

The National Mercury Monitoring Network: A Report from the May 2008 Workshop



**Richard Artz¹, Mark Cohen¹, Jawed Hameedi²,
Tony Lowery³, Winston Luke¹, David Schmeltz⁴**
on behalf of many!

1. NOAA Air Resources Laboratory
2. NOAA National Centers for Coastal Ocean Science
3. NOAA Fisheries – National Seafood Inspection Lab
4. USEPA Clean Air Markets Division

presentation at the **2008 National Water Quality
Monitoring Conference**, Atlantic City, NJ, May 19

Steering Committee for the National Mercury Monitoring Workshop*

Richard Artz	National Oceanic Atmospheric Administration
Tom Atkenson	Florida Department of Environmental Protection
Ryan Callison	Cherokee Nation
Charley Driscoll	Syracuse University
Dave Evers	Biodiversity Research Institute
David Gay	National Atmospheric Deposition Program
Rick Haeuber	US Environmental Protection Agency
Dave Krabbenhoft	US Geological Survey
Kathy Fallon Lambert	Ecologic
Rob Mason	University of Connecticut
Greg Masson	US Fish and Wildlife Service
Kristi Morris	National Park Service
David Schmeltz	US Environmental Protection Agency
Ed Swain	Minnesota Pollution Control Agency

** The composition of the Steering Committee may change (e.g., get larger) as this effort goes forward*



National Mercury MONITORING WORKSHOP

Tracking mercury concentrations in air, land, water, and biota

May 5 - 7, 2008, Annapolis, MD

Participants at the National Mercury Monitoring Workshop (~50) *

Federal Agencies	EPA, NOAA, USGS, FWS, NPS
State Agencies	Florida, Minnesota, Vermont, New York, Wisconsin
Tribal Agencies	Cherokee Nation
Universities	University of California, University of Connecticut, Florida Gulf Coast University, University of Maryland, University of Nevada, Syracuse University, University of Wisconsin, Wright State University
Research Institutions	Biodiversity Research Institute, Ecologic, Heinz Center, Smithsonian Environmental Research Center, San Francisco Estuary Institute, Science Museum of Minnesota, TetraTech
Research Consortia	National Atmospheric Deposition Program
Corporations & Trade Groups	Tekran, Electric Power Research Institute
Non-US Institutions	Environment Canada



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* Due to late additions, this may not be a complete list

Please Note:

- Not an “official” report from the Workshop
- Has not been approved by Steering Committee or Participants
- Content of this presentation taken directly from:
 - materials prepared by the Steering Committee for the meeting
 - materials presented at the meeting by participants.
- Impossible to present the full breadth and scope, but hopefully this brief summary will give you a sense of this important effort



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**SETAC
North American
Workshop on
Mercury Monitoring
and Assessment,
Pensacola, FL**

110TH CONGRESS
1ST SESSION **S. 843**
To provide for the establishment of a national mercury monitoring program.

IN THE SENATE OF THE UNITED STATES
MAY 15, 2007
Mr. CHURCH (for himself, Mr. LUTHERMAN, and Mr. CLAYTON) introduced the following bill, which was read twice, and referred to the Committee on Environment and Public Works.

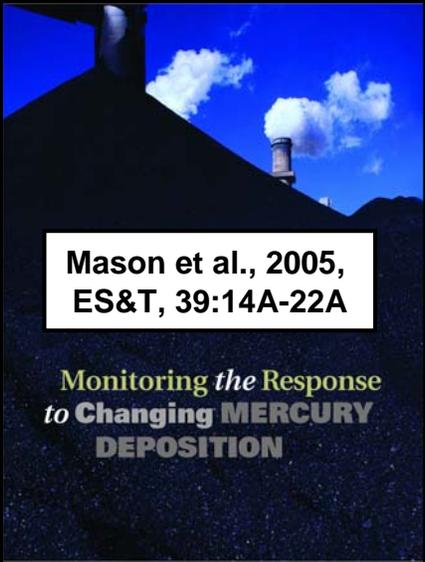
A BILL
To provide for the establishment of a national mercury monitoring program.

1. *Be it enacted by the Senate and House of Representatives*

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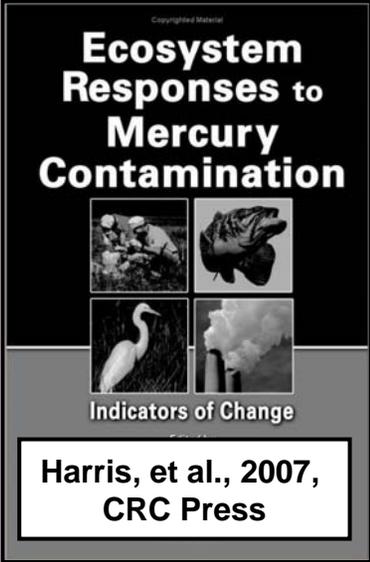
**Bills introduced in
House and Senate**

2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013



Mason et al., 2005,
ES&T, 39:14A-22A

*Monitoring the Response
to Changing MERCURY
DEPOSITION*



**Ecosystem
Responses to
Mercury
Contamination**

Indicators of Change

Harris, et al., 2007,
CRC Press

The workshop was part of an ongoing effort to enhance monitoring of ecological responses to mercury deposition through coordination of existing monitoring efforts and implementation of new monitoring, if funding resources become available.



Acadia National Park, photo courtesy of Dave Evers



Huntington Wildlife Forest, NY, photo courtesy of Charley Driscoll

Workshop participants attempted to refine the scientific and technical basis for designing a national mercury monitoring network and build agreement around implementation approaches.

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Specific goals for the workshop were to:

- Distill recommendations from previous work on measurement parameters for tracking ecological responses to mercury;
- Share information on existing North American sites and programs that monitor ecological endpoints of mercury contamination (e.g., air, water, watershed, sediments, biota);
- Identify mercury monitoring data gaps and establish options for filling those gaps.



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The meeting was organized around six questions:

- 1 – What are the goals and objectives of a national mercury monitoring network?
- 2 – What are the major elements needed to meet network goals and objectives?
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Draft goals and objectives of a national mercury monitoring network*

Monitoring Goal

Establish an integrated network to systematically monitor, assess, quantify, and report on indicators of nationwide changes in atmospheric mercury concentrations and deposition, and concentrations of mercury species in land, water, and biota in coastal and freshwater ecosystems *in response to changing mercury emissions over time.*

Monitoring Objectives

1. Establish **baseline mercury concentrations** in multiple ecosystem compartments that document environmental conditions prior to implementation of atmospheric mercury control measures *to detect future ecosystem changes that may be attributable to mercury controls over time.*
2. Track **spatial patterns and long-term, temporal changes** in mercury concentrations in specific ecosystem compartments: airsheds and watersheds, aquatic ecosystems, aquatic biota, and wildlife *as mercury emissions controls are implemented.*
3. Provide data to assess the **linkages between atmospheric mercury emissions and methyl mercury concentrations in biota** and *how these change over time.*
4. Document **changes in biological indicators** of mercury exposure and effects *relative to changes in mercury loadings* to ecosystems.
5. Provide mercury and ancillary data to **evaluate predictive and diagnostic models** and to advance the development of mercury cycling models and models to **assess source receptor relationships.**
6. Assess **potential ecological harm** and linkages to air emission sources for sites and **wildlife of conservation concern.**
7. **Connect** national mercury monitoring efforts **to other monitoring programs in North America** and adjacent waters where feasible.

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National Mercury MONITORING WORKSHOP

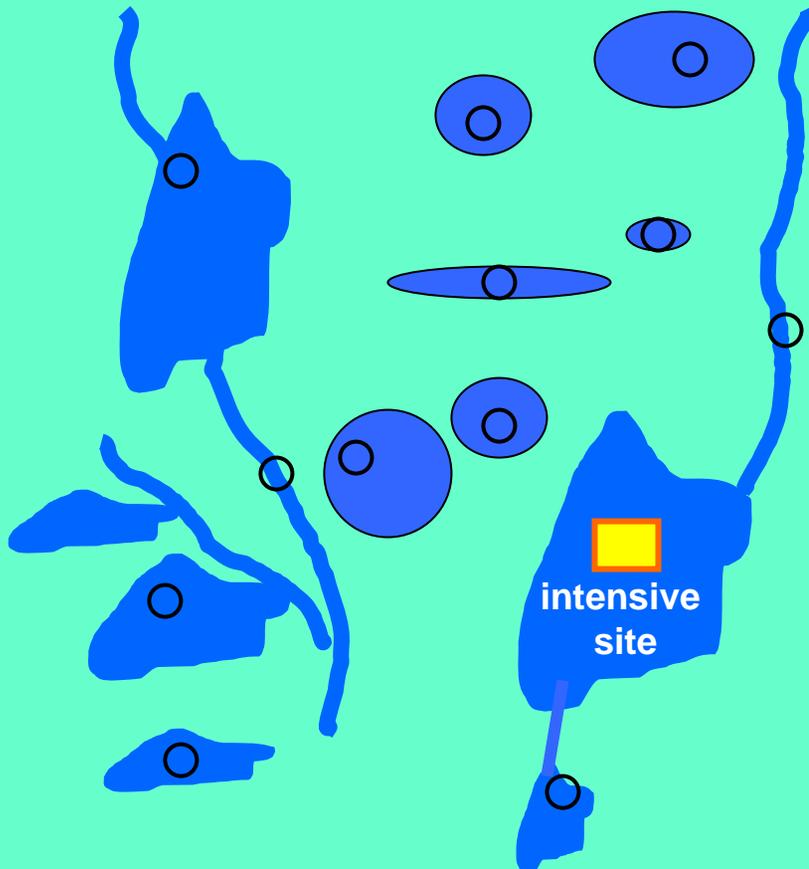
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Proposed Design

