



Mercury Contamination in Bald Eagles

Mercury is a natural but very rare part of the Earth's crust. It is used in equipment such as thermometers, float valves, and fluorescent lighting, and as part of an amalgam used to fill cavities in teeth.

Mercury is released into the atmosphere from both natural sources such as volcanoes and forest fires, and human ones. Combustion in coal-fired power plants accounts for an estimated 40% of human-caused mercury emissions in the U.S. Once in the atmosphere, mercury is carried on polluted air and deposited onto land and water through rain, snow, and dust (*Figure 1*). It eventually migrates to wetlands, lakes, and rivers where it is transformed (methylated) by bacteria into the highly toxic *methylmercury*. Once formed, methylmercury becomes more concentrated as it passes through each level of the aquatic food web, a process known as *biomagnification*. So when we talk about mercury contamination in wildlife, we are talking specifically about the toxic form called methylmercury.

Mercury levels in plants and animals have been declining since about 1970 due, in part, to regulations on manufacturing and municipal and medical

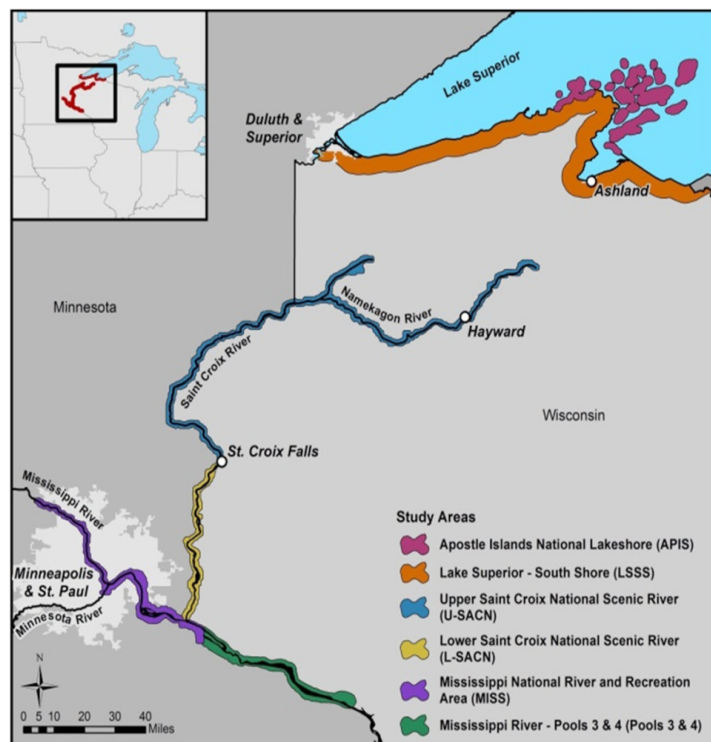


Figure 2. Bald eagle nestlings were sampled for mercury and other contaminants at six study sites: Apostle Islands National Lakeshore (APIS), the south shore of Lake Superior in Wisconsin (LSSS), the upper and lower St. Croix River (U-SACN and L-SACN, divided at St. Croix Falls, Wisconsin; U-SACN includes the Namekagon River), the Mississippi National River and Recreation Area (MISS), and Pools 3 and 4 of the Mississippi River below the MISS boundary (Pools 3 & 4).

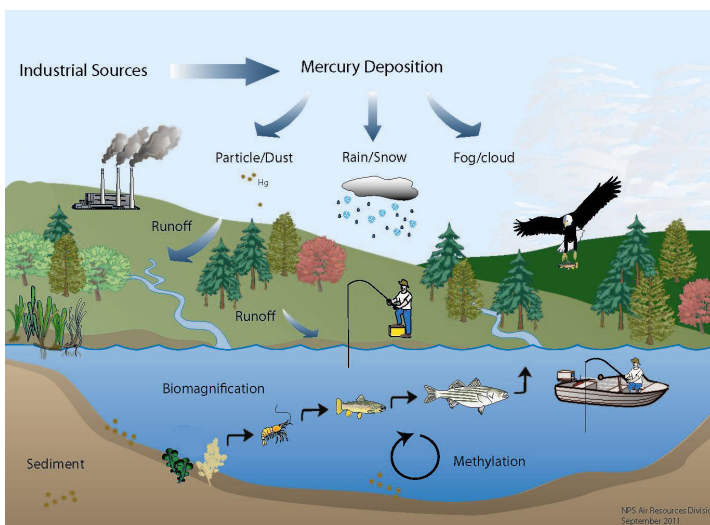


Figure 1. Mercury (Hg) enters the atmosphere, is deposited on land and water, then is transformed (methylated) by certain bacteria into toxic methylmercury (MeHg). MeHg becomes more concentrated (biomagnifies) as it moves to each higher level of the food web. GRAPHIC BY NPS AIR RESOURCES DIVISION, September 2011.

incinerators. However, recent studies indicate mercury levels remain elevated in many water bodies of the upper Midwest, making it a continuing concern for human and wildlife health.

