Trend Monitoring of Mercury in National Park Units of the Western Great Lakes Region

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Financial & Logistical Support

- National Park Service
  - Great Lakes Inventory & Monitoring Network
  - Individual park units
- Wisconsin Distinguished Professorships Program
- Univ Wisconsin-La Crosse Foundation
- Minnesota Pollution Control Agency
- US Geological Survey
- Legislative Commission on Minnesota Resources
- Thanks to UW-L co-workers Roger Haro, Kristofer Rolfhus, Sean Bailey, Nicole Forseth

NPS park units of the Great Lakes Network

Two national parks
- Isle Royale
- Voyageurs

Two riverine parks
- St Croix Riverway
- Mississippi River

Four national lakeshores
- Apostle Islands
- Indiana Dunes
- Pictured Rocks
- Sleeping Bear Dunes

One national monument
- Grand Portage

Great Lakes parks—diverse & abundant aquatic resources

Feature	Quantity
Great Lakes coastline	987 km
Great Lakes area	183,010 ha
Named streams	n = 112
Perennial streams	1,271 km
Intermittent streams	225 km
Named lakes	n = 133
Named lakes	40,843 ha
Wetlands	33,884 ha

Abundant & diverse aquatic resources

- Diverse assemblages of warm, cool, & cold-water fishes
- Fish & wildlife exposed to Hg from atmospheric deposition
- Many species of fish harvested recreationally in parks

Small streams

Recreational fisheries

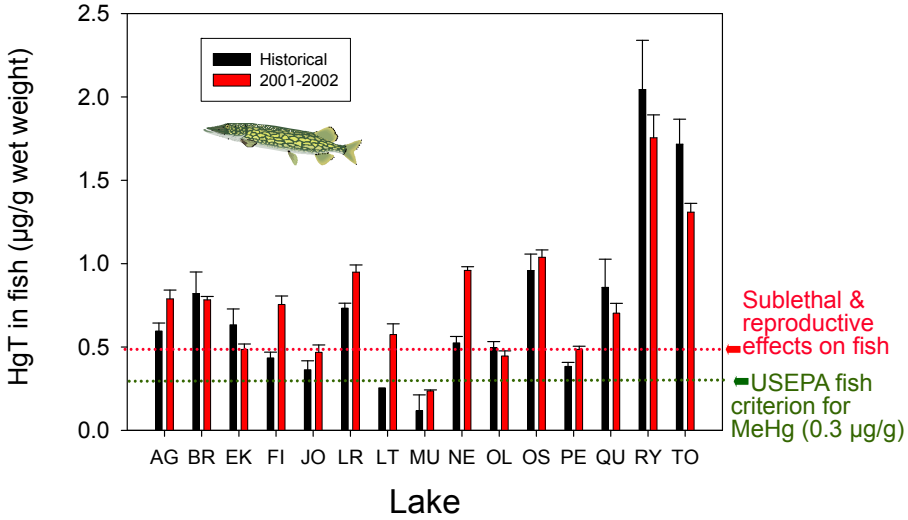
Large rivers

Sources of Mercury
Isle Royale & Voyageurs National Parks

- **Geologic sources of Hg are very small**, based on analyses of parent rocks and soils (Woodruff & others, USGS Open-File Reports)
- **Atmospheric deposition the dominant source**
- **About two-thirds of Hg from anthropogenic sources**, based on analyses of dated sediment cores (Engstrom & others)

ISRO: Drevnick et al. 2007, ES&T 41, 7266.
VOYA: Wiener et al. 2006, ES&T 40, 6261.

Hg concentration in 55-cm northern pike (with 95% CI)
- High concentrations in piscivorous fish
- Substantial variation among 15 lakes (Voyageurs shown)



Monitoring objectives

1) To assess spatial and temporal patterns in [MeHg] in aquatic food webs
2) To identify parks and sites where MeHg exposure may adversely affect biota
3) To identify factors and processes that control or influence bioaccumulation of MeHg in aquatic food webs

Two ongoing approaches for assessing MeHg bioaccumulation in 9 network parks

Aquatic biosentinel organisms

- Small prey fish (THg, whole organism)
- Adult predatory fish (THg, axial muscle)
- Larval dragonflies (MeHg, THg, whole organism)
- 6 parks (GRPO, INDU, ISRO, PIRO, SLBE, VOYA)
- 4-5 waters per park, sampled at 3-year intervals

Bald eagles (nestlings)

- HgT in breast feathers; sample 2 years on, 2 years off
- All accessible nests sampled (8 to 28 per park)
- 3 park units