Propose a combination of “intensive sites” and “cluster sites”:

- Intensive sites are those where detailed studies will be done to track changes and assess the cause of any changes
- Cluster sites will allow data from the intensive sites to be extrapolated to a broader area, and extrapolate results of the detailed investigations across ecosystems of similar atmospheric input



Propose 10-20 intensive sites in the U.S.

- Each intensive site would have 15-20 cluster sites surrounding it
- Intensive sites would be chosen to represent the different ecoregions of the U.S.

The Indicators

Air & Deposition

- Continuous speciated atmospheric concentrations
- Total wet and dry Hg deposition & flux
- Total Hg weekly wet deposition/flux
- Total and methyl Hg in throughfall
- Total and methyl Hg in litterfall
- Total Hg in snowpack
- Mercury evasion/flux
- Watershed inputs/yields

Water and Sediment

- Total and MeHg in soil
- Forest floor surveys
- Total and MeHg, %MeHg in sediments (seasonal)
- Instantaneous sediment methylation/demethylation rate
- Total and methyl Hg accumulation in cores
- Total and methyl Hg in surface water (seasonal)
- Water column Hg & MeHg profiles

Indicators in green
would be monitored at
intensive sites only

The Indicators, cont.

Aquatic Biota

- Total and MeHg in phyto/zooplankton
- Total and MeHg in estuarine benthic invertebrates
- Total and methyl Hg in whole prey fish (YOY)
- Total Hg in muscle of piscivorous fish

Indicators in green would be monitored at intensive sites only

Wildlife

Total Hg in blood, feathers, eggs (as appropriate)

Potential Indicator Species

- Comparison across habitats: Belted kingfisher
- Terrestrial: Raccoon, Bicknell's thrush
- Riverine: Mink
- Lake: Common loon
- Lake/coastal: Herring gull, Common tern
- Wetland: Tree swallow
- Estuarine: Sharp-tailed & seaside sparrows
- Marine nearshore: Harbor porpoise
- Marine off-shore: Storm petrel

current list of (evolving) site selection considerations (Workshop Steering Committee)

Baseline data
and infrastructure



- Longer-term mercury data
- Existing facilities and infrastructure to support the monitoring program

Will we see
and be able
to understand
a change?



- Sensitive to mercury inputs
- Expected to exhibit large changes due to changes in Hg deposition
- Near emission sources and may receive elevated Hg deposition
- Clearly defined response – few if any confounding factors

Model evaluation



- Useful testbed for evaluation of atmospheric Hg models
- Useful testbed for evaluation of ecosystem Hg models

Want a range
of site types



- Overall, want nationwide geographical distribution
- Overall, want range of characteristic response times
- Overall, want some background sites for characterizing global Hg inputs

Other site issues



- Within common loon breeding range
- Endangered, threatened or candidate species at risk to Hg

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What is already in place? What are the major gaps?

“MercNet” meta-database developed

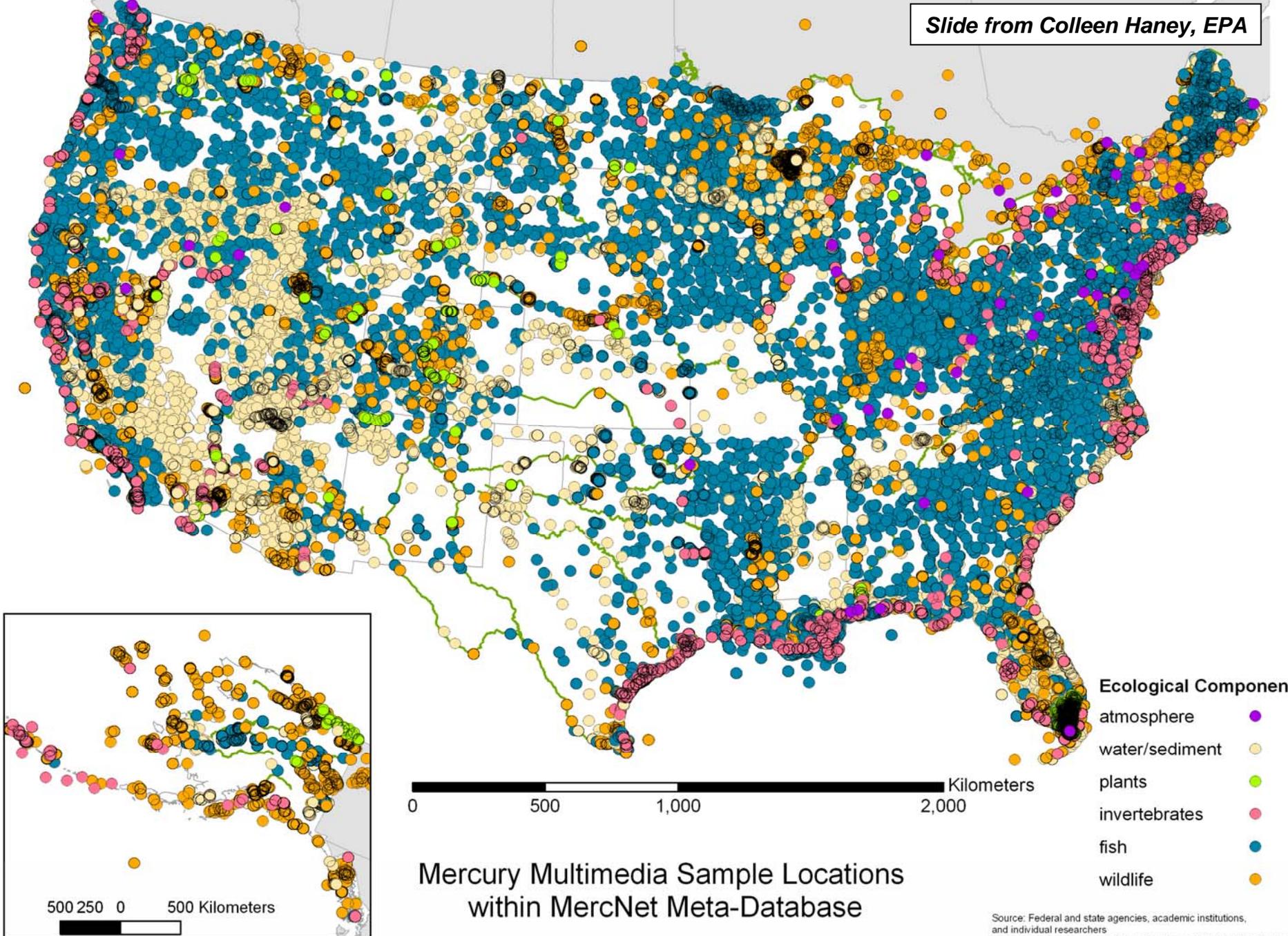
- Based on major environmental monitoring databases from EPA, NOAA, USGS, USFWS, Biodiversity Research Institute
- Records of approximately 200,000 mercury sampling events across the United States
- Various media: Atmosphere, Water, Sediment and soil, Vegetation, Invertebrates, Fish, Birds, Reptiles and Amphibians, Mammals
- Time span of records is from 1896 to 2007



