Mercury in National Park units of the western Great Lakes region—assessing bioaccumulation in aquatic food webs

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Financial & Logistical Support

- National Park Service
  - Great Lakes Network
  - Individual park units
- Wisconsin Distinguished Professors Program
- Univ Wisconsin-La Crosse Foundation
- Early work: Minn Pollution Control Agency, USGS

Nine park units of the NPS 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

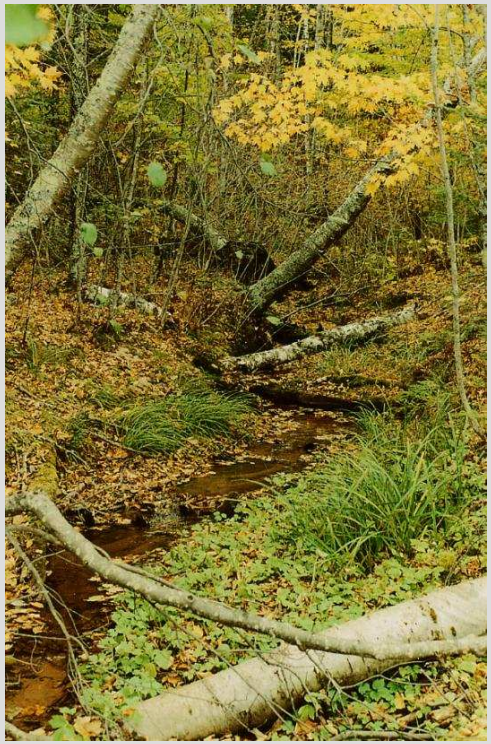
- Grand Portage

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

Natural park resources and mercury

- Atmosphere the dominant Hg source (~2/3 anthropogenic)
- Geologic Hg sources very small
- Some fish & wildlife exposed to high [MeHg]
- Recreation fishes: pathway for human exposure to MeHg



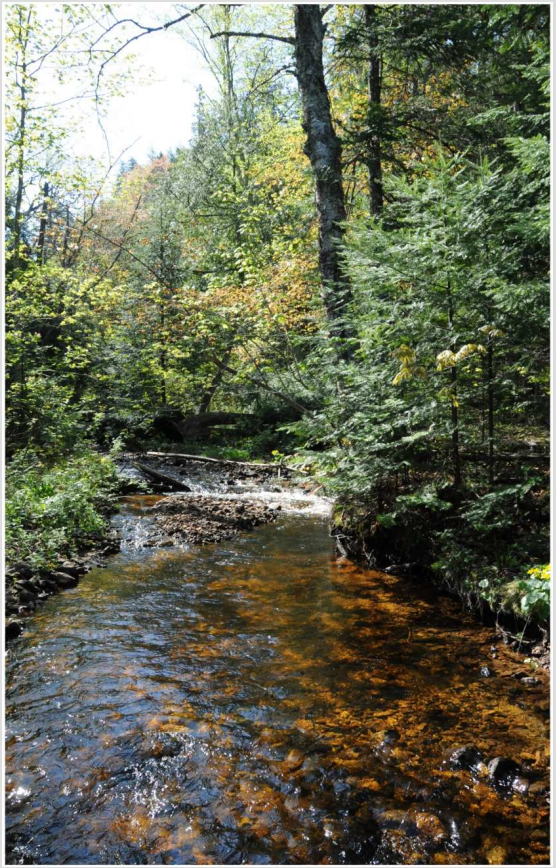
Small streams

Recreational fisheries

Large rivers

Monitoring objectives

1) To identify 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 controlling MeHg bioaccumulation in food webs



Two ongoing monitoring approaches

Aquatic biosentinels in 6 parks (UW-L, begun 2008)

- Small prey fish (THg: whole organism)
- Adult predatory fish (THg: axial muscle)
- Larval dragonflies (MeHg & THg: whole organism)
- 4-5 waters per park, at 1- to 2-yr intervals

Bald eagles in 3 parks (NPS, begun 2006)

