Emerging Contaminants in Nestling Bald Eagles at Three National Parks in the Upper Midwest

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Introduction and Objectives

The National Park Service, Great Lakes Inventory and Monitoring Network is monitoring the spatial distribution and trends of three new and emerging contaminants:

- PBDE (polybrominated diphenyl ethers, 9 congeners), used as flame retardants.
- PFOS (perfluorooctane sulfonate), used in water, oil, and grease repellent coatings (e.g. Scotchgard™), and
- PFOA (perfluorooctanoic acid), used in firefighting foams and cookware (e.g. Teflon™).

These three chemicals are under scrutiny by scientists and regulators because they are persistent, bioaccumulative, and toxic. All three are known to be endocrine disruptors and may affect thyroid hormones and the immune system, and are potentially carcinogenic. Also being monitored in this program are PCBs, DDT, mercury, and lead.

We are monitoring the occurrence of these chemicals in the serum of bald eagle nestlings at three national parks and adjacent areas. A similar study using fish and larval dragonflies is being undertaken at six other national parks in the upper Midwest.

Study Area

We sampled bald eagle nestlings to monitor environmental contaminants at Apostle Islands National Lakeshore (APIS), the upper and lower St Croix National Scenic Riverway (U-SACN, L-SACN), the Mississippi National River and Recreation Area (MISS), and two areas adjacent to these parks: the Lake Superior south shore (LSSS), and Mississippi River pools 3&4 (Fig. 1).

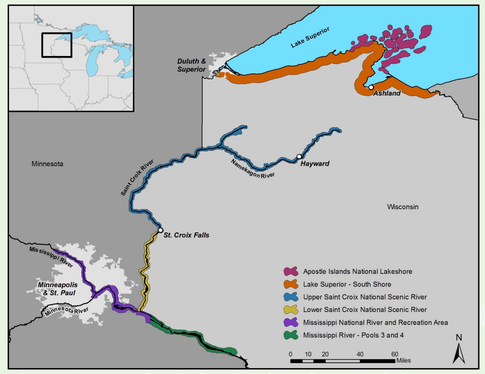

Figure 1. Area map showing location of 6 study areas including 3 national parks where bald eagles are being used to monitor concentrations of persistent environmental contaminants.

Methods

Bald eagle nestlings are hand captured in the nest when they are five to eight weeks old and brought to the ground (Figs. 2 and 3), where blood samples are taken and eaglets are measured, weighed, and banded (Fig. 4). Blood samples are centrifuged and the sera frozen for transport to the Wisconsin State Laboratory of Hygiene. PBDE levels are measured by gas chromatography/electron capture detection; PFOS and PFOA are measured by high performance liquid chromatography/ tandem mass spectrometry.

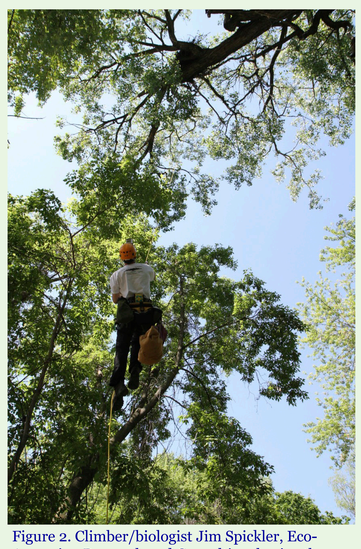

Figure 2. Climber/biologist Jim Spickler, Eco-Ascension Research and Consulting, begins the climb. Photo by Eli Nichols.

Figure 3. Bald eagle nestlings, about 7 to 8 weeks-old, in nest overlooking the St. Croix River. Photo by Jim Spickler.

Figure 4. NPS ecologist Bill Route and collaborator Mark Martell, Audubon Minnesota, draw a blood sample from a 6 to 7 week-old nestling. Photo by Eli Nichols.

Climber/biologist Jim Spickler discusses an eaglets' role in monitoring contaminants.