National Mercury
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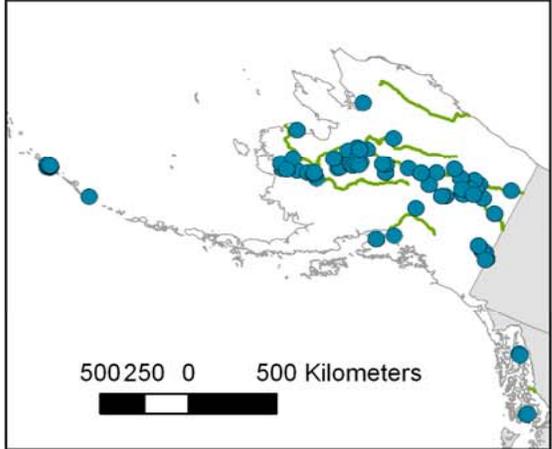
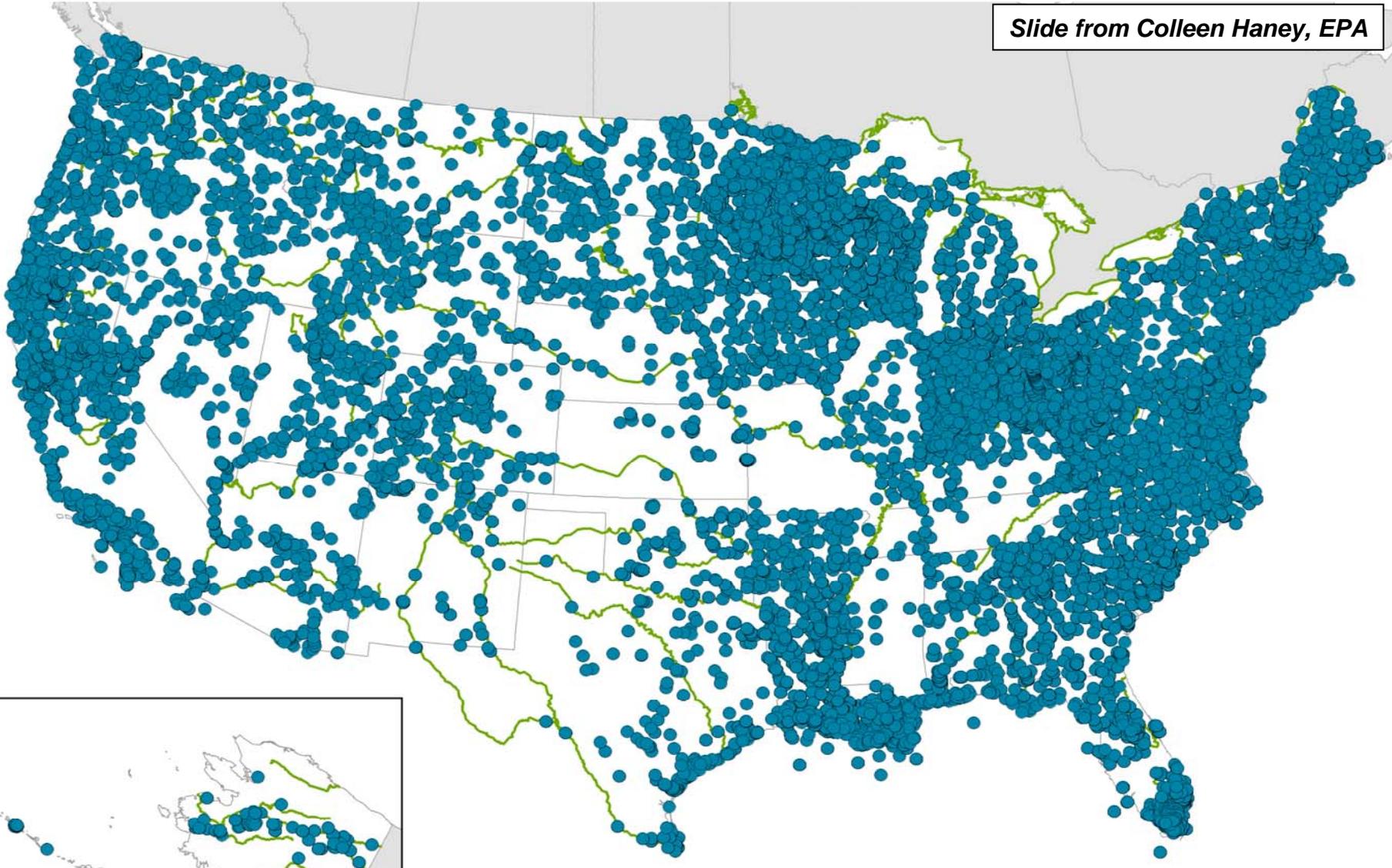
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Mercury Multimedia Sample Locations within MercNet Meta-Database

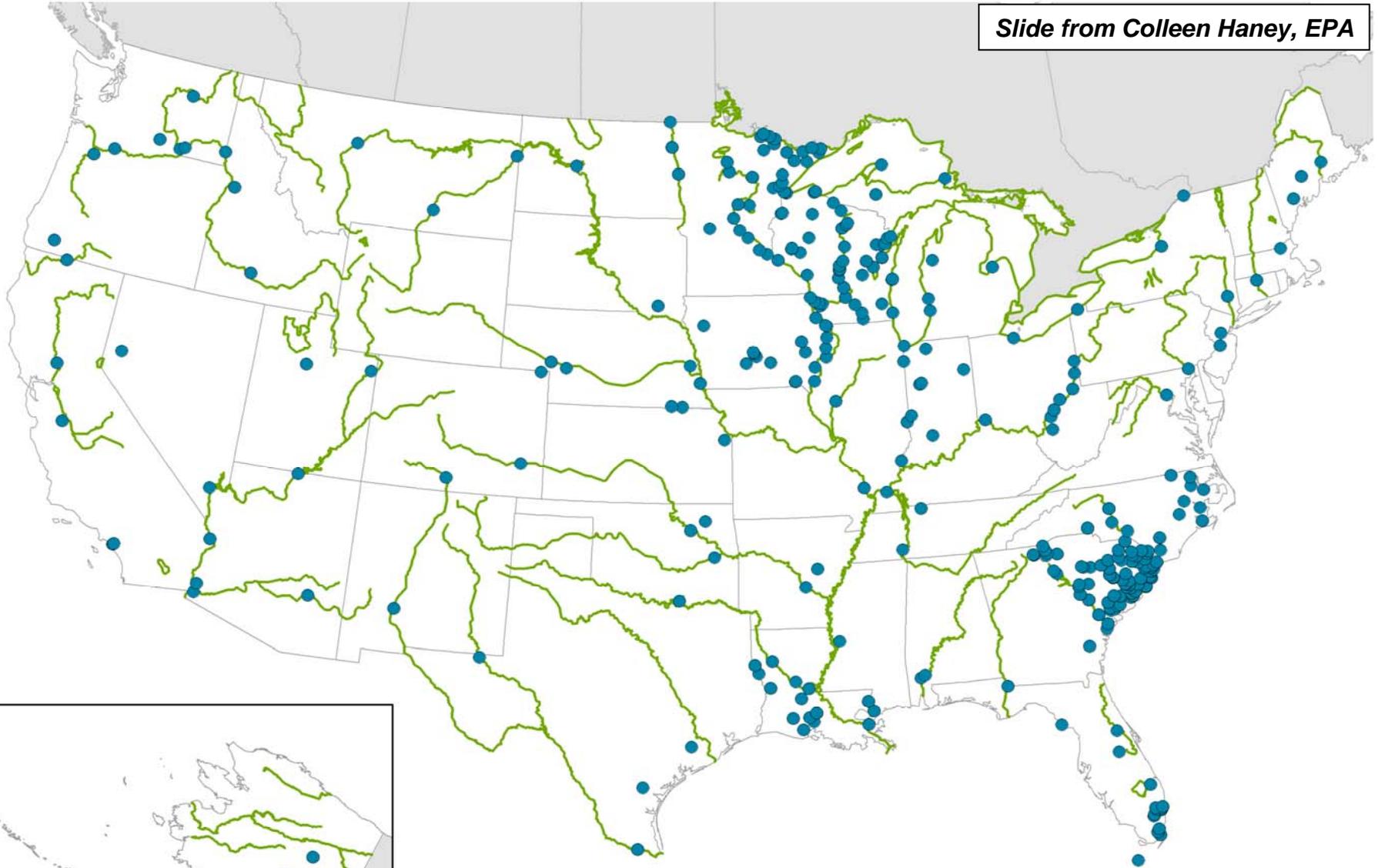
Source: Federal and state agencies, academic institutions, and individual researchers
Projection: USA Contiguous Albers Equal Area Conic USGS Version
Date: 5/2/2008
Scale: 1:17,500,000