Eagles As Indicators

Bald eagles have served as biosentinels for chemical contamination since the 1970s. As a top predator in aquatic ecosystems, bald eagles accumulate environmental contaminants from their prey. Nestling eagles are fed prey items caught in a definable local area. Eaglet blood tells us about acute contamination that is happening right now. As nestlings grow, the contaminants move from the blood into the feathers, where it builds up and can cause health and reproductive problems.

From 2006 through 2015, the National Park Service Great Lakes Inventory and Monitoring Network monitored mercury and other environmental contaminants in bald eagle nestlings in and near three national parks in the upper Midwest (see Figure 2). We also worked with the Wisconsin Department of Natural Resources to examine mercury trends in nestlings over a longer time period (1991–2015) using data they collected at two Lake Superior sites.

Status and Trends

From 2006 through 2015 maximum concentrations of mercury in nestling breast feathers were highest in the upper St. Croix and Namekagon river basins (Figure 3). This distribution pattern is indicative of more efficient methylation in the low-pH (acidic) waters found in the abundant wetlands, and in the watersheds of some tributaries that drain to Lake Superior along its south shore (i.e., LSSS). This spatial pattern is also evident by examining mercury levels over time (Figure 4).

Analyses also showed no observable trend in mercury concentrations at the APIS and U-SACN study areas over the 2006–2015 time period, and weak evidence of increase at the MISS and

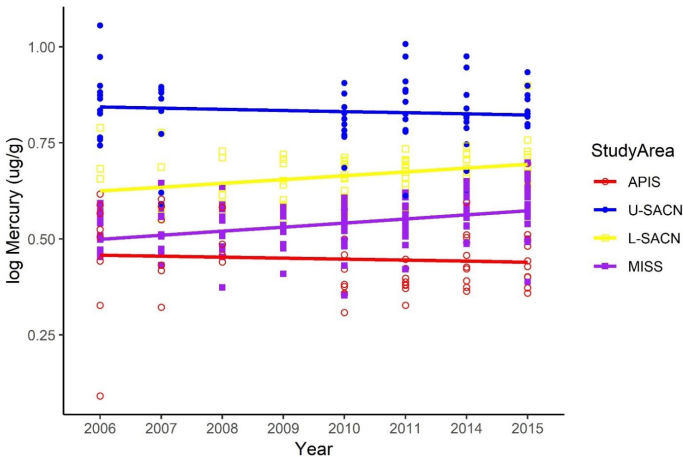


Figure 4. Mercury concentrations in micrograms per gram (µg/g) in feathers of bald eagle nestlings in four study areas, 2006–2015. APIS=Apostle Islands, U-SACN=upper Saint Croix Riverway, L-SACN=lower Saint Croix Riverway, and MISS=Mississippi National River and Recreation Area. (LSSS and Pools 3 & 4 were omitted due to low sampling frequency during this period.) Lines indicate the estimated trends.

L-SACN study areas. However, when we included data collected by the Wisconsin DNR beginning in 1991, we found that mercury concentrations in breast feathers of Lake Superior nestlings (APIS and LSSS study areas) declined by an average of 1.6% per year between 1991 and 2015 (Figure 5). This highlights the importance of what time frame is used when assessing long-term trends.

