

ECOSYSTEM SCIENCE INFORMING POLICY AT SPATIALLY SCALABLE LEVELS

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Science-based policy can get “lost” in the shuffle.



How science is applied in policy arenas is key.

From Mike Keefe of the Denver Post

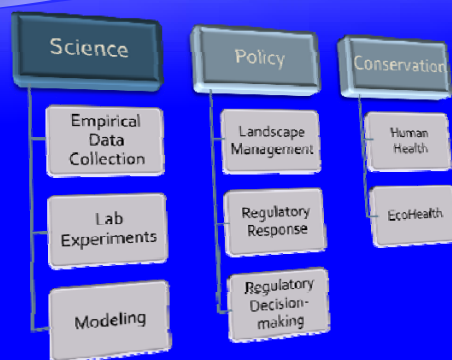
Premises for Presentation

1. *Conservation biologists* research and educate on the trends and process of biodiversity loss, degradation of functioning ecosystems, and the negative affect this is having on our capabilities to sustain the well-being of human society.
2. *Mercury* is a substance that threatens our well-being when it is redistributed at “un-natural” rates.
3. *EcoHealth* = Human Health. Clean air, water and healthy intact ecosystems are necessary for individual and population health for us.

Outline of presentation

1. The interplay of science and policy
 - Use of the Common Loon to link science and policy
2. Applying ecological scientific Hg findings with environmental management and policy
 - Using two established federal programs as examples
3. Regional scientific-policy collaborations
 - Examples of Northeast and Great Lakes efforts
4. Spatial and temporal trends of environmental Hg loads in the Great Lakes and the Northeast
 - Based on a standardized endpoint – the Common Loon
 - Additional approaches – TERRA Mercury Network
5. Comprehensive National Mercury Monitoring Act
 - A status update
 - Scalable to a global level – first Canada and then with UNEP

The interplay of Science and Policy



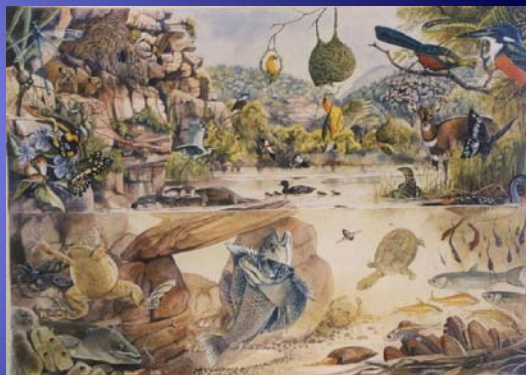
1. Communicate scientific findings based on multiple tools

2. Apply science to decision-making in management and policy arenas

3. Relate to goal of using available resources in a self-sustaining manner

What scientific indicators have the best policy implications?

Especially when the choices are so many.



Use of wildlife as a basis for policy

- ♦ Most federal regulations for contaminants are based on abiotic compartments
 - ♦ Air, water, or sediment
 - ♦ For Hg, a more comprehensive approach is needed
- ♦ Use of biota is limited because of logistical complications and biological variability
 - ♦ Standardized sampling of fish and wildlife can be challenging
 - ♦ Uncertainty in demographic, toxicology, and pharmacokinetics factors is usually high

One indicator species that transcends these challenges and uncertainties

Common Loon, *Gavia immer*



Attributes of the Common Loon

- ♦ Long-lived species – likely over 30 yrs
- ♦ Highly site faithful in summer and winter
- ♦ Behavioral ecology & demographics well known
- ♦ Continental distribution
 - ♦ Low mixing of pops
- ♦ Toxicology for Hg well known
 - ♦ Exposure profile characterized across the range
 - ♦ Effects thresholds established
- ♦ High profile to public

Demographic data based on a long-term study

Extensive effort across N. Am.

