



PFAS: Of Guitar Strings and Bald Eagles

The group of chemicals known as PFAS—perfluoroalkyl and polyfluoroalkyl substances—have the unique property of repelling both water and oil, making them useful in nonstick cookware, stain and water repellent clothing, firefighting foams, and pesticides, among other things.

The news is filled with stories of PFAS chemicals in drinking water, food packaging, cosmetics, and even cellphones and guitar strings. There is even speculation that the presence of PFAS chemicals in humans could hinder the effectiveness of the COVID-19 vaccine.

Three PFAS chemicals currently receiving a great deal of attention from scientists and regulators are:

- **Perfluorooctane sulfonate (PFOS)**, used to treat fabrics for stain and water repellency;
- **Perfluorooctanoic acid (PFOA)**, used in making non-stick surfaces for cookware and paper products; and
- **Perfluorononanoic acid (PFNA)**, used as a surfactant for specialty plastic products.

All of these are highly persistent chemicals (i.e., they breakdown slowly; PFOA is estimated to have a half-life of 92 years in the atmosphere). They are also widespread in their use, and there is growing evidence they are toxic to humans and wildlife because they accumulate in greater concentrations as they move up the food chain.

The National Park Service conducts long-term monitoring of contaminants in wildlife. From 2006 through 2015, we measured concentrations and assessed trends of 15 perfluoroalkyl substances in the blood plasma of bald eagle (*Haliaeetus leucocephalus*) nestlings at six study areas in or adjacent to Apostle Islands National Lakeshore (APIS), Mississippi National River and Recreation Area (MISS), and the St. Croix National Scenic Riverway (SACN) (Figure 1). Using archived samples collected by the Wisconsin Department of Natural Resources at the two Lake Superior study areas, we were able to assess even



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longer-term trends going back to 1995.

We evaluated the potential risk by comparing levels of PFOS in nestlings to toxicity risk information contained in ToxCast, a U.S. Environmental Protection Agency database that generates data and predictive models on thousands of chemicals of interest to the EPA.

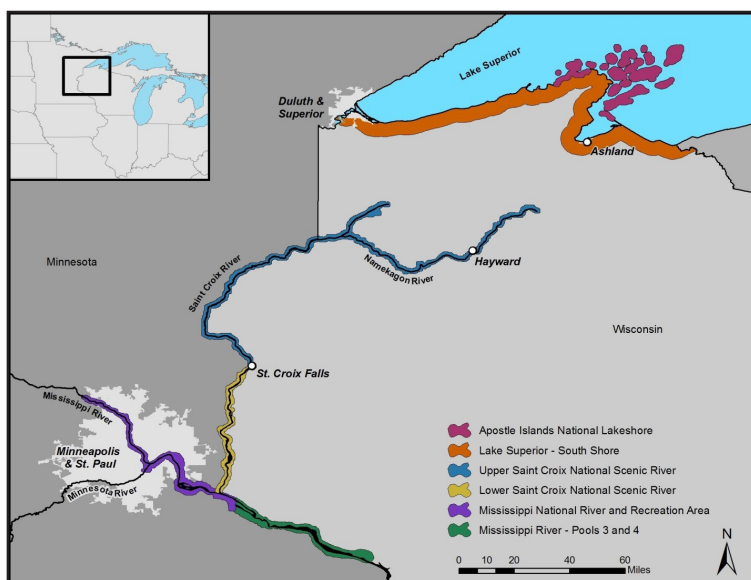


Figure 1. The six study areas in Wisconsin and Minnesota where bald eagle nestlings were monitored for PFAS and other contaminants.

What We Found

Bald eagle nestlings at all sites had detectable levels of at least one—and often more than one—PFAS. Combining all PFAS concentrations in nestlings by park, the highest levels were found in and near industrialized river sites (Pools 3&4 on the Mississippi River, and the Lower St. Croix River); lower concentrations were found at the Lake Superior and remote upper St. Croix River study areas (*Figure 2, top panel*).

PFOS was by far the most commonly detected PFAS chemical. PFOS concentrations strongly influenced the total levels of PFAS in eagle nestlings across all the study areas, including the industrial river sites. High levels of PFOS in the industrialized river sites were not surprising (*Figure 2, bottom panel*), as this is where 3M manufactured and disposed of PFAS chemicals, and where other sources of PFOS, such as the effluent of wastewater treatment plants, play a larger role. The decline in PFOS in eagle nestlings on the lower St. Croix and Mississippi Rivers coincided with the removal of PFOS from the market by the 3M Corporation in about 2002.

