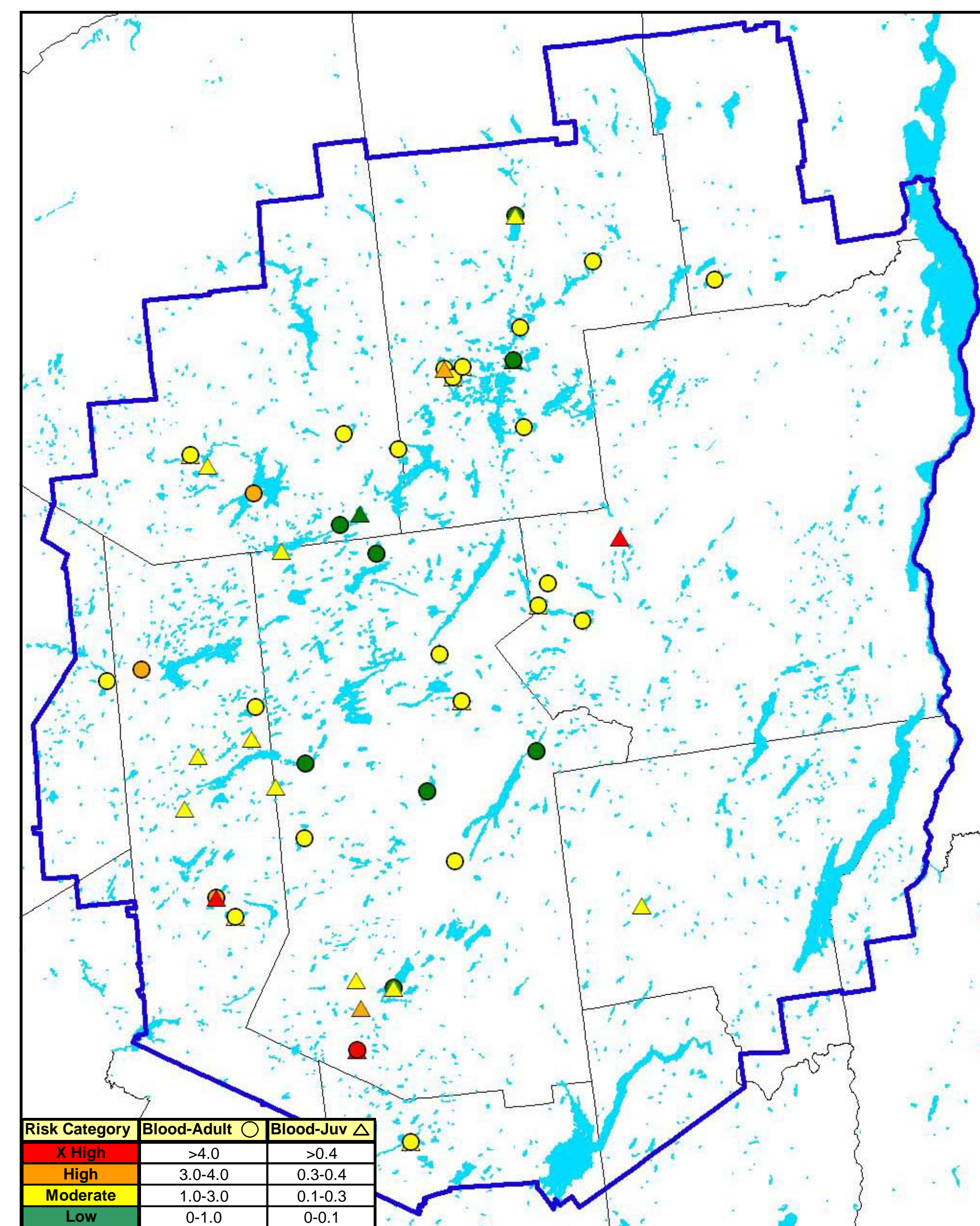# LONG-TERM MONITORING AND ASSESSMENT OF MERCURY BASED ON INTEGRATED SAMPLING EFFORTS USING THE COMMON LOON, PREY FISH, WATER, AND SEDIMENT

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INTRODUCTION

Anthropogenic inputs of mercury into the environment, primarily originating from coal burning and incinerator emissions, have resulted in an increasing gradient of mercury found in loons from west to east across North America. In conjunction, the current availability of methylmercury in aquatic ecosystems of northeastern North America is at levels posing risks to human and ecological health, as reflected in the number of human fish consumption advisories for many parts of the region, including many Adirondack lakes.