Mercury Fish Tissue Sample Locations

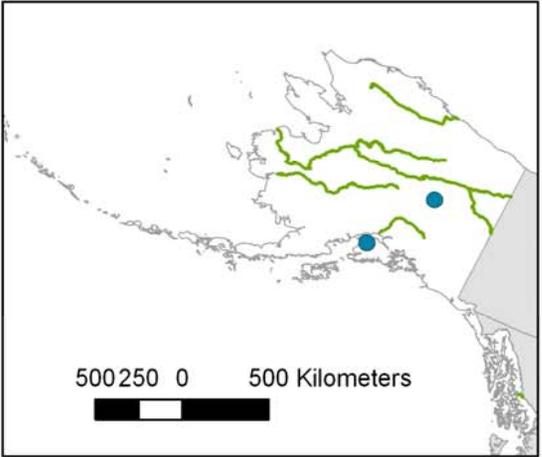
Sampling Locations ●

Source: Federal and state agencies, academic institutions, and individual researchers
Projection: USA Contiguous Albers Equal Area Conic
USGS Version
Date: 5/1/2008
Scale: 1:17,500,000



Sampling Locations ●

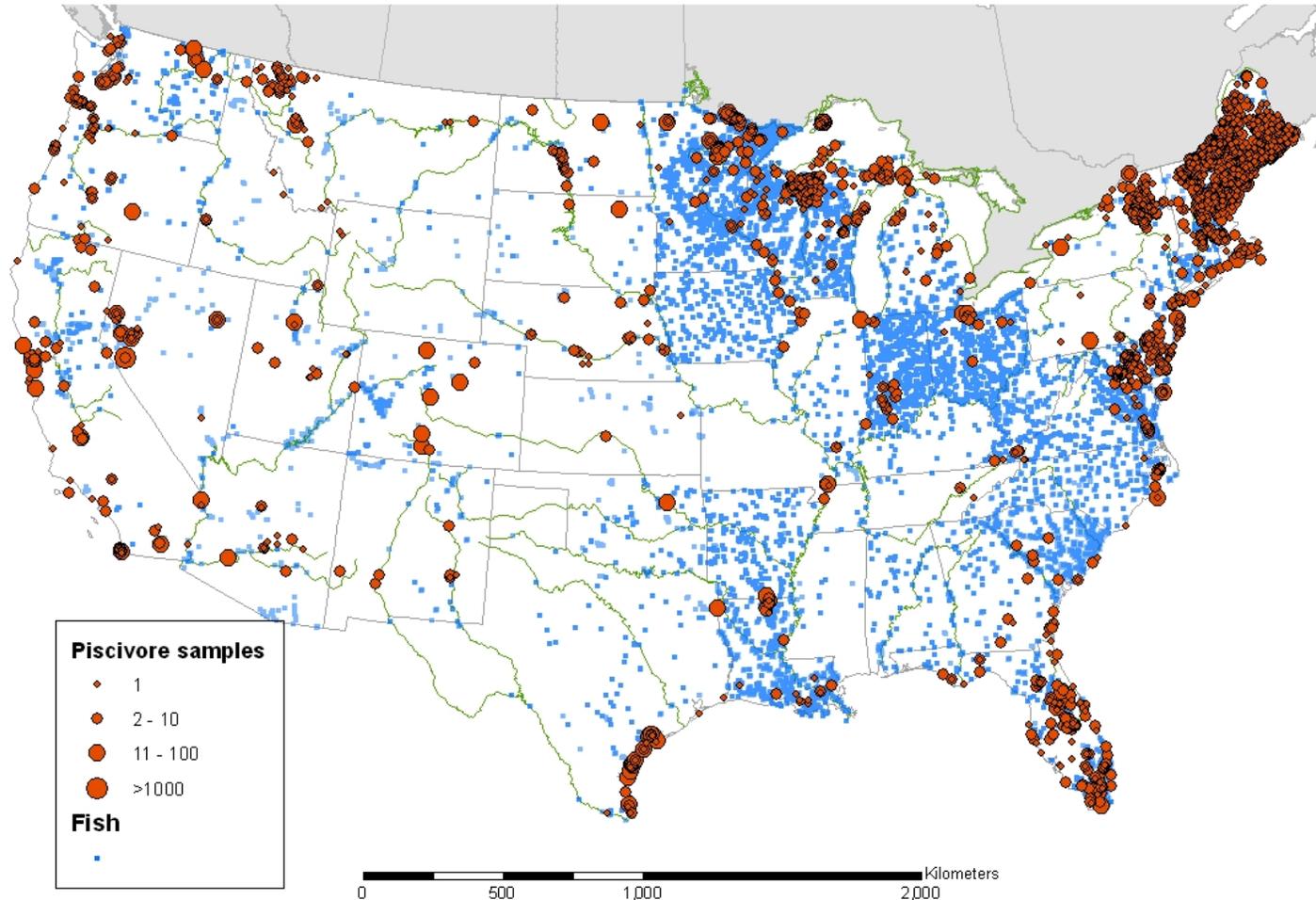
Mercury Fish Tissue Sample Locations with Repeat Sampling in at least Five Distinct Years



Source: Federal and state agencies, academic institutions, and individual researchers
Projection: USA Contiguous Albers Equal Area Conic
USGS Version
Date: 5/1/2008
Scale: 1:17,500,000

Avian piscivores

Common Loon (>4,000 records), Bald Eagle (900 records), Wading birds (450 records)
Key Group because risk and injury assessments can be made based on known LOAELs



