MERCURY EXPOSURE AS MEASURED THROUGH ABANDONED COMMON LOON EGGS IN NEW HAMPSHIRE, 1998

1999 Report
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by
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Introduction

Mercury (Hg) is a highly mobile contaminant with the ability to cycle through land, air and water. One of its organic forms, methlymercury (MeHg) bioaccumulates and biomagnifies in upper trophic level wildlife, such as piscivorous birds (see Meyer et al. 1995, Scheuhammer 1987, 1991).

Current Hg levels surpass those that occur naturally as a result of anthropogenic sources such as municipal and medical incinerators and boilers (Swain et al. 1992, USEPA 1997, NESCAUM 1998). Wet and dry Hg deposition models developed by the U.S. Environmental Protection Agency (USEPA) in a report to Congress (1997) indicate northeastern United States to be at particular risk to elevated levels of mercury deposition. Nearly fifty percent of this deposition is from sources within the region. One of the highest exposure areas predicted in these models is the southeastern corner of New Hampshire.

The Loon Preservation Committee (LPC) routinely conducts opportunistic collections of abandoned loon eggs as part of its monitoring program in New Hampshire (see Figure 1). Analysis of 36 loon eggs collected in the mid-1970s by LPC and 120 eggs collected in 1992-97 detected mercury at levels that could impact reproductive success (Haseltine et al 1983, LPC unpubl data).

In 1998, LPC was tasked by the U.S. Fish and Wildlife Service (Project ID: 5F20/9550002.0) to sample inviable loon eggs statewide as part of the Northeast Loon Study Working Group. This group is conducting a national study on the distribution and abundance of Hg in the environment as measured through common loons. Severe flooding in May and June of that year (53% nest loss) yielded 82 eggs. Eggs collected from flooded nests allowed for a more representative sample of the population than previous collections of only inviable eggs.

Methods

Field Collection

Data were collected on territorial pairs (defined as a pair of loons defending a territory for at least 4 weeks and having the potential to breed), single birds, (adults that have not established a pair bond lasting 4 weeks), nesting pairs (those laying at least one egg), and successful pairs (at least 1 chick hatched) for each lake in the monitoring region. Nest sites were mapped on 1:24,000 USGS topographical maps and digitized, and hatch dates calculated using a 29-day count from the onset of incubation. Information gathered on successful nests included numbers of chicks and unhatched eggs. Information gathered on failed nests included speculation about the cause of nest failure.

Whole eggs were collected only when it was certain they had failed. Collection of eggs from nests occurred when birds were observed to be off-nest for over 24 hours. If an egg was cold or obviously addled, it was marked with an "X" in pencil. If the "X" was in the same position by the following day, indicating the egg had not been turned, the egg was collected.

Storage

Each egg was doubled-bagged in small resealable plastic bags with collection tags in each bag noting collection date, lake, territory, and town. Eggs were frozen and stored at the Loon Center's sample freezer for later processing in the lab. Each egg was accompanied by a biological collection report with information regarding history of nest, number of eggs, reason for failure, and fate of other egg in the clutch.

Laboratory Processing

Processing for contaminant analyses occurred in-house by the following procedure: the whole egg was weighed to the nearest 0.10 g on an electronic balance. Measurements of length and width to the nearest 0.01 mm were obtained using calipers, and egg volumes (0.10 g) were collected by water displacement. Shells were scored and opened. Contents were weighed to the nearest 0.10 g and placed in labeled 500 ml chemically cleaned jars (I-Chem Co., Newcastle, DE). Eggs were evaluated for viability then rated for developmental stage: 0 = infertile, 1 = fertile and undeveloped, 2 = eyes present, 3 = feathers present, and 4 = fully developed. All content samples were sent to the University of Pennsylvania for total mercury analysis. Mercury results were adjusted for moisture loss using Stickel's formula (1973).

Results and Discussion

In 1998, 61 abandoned whole eggs were processed and analyzed for total mercury (Appendix I). Fifty-four percent (n=33) of these did not exhibit elevated Hg levels and were within the no observed effects level (<0.5 ppm) (Thompson, 1996). However, 36% of the eggs laid (n = 22) were above the lowest observed effects level (>0.5 ppm) and 9.8% of eggs (n=6) showed levels that may cause reproductive impairment (>1.0 ppm) (Thompson 1996, Barr 1986, BRI unpublished data). In our study, 2 eggs analyzed exceeded levels which Barr (1986) considered lethal to loon eggs.

Egg Hg values indicate the capacity of a lake to produce MeHg levels that risk loon reproductive success. Mean egg Hg throughout the state, by territory, was found to be 0.529 ppm +/- 0.288 (Table 1). As predicted from USEPA modeling, loon territories from the southeastern corner of the state (Seacoast monitoring region) had the highest mean egg Hg levels at 0.771 ppm +/- 0.279. Combustion from municipal and medical incinerators in these areas are potential point sources (NESCAUM 1998).