Results

From 2006 through 2009 we sampled and analyzed serum samples from 154 nestling bald eagles for total PBDEs, PFOS, and PFOA. All 154 samples contained PBDEs, and levels were particularly high in nestlings near Pig's Eye Lake on the Mississippi River in South St. Paul, MN (MISS study area), and near the city of Superior, WI on Lake Superior (LSSS study area; Fig. 5). Nestlings with the highest levels (red or dark-red dots on Fig. 5) were unique in their proximity to large municipal waste disposal sites.

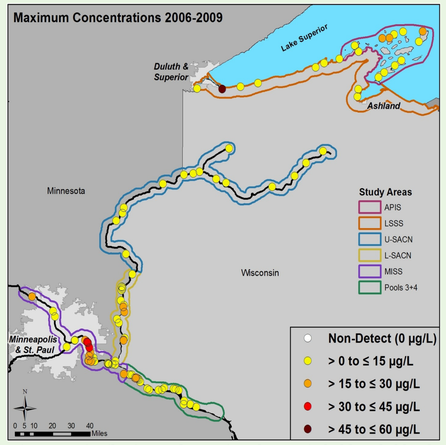

Figure 5. Distribution and quantity of PBDE in bald eagle blood from 6 study areas.

When combined with data from five nestlings sampled in 2001 by the Wisconsin Department of Natural Resources, our results suggest that PBDEs nearly doubled in Lake Superior (APIS and LSSS study areas) between 2001 and 2007, but have since declined in all study areas (Fig. 6). The statistical significance of this pattern will be tested in 2011 when we have six years of data, but the apparent increase and subsequent decline follows global trends in use of the nine PBDE congeners we monitored. These so called 'penta-PBDEs' have been restricted in Europe, Canada, and some states and hence use by industry has declined. In 2010 we began targeting the 'deca-PBDEs', which are largely replacing the penta-PBDEs in industrial use.

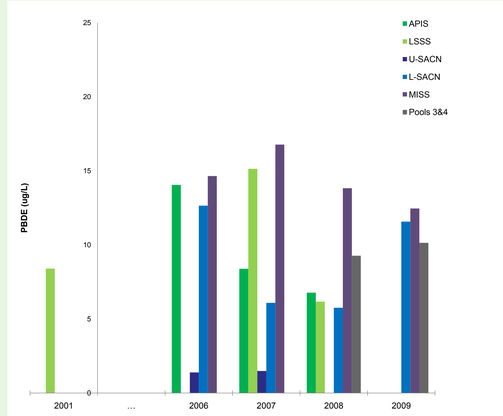

Figure 6. Levels of total PBDEs in bald eagle blood from 6 study areas.

We found PFOS in all nestlings sampled, but PFOA was below our detection limits for some nestlings (white dots: Figs. 7 and 8). PFOS levels were as much as 240 times higher than PFOA, reflecting differences in the source and chemical properties of these two related contaminants. Higher levels of PFOS (red and dark-red dots in Fig. 7) in the L-SACN and MISS study areas can be associated with point-sources in this highly urban and industrialized region. PFOS readily binds to sediments and is known to rapidly bioaccumulate in food webs. By contrast, PFOA was higher in APIS where the large surface area of Lake Superior likely collects this contaminant from regional and global sources. PFOA is more water-soluble, bioaccumulates less, and has a longer half-life in the atmosphere than PFOS. The remote and fast moving waters of the U-SACN had the lowest levels of all three contaminants (Figs. 6, 7, and 8).

Our results show evidence of decline in levels of PFOS and PFOA (P = 0.06 and 0.006 respectively) in bald eagle nestlings across all study areas. This decline is most pronounced for PFOS in nestlings at MISS and L-SACN (Fig. 9).

