Songbirds:

Indicators of Mercury in National Park Ecosystems

A Preliminary Evaluation of Mercury Availability in Yosemite, Grand Teton, and Mount Rainier National Parks

Western songbirds forage over large areas, consuming invertebrates that feed in vast tracts of mountain forest and meadow, rivers and lakes—seemingly pristine habitats that in reality present a hidden risk of mercury contamination.

Mercury is a pollutant that is cause for concern on local, regional, and global scales. While areas of high contamination (known as biological mercury hotspots) may occur near sources of mercury pollution, often they do not. Because mercury released into the atmosphere can circle the world before being deposited, habitats located far from point sources can still be of major concern for wildlife health.

The human health issues related to mercury contamination are well documented—mercury can impair cardiovascular health, IQ, workplace productivity, and motor control. Similarly, mercury negatively affects wildlife populations by altering behavior and hindering reproduction. Previous investigations have emphasized the adverse effects on fish-eating wildlife such as Common Loons, Bald Eagles, and river otters.

The effects of mercury on wildlife and the environment have been relatively well studied in the eastern United States. Prior to this study, however, little to no data have been available regarding mercury in the terrestrial ecosystem, and specifically in songbirds, in the West. This study aims to assess the mercury levels in a variety of insect-eating songbirds throughout three western national parks, and to understand how songbirds can be used as indicators of the health of these ecosystems.

Top, left to right: MacGillivray's Warbler, Hermit Thrush, Oregon Junco, Yellow Warbler, Song Sparrow. At left: Schwabacher Landing, Grand Teton National Park.

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Study Areas: Western National Parks

We selected study sites at three national parks: Mount Rainier and Yosemite, on the west side of Cascade Range and Sierra Nevada respectively, because they receive coastal winds and precipitation; and Grand Teton, on the west side of the Rocky Mountains, because that park lies farther inland and is subject to differing weather patterns and precipitation sources.

Mercury accumulation in these parks is probably due to atmospheric deposition from both local and global sources. Mountain ranges act as precipitation barriers (and perhaps as barriers to mercury deposition).

The level of mercury found in wildlife is dependent on habitat sensitivity (box below). The parks in this study have a high proportion of wetland, riparian, and forested habitats that are known to efficiently methylate mercury (Driscoll et al. 2007). In addition, we chose these sites because climate varies considerably among the parks (Grand Teton is the most arid, Mount Rainier the dampest), and annual precipitation varies considerably with elevation within each park.

In a preliminary analysis of songbird data from five sites, we observed elevated mercury levels in wet and foggy forest habitats like the Pacific Northwest.

Habitat Sensitivity to Mercury

Elemental mercury is converted to a persistent organic form through the process of methylation, which occurs with the help of bacteria found primarily in wet areas. Methlylated mercury can also be deposited through rain and fog.

Large variations in mercury levels exist in wildlife depending on habitat type. In drier habitats, where methylation is minimal, wildlife may be less at risk and relatively protected from mercury toxicity.

Wetlands allow for high rates of methylation, which are reflected in high mercury levels in the organisms that live there.

Mercury contamination is a hidden risk in the seemingly pristine landscapes of our western national parks. Lyell Fork, above, was the highest elevation site we sampled and showed the highest mercury levels of all the sites we sampled in Yosemite.