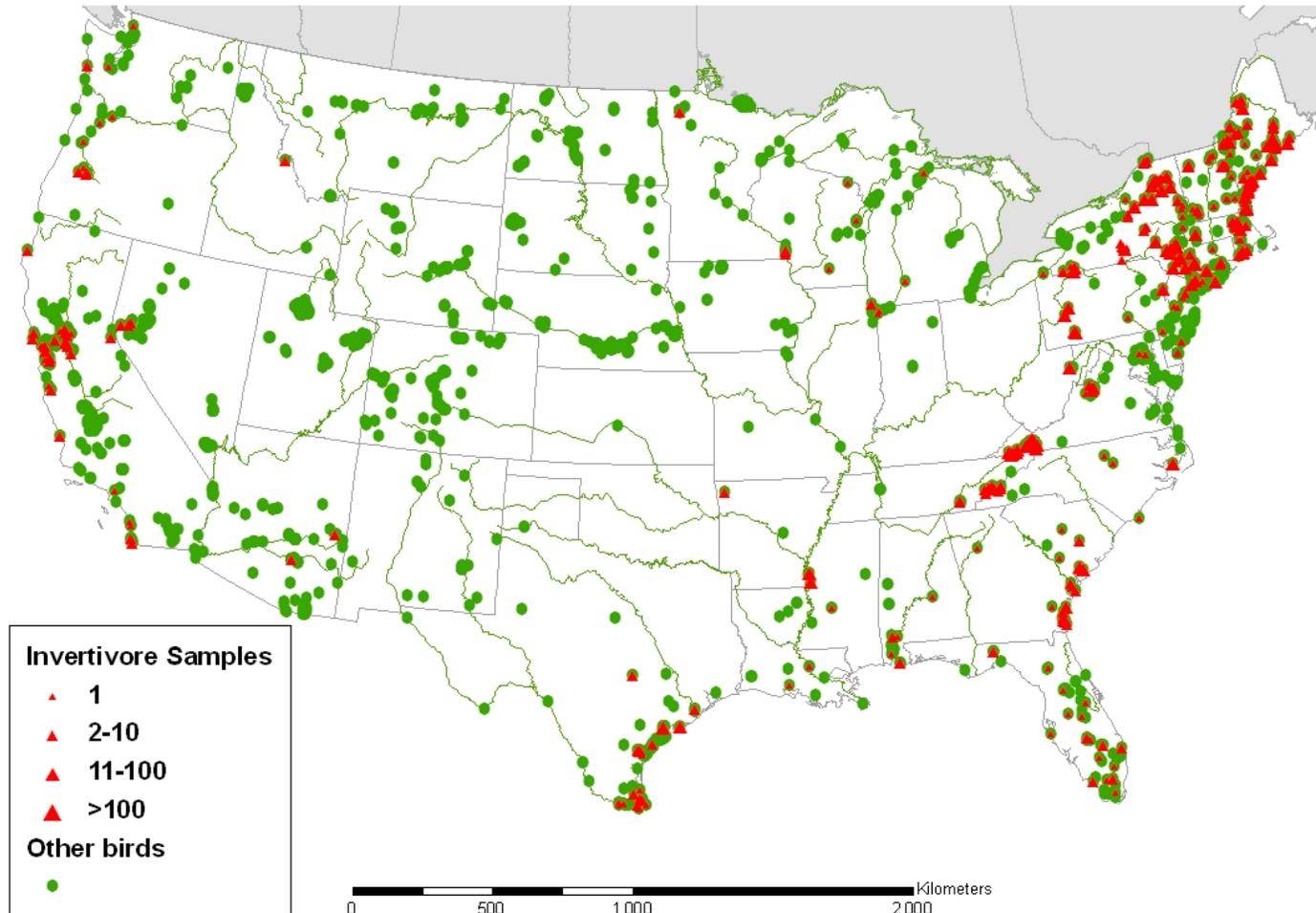
Piscivorous Bird and Fish Locations

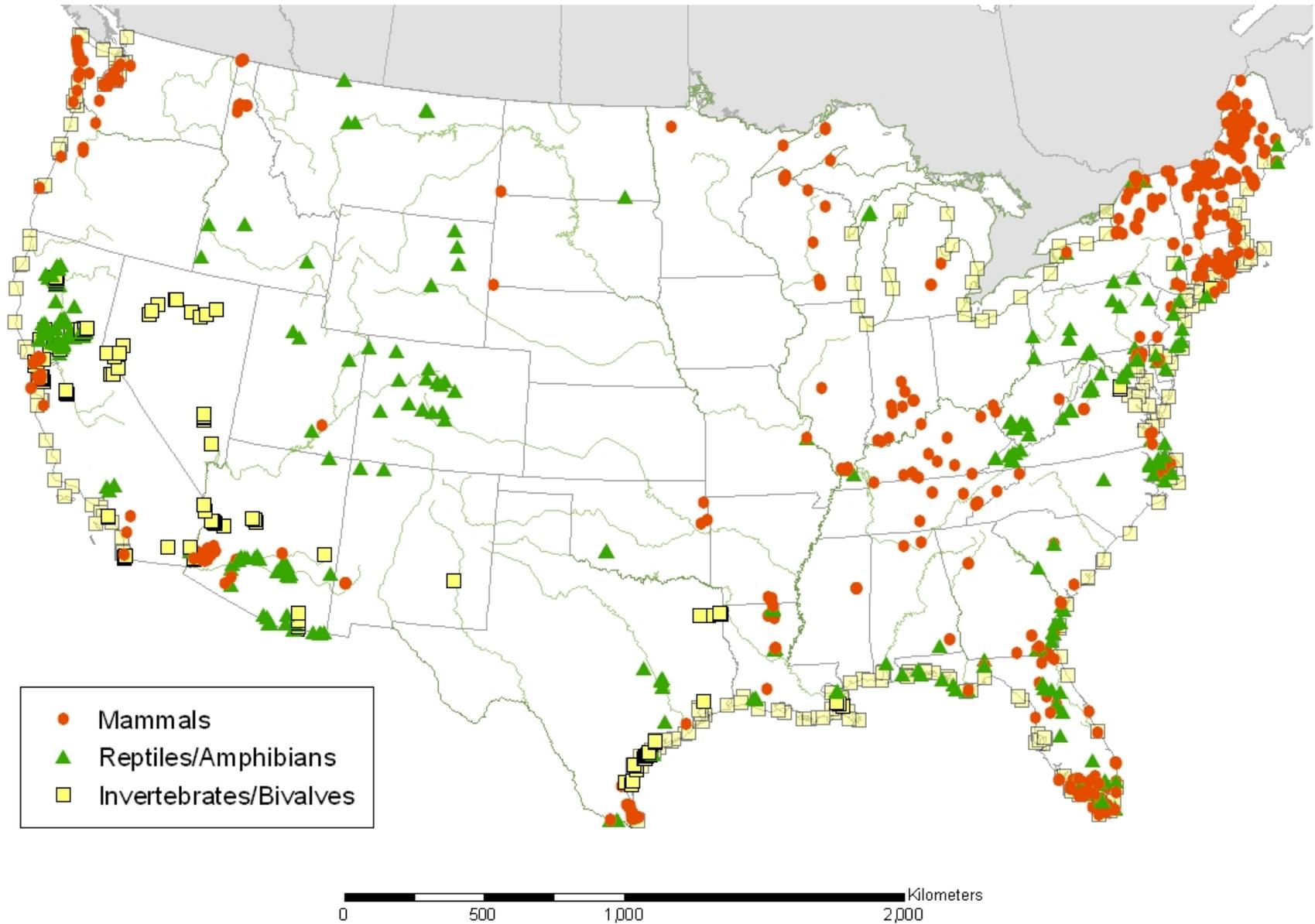
Source: Federal, state, academic, and private research datasets
Projection: USA Contiguous Albers Equal Area Conic
Datum: NAD83
Date: 4/30/2009
Scale: 1:117,500,000

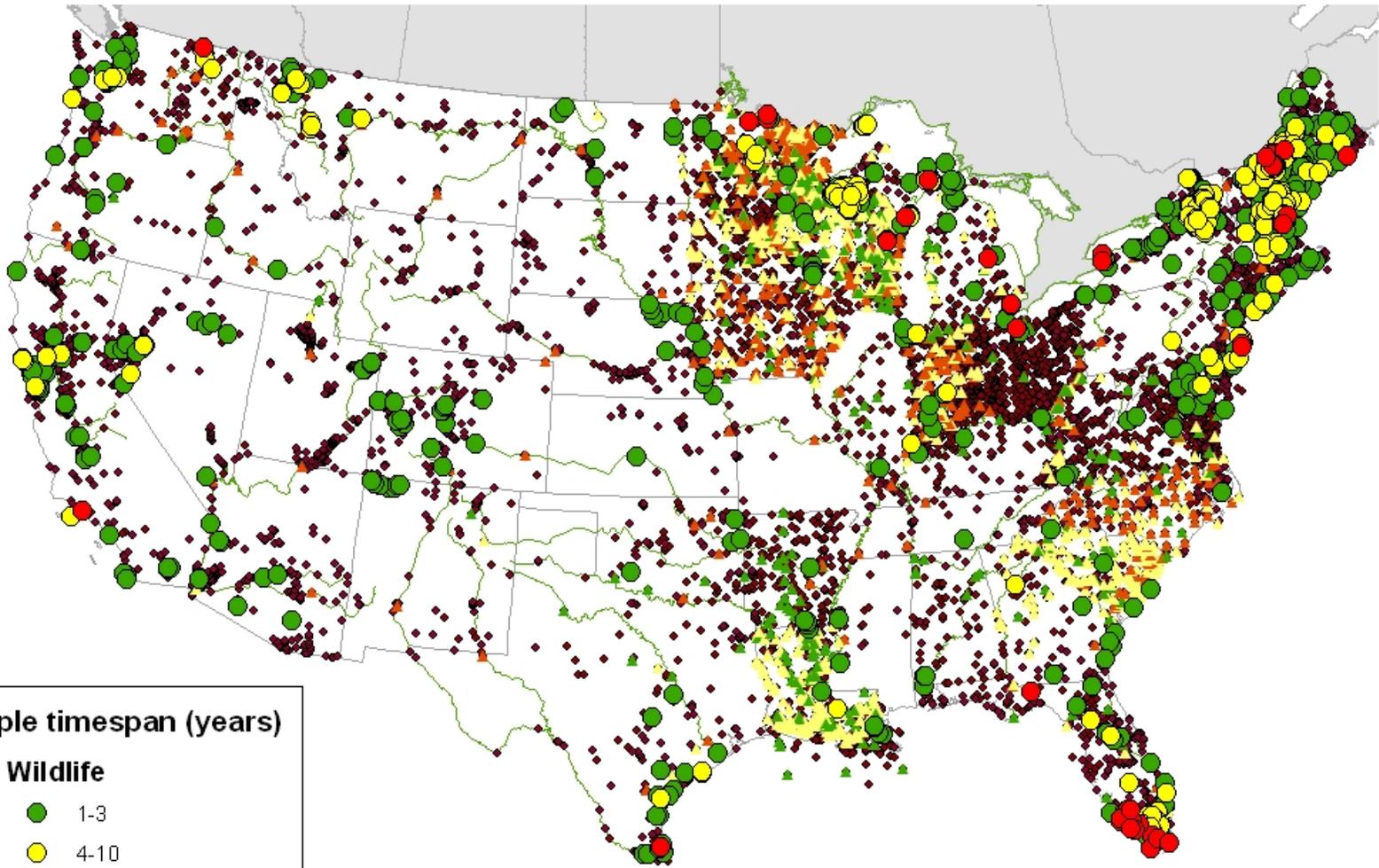
Avian invertivores

Songbirds (>3,000 records)

Key Group because risk and injury may be greatest and most diverse







Resample timespan (years)

