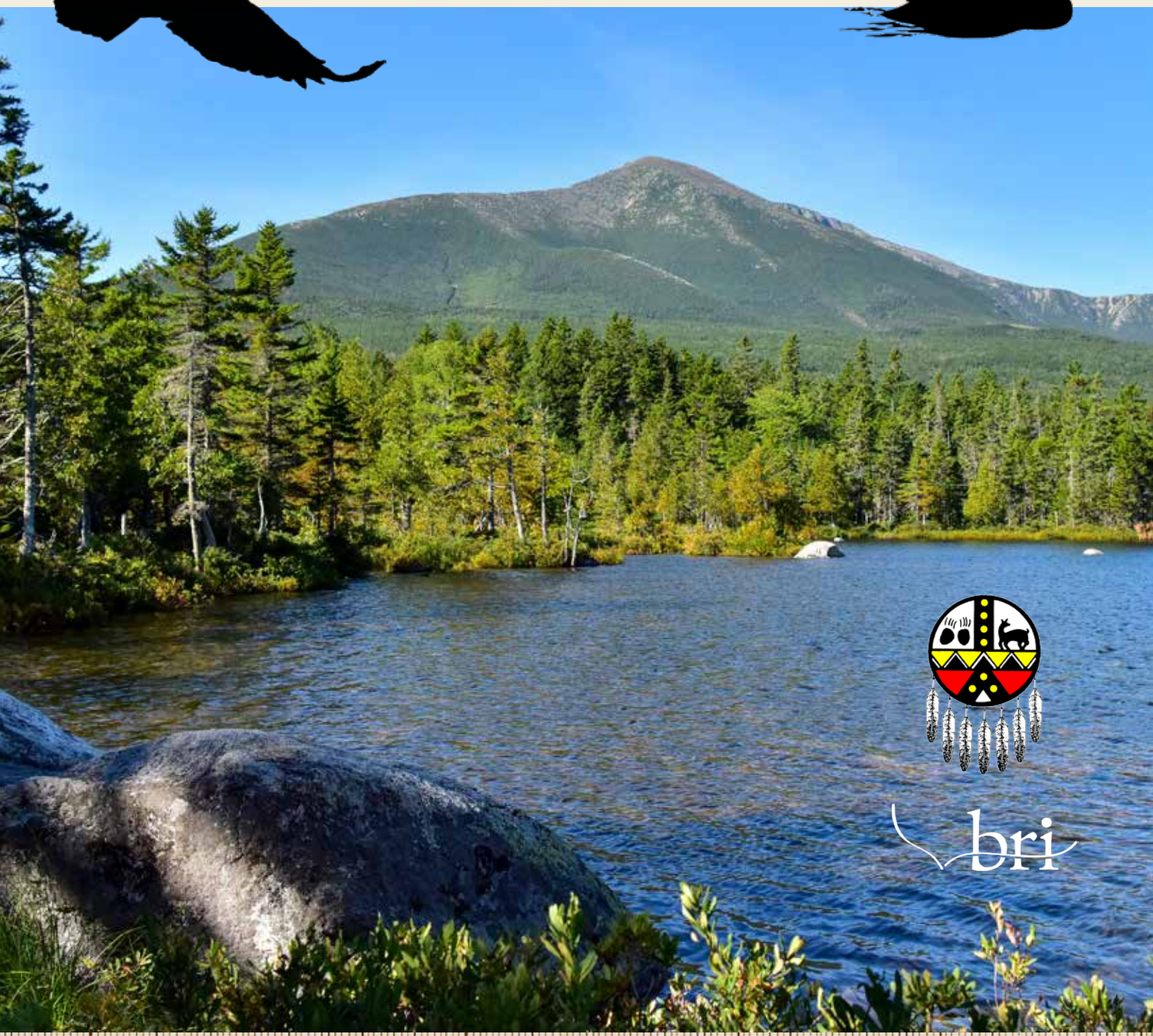
Sentinels in the North Woods

Evaluating Mercury and Lead Exposure Risk of Bald Eagles and Common Loons in Northeastern Maine



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Mi'kmaq Nation

A Land Rich in Resources

In the northeastern corner of Maine's Saint John River watershed lies the Fish River Chain of Lakes, a biologically rich waterway comprised of several large lakes interconnected by the Fish River (Figure 1). This region is particularly important to the Mi'kmaq Nation because it lies in the heart of the area in which tribal members have long lived, worked, hunted, and fished.

