

Potential Negative Impacts of Air Pollutants on Thrushes and Other Songbirds in the Appalachian Mountains

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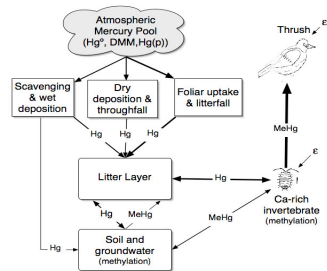
Abstract

Because eastern U.S. breeding bird populations may be suffering the negative effects of multiple stressors such as fragmentation, acidic and Hg deposition, as well as other human-caused environmental changes, the effects of air pollutants on thrushes breeding in northeastern forests are examined. Focal species include the Wood Thrush (*Hylocichla mustelina*) and Bicknell's Thrush (*C. bicknelli*). The Wood Thrush is experiencing rangewide decreasing population trends with particularly sharp declines over much of the Northeast. Because the Bicknell's Thrush's habitat is restricted to mountain tops where cloud and fog acidic and Hg deposition occur, in addition to increased precipitation due to orographic effects, this species illustrates the effects of high levels of both acidic and Hg deposition. In 2005, we collected bird blood, soil and invertebrate samples from 12 sites in New York and Pennsylvania to test for mercury and calcium content. We show results for soil and songbird levels from preliminary studies in northeastern states.



Impacts on bird populations. Further, Hg methylation by sulfate-reducing bacteria that convert non-toxic inorganic mercury (Hg) into toxic methylmercury (MeHg) is enhanced in acidic environments. Acidic environments are also typically poor in calcium (Ca) and Ca-rich prey are scarce. Insectivorous birds in forested areas also receiving Hg deposition are thus particularly susceptible because they occur at high trophic levels (e.g., susceptible to bioaccumulation), are long-lived (e.g., susceptible to bioaccumulation), and dependent on Ca-rich supplemental prey items for breeding, are vulnerable to physiological and reproductive impacts from elevated Hg levels.

Figure 1: Hypothesized pathways of mercury deposition and bioaccumulation in forested areas.



Research Objectives

- Describe a previously undocumented terrestrial pathway linking atmospheric deposition of mercury with the bioaccumulation of converted methyl-mercury in the blood of birds.
- Document the causative pathway linking acid-ion deposition, soil-calcium depletion, reduction in calcium-rich invertebrate prey, and reduced reproductive fitness in birds.
- Test for negative effects of these atmospheric pollutants on physiological indicators such as fluctuating asymmetry and DNA fragmentation.
- Empirically model the effects of these multiple stressors, as well as measures of landscape-level forest fragmentation, on the distribution, habitat suitability, and population response of focal bird species throughout their ranges to test for the presence of synergistic, or multiplicative, interaction terms.

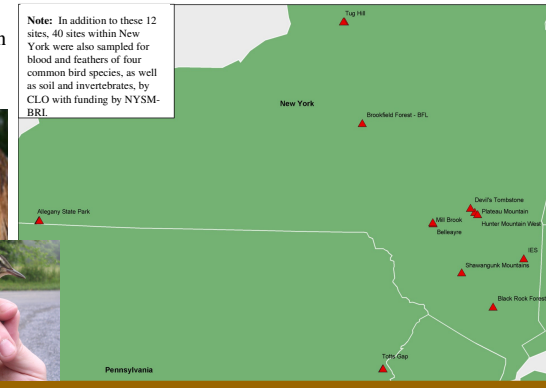
Networking Objectives

- Develop and implement a new monitoring program, the Appalachian Mountain Mercury Network (AMMN), to quantify mercury inputs to sensitive high elevation habitats that receive high mercury loading.
- Integrate AMMN with nationwide mercury measurements in abiotic and biotic ecosystem to monitor changes in mercury levels over time.
- Network with other avian monitoring projects such as the Cornell Lab or Ornithology's (CLO) Birds of Forested Landscapes (BFL), Vermont Institute of Natural Science's Mountain BirdWatch (MBW), and Partners in Flight (PIF) to determine the effects of mercury on productivity, presence and density of birds.