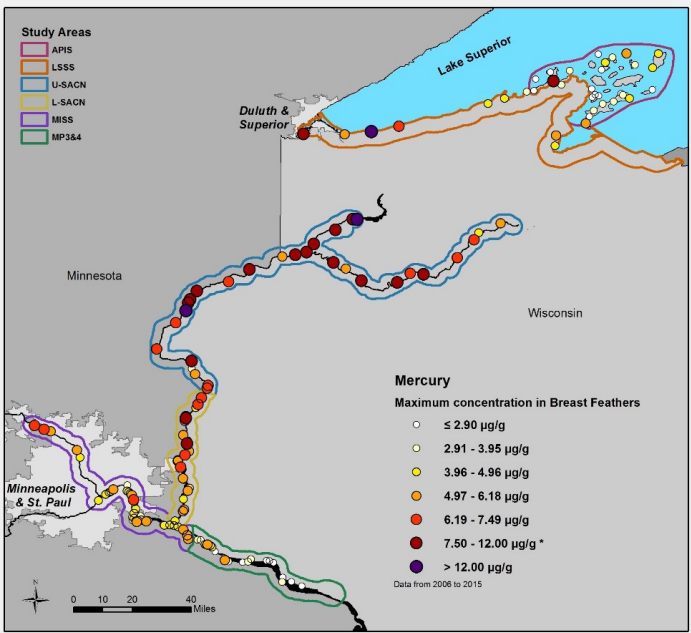


Figure 3. Maximum concentrations of mercury found in breast feathers of bald eagle nestlings across six study areas, 2006–2011, 2014, 2015. Each colored dot represents a monitored territory and the color and size bins show the maximum concentration of the chemical found in each territory over the period of study. The asterisk (*) for maximum concentration denotes a threshold value above which neurologic damage may occur.

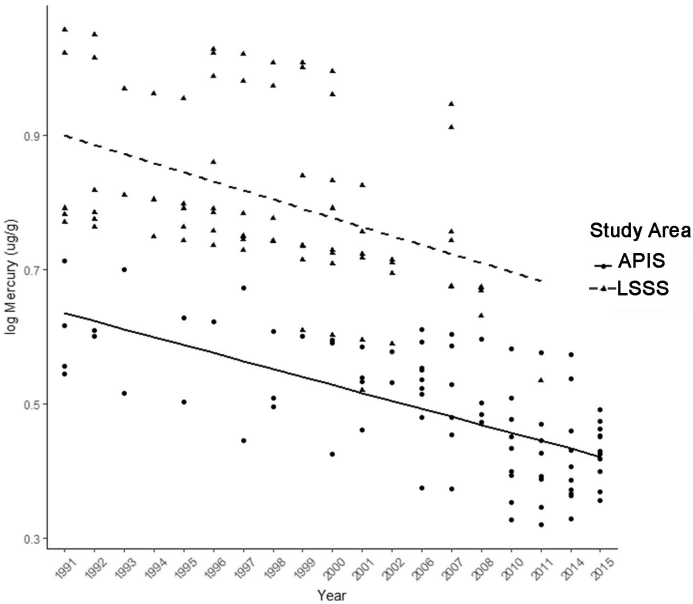


Figure 5. Mercury concentrations in micrograms per gram (µg/g) in feathers of eagle nestlings on Lake Superior in Wisconsin, 1991–2015. APIS=Apostle Islands, LSSS=Lake Superior South Shore. LSSS had higher concentrations. Estimated trends indicate a 1.6% decline in mercury concentration per year in both study areas.

Management Implications

Mercury is the most pervasive contaminant in the upper Midwest, and increasing levels in some of our study areas and the potential for population-level effects suggest that it is important to continue monitoring contaminants in the national parks. But we do not have to use eagle nestlings.