The Fish River Chain of Lakes and surrounding regions are uniquely rich in natural resources. Due to its northern latitude, the area harbors unique seasonal assemblages of birds and highly productive freshwater fisheries that attract hunters, anglers, and other outdoor enthusiasts from throughout New England and Canada.

Two of the most iconic North American bird species are abundant in this region: the Common Loon and the Bald Eagle. Aroostook County supports both the fastest growing portion of Maine's resident Bald Eagle population and spectacular aggregations during the winter and summer months. The area also supports what wildlife biologists suspect may be a stronghold for northern Maine's Common Loon population, which had never been intensively surveyed prior to this project.

The Loon and the Eagle

Common Loons and Bald Eagles are sacred animals for the Mi'kmaq people. Cloaked in mystery, the loon is embedded deeply in myth and legend. The Mi'kmaq people say that to hear a passing loon's laugh is a sign of future happiness, but the loon's mournful cry is a harbinger of sorrow.

Traditional stories and legends tell of the great respect and awe that Indigenous people hold for the Bald Eagle. The eagle soars highest in the sky and is believed to carry prayers to the Creator. As such, Native Americans have used Bald Eagle feathers in sacred ceremonies for hundreds of years.

Common Loons need large, clean lakes to breed.

Feeding on fish that humans also consume, loons and eagles are commonly used as environmental indicators.

Project Background and Capacity Building

The Mi'kmaq Nation received a grant from the U.S. Fish and Wildlife Service Tribal Wildlife Grants (TWG) Program in 2020 to initiate this project.

The TWG Program was created by Congress in 2001 to conserve at-risk fish and wildlife, and to help tribes conserve species of fish, wildlife, and plants that are of traditional and cultural significance. To date, the TWG Program, administered by the U.S. Fish and Wildlife Service (USFWS), has awarded more than $94 million to federally recognized Native American Tribes throughout the U.S.

In addition to learning about mercury and lead exposure in wildlife and conducting educational outreach, the grant also enhanced the Tribe's ability to conduct future fieldwork. This capacity building included hiring and training tribal members to work on the project, and the purchase of two boats. These boats improve tribal access to the small ponds and large lakes throughout northern Maine and enhance their ability to conduct biological and water quality research.

This project collaboration with Biodiversity Research Institute (BRI) additionally helped the Tribe initiate an effort to restore Common Loons lost to the Bouchard Barge 120 oil spill that occurred in Buzzards Bay, Massachusetts in 2003. This project, administered by the USFWS and BRI, will take place from 2022–2025.

To learn more about BRI's Common Loon restoration effort, visit:
www.briwildlife.org/loon-program