Larval dragonflies (Odonata) as aquatic biosentinels

- Obligate predators; most identifiable to species
- Many species regionally widespread
- Larvae restricted to water where hatched
- Sufficient mass readily obtained with simple gear
- Ecology well documented at genus level
- Inhabit diverse aquatic & wetland habitats
- **Can extend monitoring to fishless waters**

1-Year-Old Yellow Perch (prey fish)

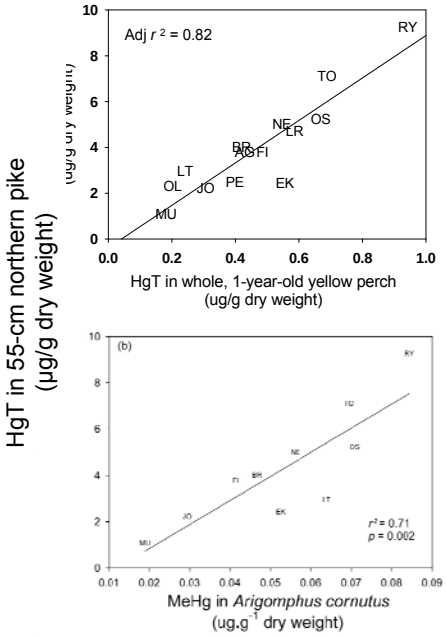
Biosentinel of MeHg in lacustrine food webs

- Regionally widespread and usually abundant
- Species important in trophic transfer of MeHg
- Most Hg in whole yellow perch is MeHg
- Constrained diet during first year
- Total Hg reflects [MeHg] in food web
- Precise estimates of mean [Hg] with n of 15-25 fish

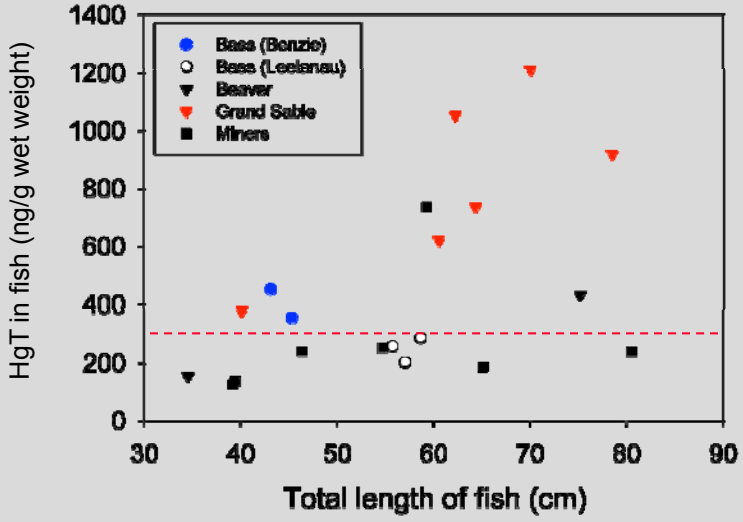
Perch & dragonflies as indicators of Hg in predatory fish (Voyageurs lakes)

Yellow perch (age-1)

Horned clubtail dragonfly
Arigomphus cornutus
(shown as adult)



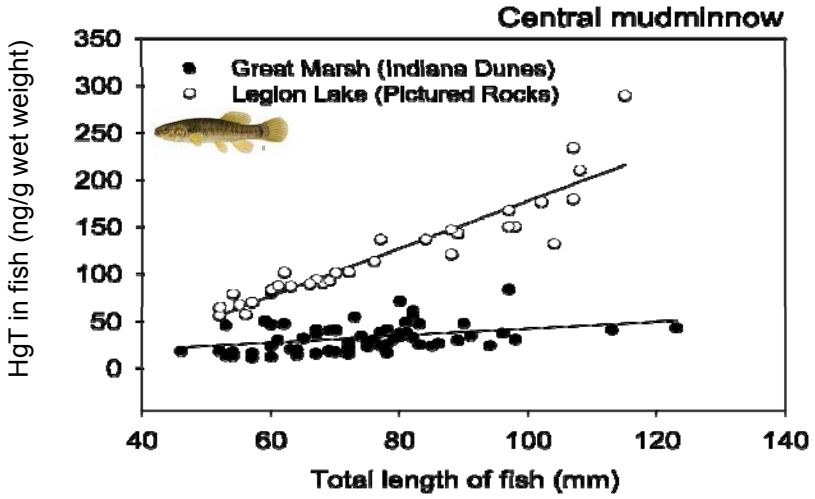
Mercury in northern pike (lakes in Pictured Rocks & Sleeping Bear Dunes Nat Lakeshores)