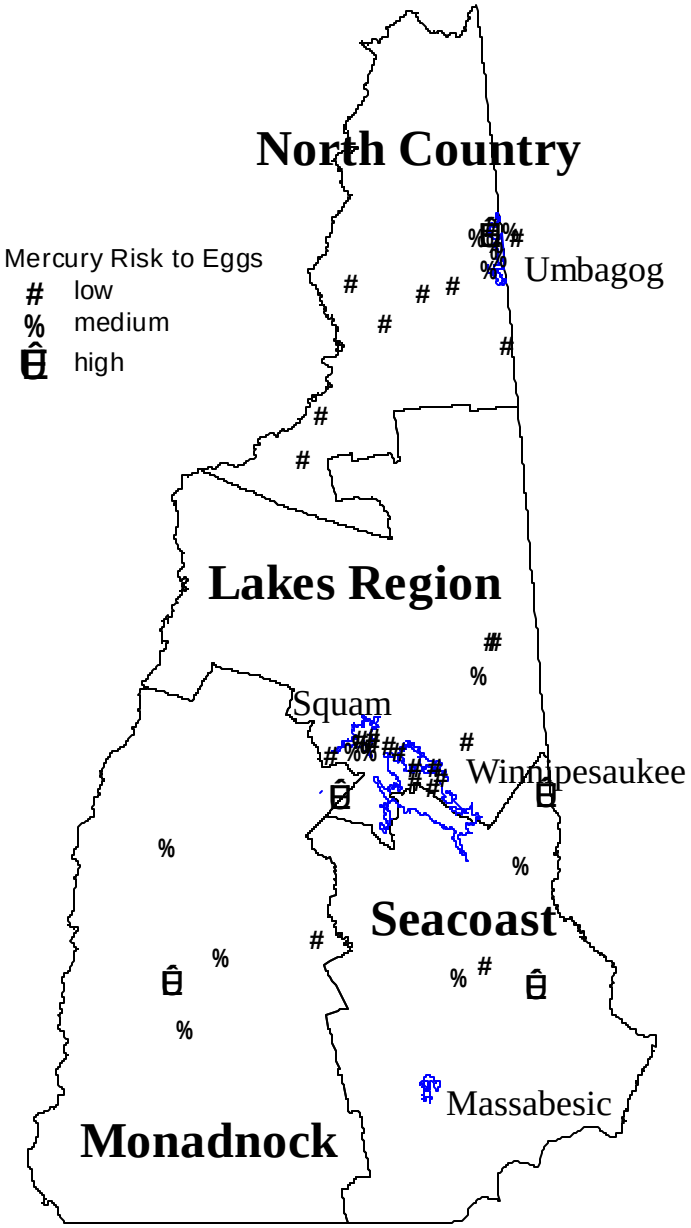
Table 1. New Hampshire mean egg Hg by territory and individual per monitoring region, 1998

Monitoring Region	Mean egg Hg by territory	+/-SD	N	Mean egg Hg by individual egg	+/-SD
Seacoast	0.771	0.279	7	0.851	0.361
Monadnock	0.705	0.298	6*	0.736	0.299
Lakes Region	0.454	0.267	10	0.462	0.340
Lake Winnipesaukee	*0.326*	*0.106*	*7*	*0.328*	*0.140*
Squam Lake	*0.407*	*0.278*	*11*	*0.417*	*0.361*
North Country	0.497	0.279	8	0.479	0.290
Lake Umbagog	*0.683*	*0.293*	*9*	*0.595*	*0.289*
NH Totals	0.529	0.288	60	0.540	0.399

Egg collected from May/Butterfield Pond not included.

The Monadnock monitoring region also showed elevated levels of egg mercury (0.705 ppm +/- 0.295, n=6). The egg analyzed from May/Butterfield Pond in Washington, NH (centrally located

FIGURE 1. Location of Egg Collection Sites and Loon Preservation Committee Monitoring Regions for the Summer, 1998 Sampling Period.



within the Monadnock monitoring region) had a Hg level of 2.66 ppm, the highest Hg value found state-wide. According to historic records, logs painted with a mercury-based preservative were sunk in the pond during the late 1930s. Due to this history, May/Butterfield Pond is likely not representative of atmospherically deposited Hg in the Monadnock region, and was therefore not included in that region's mean.

Eggs collected from the North Country region have Hg levels that are thought not to impact loon productivity (i.e. <0.5 ppm). Unlike most other loon territories in this region, territories from Lake Umbagog, a reservoir experiencing sizable water level fluctuations, tend to have higher Hg levels (mean 0.683 ppm +/- 0.293, n=9). Water-level fluctuations in reservoirs that are part of flooded river valleys have been shown to increase Hg availability to biota (Evers et al. 1996, 1997, 1998).

Mean egg Hg levels by territory in the Lakes Region (central New Hampshire) did not exceed impact levels (0.454 ppm +/- 0.267). Lakes Winnipesaukee and Squam are the largest lakes in the Lakes Region and are monitored separately. Both of these lakes contain a significant population of loons with 18 and 15 loon territories respectively in 1998. Mean egg Hg for Winnipesaukee territories (0.326 ppm +/- 0.106, n=7) was below impact levels. Squam Lake also had low mean territory Hg (0.407 ppm +/- 0.278, n=11), but eggs from Heron Cove had a mean egg Hg of 0.922 ppm (n=2).

An insufficient sample size of eggs >0.1 ppm precluded statistical analyses of relationships between egg Hg and 5 year mean reproductive success, or egg development state. However, egg Hg contents of 0.5 - 2.0 ppm impacted reproductive success of other birds (Gilbertson 1974, Heinz, 1979, Thompson 1996), and Barr (1986) found Hg levels >1.34 ppm in loon eggs caused them to be inviable. Eggs collected in New Hampshire in 1998 support the conclusions of the USEPA's mercury report and validate the risk modeling within the state. Recent studies by Burgess et al. (1998) correlate lowered reproductive success in loons with elevated Hg levels. Due to high Hg levels existing within the state, LPC recommends further monitoring of eggs, and comparing egg Hg levels and blood Hg levels of banded loons with historic reproductive success of loon pairs on New Hampshire territories.

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