- Color-marking and monitoring
 - 1989 to present (over 20 years)
- >4,000 loons uniquely marked at >350 lakes
 - ~70% adults, 30% chicks
 - ~20% adults recaptured
 - >95% breeding
- Continental effort (extensive data collection)
 - 7 provinces
 - 11 states (breeding), 1 state (migration), 5 states (winter)

Intensive effort in western ME



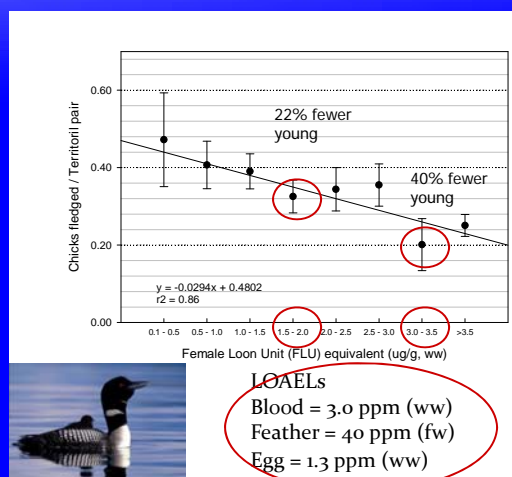
1993-present
>200 territories

Common Loon – reproductive effects now shown in New England (and elsewhere)

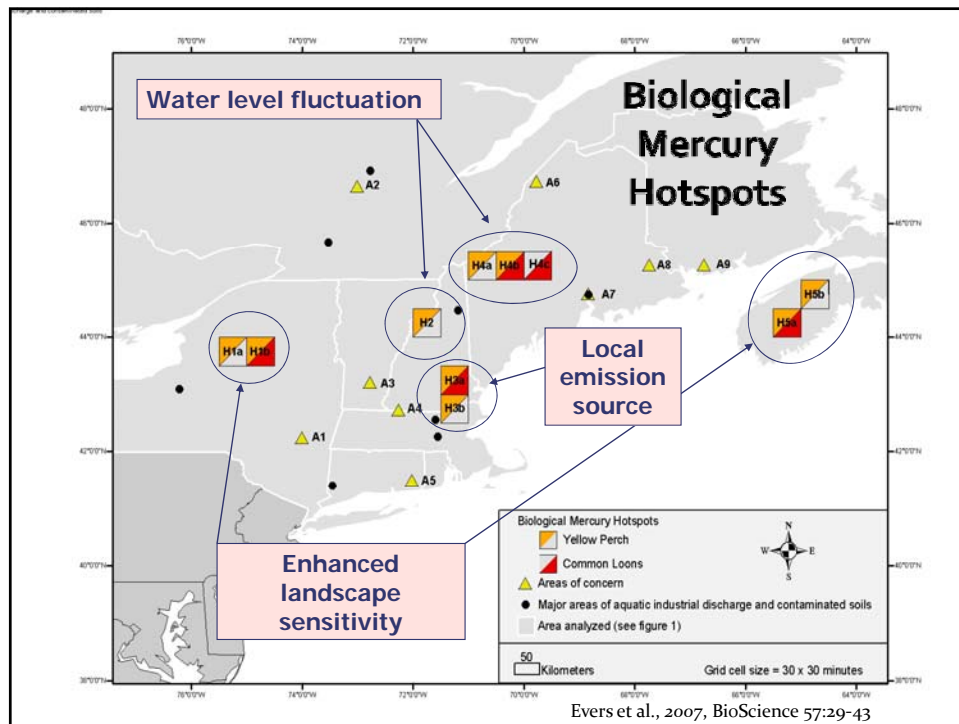
A. Recent findings from a 10-year study indicate sig. relationship between increasing Hg levels and:

1. Physiological changes
2. Abnormal behavior
3. Survival
4. Reproductive success

B. Based on these findings, many areas of the Northeast contain population sinks because of Hg

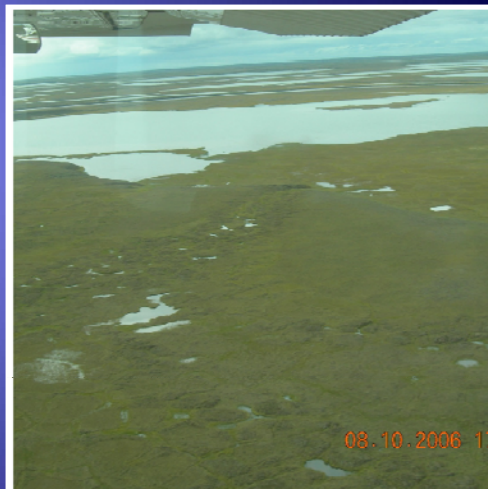


Evers et al., 2008, Ecotoxicology 17:69-81



How can science
really be applied to
policy ?