Wildlife

- 1-3
- 4-10
- >10

Fish

- ▲ 1-3
- ▲ 4-10
- ▲ >10

No resample

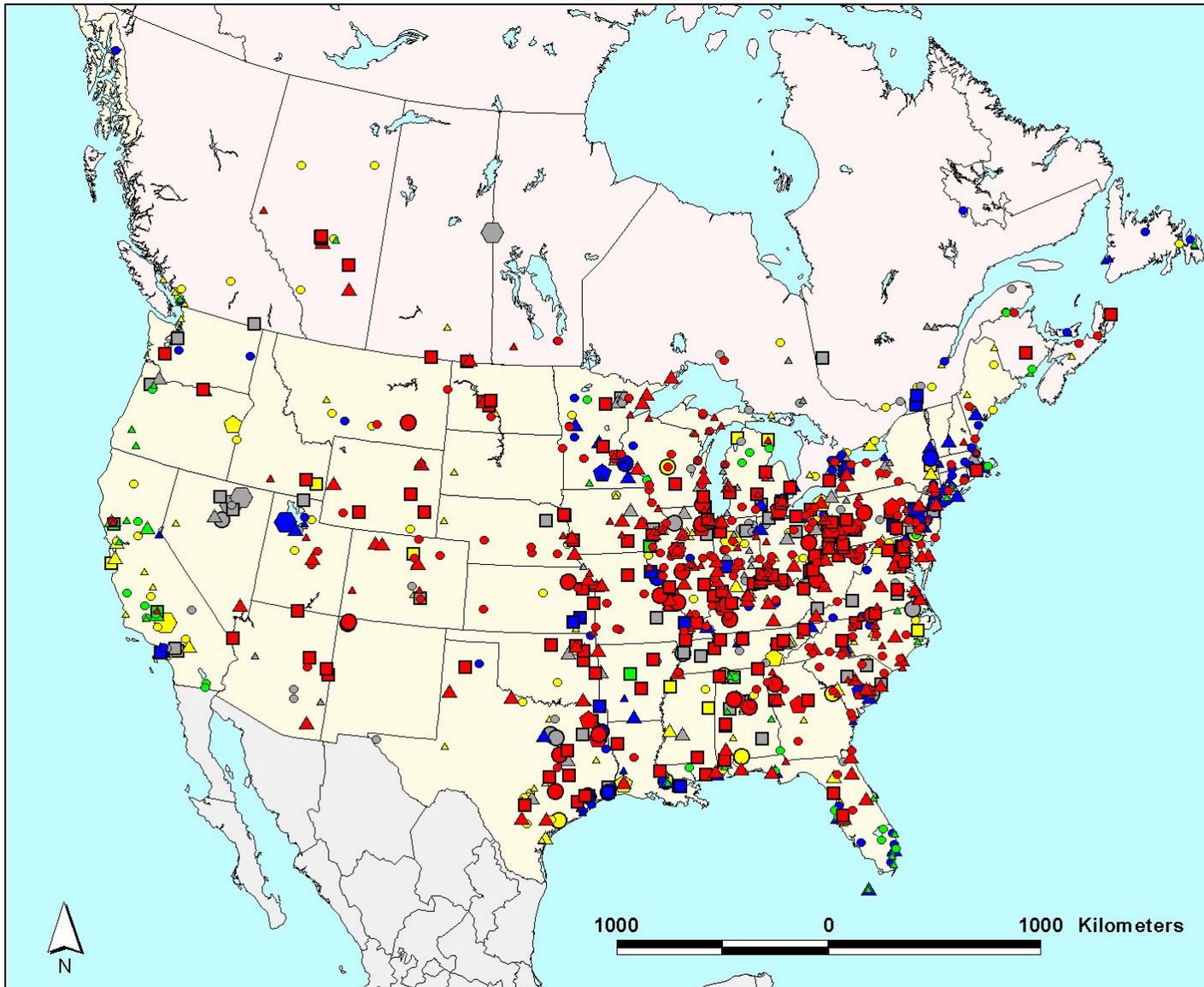
- ◆



Fish and Wildlife Resample Locations

Source: Federal, state, academic, and private research datasets
Projection: USA Contiguous Albers Equal Area Conic
USGS version
Date: 4/30/2008
Scale: 1:17,500,000

2002 U.S. and Canadian Emissions of Total Mercury [Hg(0) + Hg(p) + RGM]



Large Point Sources of Mercury Emissions Based on the 2002 EPA NEI and 2002 Envr Canada NPRI*

size/shape of symbol denotes amount of mercury emitted (kg/yr)

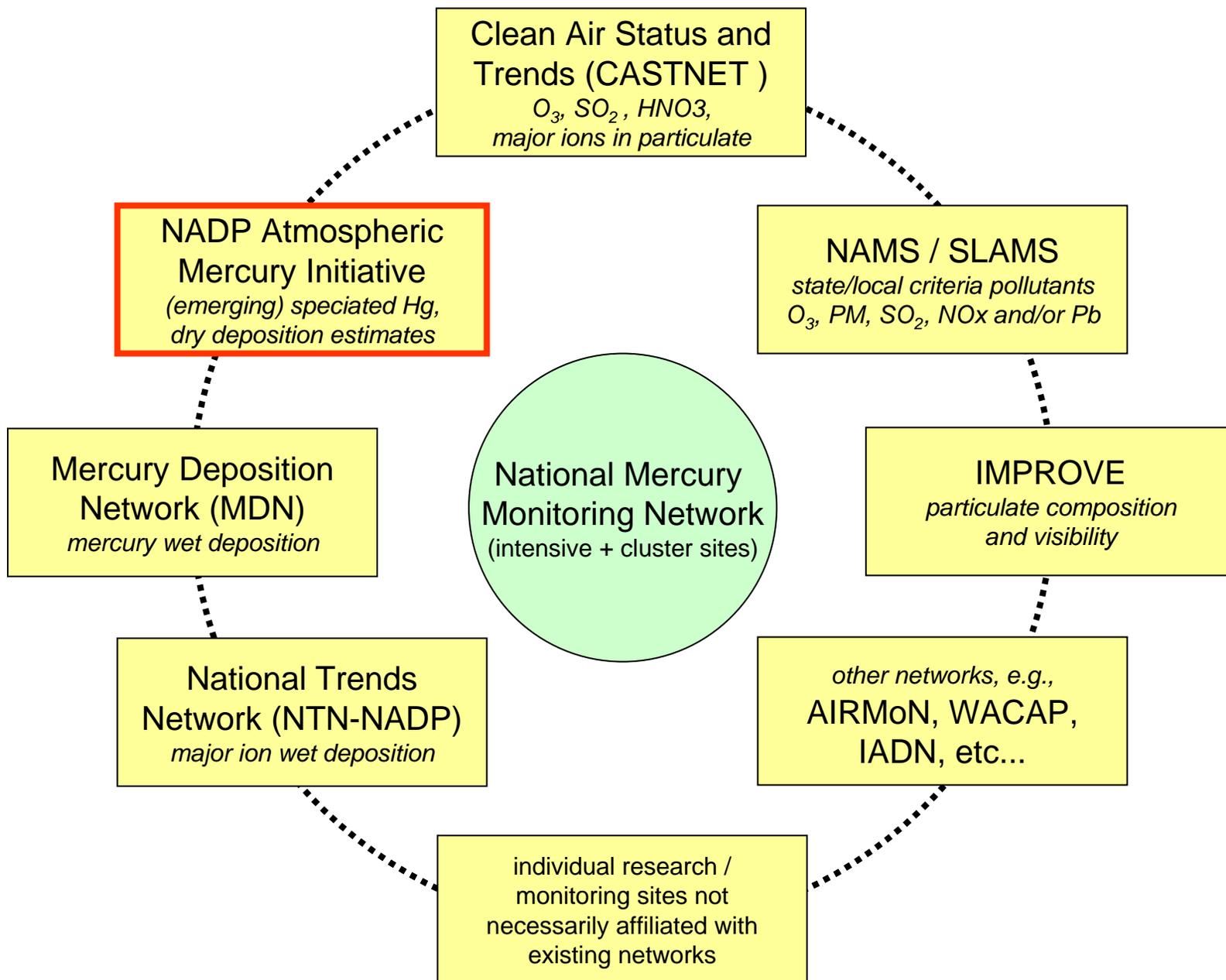
△	5 - 10
○	10 - 50
△	50 - 100
□	100 - 300
○	300 - 500
⬠	500 - 1000
⬡	1000 - 3000

