been used in fishing tackle and ammunition, including bullets and shot for both target shooting and hunting. Wildlife lead poisoning resulting from exposure to lead from spent ammunition and fishing tackle is a widely known problem, detailed in a substantial body of research.

Wildlife may be exposed to lead through different pathways, including:

i. lead is released from spent ammunition or fishing tackle, dissolves and is taken up by plants and animals, potentially accumulating in the food web,

ii. spent ammunition or fishing tackle is directly ingested, which is a primary exposure pathway resulting in lead poisoning in many waterfowl species,

iii. predators and scavengers ingest prey with bullets, shot or ammunition fragments in their flesh, which can cause secondary poisoning, and

iv. embedded bullets or fragments in the flesh.

The majority of available studies related to lead toxicity on wildlife focus on birds, as they are probably the species most visibly affected by lead from spent ammunition. Birds can retain ingested lead from spent ammunition or fishing tackle in their stomach or gizzards, where these materials slowly disintegrate and dissolve due to digestive acids and mechanical action. Once dissolved, lead is absorbed into the bloodstream and can reach all organs and tissues. Depending on the number or size of lead fragments, the animal can be exposed to levels of lead that can result in both lethal and sub-lethal poisoning. For some species, lead poisoning represents one of the most dominant causes of death. Sublethal poisoning results in many important adverse outcomes because lead affects biological systems in wildlife, such as the blood, nervous and immune systems, which may also lead to changes in their behavior or reproduction. Long-term, or chronic, exposure to lead can cause anemia, lethargy, muscle atrophy (wastage), neurological disorders and loss of balance, or interruptions in the body's ability to fight disease among other things. Wildlife exposed to high lead levels for a short amount of time, known as acute exposure, often die rapidly. In addition to the direct effects caused by exposure to high lead levels, indirect effects, such as higher susceptibility to predation or diseases, can also occur and are harder to notice. The devastating effects on waterfowl populations from exposure to lead have resulted in a ban on the use of lead in ammunition in wetlands in many countries around the world, including a ban that will be effective this year, 2021, in the European Union.

Lead exposure and effects on humans

Humans can be exposed to lead through various pathways, such as incidental ingestion, for example, ingesting lead in drinking water or game meat, inhaling lead that has adhered to dust or through skin exposure – although this pathway is less common. Numerous studies have shown a negative relationship between human lead exposure and IQ and cognitive skills, as well as a strong relationship between childhood lead exposure and subsequent aggressive crime. A 2020 report by UNICEF and Pure Earth estimated that globally, one in three children (approximately 800 million) have blood lead concentrations that are at or above 5 micrograms per deciliter (µg/dL), an exposure level identified by the US Centers for Disease Control and Prevention (CDC) and the World Health Or-

ganization (WHO) as being associated with learning difficulties and behavioral deficits in children. In adults, higher exposure to lead is associated with decreased renal function, higher blood pressure and cardiovascular disease. In 2017, the Global Burden of Diseases, Injuries, and Risk Factors Study estimated that lead exposure accounted for 1.5 million deaths and 24.4 million years of healthy life lost worldwide due to its long-term effects on health.

Lead Regulation

The extensive information regarding the environmental toxicity of lead and lead-associated adverse effects on humans, especially among children, has resulted in the replacement of lead by other, less toxic, materials in a number of applications. This has led to bans on its use in pipes and paints in almost every country in the world over the last century. In fact, in 2015 the Global Alliance to Eliminate Lead Paint, an initiative of the WHO and the UN Environment Programme (UNEP), announced the goal of global elimination of lead paint by 2020. Further, leaded gasoline has been banned in many parts of the world and, in July 2021, finally ceased to be marketed worldwide for the automotive industry. However, leaded aviation fuel (or avgas) remains in use worldwide.

Use of lead in fishing tackle and ammunition continues despite evidence of its adverse effects on human and wildlife health and the availability of suitable nontoxic alternatives, some of which have been in use in some locations for decades. The presence of spent lead ammunition or fragments in game meat is of particular concern for human health. For example, five million people in the EU are high-level consumers of game animals shot with lead ammunition. Likewise, lead shot is of concern for birds – around one million waterbirds in Europe are estimated to be killed each year by lead derived from spent ammunition.

The overwhelming evidence for significant adverse ecological effects of lead from spent ammunition and fishing tackle has resulted in the implementation of national regulations, leading to the ban of lead ammunition in some European countries. Two of these, Denmark and The Netherlands, banned the use of lead ammunition in all types of habitats decades ago. Other European countries have partial bans: 16 countries have a total ban in wetlands and/or for waterbird hunting, while five countries have a partial ban in some wetlands. Restriction on the use of lead ammunition in wetlands will apply in all European Union member states starting in February 2023. Other countries, such as the U.S. and Canada, have banned the use of lead shot in waterfowl hunting for decades. Further, beginning in 2023, Denmark will phase out lead-based rifle ammunition for hunting, becoming the first country in Europe to do so. In 2019, the state of California banned lead ammunition for hunting.

Given the adverse health consequences associated with the use of lead ammunition for outdoor shooting and in fishing tackle, and the availability of safer effective alternatives, continued use of lead in ammunition and fishing tackle is no longer warranted. An EU ban of lead in ammunition and fishing tackle will be a big step toward a cleaner and greener society and contribute to the European Green Deal for preserving our environment, in support of the EU "Zero Pollution" action plan.

Resources

European Chemicals Agency (ECHA). 2021. Consultation on a proposed restriction on lead and its compounds in ammunition for outdoor shooting and in fishing tackle.

European Commission, 2021. Pathway to a Healthy Planet for All EU Action Plan: 'Towards Zero Pollution for Air, Water and Soil' COM/2021/400 final.

International Lead Association. Material Stewardship and Sustainability.

UNICEF. 2020. The Toxic Truth: Children's Exposure to Lead Pollution Undermines a Generation of Future Potential.

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