- Provide information that could potentially link major mercury emission sources from the Ohio River Valley with atmospheric deposition in New York and New England.
- Products of our research will be communicated to the lay public and legislators via printed material and websites.
- Disseminate conservation-related findings directly to public agencies, land managers, and private landowners.



by the state or The Conservancy (TNC) in New York and Pennsylvania.



Methods

We chose high and low elevation sites on state and TNC owned properties within the states of Pennsylvania and New York based on call count and habitat surveys as well as historical data demonstrating the presence of thrushes. We captured thrushes and other insectivorous birds from mid June to early August using mist nets in conjunction with playback tapes and thrush decoys. We banded each bird and collected wing, tail and bill measurements as well as weight and fat deposit information. In addition, we collected second secondaries and blood samples by brachial venipuncture. Finally, we collected soil and invertebrate samples from each site.



Photos courtesy of The Nature Conservancy

Results

Pilot field efforts in 2004 have been partly analyzed and indicate compelling relationships between soil exchangeable calcium and thrush blood Hg (Figure 2) and between thrush blood Hg and soil pH (Figure 3). Blood sampling efforts for several songbird species, with an emphasis on thrushes, provide some context for within-site interspecies comparisons (Figure 4). Wood thrush tend to have higher blood Hg levels vs. the Veery. The Bicknell's thrush tend to have higher blood Hg levels vs. other thrushes. Aquatic-foraging water-thrushes tend to have higher blood Hg levels than terrestrial-foraging thrushes. In 2005, 98 thrushes and 116 other songbirds were captured and sampled at 12 separate sites (Table 1). Invertebrate prey and soil samples were also taken.

Figure 2. Based on preliminary data from a central New York site, collected in 2004, where n = 7 Wood Thrushes and p = 0.0326. At the same site blood mercury levels for the closely-related Veery showed a weakly positive but non-significant relationship between soil calcium and blood Hg content.

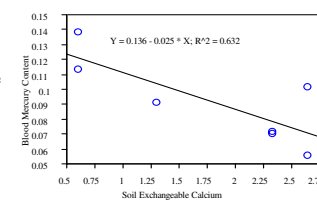
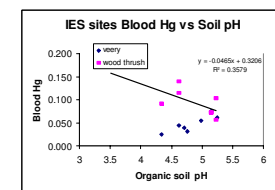


Figure 3. Based on preliminary data from an eastern New York site (Institute of Ecosystem Studies - IES), collected in 2004, where n = 6 for Wood Thrush and n=7 for Veery. Blood Hg levels showed a negative and significant relationship between organic soil pH and blood Hg content.



Blood mercury levels from sites in Maine, New Hampshire, New York and Massachusetts are our primary target species. The wood thrush is exhibiting long-term declines. The Bicknell's thrush, a high-elevation species, shows the highest decline. Aquatic foraging songbirds, such as waterthrushes, likely have some of the highest blood mercury levels of forest songbirds. (Note: LOAEL or lowest observed adverse effect level egg Hg dosing studies and associated field efforts with tree swallows).

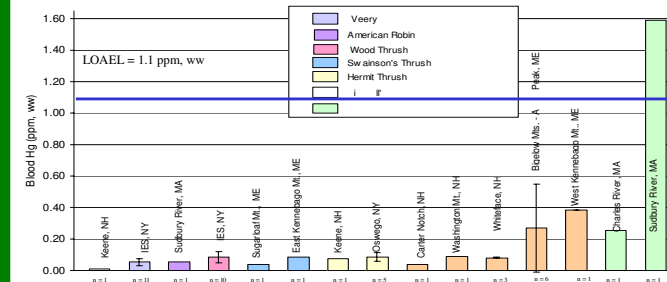


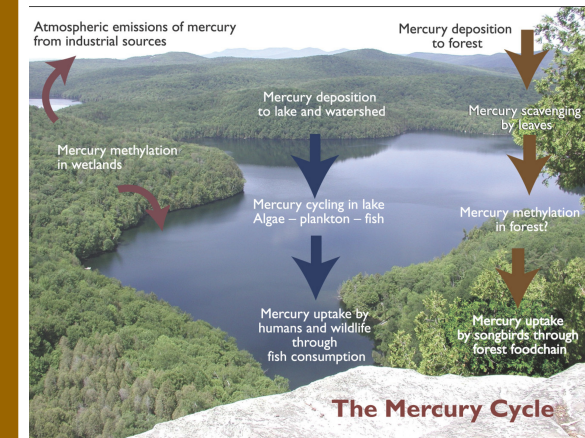
Table 1. Total soil, invertebrate and avian blood samples per site, 2005

