MODULE 2 LAKES

2.1

MERCURY IN BALD EAGLES

Evaluating exposure of Maine's Bald Eagle population to Mercury: assessing impacts on productivity and spatial exposure patterns.

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1.0 Executive Summary

A recent US Fish and Wildlife Service proposal to delist the Bald Eagle (*Haliaeetus leucocephalus*) from the Endangered Species List noted lasting concerns for the potential impacts of contaminants on some populations. Previous and ongoing toxicological assessments highlight specific contaminant concerns for Maine's Bald Eagle population, and warrant consideration in upcoming management decisions.

This report summarizes findings from an ongoing eagle mercury monitoring and impacts study supported by non-profit (BioDiversity Research Institute), state (Maine Dept. of Inland Fisheries and Wildlife, Maine Dept. of Environmental Protection), federal (US Fish and Wildlife Service) and industry (FPL Energy Maine Hydro) organizations. Substantial support for this project was provided by the Maine Department of Environmental Protection.

We collected and analyzed mercury concentrations in Bald Eagle nestling blood, shed adult feathers, and abandoned eggs from freshwater-based Bald Eagle nests in Maine (2001-2006) to (1) evaluate dietary mercury (Hg) exposure, (2) assess if Hg exposure might be negatively impacting eagle productivity in Maine, and (3) evaluate spatial and temporal Hg trends in Maine. The following is a summary of current findings:

- *Nestling eagle Hg exposure:* **Maine Bald Eagle nestlings and adults are exposed to elevated levels of methylmercury via the freshwater foodweb. Eagles in lacustrine habitats are particularly at risk. Blood mercury exposure levels of Maine eaglets is higher than many regional comparisons, and most similar to populations associated with significant point source pollution problems (e.g., Hg mines, dredging).**
  [Fig. 2; p. 14]

- *Adult eagle Hg exposure - feathers:* **Exposure levels in Maine's adult Bald Eagles (as indicated by shed adult feathers) is elevated in comparison to virtually all comparison populations. As found in eaglet blood, mean Hg concentrations in Maine adult eagle feathers are most comparable to levels found at a site associated with a Hg mine (Pinchi Lake, BC).**
  [Fig. 3; p. 17]

- *Hg in Eggs:* **Hg in abandoned Bald Eagle eggs from Maine study sites is elevated compared to most populations in the U.S.**
  [Table 4; p. 18]

- *Hg-Productivity Relationships: potential impacts:* **We document significant negative relationships between eagle blood Hg and 3,5, and 10- year eagle productivity (chicks fledged/occupied nest). This has not been documented in other eagle populations, suggesting Maine's eagle population may be experiencing reproductive impacts due to Hg exposure despite population growth. [Fig. 4; p. 20]**

- *Spatial Patterns:* **Eaglet blood mercury levels were significantly different among 10 Maine watersheds, but sample sizes preclude powerful analyses.**

Eaglet mercury exposure in Maine highlights geographic mercury "hot spots" that demonstrate a general agreement with Hg findings in common loons and fish. [Figs. 7-8; pps. 25-6]

- *Long-term trends:* **Mercury bioavailability as indicated by nestling blood does not appear to be markedly different in lacustrine habitats during 2001-2005 in comparison to 1991-1992. Riverine comparisons suggest that levels are likely the same or higher than 1991-1992 levels. We recommend long-term monitoring of temporal Hg trends in Maine by periodic sampling (i.e., 1—15-yr intervals) as is currently conducted in other regions. [Fig. 6; p. 23]**
- *Proportion of sampled eaglets at levels of concern:* **Our findings suggest that Maine's Bald Eagle population is within the range of negative impacts; that between 19-30% of eaglets sampled in lacustrine habitats contain blood mercury levels designated as elevated or higher (>0.70 ppm), and 4-9% of those sampled are highly elevated. [Fig. 9; p. 28]**
- *Proportions of adult feathers at levels of concern:* **Feather Hg concentrations ranging to >93 ppm indicate a substantial proportion of Maine's adult eagle population are bioaccumulating mercury; these levels are highly elevated and suggestive of impacts. [Fig. 11; p. 29]**

The full report is available as a separate file with the SWAT report at http://www.maine.gov/dep/blwq/docmonitoring/swat/index.htm