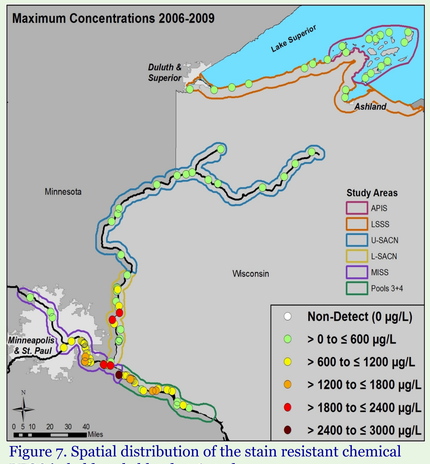

Figure 7. Spatial distribution of the stain resistant chemical PFOS in bald eagle blood at 6 study areas.

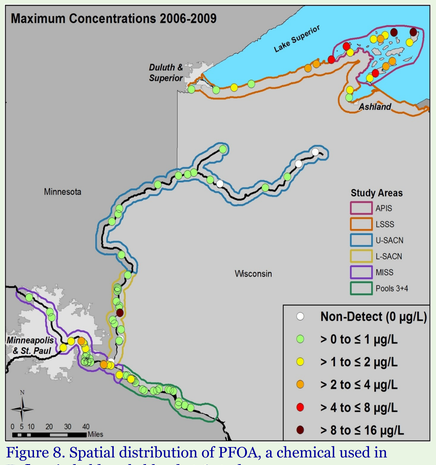

Figure 8. Spatial distribution of PFOA, a chemical used in Teflon, in bald eagle blood at 6 study areas.

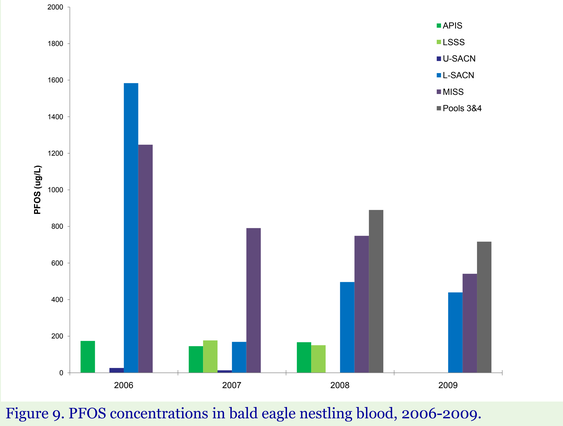

Figure 9. PFOS concentrations in bald eagle nestling blood, 2006-2009.

The declines we observed in PBDEs, PFOS, and PFOA can be linked to reductions in use by industry as a result of scientific scrutiny, regulation, and/or self-imposed reductions. For example, the 3M Corporation and the DuPont Corporation have met or exceeded their goal of zero PFOS release by 2015. Yet these chemicals will continue to enter the environment for many years. Millions of products containing them will slowly break down and there are many tons of buried industrial waste. Municipal and industrial waste sites are not designed to handle these human-created, highly persistent chemicals.

Future efforts

We will continue to sample bald eagle nestlings at APIS, MISS, and SACN through 2011 and on a two-year rotation thereafter. With funding from the Great Lakes Restoration Initiative we have begun assessing a new suite of chemicals. The environmental concentrations of chemicals we currently monitor appear to have declined, but we must be vigilant for new and equally persistent, bioaccumulative, and toxic chemicals that replace them.

Acknowledgments

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Publications

Dykstra, C. R., W. T. Route, M. W. Meyer, and P. W. Rasmussen. 2010. Contaminant concentrations in bald eagles nesting on Lake Superior, the upper Mississippi River, and the St. Croix River. Journal of Great Lakes Research 36:561-569.

Route, B., P. R. Rasmussen, R. Key, M. Meyer, and M. Martell. 2011. Spatial patterns of persistent contaminants in bald eagle nestlings at three national parks in the upper Midwest: 2006-2009. National Park Service, Natural Resource Technical Report NPS/GLKN/NRTR-2011/431. Available on-line at http://science.nature.nps.gov/im/units/GLKN/monitorreportpubs.cfm