For more on the TWG Program, visit:
www.fws.gov/service/tribal-wildlife-grants

Fish River Chain of Lakes Region: A Biological Hotspot in Northern Maine

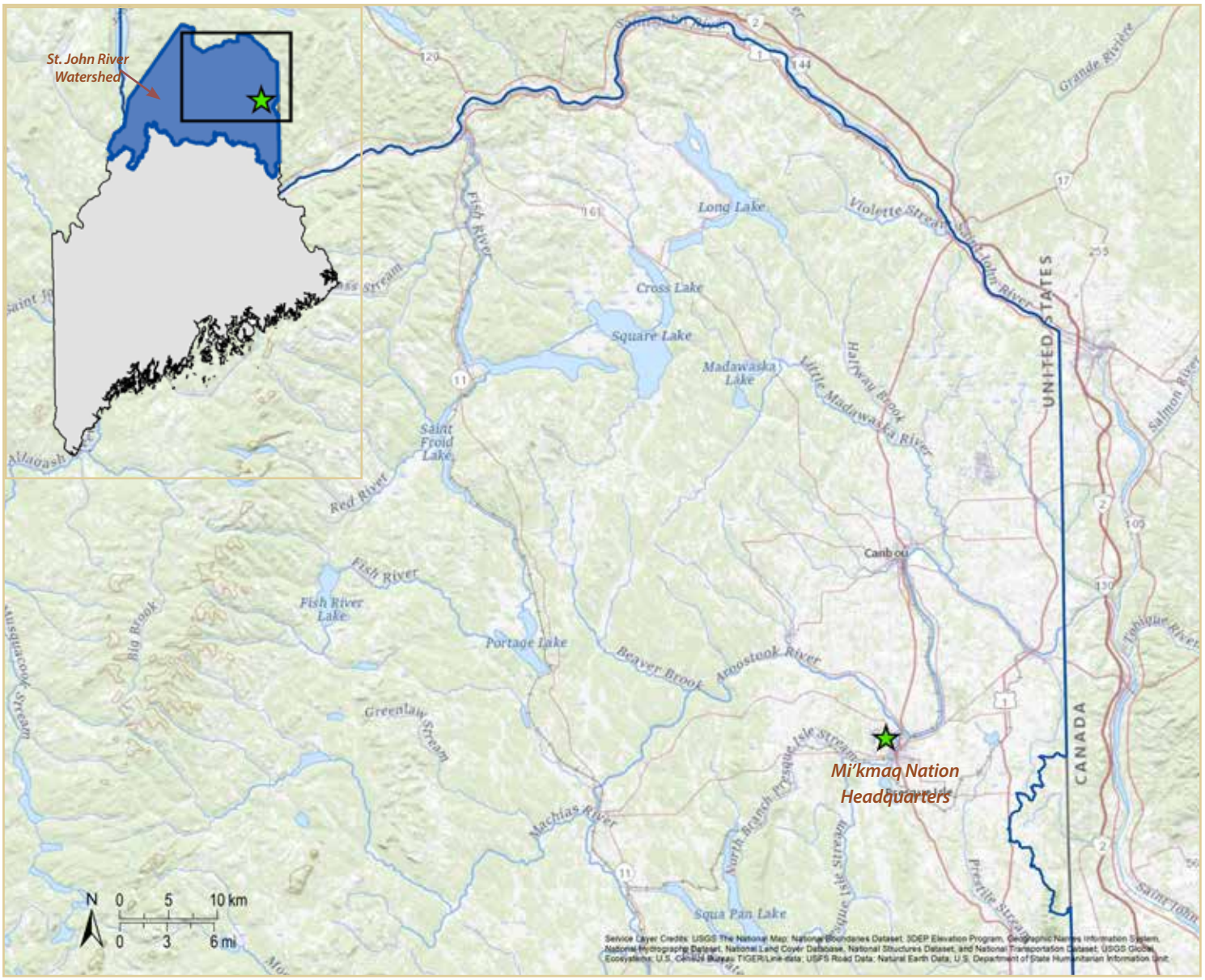

Figure 1. *The Mi'kmaq Nation tribe inhabited lands from the Maritime Provinces down the Atlantic Seaboard of Northeastern North America. The tribe was federally recognized in 1991. Today, the majority of the nearly 1,500 Mi'kmaq Nation members live within Aroostook County in Northern Maine (inset). The tribal headquarters is located in Presque Isle.*

The Fish River Chain of Lakes Region

Despite its known biological richness, the remoteness of this northern Maine region has resulted in its general underrepresentation in many statewide and regional scientific studies.

In 2021, the Mi'kmaq Nation received grant funding to evaluate the exposure of Bald Eagles and Common Loons to mercury and lead, which can threaten both species. No prior efforts have evaluated mercury and lead exposure in loons or eagles in northern Maine. The grant also committed to conducting outreach on the health risks of lead and mercury to wildlife and humans, and to expanding the tribe's capacity through field training and equipment purchases.

The Mi'kmaq Nation partnered with biologists from Biodiversity Research Institute (BRI) to capture and collect samples from Common Loons and Bald Eagles in the Fish River Chain of Lakes region to evaluate their exposure to mercury and lead.

This science publication outlines the sources of these heavy metals, the risks they pose to wildlife and humans, and the actions we can all take to do something about it.

Monitoring Mercury for Human, Wildlife,

Mercury in the Environment

Mercury pollution is a local, regional, and global problem that adversely affects ecosystems worldwide—including the northernmost regions of Maine.

Mercury can be emitted from natural sources such as volcanoes and released by natural processes such as wildfires. However, globally, more than two-thirds of the mercury currently released into the environment originates, either directly or indirectly, from human activities. Since the onset of the Industrial Revolution, mercury has been released into the air and into waterways from activities such as fossil fuel combustion, waste incineration, metal smelting, chlorine production, and discharges in wastewater and other sources.

Mercury released into the atmosphere can circle the globe before being deposited onto our forests, lakes, and streams. As a result, mercury is prevalent in some of the most remote and seemingly pristine ecosystems in the world. In North America, west to east prevailing wind patterns generally result in greater mercury pollution in northeastern North America.