The Common Loon (*Gavia immer*), a Species of Special Concern in New York State, breeds on waterbodies throughout New York's six million acre Adirondack Park. Current mercury risk assessments in the Northeast have shown that the Common Loon is a suitable bioindicator of aquatic mercury toxicity based on its ecology – a piscivorous predator at the top of the food web – and detectable behavioral and reproductive changes due to mercury toxicity. The logistics of studying this species and the high value the public places on Common Loons contribute to the choice of this species as a study subject.

Through a cooperative effort between members of the Adirondack Loon Cooperative Program, this project will determine levels of abiotic and biotic mercury exposure to help assess the risk to human and ecological health in New York State and northeastern North America. Based on risk categories developed from the literature and *in situ* studies by BioDiversity Research Institute and their collaborators, results from 1998-2000 indicated that 17% of the loons sampled were estimated to be at risk for harmful effects from mercury contamination.

Long-term monitoring of mercury contamination and reproductive success of Adirondack loons will be evaluated in relation to chemical analysis of mercury in prey fish, crayfish, zooplankton, water, and sediment samples collected from loon territories on these lakes to provide an indication of the risk mercury poses to environmental quality in northern New York. Loon productivity and mercury results will be provided to U.S. EPA to develop a population model for loons in the Adirondack Park to determine if mercury toxicity is resulting in a negative impact on the breeding loon population in the Park. Increased knowledge of the relationships between biotic and abiotic mercury levels throughout the food chain will provide a stronger foundation for regulatory agencies to make decisions about regulation of environmental mercury contamination and the management of wildlife species and freshwater ecosystems.

ABSTRACT

The Adirondack Cooperative Loon Program, a partnership of the Wildlife Conservation Society, Natural History Museum of the Adirondacks, NYS Department of Environmental Conservation, BioDiversity Research Institute, and the Audubon Society of New York, is using the Common Loon (*Gavia immer*) as an indicator species to assess the mercury exposure and risk in aquatic ecosystems in New York's Adirondack Park. As part of a long-term study examining loon survival and reproductive success in relation to mercury, abiotic (water and sediment) and biotic (loon, prey fish, crayfish, and zooplankton) samples were collected from 44 lakes in the Park from 2003-2004.

Mercury analysis of these samples is used to develop a mercury exposure profile to evaluate the ecological risk that mercury deposition poses to Adirondack waterbodies. Ecological risk will be quantitatively assessed using a formula for a wildlife criterion value to determine if the water column mercury value is protective of wildlife at the population level in the Adirondack Park. The differences in reproductive success and survival in common loons in relation to their mercury exposure is used to develop a mercury hazard profile.

A population model will also be developed to determine if mercury contamination is affecting the population growth rate of loons in the Adirondacks. Results of this project will provide a scientific basis for regulatory agencies and policy makers in New York State to make informed decisions regarding the regulation of airborne pollutants and the management of wildlife species and freshwater ecosystems.

PROJECT OBJECTIVES

1. Develop a mercury exposure profile by evaluating abiotic (sediment and water column) and biotic (prey fish, crayfish, zooplankton, and loon blood, feathers, and eggs) mercury levels in the aquatic environment.

2. Develop a mercury hazard profile using the Common Loon as the indicator species by evaluating the reproductive success and survival of Adirondack loons in relation to their blood mercury levels.

3. Assess mercury risk in Adirondack aquatic ecosystems using a wildlife criterion value which provides a water column mercury value that is protective of wildlife at the population level.

4. Develop a population model to determine if the Adirondack loon population is negatively impacted by mercury contamination of the aquatic ecosystem.

