Assessment of methlymercury availability to bats in New York - 2006

Dave Yates[1], David Evers[1], Dave Braun[2], Michelle Brown[2], Tim Divoll[1], Jeff Loukmas[3], Amy Sauer[4], Nina Schoch[5] and Robert Taylor[6]

[1] BioDiversity Research Institute (dave.yates@briloon.org) [2] Texas A&M Trace Element Research Lab [3]New York Department of Environmental Conservation [4]Syracuse University [5]Wildlife Conservation Society [6]Texas A&M University

Abstract

More than half of the species of bats in the U.S. can be characterized as foraging over water for emergent insects. There have been very few investigations measuring the exposure of mercury (Hg) to bats. Because of factors that relate to the bat's natural history and vulnerability to anthropogenic stressors, over half of the species in the United States are listed as endangered and threatened or are under consideration for listing. Bats comprise about one-quarter of the mammalian species and constitute a substantial portion of the mammalian biological diversity in the United States. We present findings from a pilot effort to evaluate Hg exposure in multiple bat species from New York State. We sampled blood and fur from 96 bats at eight sites in New York State. Samples were analyzed for total Hg (>95% Hg in fur is MeHg). We demonstrate that 16% and 5% of the bats sampled had fur Hg concentrations that exceeded the lowest observed effects levels in dosed mice (i.e., 10.8 ug/g, fw) and furbearers (i.e., 20.0 ug/g, fw), respectively. This study demonstrates the potential risk of anthropogenic releases of Hg in the airsheds and watersheds of New York State for bats and parallels risks found in diurnal invertivores – songbirds.

Hoary Bat

Northern Long-eared Bat

Introduction

Mercury and other aquatic-based persistent bioaccumulative contaminants are prevalent in freshwater environments. Mercury availability to fish and wildlife varies within a landscape because its availability is strongly influenced by biogeochemistry and hydrology. Recent compelling evidence now indicates that the atmospheric deposition of sulfuric acid (S), nitric acid (N) and mercury (Hg) have the potential for landscape-level impacts on not only piscivorous wildlife, but invertivores such as bats and songbirds. Sulfur deposition or acid rain has negatively impacted parts of northeastern North America for many decades. Hg methylation by sulfate-reducing anaerobic bacteria that convert non-toxic inorganic Hg into toxic organic methlymercury (MeHg) is enhanced in acidic environments. Insectivorous bats in acidified areas of mountains and bog habitats are thus particularly susceptible to the combined impacts of air pollutants because they occur at high trophic levels (i.e., susceptible to biomagnification of Hg). To understand the risk of MeHg availability to bats, baseline information is needed to quantify spatial and temporal patterns. Further needs include knowledge of the MeHg levels that place bats at risk to behavioral, physiological, reproductive and survival abnormalities. Our current objective is to develop the first Hg exposure profile for New York State bat populations.

Methods and Study Area

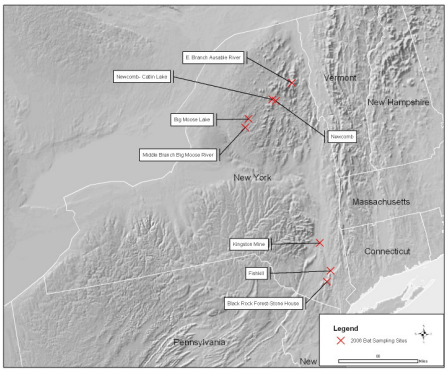
Capture and Sample Collection

Bat capture and sampling occurred at eight different sites in June and July, 2006 (Fig. 1). Triple-, double- and single-high nets were strung directly in front of ledge outcroppings or between trees along small access roads, or in the middle of the river, in such a way that funneled the bats into nets. Roads were chosen that led toward water (with the assumption that bats would fly toward the water to drink and feed soon after leaving their daytime roosts). Nets were set at dusk and monitored until at least 2300 h; and if bats were captured, nets were left standing until 0100 h. All bats captured were identified to species, checked for reproductive status, sexed, and aged. Small blood samples were collected by puncturing a vein in the wing with a 27.5 g needle. Fur samples were also collected with stainless steel scissors from the body of the bats. All bats were released unharmed at the site.

Sample Analysis

Ninety six fur samples were analyzed for total Hg using Cold Vapor Atomic Absorption (CVAA) methods. Laboratory analysis was conducted by Texas A&M Trace Element Research Lab (TERL), College Station, Texas. TERL has conducted BRI's Hg analysis for bird tissues (blood, feathers, and eggs), fish, and crayfish for the past ten years. Mercury levels are given as fresh weight (fw) for fur. Instead of analyzing methylmercury (MeHg) levels we focused on total Hg because it is (1) less costly, (2) generally correlated with MeHg in most tissues (Kucera 1983), and (3) reflective of fur Hg levels because >95% of the Hg is methyl (Thompson 1996).

Figure 1. Bat sampling locations for 2006.



Acknowledgements: We thank the many biologists that assisted with this effort and in particular, John Chenger, from Bat Conservation and Management for samples. The New York State and Energy Research Development Authority and The Nature Conservancy providing funding.