Addressing concerns of park managers

Great Marsh: wetland-restoration project

Legion Lake: low-pH lake with nesting loons



Mercury in Nestling Bald Eagles

Bill Route, Project Leader

Sampling in three parks

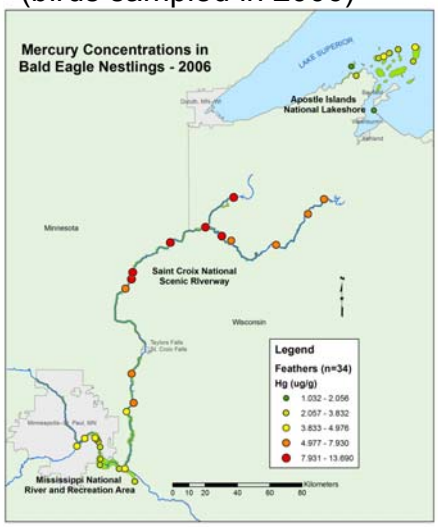
- Apostle Islands
- St Croix Scenic Riverway
- Mississippi River

Chemical analyses

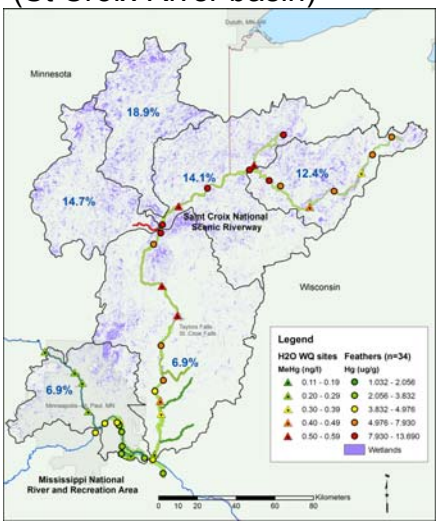
- THg in feathers
- Organic contaminants in blood serum (PBDEs, PFCs, PCBs, DDT and metabolites)

Spatial Patterns: Mercury in Bald Eagles

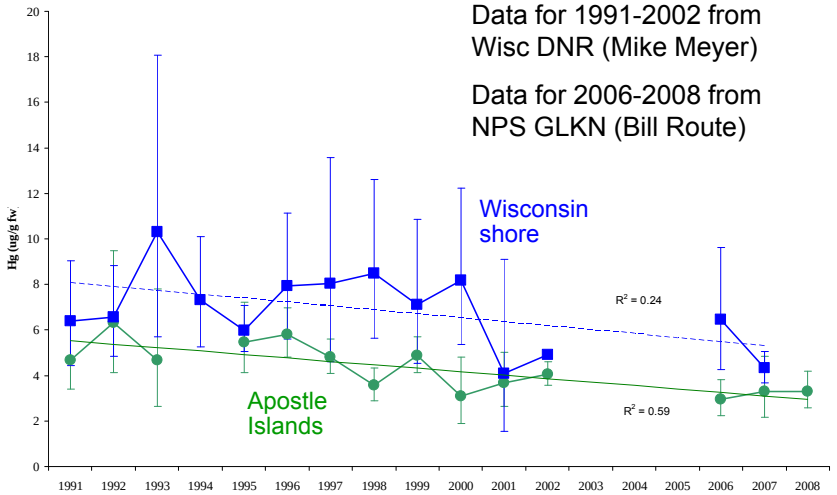
HgT in breast feathers
(birds sampled in 2006)



Relation to wetland density
(St Croix River basin)



Decadal trend in THg in bald eagle feathers: southern Lake Superior (geometric mean & 95% CI)



Data for 1991-2002 from
Wisc DNR (Mike Meyer)

Data for 2006-2008 from
NPS GLKN (Bill Route)

Ongoing analyses of dated sediment cores to assess recent trends in Hg loadings
(Dan Engstrom, SCWRS)

Study Sites

- Voyageurs (7 lakes)
- Isle Royale (4)
- Apostle Islands (2)
- Pictured Rocks (2)
- Sleeping Bear Dunes (3)
- Grand Portage (2)
- Re-coring 20 NE MN lakes (funded by GLAD)

Great Lakes Parks as monitoring sites

- **Hg-sensitive landscapes**; significant MeHg exposure of piscivorous fish & wildlife
- **Protected landscapes** with diverse and important aquatic resources
- **Strong interest & support** (NPS & public)
- **Substantial existing data** (Hg & ancillary)
- **Strong science capability**; many collaborating investigators & institutions
- **Regionally distributed parks**, with landscapes ranging from lightly impacted (Isle Royale) to heavily impacted by humans (Indiana Dunes)