Especially when the terrain is
so vast



Applying ecological scientific Hg findings with environmental management and policy: The Nexus of Mercury Regulations and Waterbirds

1. Federal Energy Regulatory Commission (FERC)
 - Relicensing of dams
 - Settlement agreements may require management and monitoring of biota, including breeding waterbirds
2. Natural Resource Damage Assessment and Restoration Program (NRDAR)
 - Assessing hazardous contaminant release in the environment
 - Settlement agreements may require assessment and restoration of injured wildlife

FERC & Hydro Power Story

Step 1

- FERC regulations dictate the need to relicense a dam
- A Stakeholder Group forms (federal and state government, tribes, and interested parties) and regularly meets with the Responsible Party (the dam owner)

Step 2

- An assessment is conducted over several years evaluating potential ecological impacts by current reservoir management.
- An application is filed alongside the reports after a settlement agreement is reached by the Stakeholder Group

Step 3

- Management changes are made according to the policy decisions made by the Stakeholder Group and the approval of FERC
- Monitoring is conducted

FERC Example - Maine

- Investigative studies determine Hg exposure in an indicator avian piscivore, such as the Common Loon
- If levels exceed LOAELs then reservoir management may need to change – such as steadying the water levels in the summer
- Long-term monitoring of Hg exposure is employed (25-50 year licenses) – in the Northeast many cases are based on loons



NRDAR & Legacy Mercury Story

Step 1

- NRDAR regulations dictate the injury assessment and restoration of mercury at a contaminated site
- A Record of Decision (ROD) identifies a site of concern and trustees are identified

Step 2

- A Trustee Council regularly meets with the Responsible Party (the polluter)
- An injury assessment is conducted over several years and a bird-year-lost metric may be applied.

Step 3

- Bird-years-lost are economized based on restoration
- Restoration dollars are used

NRDAR Example

- ♦ For example, if loons were used as an indicator for injury on avian piscivores, we would determine:
 - ♦ Loon-years lost – 4,200
 - ♦ Equivalent restoration needed to replace loon-years – 24 nesting pairs, 0.48 fledged young/TP over 100 years
 - ♦ Cost of shoreline acres needed - \$4.5 million
 - ♦ Or \$1,071 / loon-year or \$187,500 per nesting pair



Chlor-alkali Plant

**How can future
science and policy
relationships be
formed?**

Especially when there is a lot
of chaos and bumping around



Regional scientific-policy collaborations

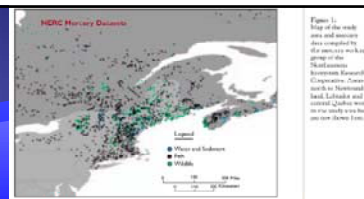
Western Coast-Mountains-Alaska 2011?

Great Lakes 2008-2011

Northeast 2001-2005



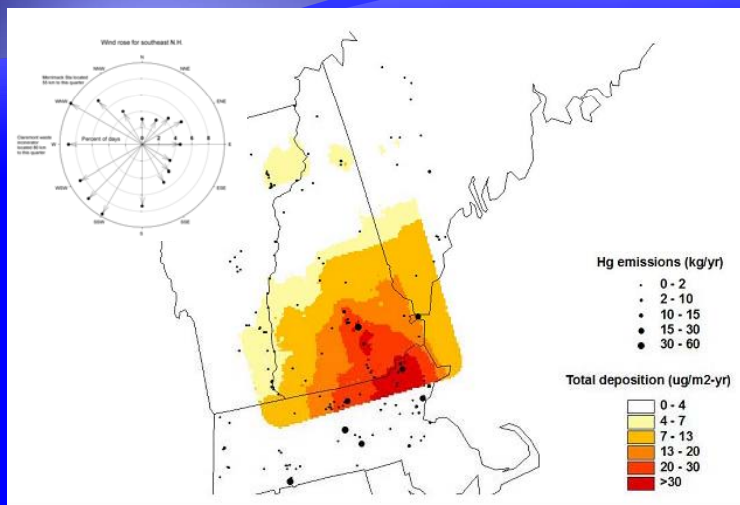
Northeast Region



- ◆ Co-investigator – Tom Clair, Environment Canada
 - ◆ Dedicated data analyst – Wing Goodale
- ◆ 2001-2005, 3 workshops
- ◆ 71 Scientists, produced 21 peer-reviewed papers
- ◆ Collected over 30,000 Hg data points across the Northeast, including Canada
- ◆ Demonstrated
 - ◆ Linkage between Great Lakes emissions and Northeast deposition
 - ◆ Elevated Hg levels in many biota, including songbirds
 - ◆ Biological Hg hotspots
 - ◆ Need for comprehensive, standardized monitoring