Results

Sampling effort

We captured 96 bats in 2006 at six sites and received fur samples from two additional sites that were surveyed by Bat Conservation and Management. Seven species were captured at the sampling site during 17 nights of trapping: Little brown bat (*Myotis lucifigus,* n=64), Northern Long-eared bat (*Myotis septentrionalis,* n=11), Indiana bat (*Myotis sodalis*, n=11) Big Brown bat (*Eptesicus fuscus*, n=10), Eastern Small-footed bat (*Myotis leibii,* n=2), Eastern Red bat (*Lasiurus borealis*, n=1), and Hoary bat (*Lasiurus cinereous,* n=1) (Table 1).

Table 1. Location and species captured during 2006 effort.

Species*	Black Rock Forest	E. Branch Ausable River	Newcomb	Newcomb-Catlin Lake	Fishkill	Big Moose Lake	Middle Branch Big Moose River	Kingston Mine	Total
EPFU	0	2	0	0	7	0	0	1	10
LABO	0	0	0	0	0	0	0	1	1
LACI	0	1	0	0	0	0	0	0	1
MYLE	0	0	0	0	0	0	0	2	2
MYLU	1	0	15	2	14	11	19	2	64
MYSE	6	0	0	1	0	0	0	0	7
MYSO	0	0	0	0	11	0	0	0	11
Total	7	3	15	3	32	11	19	6	96

*EPFU=Big Brown bat, LABO=Eastern Red bat, LACI=Hoary bat, MYLE=Eastern Small-footed bat, MYLU=Little brown bat, MYSE=Northern Long-eared bat, MYSO=Indiana bat

Mercury exposure in bats

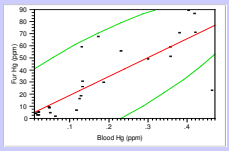
Mean fur Hg concentrations ranged from 3.43 ppm (+/-2.72), at Newcomb-Catlin Lake, to 14.90 ppm (+/-11.25), at Big Moose Lake (Table 2). Fur Hg concentrations from all areas ranged between 0.94 ppm and 35.0 ppm (Table 2). An adult male little brown bat from Big Moose Lake exhibited the highest Hg concentration (35 ppm). A juvenile male little brown, from the middle branch Big Moose River, exhibited the lowest Hg concentration (0.94 ppm) (Table 2).

Table 2. Mean fur Hg concentrations by location.

Location	n	Mean	s.d. +/-	Min	Max
Black Rock Forest-Stone House	7	5.22	2.41	2.62	9.72
E. Branch Ausable River	3	3.47	1.86	1.63	5.35
Newcomb	15	6.61	3.53	1.16	13.80
Newcomb- Catlin Lake	3	3.43	2.72	1.48	6.54
Big Moose Lake	11	14.90	11.25	3.65	35.00
Middle Branch Big Moose River	19	4.26	2.66	0.94	10.70
Kingston Mine	6	8.73	5.79	2.11	16.00
Fishkill	32	8.59	6.72	1.23	30.20

There is a significant correlation between blood and fur Hg that provides a predictive tool – useful for relating fur from bat carcasses to blood Hg levels that are reflective of site-specific dietary uptake of MeHg.

Figure 2. Fur and blood Hg levels were significantly correlated (r^2=0.82, p<0.001, n=58). Blood and fur represent multiple species.



Indiana Bat

Eastern Pipistrelle

Summary of Bat Hg Literature

•Researchers in Japan examined various species of Chiroptera from areas sprayed with mercury fungicides. They measured total fur Hg in 1965 and 1966 and found 33.0 ppm (+/-6.3) and 33.7 ppm (+/-4.2), respectively.

•Fur Hg concentrations found in Chiroptera from BRI at a contaminated area of North Fork of the Holston River, Virginia (mean Hg 49.9 +/- 10.3 ppm) exceeded values from Japan.

•In Arkansas, researchers examined Chiroptera species from Arkansas rivers under fish consumption advisories and found Hg concentrations ranging from 1 to 30 ppm in fur. They concluded that Hg accumulation had exceeded the hazard criteria set by USFWS and that Hg accumulation in the bats is a serious problem that warranted further investigation.

•In eastern Ontario and Québec, researchers in 1997 pooled samples from 5 sites and found Hg concentrations ranging from 2.0 to 7.6 ppm in fur. In 1998, they found fur Hg concentrations that approached or exceeded 10 ppm.

•A risk assessment for aerial insectivorous wildlife on the Clinch River, TN (Oak Ridge Reservation) modeled dose levels for the NOAEL and LOAEL for little brown bats are 0.114 and 0.56 ppm, respectively. Bats experiencing exposure equal or greater than the LOAEL were found to display impaired growth, reproduction, and offspring viability.

Conclusions for New York State

•Bat fur Hg levels in Big Moose Lake and Fishkill area exceeded studies in Arkansas, Japan, and Ontario where researchers considered their bat populations at risk.

•Of the 96 individual bats sampled in NY, 16% had fur Hg burdens that exceeded levels of concern in mice (i.e., 10.8 ug/g, fw). Five of the 96 individuals (5%) exceeded the 20.0 ug/g, fw considered to contain fur Hg burdens that exceeded levels of concern in mink and otter.

•Based on findings from our pilot assessment in 2006, we conclude that bats from some areas in New York State could be negatively impacted from MeHg: bats from Big Moose Lake, Fishkill and the Kingston Mine area are at greatest risk.