color of symbol denotes type of mercury source

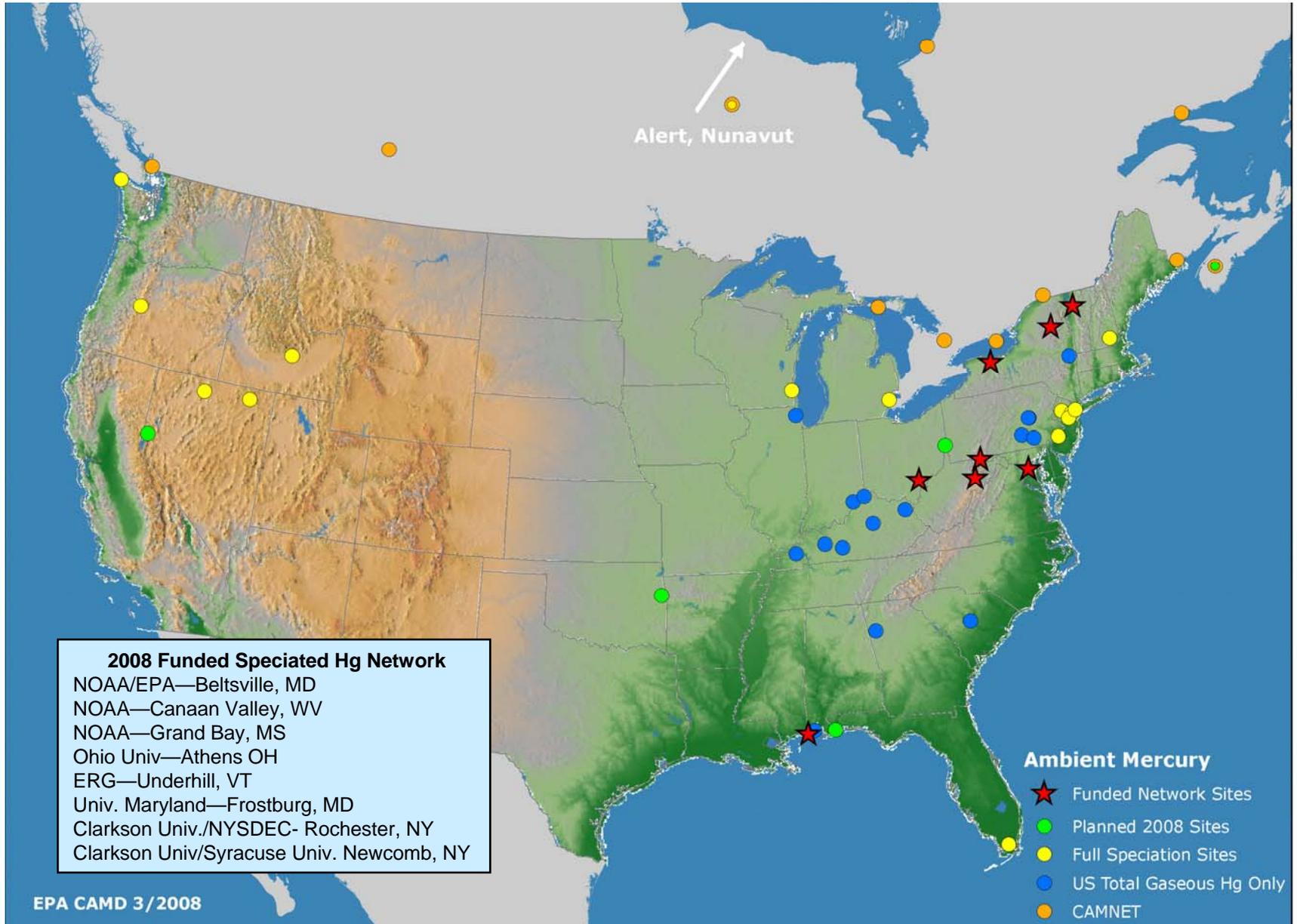
■	coal-fired power plants
■	other fuel combustion
■	waste incineration
■	metallurgical
■	manufacturing & other

* Note – some large Canadian point sources may not be included due to secrecy agreements between industry and the Canadian government.

There are a number of existing atmospheric measurement networks and sites



2008 NADP Atmospheric Mercury Initiative Network Sites



measurements needed to assess and understand atmospheric mercury

The presence of existing speciated atmospheric mercury measurements is an important siting consideration

				Measurement Network					
				Atmospheric Mercury Initiative	Mercury Deposition Network	CASTNET	NADP - NTN	NAMS / SLAMS	IMPROVE
Speciated Ambient Mercury concentration	***	\$\$\$\$		Green	Grey	Grey	Grey	Grey	Grey
Meteorological parameters (wind speed & direction, etc...)	***	\$		Green	Grey	Green	Grey	Yellow	Yellow
Mercury wet deposition	**	\$	\$\$ event-based	Orange	Green	Grey	Grey	Grey	Grey
Concentrations of key trace gases (e.g., SO ₂ , O ₃ , NO _x , CO)	**	\$	Continuous? # of pollutants?	Yellow	Grey	Green	Grey	Yellow	Grey
Major Ion wet deposition	*	\$	\$\$ event-based	Orange	Orange	Orange	Green	Grey	Grey
Particulate Matter	*	\$	\$\$ composition	Grey	Grey	SO4 NO3	Grey	Yellow	Green

Green always or usually included

Orange usually co-located with this measurement

Yellow sometimes or partially included

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Initial Characterization of Potential “Intensive” Sites

- In some cases, places with substantial mercury monitoring (historical and/or current)
- In some cases, places with some mercury monitoring, but would have to be expanded
- In some cases, places with little or no mercury monitoring, but considered to be important for geographical or other reasons
- List is not complete...*
- Characterization of potential intensive sites is not complete...*

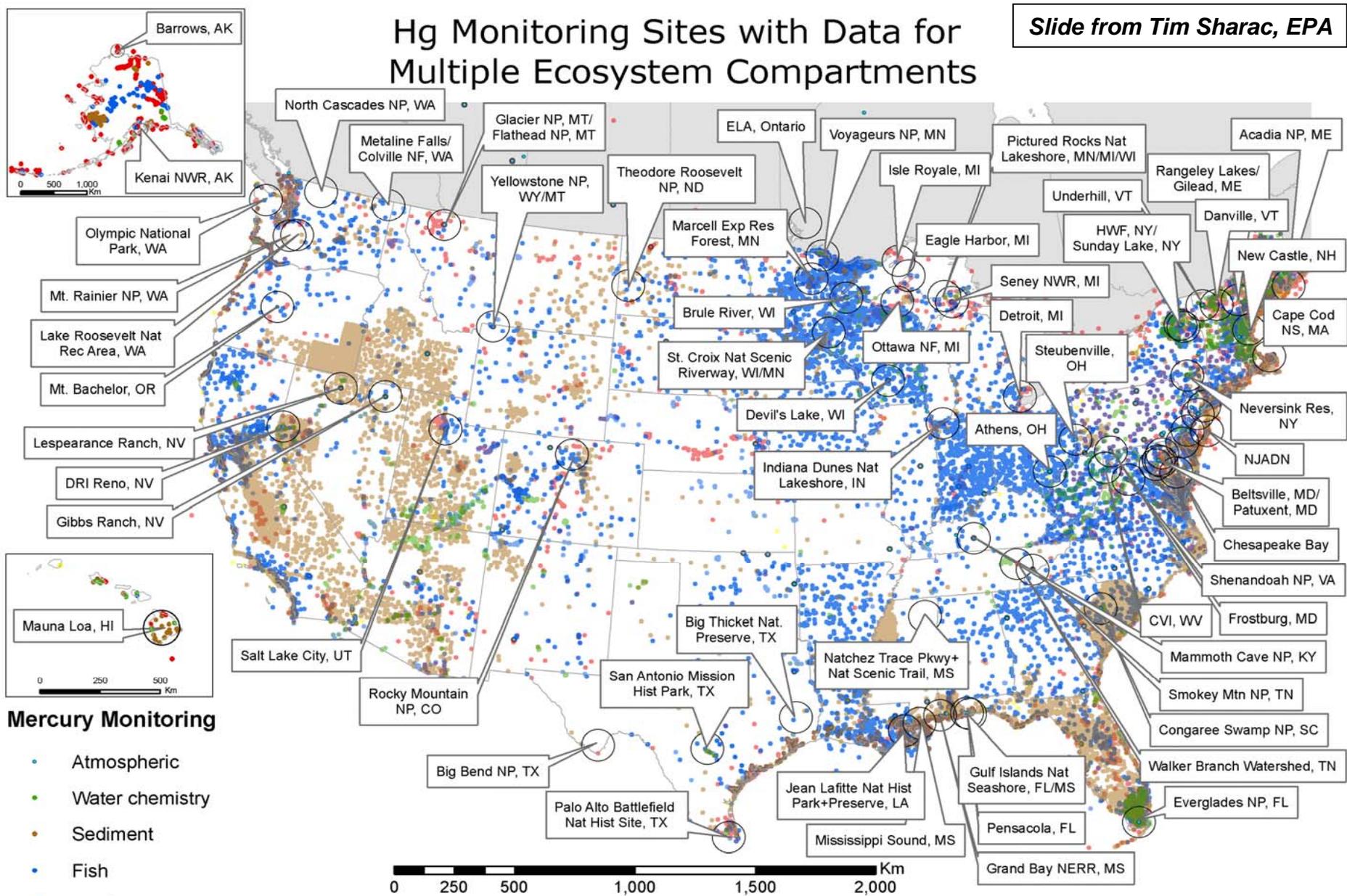


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Hg Monitoring Sites with Data for Multiple Ecosystem Compartments