Sources of Mercury

Once mercury enters an ecosystem, it can be transformed by bacteria into methylmercury, a toxic substance that readily accumulates in organisms throughout the food web. Mercury concentrations tend to be higher in consumers relative to their prey (a process called biomagnification), which puts organisms at the top of food webs—such as Bald Eagles, Common Loons, and humans—at highest risk of accumulating toxic levels of mercury in their bodies over time.

Numerous site-specific factors, such as water chemistry, shoreline composition, wetland acreage, and others, affect the degree to which individual lakes or habitats facilitate the production of mercury. As a result, fish from neighboring lakes with similar mercury inputs can have very different mercury levels.

Mercury pollution carried on winds and deposited across North America can affect environments that seem to be isolated from source points.

Mercury Risks to Human Health

In the United States, people are primarily exposed to mercury through the consumption of contaminated fish. Mercury is a potent neurotoxin and the human health issues related to exposure are well documented. Mercury can impair the nervous system, cardiovascular system, kidneys, lungs, liver, and immune system. Anyone (children and adults alike) who frequently eats fish high in mercury is especially at risk.

Since the age and dietary habits of fish affect their exposure to mercury, some species pose higher health risks than others to human consumers. Fish at the top of the food web (e.g., pike, pickerel) typically have higher levels of mercury in their tissues than fish that feed at the bottom of the food web (e.g., brook trout, river herring, white sucker; Figure 3). Additionally, since mercury accumulates in individuals over time, older (and larger) fish often have higher mercury loads than younger (smaller) fish.

Different tissues can answer different questions: Blood provides a way to understand the exposure to contaminants in the short-term (i.e., days or weeks), while adult feathers reflect long-term body burdens of mercury. Analysis of eggs provides perspectives on both short- and long-term exposure in adult females.

Following federal guidelines shown in Table 1, people can continue to take advantage of the health benefits associated with fish consumption while also limiting the potential for adverse health effects associated with mercury exposure. This is particularly important in native communities where fishing is part of a deep cultural tradition.

Mercury Impacts on Wildlife Health

Mercury pollution has been documented to negatively affect some of the most iconic birds in northeastern North America, including Common Loons and Bald Eagles. These species are well-established bioindicators to monitor environmental mercury patterns and effects.

Independent studies found that Common Loons exposed to high levels of mercury produce fewer fledged young than those with low mercury exposure. Similarly, negative correlations between mercury exposure and reproductive success (productivity) have been documented in Maine's lake-dwelling Bald Eagle population. These findings are consistent with expectations based on other studies and geographic patterns indicating mercury exposure is particularly high in northeastern North America.

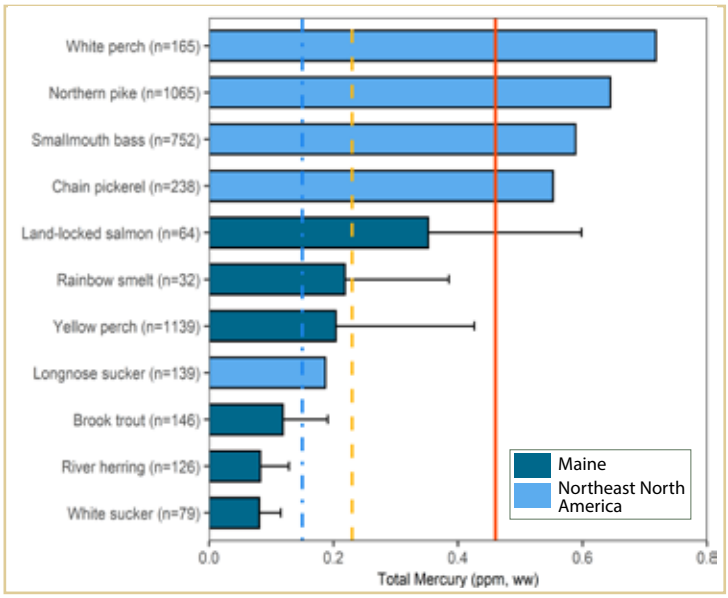

Figure 3. *Mean total mercury (Hg) concentrations in fish muscle. Error bars for Maine (dark blue) represent standard deviations (source: BRI database). For fish species with inadequate sample sizes in Maine, means reflecting those reported for northeastern North America were used (Kamman et al. 2005; light blue bars).*