Eagle nestlings along Lake Superior had moderately high levels of combined total PFAS despite the relative remoteness of those areas, and concentrations did not decrease over time. These patterns likely reflect environmental conditions on Lake Superior and the ecology of the eagles there. In particular, Lake Superior's average 191-year turnover time (the amount of time it takes to replace every drop of water) allows for significant accumulation of persistent compounds within the sediments and biota. While PFOS was the most abundant PFAS at APIS and LSSS, others, including some of the longer-chain compounds, were more important. Concentrations of 7 of the 12 PFAS chemicals detected at APIS were higher than at any of the other study areas.

PFOS levels in nearly all nestlings were at concentrations that, according to ToxCast, could affect the genes involved in motor coordination, heart function, behavior, and blood circulation. However, because the toxicity

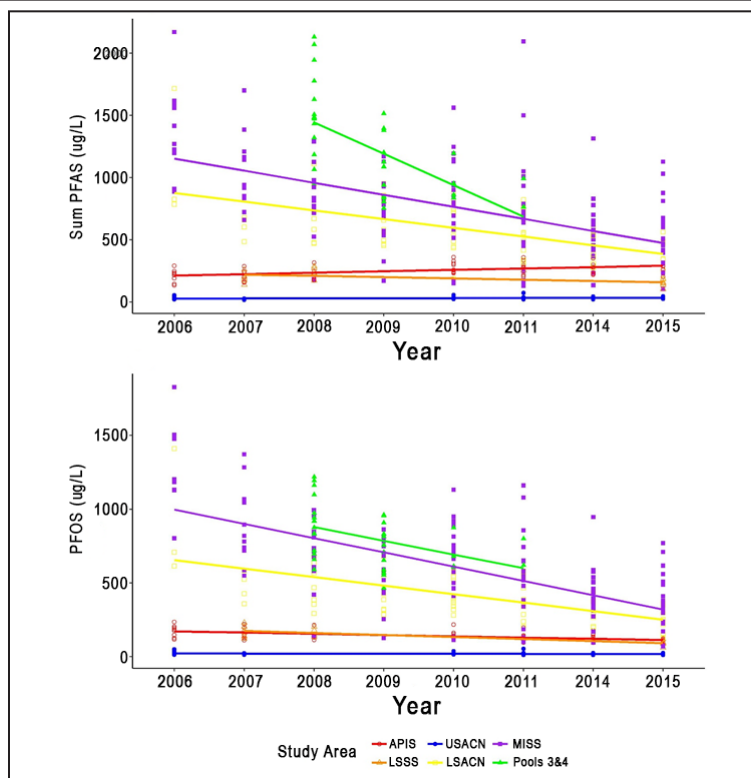


Figure 2. Combined total of all PFAS concentrations (SumPFAS) (*top*) and PFOS concentration only (*bottom*) (micrograms per liter, $\mu\text{g/L}$) in plasma of nestling bald eagles at six study areas in Wisconsin and Minnesota, 2006–2015. Dots show concentrations for each site; lines show trends over time for each site. APIS=Apostle Islands National Lakeshore, USACN=upper reaches of St. Croix National Scenic Riverway, MISS=Mississippi National River and Recreation Area, LSSS=Lake Superior South Shore, LSACN=lower reaches of St. Croix National Scenic Riverway, Pools3&4=Mississippi River site. Note the data gap between 2011 and 2014.

thresholds in ToxCast are based on mammals, it is unclear what these results mean for bald eagles.

Management Implications and Actions

Animal studies have shown that the fetus and infant are sensitive life stages to PFAS exposures. Humans are exposed to PFAS chemicals at all stages of life, including in the womb, during infancy, and during puberty. These human-made chemicals have contaminated some municipal water supplies, and PFOS levels have triggered fish consumption advisories for sections of the Mississippi River. State and federal regulators are using these results to better understand how widely PFAS chemicals have contaminated the Mississippi River ecosystem and to evaluate the contamination trends in fish and wildlife. ●

For More Information

Dykstra, C.R., W.T. Route, and K.A. Williams. 2020. Trends and patterns of perfluoroalkyl substances in blood samples of bald eagle nestlings in Wisconsin and Minnesota, USA. *Environmental Toxicology and Chemistry*. DOI: <https://doi.org/10.1002/etc.4864>.

Elliott S.M., W.T. Route, L.A. DeCicco, D.D. VanderMeulen, S.R. Corsi, and B.R. Blackwell. 2019. Contaminants in bald eagles of the upper Midwestern U.S.: A framework for prioritizing future research based on in-vitro bioassays. *Environmental Pollution*. Available at: <https://irma.nps.gov/DataStore/DownloadFile/609925>.