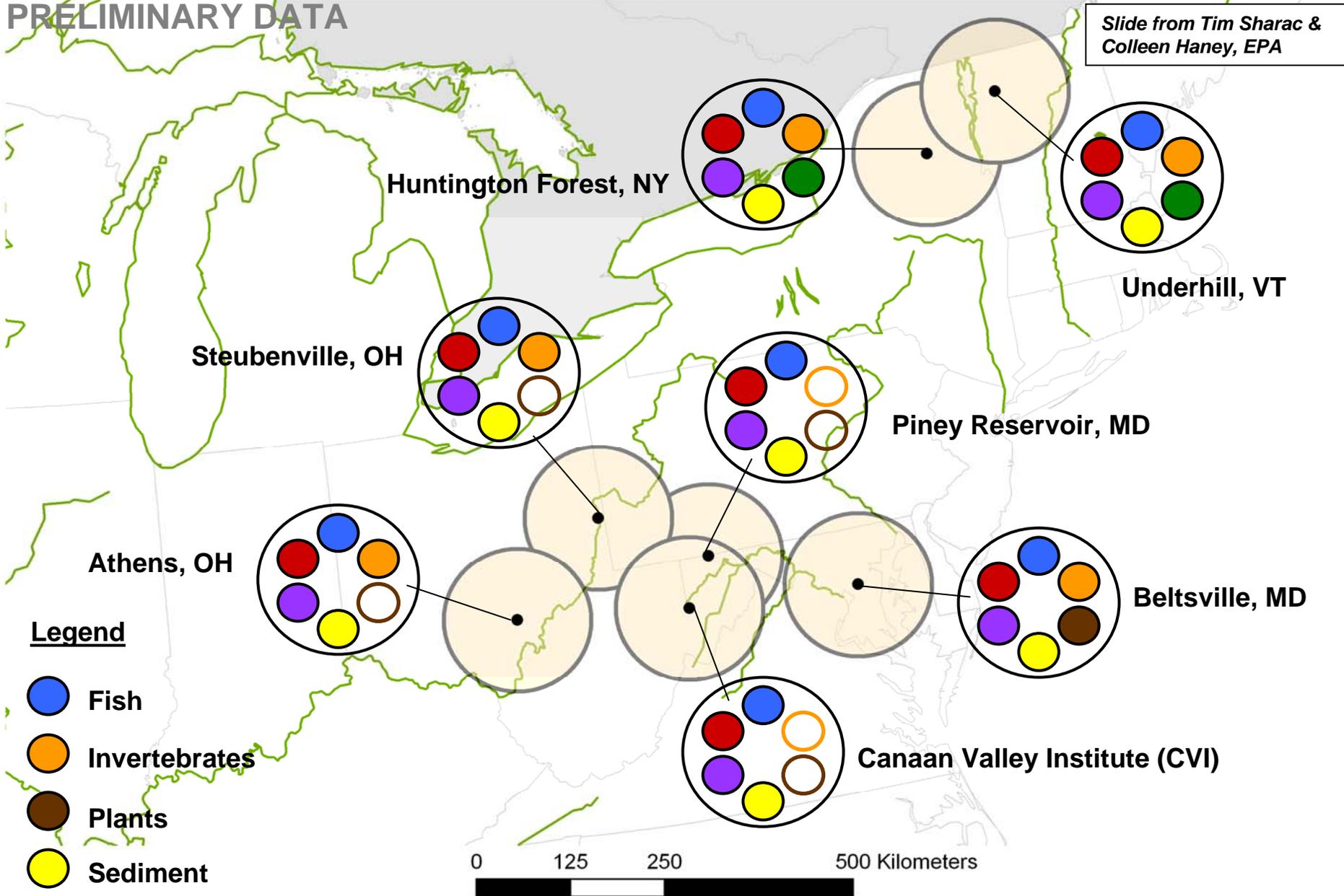
Mercury Monitoring

- Atmospheric
- Water chemistry
- Sediment
- Fish
- Birds
- Invertebrates
- 100 km radius circles

69 Mercury Monitoring Sites

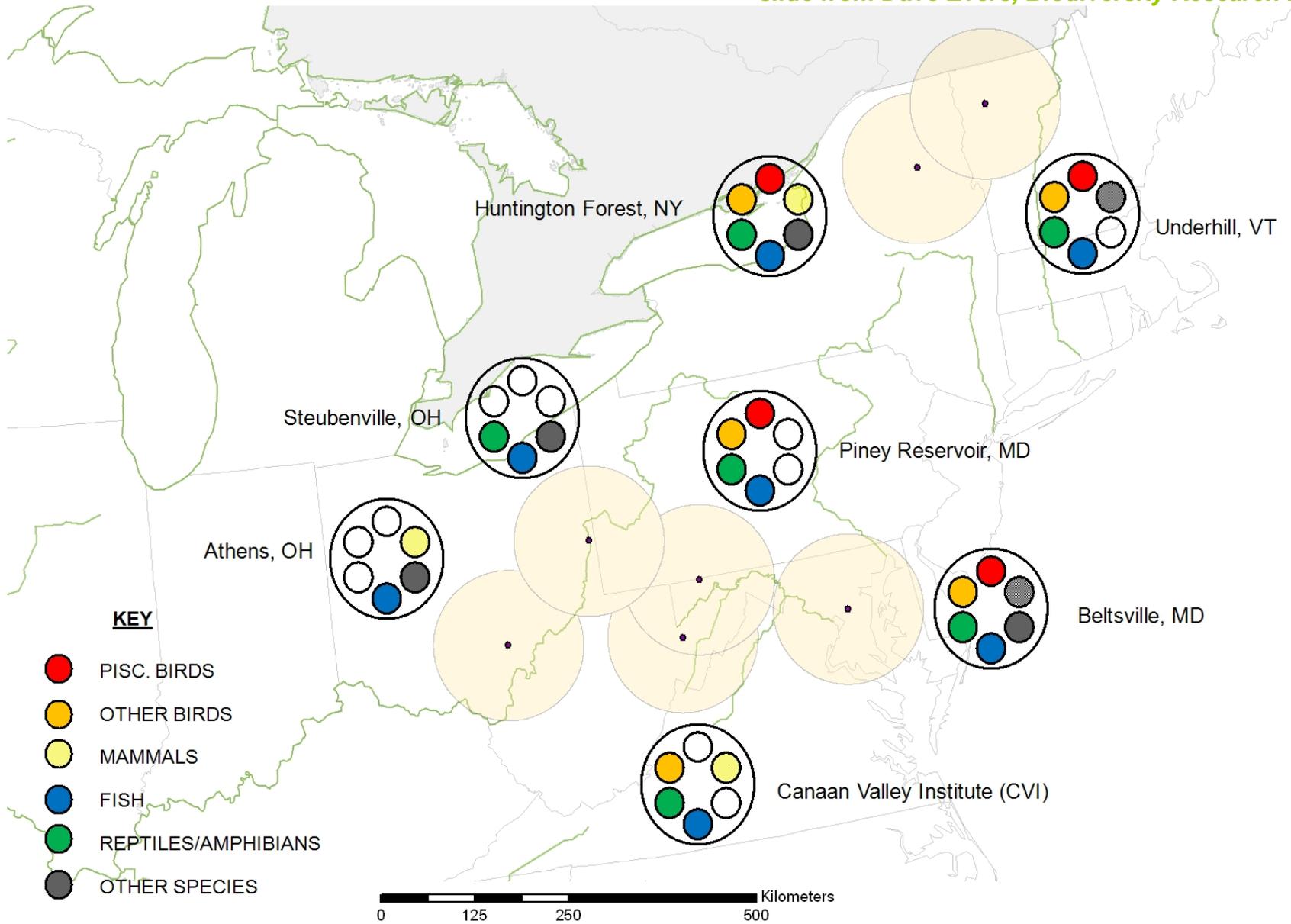
Source: US EPA-OAR-OAP-CAMD, NADP/MDN, NADP/NTN, other sources
 Projection: USA Contiguous Albers Equal Area Conic
 USGS Version
 Date: 4/30/2008
 Scale: 1:20,000,000

Slide from Tim Sharac & Colleen Haney, EPA



Mercury Monitoring Data at Northeastern and Midwestern Speciated Atmospheric Hg Monitoring Locations

Source: Federal and state agencies, academic institutions, and individual researchers
Projection: USA Contiguous Albers Equal Area Conic USGS Version
Date: 5/1/2008
Scale: 1:6,500,000



Sample Representation at Deposition Sites - Northeast

Source: Federal, state, academic, and private research datasets
Projection: USA Contiguous Albers Equal Area Conic
USGS Version
Date: 4/30/2008
Scale: 1:6,500,000

Thanks!



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