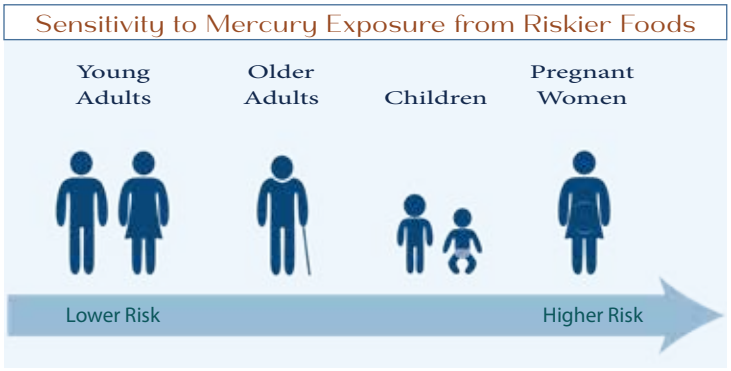

Figure 2. *Some age groups of people are more sensitive to mercury exposure via their diet than others. Pregnant women and children are particularly vulnerable to the adverse effects of mercury.*

Mercury contamination in fish harms the fish as well as the wildlife and people that consume it. Some fish, such as brook trout (above), are typically relatively low in mercury; others, such as pike and white perch, can have high concentrations of mercury.

Looking Ahead

Recent evidence suggests that climate-related factors influence patterns of mercury exposure in aquatic and terrestrial biota. Increasing temperature and rainfall, combined with shifting habitat distributions, will shape future mercury deposition and methylation, and in turn, exposure risk. Understanding how these large-scale factors will play out on smaller spatial and temporal scales will require continued research and monitoring.

Table 1. *Fish consumption guidelines (based on USEPA 2019 guidelines).*

FDA/US EPA Consumption Guidelines:		
Total Mercury (ppm/ww)	Colored Line	Recommended Fish Meals
0.15		2 per week
0.23		1 per week
0.46		none

How You Can Help

- Learn which species of fish are safest to eat and spread the word that most fish and shellfish are healthy food choices.
- Reduce the use of products containing mercury and dispose of them appropriately; see fact sheets at www.newmoa.org/
- Support state and federal policy actions supporting pollution regulation

Lead and the Environment: A Lethal Mix

Loons and Eagles as Bioindicators

Lead is a naturally occurring high-density metal that is extracted from ores and refined into a soft, malleable material. Due to its unique physical properties, lead has been incorporated into a wide variety of common household and industrial products including gasoline, electronics, plumbing hardware, cosmetics, and paint.

While we have known that lead exposure poses significant risks to human and ecological health for decades, lead remains pervasive in many products and our environment. When ingested in even small quantities, lead can cause a wide variety of neurological and physiological problems, particularly if exposure occurs during development.

Common Loons and Bald Eagles, two of the most well-established bird bioindicators, can be significantly impacted by lead; however, their exposure pathways are notably different. These species demonstrate two primary paths in which lead impacts wildlife. These pathways are also relevant when evaluating several avenues of potential exposure in humans.

Lead Exposure to Common Loons

A leading cause of mortality in loons is lead toxicosis; lead poisoning was responsible for nearly half of the documented mortalities of adult loons in New Hampshire between 1989-2012—a loss estimated to reduce the statewide loon population by 43 percent during that period.

Common Loons and other waterbirds are exposed to lead when they swallow lead fishing weights (e.g., split shot, sinkers, jigs). The lead sinkers come from two different sources: 1) the lake bottom where loons mistakenly pick up lost lead sinkers to aid in mechanical grinding of food in their gizzards; and 2) prey fish that have either swallowed or are trailing fishing line and lead tackle (Figure 4).

Once ingested, lead causes lethargy and erratic behavior such as staggering and gasping. Eventually the individual loses the ability to eat and becomes incapacitated on shore, where they are highly vulnerable to other threats. Waterbirds often die within two to three weeks after swallowing the lead jig or sinker. Even a small piece of lead is fatal.