5. Increase public and scientific understanding of the impact of mercury pollution on aquatic ecosystems.

METHODS

Forty-four lakes inhabited by loons were examined over the two-year project (2003-2004). The following samples were collected for mercury analysis:

- Blood and feather samples from 85 loons (49 adults and 36 juveniles) on the 44 study lakes. Loons were captured using nightlighting and playback techniques
- 23 non-viable loon eggs from 17 lakes.
- Water samples from 44 lakes using a standard "clean hands-dirty hands" protocol.
- Zooplankton samples from 43 study lakes using townets.
- Crayfish samples from 26 lakes by visual scans and traps.
- Sediment core samples from 32 lake.
- Composite of five fish in each of four size classes (5-10cm, 10-15cm, 15-20cm and 20-25cm) using hook and line, trap nets, seine nets, and gill nets. Fish samples were collected in all four size class categories from 34 lakes, and in 1-3 of the size classes from 10 study lakes.

ACLP field staff conducted weekly observations on 62 lakes in the Adirondack Park each summer to determine the survival and reproductive success of the uniquely color-banded loons.

PRELIMINARY RESULTS

- Average loon blood mercury risk categories varied on lakes throughout the Adirondack Park (Figure #1, Table #1).

TABLE #1: NUMBER OF ACLP STUDY LAKES BY BLOOD HG RISK CATEGORY

Number of Lakes	Low	Moderate	High	X-High
Adult Risk Category	8	21	3	1
Juvenile Risk Category	2	17	2	3
Total Loon Risk Category	10	38	5	4

(Loon Blood Hg Risk Category)

- Average male loon blood mercury levels were higher than that of female loons.
- Average adult loon blood mercury levels were higher than that of juvenile loons (Table #2).

TABLE #2: SUMMARY STATISTICS - LOON BLOOD HG LEVELS

Age	Sex	# Birds	Avg Hg (ppm)	Std Dev Hg (ppm)	Min Hg (ppm)	Max Hg (ppm)
Adult	Total	48	1.78	1.17	0.43	5.87
	Female	24	1.53	1.24	0.43	5.87
	Male	24	2.03	1.06	0.62	3.85
Juvenile		35	0.26	0.19	0.06	0.82

- Water, sediment, and zooplankton total and methyl mercury levels were typical of Adirondack and Northeastern lakes (Table #3).
- Analysis of crayfish and fish mercury levels is pending.

TABLE #3: SUMMARY STATISTICS - WATER, SEDIMENT, AND ZOOPLANKTON HG LEVELS

	THg (avg) (min - max)	MeHg (avg) (min - max)	%MeHg (avg) (min - max)
Water (ng/L)	1.73 (0.096 - 4.95)	0.15 (0 - 3.10)	5.3 (0-19)
Sediment (ng/g)	29.4 (1.69 - 200)	2.2 (0.002-27)	4.01 (0.01 - 28)
Zooplankton (ug/g)	0.41 (0.007 - 3.03)	0.12 (0.004 - 1.29)	29.6 (1.5 - 74)

Results will be further analyzed to develop an exposure profile evaluating the relationships between mercury concentrations at different levels of the food web. A population model will be developed to determine if mercury contamination is affecting the growth rate of the Adirondack loon population. A wildlife criterion value will be used to assess the ecological risk that mercury contamination poses to wildlife at the population level in the Adirondack Park.

The results of this project are provided to the scientific and public communities through a variety of outreach techniques, including public presentations, websites, biannual newsletters, and interactive school curricula. This project will lead to a better public and scientific understanding of the impact of energy-related pollutants on ecological health in the Adirondack Park and northeastern North America, and will provide natural resource managers and policy makers with additional scientific evidence for making informed decisions concerning state and national management policies for Common Loon populations and the regulation of airborne environmental pollutants.

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FIGURE #1: AVERAGE LOON BLOOD HG RISK LEVELS ON ACLP STUDY LAKES, 2003-2004

Risk Category	Blood-Adult ○	Blood-Juv △
X-High	>4.0	>0.4
High	3.0-4.0	0.3-0.4
Moderate	1.0-3.0	0.1-0.3
Low	0-1.0	0-0.1