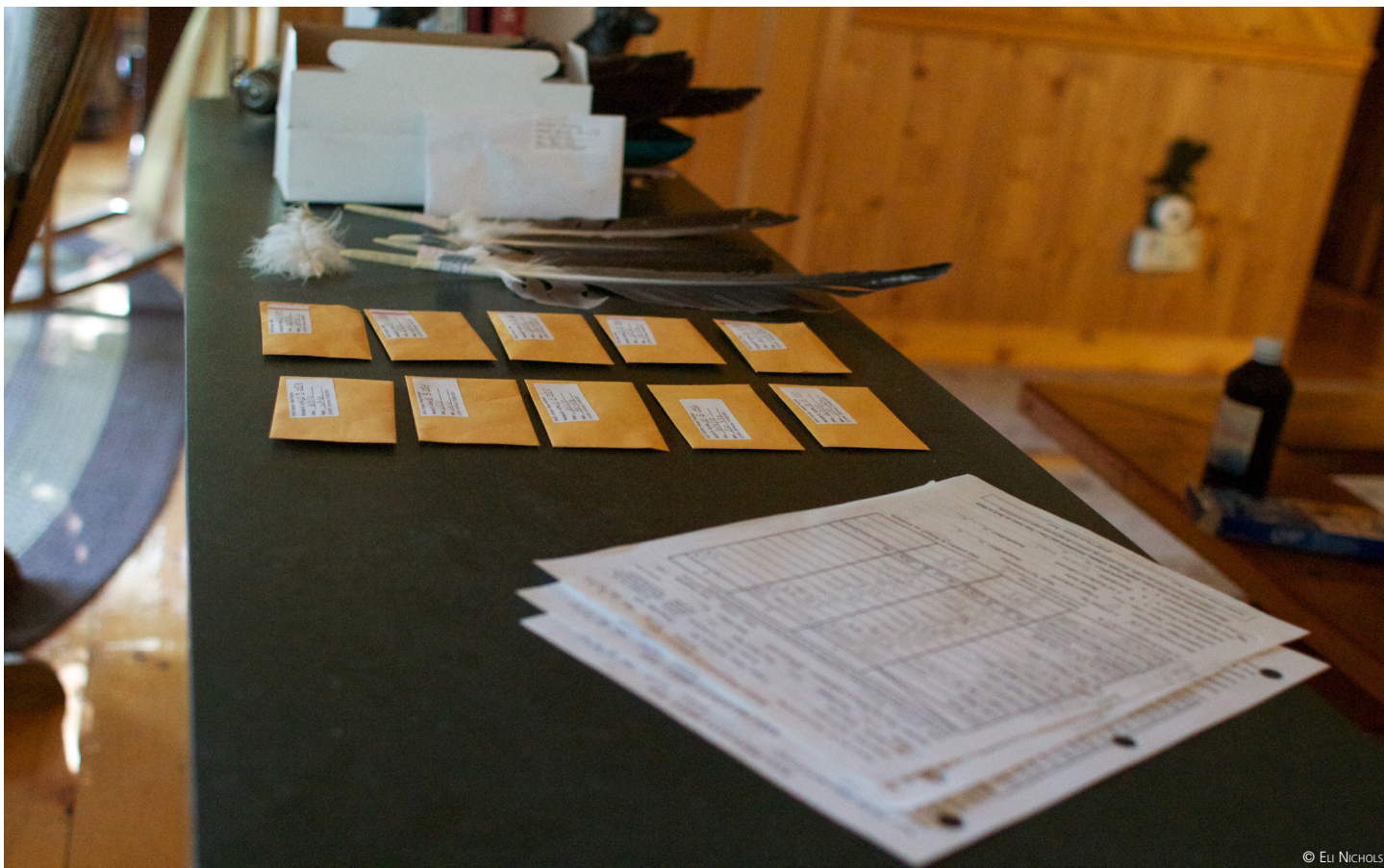
When we began monitoring contaminants in 2006, we sampled eagle nestlings at three parks while our partners from the University of Wisconsin–La Crosse collected and analyzed fish and dragonfly larvae at the other six parks. When they compared the data, our university partners found that mercury concentrations in larval dragonflies were correlated with those in fish, the only difference being in the level of biomagnification that occurred in that one step up the food web. So in 2015, we shifted the focus of our long-term contaminants monitoring

to use only dragonfly larvae and fish in tracking the presence and effects of mercury in the Great Lakes Network parks. This change coincided with the start of a NPS-wide Dragonfly Monitoring Program (DMP) coordinated by the NPS Air Resources Division.

This change in focus is more time- and cost-effective; provides the same level of reliable information as sampling from eagle nestlings; allows us to sample fishless water bodies such as wetlands, which can be important sites of methylmercury production; and allows us to make comparisons across the nine network parks using the same level of the food web. Further, the relative simplicity of sampling dragonfly larvae presents an exciting opportunity to involve citizen scientists in monitoring the health of the Great Lakes Network national parks.



Two to three breast feathers are collected from each eagle nestling and analyzed for contaminant levels. Contaminants move from the blood into the feathers as the bird ages. The blue color in this bird's wings is blood in the new feather shafts. NPS PHOTO.



© ELI NICHOLS

Information in this resource brief is based on data collected by the National Park Service Great Lakes Inventory and Monitoring Network as part of its long-term contaminants monitoring program. The full report is available online:

Dykstra, C.R., W.T. Route, K. Williams, R.L. Key, and M. Meyer. 2019. Trends and patterns of PCB, DDE, and mercury contamination in bald eagle nestlings in the upper Midwest. *Journal of Great Lakes Research* 45(2): 252–262. <https://doi.org/10.1016/j.jglr.2019.01.010>.