Figure 5. *An X-ray of a loon that had ingested a lead fishing jig.*

Source: Tufts University

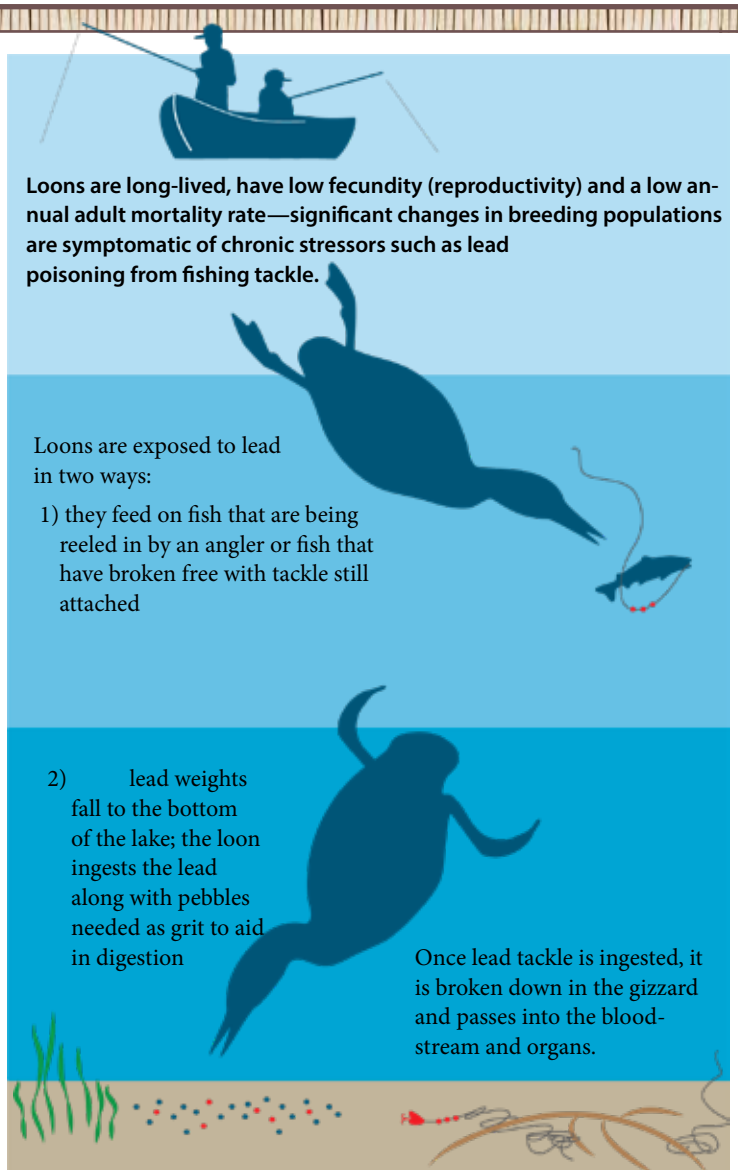

Figure 4. *How loons are exposed to lead.*

How You Can Help

- Use nonlead lead sinkers and jigs; trade in or dispose of your lead tackle at collection/disposal sites.
- Host a tackle exchange/buyback program (grants may be available for fishing retailers).
- Host a lead exchange at a boat ramp, lake association meeting, or community event.
- Install and maintain a lead tackle collection site at your local lake.
- Post/distribute informational materials on lead and loons at lakes (see back page for resources).
- Include an educational presentation on lead poisoning at your local event.
- Understand laws regulating lead (see back page).
- Support passage of tribal, federal, state, local laws restricting the sale and use of lead fishing gear.

Primary Source: fishleadfree.org

Figure 6. *Bald Eagles and other scavengers are commonly exposed to lead when they feed upon carcass remnants shot with lead ammunition. Lead fragments also pose health risks to hunters consuming game meat.*

Lead Exposure in Bald Eagles

When a lead bullet strikes a game animal, as much as one-third or more of the bullet can fragment into hundreds of tiny pieces. Studies show that these fragments can become lodged in tissue up to 14 inches from the point of entry.

Scavenging wildlife such as Bald Eagles are exposed to lead through the consumption of the lead bullet fragments remaining in animal carcasses or gutpiles left behind by hunters. Some lead fragments are not visible to the naked eye, but they are easily detected in X-rays (Figure 7).

Lead poisoning induces neurological and motor impairments that typically progress to death in a matter of days. A lead fragment smaller than a grain of rice is enough to kill an eagle.

Two independent studies recently linked lead exposure to slowed population recovery in Bald Eagle populations at both regional and national scales. The population-level consequences of lead poisoning have been notably more dire in species such as the California Condor, which experienced catastrophic declines and near extinction in large part due to lead poisoning.