Location / Species	Sample Size	Invertebrates*	Soil	Location / Species	Sample Size	Invertebrates*	Soil
Allegany State Park, NY	1 sp, 2c, 2m	2	BS	none	0		
Hermit Thrush	1		Wood Thrush	8			
Veery	4		Veery	2			
Lutescent Warbling Vireo	3		Mitlenek, NY	none	0		
Other songbirds	11		Hermit Thrush	2			
Bluebird, NY	2 sl, 4 ca	4	Wood Thrush	4			
Swainson's Thrush	1		Other Songbirds	5			
Black Rock Forest, NY	1 sp, 2 so, 2 m, 2 c	2	Platinum Mountain, NY	3c, 4 ca, 2 sl, 3b, 2sb	4		
Veery	2		Bicknell's Thrush	11			
Wood Thrush	2		Hermit Thrush	5			
Other songbirds	11		Swainson's Thrush	9			
Brookfield Forest, NY	3 sp	2	Other Songbirds	1			
Veery	2		Shawangunk, NY	3 sp, 3c, 1 m, 1 b	2		
Wood Thrush	2		Hermit Thrush	1			
Other Songbirds	3		Other Songbirds	9			
Deer's Tombstone, NY	4 sp, 1 m, 1 sl, 2 c, 2 cr	2	Trot's Gap, PA	1 sp, 1 c, 1 b	2		
American Robin	6		Wood Thrush	10			
Veery	6		Other Songbirds	16			
Wood Thrush	7		Tug Hill, NY	1 sp, 2c, 1 m, 1 k	2		
Lutescent Warbling Vireo	2		Hermit Thrush	5			
Other songbirds	42		Swainson's Thrush	1			
Hunter Mountain West, NY	3 sp, 1 c	1	Other Songbirds	9			

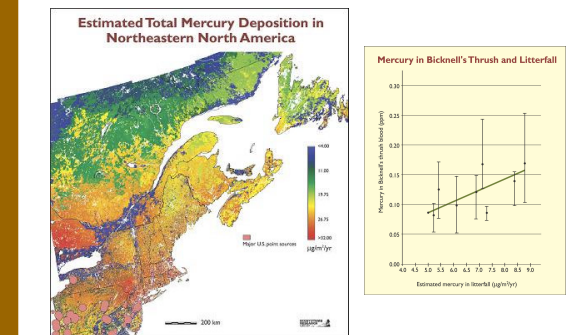


Preliminary Conclusions

1. Methylmercury (MeHg) is available to higher trophic level organisms, including insectivorous songbirds feeding in aquatic systems as well as those in strictly terrestrial systems.



2. Mercury deposition is likely greatest at high elevations and correlates with MeHg availability in the Bicknell's thrush. (Figures above and below are from "Mercury Connections: The extent and effects of mercury pollution in northeastern North America", available at BioDiversity Research Institute).



3. Habitats that are acidic likely create conditions that limit Ca availability and increase MeHg availability to birds. Such conditions could lead to impacts at population levels.

Plans in 2006

- We plan to establish the Appalachian Mountain Mercury Network as a long-term scientific effort to better understand and monitor the exposure and effects of mercury in thrushes and other forest songbirds.
- Monitoring stations will include those sampled in 2005 in New York and Pennsylvania, as well as new ones in Maine, New Hampshire, New York, Vermont, and Virginia.
- Sampling efforts in 2006 will include blood and feathers of invertebrate prey, and soils for testing Hg and Ca.

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