2.2

MERCURY IN EAST POND

2.2 MERCURY IN EAST POND (not funded by SWAT)

East Pond is one of several lakes in Kennebec County that has an annual nuisance algae bloom and does not meet Maine's Water Quality Standards (minimum 2 meter Secchi disk transparency), as established by the Maine Legislature (Title 38 MRSA 464-468). Maine is legally required under the federal Clean Water Act to restore water quality by assessing the cause of the impairment and implementing restoration strategies. East Pond's water quality problems are described in detail in the Maine Department of Environmental Protection (DEP) report, 'East Pond Total Maximum Daily (Annual) Load' (DEPLW2001-10). East Pond's algae bloom is largely attributed to sediment accumulation of non-point source nutrients (phosphorus), which is likely exacerbated by the presence of white perch populations. Since their introduction into East Pond, white perch have become the dominant fish biomass and play a significant role in the lake's biological equilibrium. The biological balance is influenced by the dynamic interaction between primary producers (phytoplankton or algae) and consumers, higher up the trophic scale, which include zooplankton and fish. Zooplankton consumes phytoplankton, which are responsible for the nuisance algae blooms that occur in lakes. Fish primarily consume either zooplankton or other fish depending on their size and the availability of forage. The dominant white perch population occupies a niche that exclusively targets zooplankton at early life stages and then moves on to a combination of small fish and zooplankton as they grow.

As the white perch populations increase, the lake internal mechanisms for controlling algae blooms (phytoplankton) decrease. The Biomanipulation Project in East Pond is based on work done in Europe and the mid-west to improve water clarity through the manipulation of fish populations. A number of studies demonstrate that control of algae can be achieved through the reduction of fish that target zooplankton. The project will reduce the perch populations by culling spawning adults primarily through trap-netting efforts. This reduction should allow the zooplankton populations to rebound and balance things out once more. This may take several trapping seasons before a water quality improvement becomes apparent. The current project includes the following partners: the Maine DEP (Lakes Assessment Section - Division of Environmental Assessment), the University of Maine (Department of Biological Sciences), the East Pond Lake Association and Maine Department of Inland Fisheries & Wildlife.

The project seeks to remove as many planktivorous fish (white perch, yellow perch, and black crappie) as possible. The estimated population of white perch in the lake is approximately 100,000 with a wide confidence interval. There was some thought about whether or not the white perch removed could be given to people to eat. From DEP's Fish Tissue Contamination in Maine Lakes Study in 1992-3, white perch were the species most contaminated with mercury statewide. Concentrations of mercury in smallmouth bass from East Pond in that study were quite high (mean 0.890 ug/g). Consequently, in 2006, 10 white perch were collected from East Pond and analyzed for mercury. The fish were of relatively large size (mean 249 mm, 10 in). The mean and 95th upper confidence level mercury concentration were 0.178 ug/g and 0.211 ug/g respectively, around MCDC's FTAL of 0.200 ng/g. Although concentrations were relatively low the 95th

UCL exceeded the FTAL and consequently DEP and MCDC decided not to give the fish out for human consumption. The fish are instead taken to a local farm for composting.

2.3

MERCURY IN LAKES DOWNWIND OF HOLTRACHEM

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In 1996, fish and sediments from several lakes and ponds southeast (downwind) of Orrington were found to have higher concentrations of mercury than the general population of Maine lakes (DEP, 1997). Orrington is the location of two suspected sources of air emissions of mercury. 1) The Penobscot Energy Recovery Corporation's facility is one of waste-to-energy municipal waste combustors, which are known sources of air emissions of mercury at some level, depending on type of facility and controls. 2) The Holtrachem Manufacturing Corporation's chloralkalai facility produced chlorine using a mercury cell process until it closed in 2000. The facility had numerous releases of mercury to the air, land, and water while operating and the site is still heavily contaminated and is undergoing a hazardous waste cleanup.

Given that studies in other states have shown relatively rapid (3 years) declines in fish mercury levels to elimination of some local air sources of mercury, the lakes downwind of Orrington were sampled again in 2006 to determine if there have been any changes since 1996 and after Holtrachem closed in 2000. An effort was made to collect fish of the same relative size from each lake, but lengths were different between the two years for some lakes. Given that our 'Fish Tissue Contamination in Maine Lakes' study in 1993-4 documented that length was a primary determinant of mercury concentration in fish, all 1996 and 2006 mercury data were normalized to length prior for statistical analysis.

Results show that there was no lake where concentrations have significantly (Mann Whitney $p=0.05$) diminished, and only one (Jacob Buck Pond) where concentrations were significantly different, which was an increase (Figure 2.3.1). Since sample sizes for each lake were relatively small (n=3-11), these conclusions are tenuous. Consequently, data for each year were grouped to give larger samples sizes (n=49 and 31 for 1996 and 2006 respectively). There was no significant difference between the two years ($p= 0.972$).

Figure 2.3.1 Mean Mercury Concentrations (ng/g) in Fish from Lakes Downwind of Orrington