Lead Exposure in Humans

Lead ammunition also poses potential health risks to people who consume wild game meat. Studies have found lead fragments in game meat packages after processing, which highlights the potential for hunters and their families to consume lead. While relatively rare, anglers are occasionally exposed to lead via accidental consumption of lead fishing weights. Such cases are most common in young children.

Once absorbed in the digestive tract, lead damages organs, interferes with bodily functions, and enters bone tissue for potential remobilization years later. There is no safe level of lead in humans.

Nonlead bullets are extremely effective

Bullets made from 100% copper were initially developed in the mid-1980s as a premium option for big-game hunting. Their design resulted in extremely consistent and rapid expansion combined with excellent weight retention and associated deep penetration. In addition, they gained a reputation as being very accurate.

Source: Hunting with Nonlead

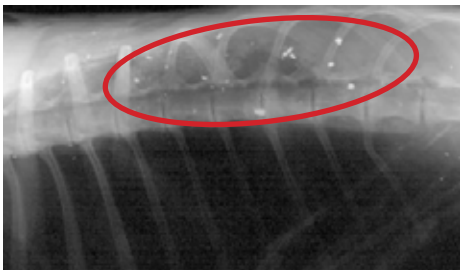

Figure 7. *X-ray shows the presence of lead bullet fragments in deer backstrap.*

Source: Hunting with Nonlead

How You Can Help

- Make the permanent switch to nonlead ammunition when hunting.
- Spread the word about the risks of lead ammunition use to wildlife (eagles, vultures and other scavengers) and people consuming game meat (especially children).
- Teach younger generations about the value of hunting as a conservation tool, and the role that nonlead ammo plays in successful wildlife management with hunting.
- Support local and online vendors in Maine that sell nonlead ammunition (see back page for resources).

Resources

General Information

For general information and resources about **lead (Pb)** risks to human health, please visit:

- Centers for Disease Control and Prevention (background): www.cdc.gov
- U.S. Environmental Protection Agency—Tribal Lead Curriculum: www.epa.gov/lead/tribal-lead-curriculum
- American Academy of Pediatrics—Lead Exposure: www.aap.org/en/patient-care/lead-exposure/

For general information and resources about **mercury (Hg)** risks to human health, please visit:

- Maine Department of Environmental Protection: https://www.maine.gov/dep/mercury/
- Maine Bureau of Health Fish Consumption Advisory: www.maine.gov/dhhs/mecdc/environmental-health/eohp/fish/documents/meffguide.pdf
- U.S. Environmental Protection Agency: www.epa.gov/mercury
- EPA-FDA consumption guidelines: www.epa.gov/fish-tech/epa-fda-advice-about-eating-fish-and-shellfish
- Biodiversity Research Institute: www.briwildlife.org/hgcenter/

Lead-free Hunting

- Maine Department of Inland Fisheries and Wildlife: www.maine.gov/ifw/hunting-trapping/nonlead-ammunition.html
- The North American Non-lead Partnership—The Peregrine Fund provides information to hunters about safer choices of ammunition: www.peregrinefund.org/projects/north-american-non-lead-partnership
- Hunting with Non-lead, an organization dedicated to providing accurate information and resources to hunters and wildlife managers: https://huntingwithnonlead.org
- Hunters for Eagle Conservation: https://huntersforeagleconservation.org
- Sporting Lead Free is a nonprofit whose mission is to encourage the use of lead-free ammunition: sportingleadfree.org/hook

Lead-free Fishing

- Fish Lead Free Initiative helps anglers switch to lead-free tackle. You can find information about your state laws, tips for using lead-free tackle, where to buy lead-free tackle locally, and where to dispose of lead properly. Visit: fishleadfree.org
- Sporting Lead Free is a nonprofit whose mission is to encourage the use of lead-free tackle and promote the conservation ethics of our sporting communities: https://sportingleadfree.org/hook
- Maine Audubon provides lead-free products and lead-tackle recycling assistance for anglers and builds awareness of Maine's current lead tackle laws: https://maineaudubon.org/projects/loons/fish-lead-free/
- Loon Preservation Committee—Lead poisoning is considered responsible for a 41% reduction in New Hampshire's loon population (1989 - 2012). LPC has been at the forefront of this issue for decades; see information and resources at: www.loon.org

For more information, see the online version of this publication at: www.briwildlife.org/mikmaq

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References

To find a bibliography of references related to this publication, and the technical report summarizing the findings of this study, please visit:

briwildlife.org/mercury-and-lead-exposure/

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