<http://www.briloon.org/about/staff/NortheasternMercuryProject.php>

Mercury models using Hg emission sources and deposition rates can predict deposition hotspots

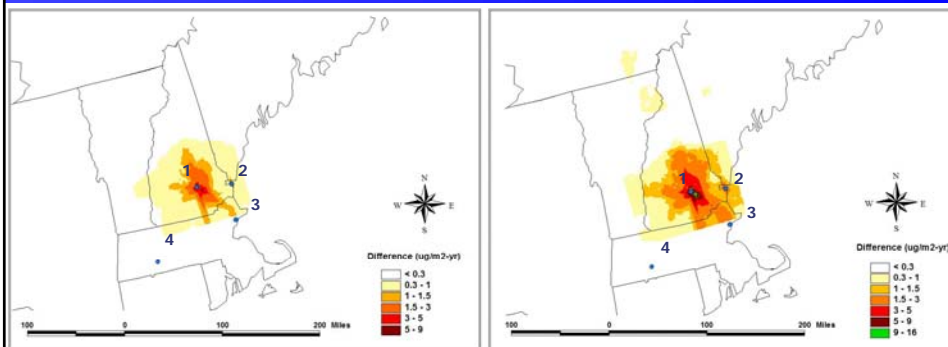


Total Hg deposition estimated using ISCST3 for 2002 and a windrose showing the source of air flow for May through August 1999 to 2002 for southern New Hampshire based on weekly wind roses from NOAA ARL READY analyses (NOAA 2005).

Mercury models can predict changes in Hg emissions and deposition rates.

A = 50% reduction

B = 90% reduction



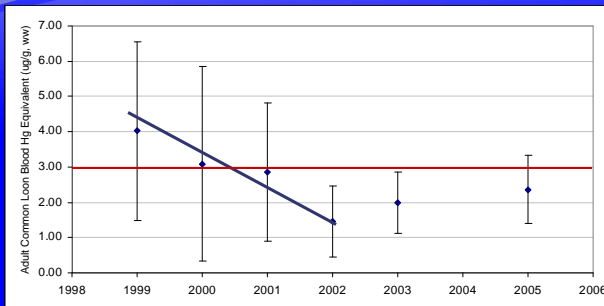
¹ Hg powerplant emission sources: (1) Merrimack Station, (2) Schiller Station, (3) Salem Harbor, (4) Mount Tom.

Total differences in Hg deposition (ug/m2-yr) statewide in New Hampshire with 50% emission reduction (a) and with 90% emission reduction (b) from 4 coal-fired utilities¹ in New England.

Temporal Patterns - Demonstration of rapid recovery in biotic Hg levels in southeastern New Hampshire



- Area water chemistry and watershed variables do not indicate > normal methylation (i.e., area similar to control)
- Based on 52 individuals on 10 lakes
- 3 ppm (ww) is LOAEL



~7,000 lbs of Hg emitted w/n 100 miles upwind

~6,600 lbs of Hg reduced locally from 1999-2001

??

Driscoll et al., 2007 BioScience 56:17-28

Great Lakes Region



- ♦ Co-investigator – Jim Wiener, Univ. Wisconsin
 - ♦ Dedicated data analyst – Kate Williams
- ♦ 2008-2011, 2 workshops
- ♦ >70 Scientists and Policy makers
 - ♦ Representing over 40 entities
- ♦ Two special journal issues (18-22 papers each)
 - ♦ Ecotoxicology and Environmental Pollution
- ♦ Collected over 200,000 Hg data points across the Great Lakes, including Ontario

<http://www.briloon.org/about/staff/MercuryintheGreatLakesRegion.php>

Project Objectives

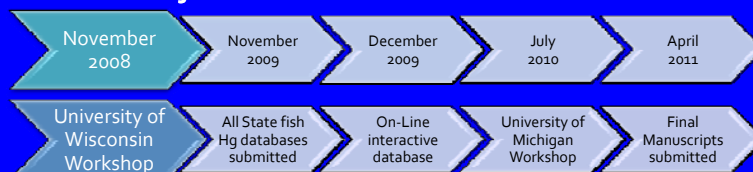
1. Develop a network of scientists
2. Provide a forum for Hg scientists to communicate their results to policy makers
3. Develop a common database of Hg concentrations and merge with the Northeast
4. Develop a searchable website
5. Identify key questions about Hg in the Great Lakes region
6. Publish a series of manuscripts