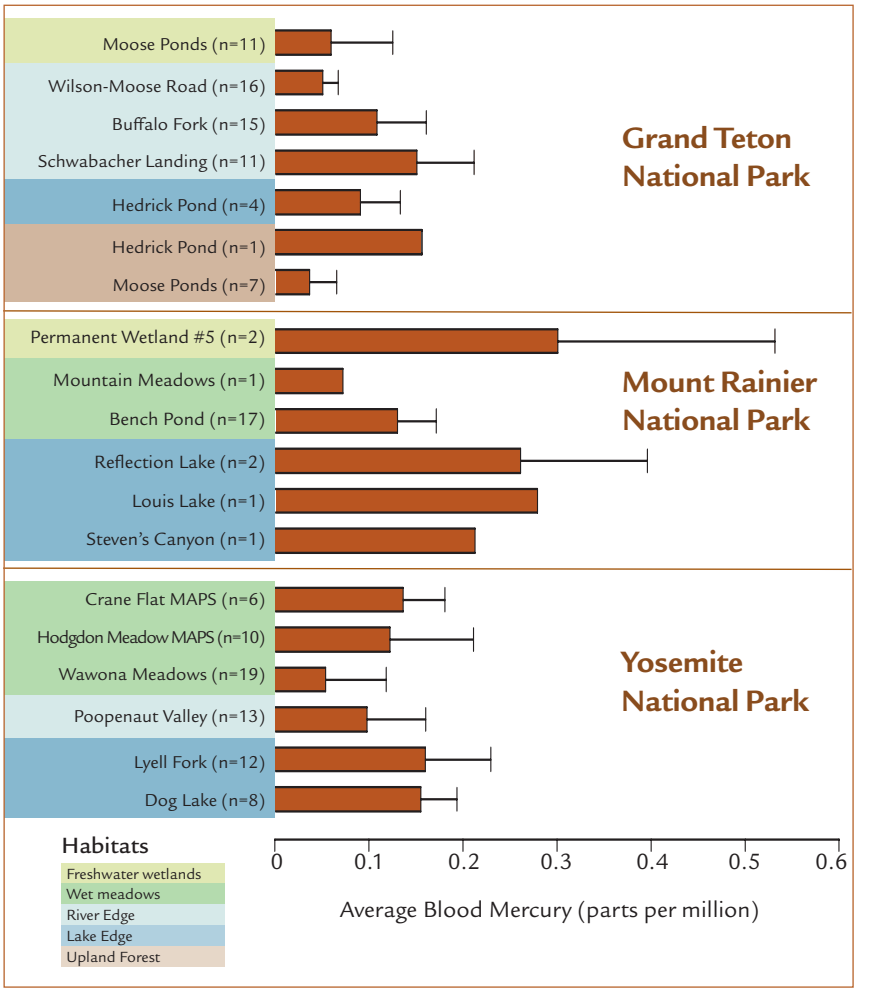


Figure 1. We captured insect-eating songbirds in and around aquatic habitats at three national parks: Grand Teton, Mount Rainier, and Yosemite. This graph shows the average blood mercury levels by habitat type within these parks. While sample sizes are too small to make broad-scale inferences about habitat and mercury availability, Mount Rainier had higher levels of mercury than the other two parks. Error bars represent standard error of the mean.

Songbirds as Sentinel Species

Wildlife vary in their mercury exposure based primarily on what they eat. Most wildlife mercury studies have focused on top-predator fish-eating birds such as loons or eagles. However, emerging science now demonstrates that terrestrial songbirds associated with aquatic habitats can accumulate mercury at concentrations similar to or greater than fish-eating birds (Evers et al. 2005; Cristol et al. 2008; Jackson et al. 2011).

In wetland areas such as bogs or rainy mountain regions with no significant fish populations, songbirds have proven to be ideal indicators of mercury exposure. They eat primarily insects, spiders, snails, and other invertebrates in a wide variety of habitats. We can assess methylmercury risk in these birds over broad spatial and temporal scales with sample sizes that are cost effective and logistically efficient. Moreover, songbirds may be at even greater risk to mercury toxicity because they are potentially more sensitive to the toxicological effects of mercury than species traditionally used for measuring adverse threshold effects (e.g., mallards; Heinz et al. 2009).

Study Findings

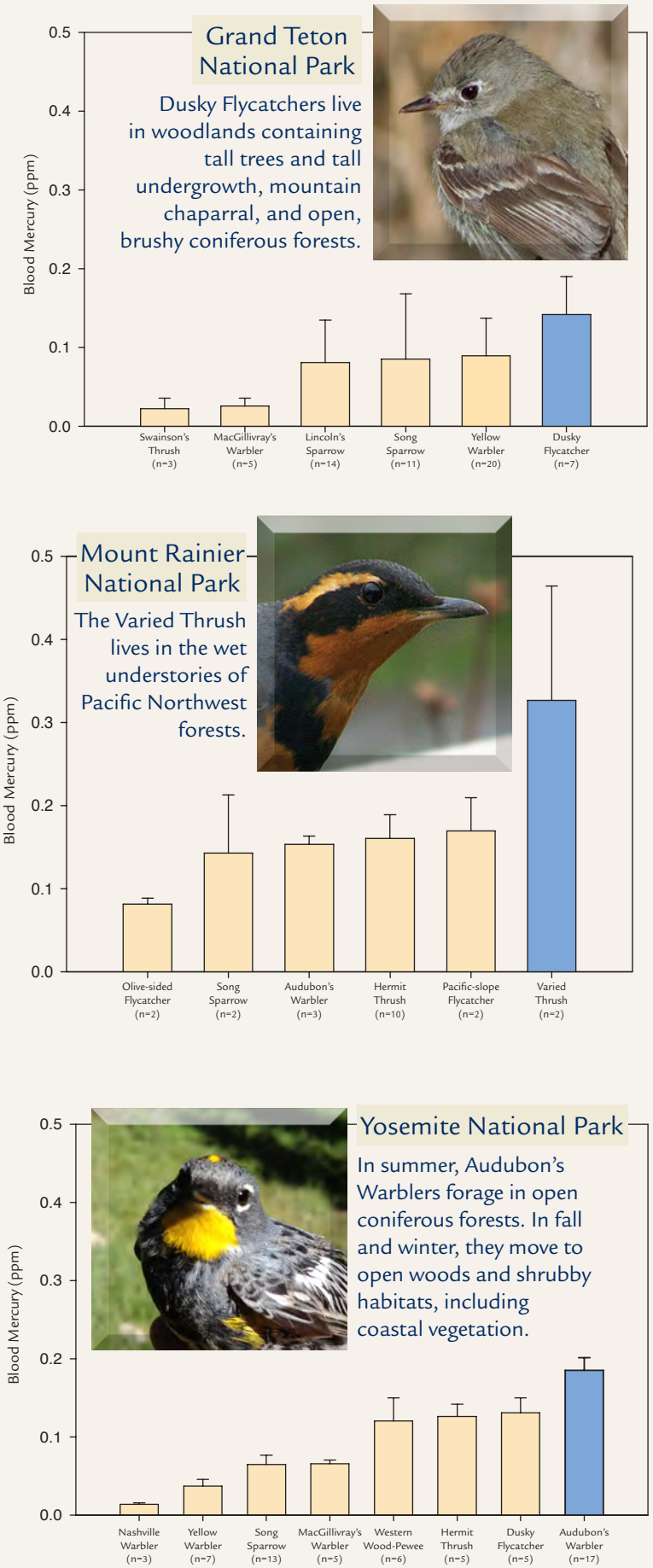
Overall, blood mercury levels were on average lower than currently known effect levels in songbirds (~0.35 parts per million), although some individuals exceeded that threshold. Dusky Flycatcher, Varied Thrush, and Audubon's Warbler showed the highest mercury levels among all species (Figure 2).