Great Lakes Mercury Workgroup Structure

Group Leaders

- Atmospheric Deposition – David Gay
- Sediment Cores – Dan Engstrom and Ed Swain
- Water and Watersheds – Dave Krabbenhoft and Mark Brigham
- Lower Food Web – Mike Paterson and Britt Hall
- Fish – Bruce Monson
- Wildlife – Mike Meyer and Nil Basu

Timeline – major deliverable dates



Western Region



- ♦ Initial discussions in October 2008 with USEPA
- ♦ USEPA, NPS, and USFWS are interested in forming a Western Mercury Working Group
- ♦ States of interest:
 - ♦ California, Oregon, Washington, Nevada, Idaho, and Alaska
- ♦ Funding strategy is being investigated
- ♦ Start-up interest in 2010 or 2011

How can regional compilations of data be best used ?

Especially when there are a lot of pieces to the puzzle.

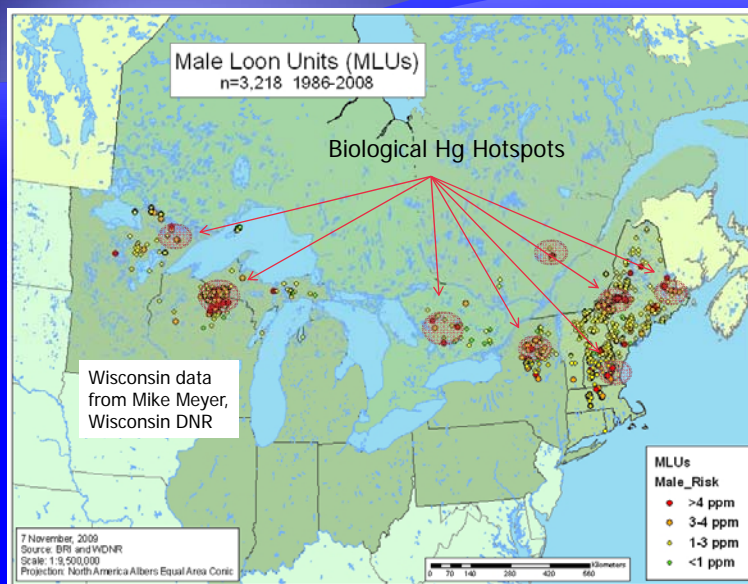


Spatial gradients and temporal trends of environmental Hg loads in the Great Lakes and the Northeast

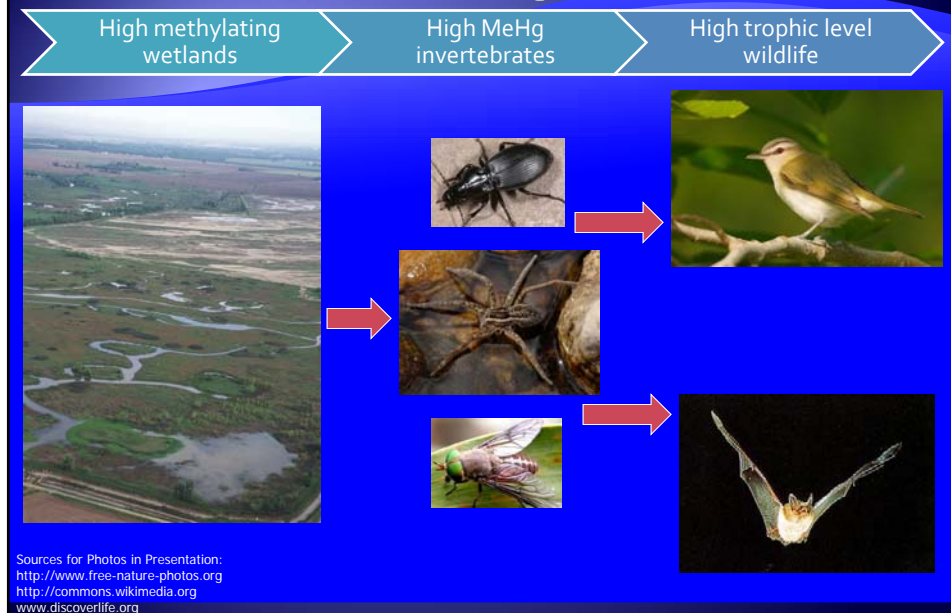
- ♦ Spatial Gradients
 - ♦ Common Loon – Standardized data for piscivores*
 - ♦ Songbirds – Standardized data for invertivores
 - ♦ Potential link with atmospheric deposition
- ♦ Temporal Trends
 - ♦ Common Loon (Northeast and Great Lakes)*
 - ♦ Bald Eagle (Great Lakes)*

*From Wisconsin DNR and NPS

Spatial gradient of MeHg availability across the Great Lakes and Northeast: Common Loon



Terrestrial Food Web MeHg Transfer



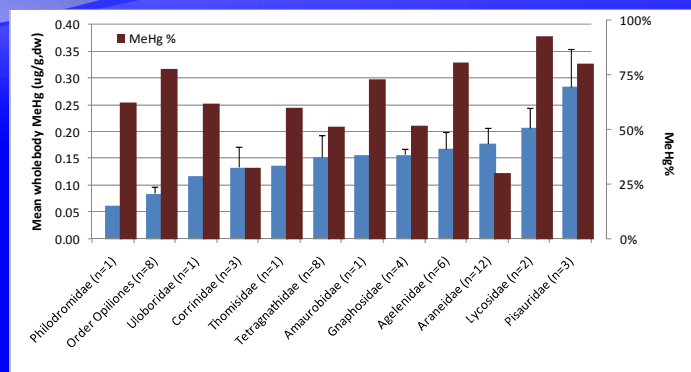
Total Hg and MeHg in spiders of Dome Island, Lake George (n=50)

- Mean proportion of MeHg in 12 families of arachnids = 65%

- Range = 30-95%

- Areas with higher Hg loads do have higher proportion of MeHg

- Like fish, some spider families average higher Hg levels than others



Fishing spider



Wolf spider



Long-jawed orb weaver

Terrestrial Ecosystem Research Assessment (TERRA) Mercury Network

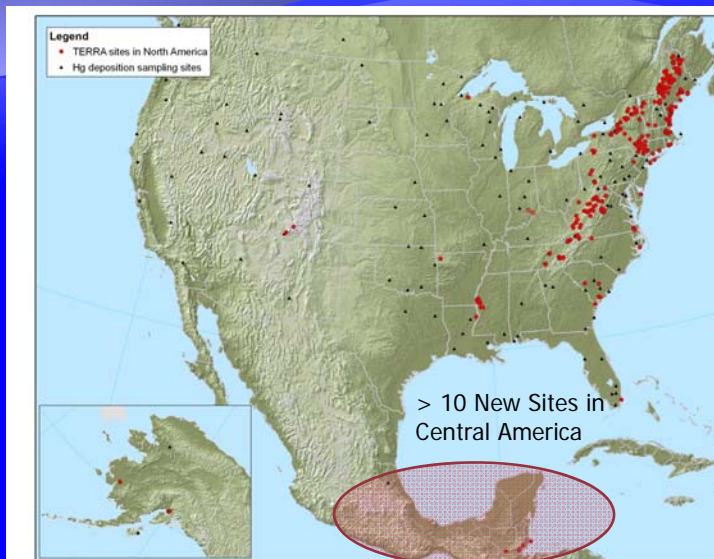
- >220 sites from Alaska to Panama

- >10 new sites in every country in Central America

- Litterfall, soil, invertebrates, birds and/or bats

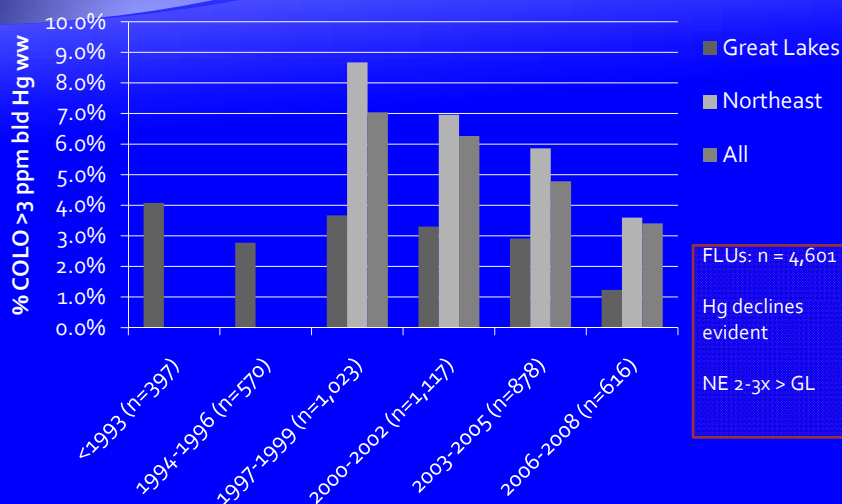
Objectives

1. Predict biotic response from Hg deposition
2. Develop spatial gradients of terrestrial MeHg availability
3. Baseline for the National Mercury Monitoring Network



<http://www.briloan.org/science-and-conservation/programs/TERRA.php>

Temporal patterns of MeHg availability across the Great Lakes and Northeast: Common Loon



How can all of the
science and policy
interest in Hg come
together?