All but the Varied Thrush are widely distributed across the western United States and could be used as sentinel species for changes in mercury availability.

When compared to similar species from eastern North America, we find that these data are similar to what we see at nonpoint source sites (Figure 3).

Figure 2. The songbirds at right showed some of the highest mercury levels, represented by the blue bar, of the birds sampled in each park. Error bars represent standard error of the mean.

Mercury Levels in Songbirds



Further Research

The sites in this study represent some of the most pristine landscapes in the United States. Yet, these remote places have seen increases in mercury deposition over the past two centuries (Mast et al. 2010). Mercury in the form of atmospheric pollution travels on winds from as near as the local power plant (point source) or as far as Asia (Seigneur et al. 2004). Further testing on more species in additional parks across the region will help us clarify the sources of this contamination.

Songbird blood mercury is a useful tool for understanding risk of mercury exposure in a variety of terrestrial and aquatic ecosystems (Evers et al. 2012). Remote sites such as those in the western national parks will be important to monitor as domestic and global policies regarding reduction of mercury pollution become enacted. Long-term songbird monitoring on a regional scale can demonstrate the effects of those rulings on our varied landscape.

Management Recommendations

Despite rising global mercury emissions, managers and policymakers can act on a local scale to limit future ecosystem degradation. ***Hidden Risk: Mercury in Terrestrial Systems of the Northeast*** highlights BRI's scientific findings on mercury contamination in songbirds throughout 11 northeastern states. In this publication, we present recommendations for reducing mercury exposure in the environment, such as:

- Improve fire management
- Control reservoir water level fluctuations
- Restrict logging near water bodies

To learn more, visit **www.briloon.org/hiddenrisk.**

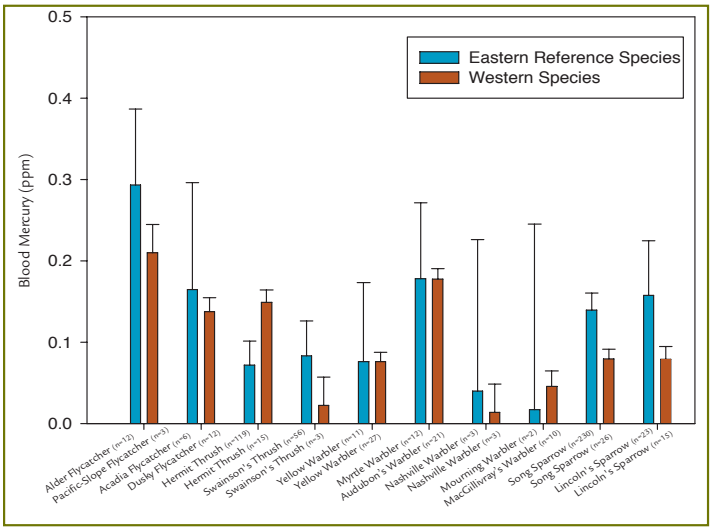


Figure 3. A comparison of western species with their nearest eastern U.S. relative (in some cases, they are the same species).* Taken together, the data suggest that mercury availability in remote habitats could be similar to what we see in the eastern U.S., depending on the habitat. Error bars represent standard error of the mean. *Data source: BRI songbird database—nonpoint source sites.

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Photos: BRI-Allyson Jackson/Evan Adams; Dusky Flycatcher: Flickr Darren P. Clark; Varied Thrush: Flickr comicsailor. **Editing/Production:** Deborah McKew

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