Especially when it is timely.

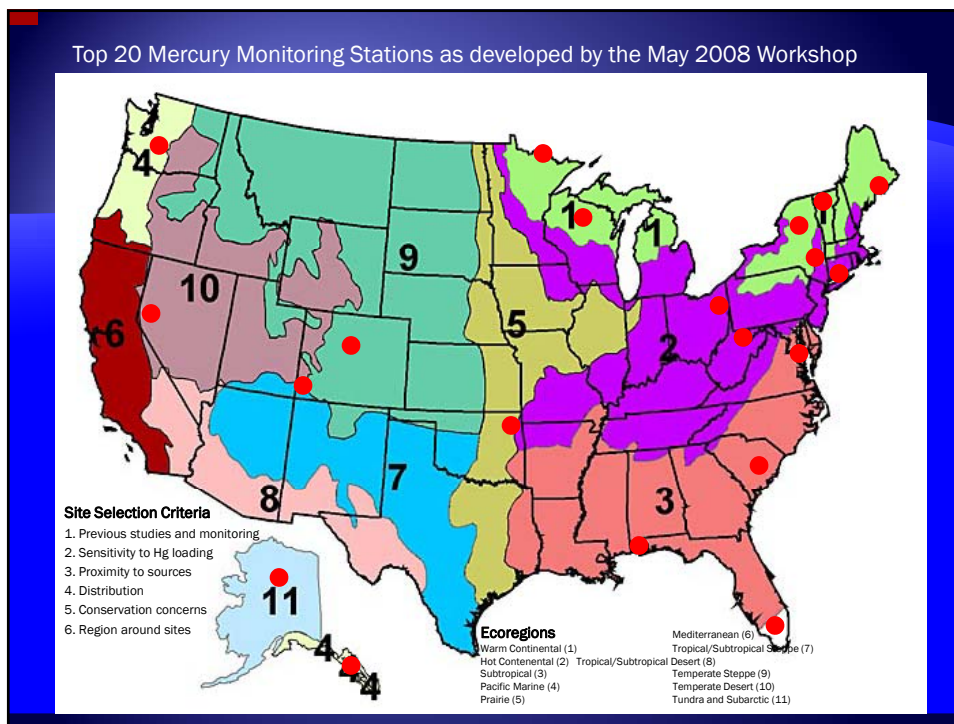


MercNet

- ♦ Designed to be the national, standardized monitoring component for Hg emissions regulations
- ♦ Experimental design and methodologies determined and published
 - Mason et al. 2005, ES&T 39:15A-22A
 - Harris et al. 2007, CRC Press book
 - Evers et al. 2008 EcoHealth 5:426-441
- ♦ Air emission changes need to be tracked comprehensively with multi-media because of their non-linear relationship with response biota
 - Air, sediment, water, lower foodweb, upper foodweb (birds and mammals)
- ♦ MercNet Hg database created (USEPA-BRI project)
 - >500,000 data points and actively growing
- ♦ Recent national workshop (May 2008) identified 20 potential monitoring locations.



<http://www.briloan.org/about/staff/MercNetTheNationalMercuryMonitoringProgram.php>



Comprehensive National Mercury Monitoring Act

- Legislative bill includes USEPA to administer network in collaboration with USFWS, USGS, NPS, and NOAA
- Legislation includes, in detail, the structure and methodologies covered in peer-reviewed publications
- Legislation first introduced in March 2007
 - Collins, Lieberman, Clinton – Environment and Public Works
 - Allen and Walsh – Energy and Commerce
- Legislation will be introduced soon – December 2009
 - Collins, Carper (and others?) – Environmental and Public Works
 - Pingree (and others) – Energy and Commerce
- Legislation calls for \$95 million for 3 years
- May be included with Senator Carper's "Three Pollutant Bill"



Questions?