- Sampled early May-early June
- Nestlings at age 5-9 weeks (HgT: breast feathers)
- All accessible nests sampled (8 to 28 per park)
- Sampling 2 years on, 2 years off

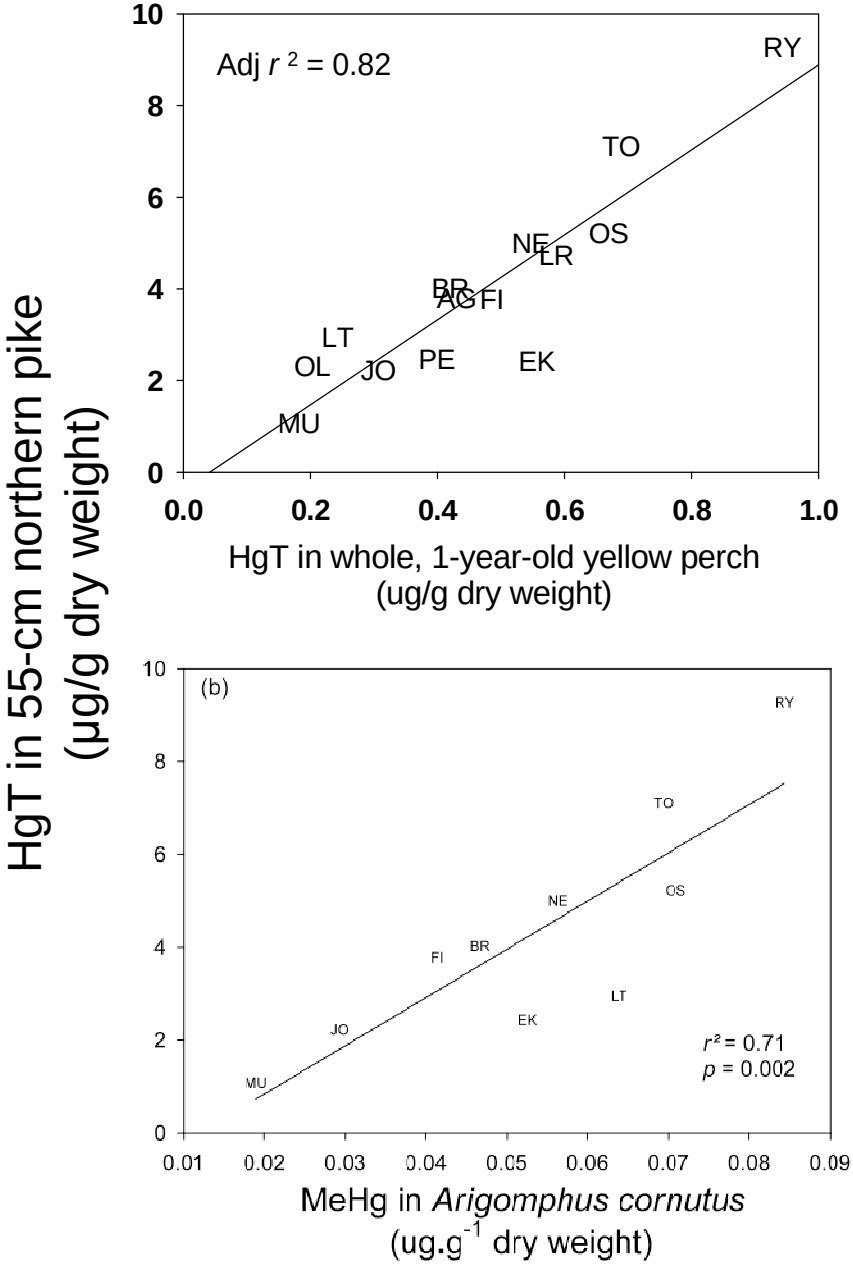
Larval dragonflies (Odonata) as aquatic biosentinels

- Obligate predators; ecology well documented
- Many taxa widespread; most identifiable to species
- Individual mass sufficient for THg & MeHg
- Readily obtained with simple gear
- Restricted to water body where hatched
- Inhabit diverse aquatic & wetland habitats
- **Extend monitoring to fishless waters**

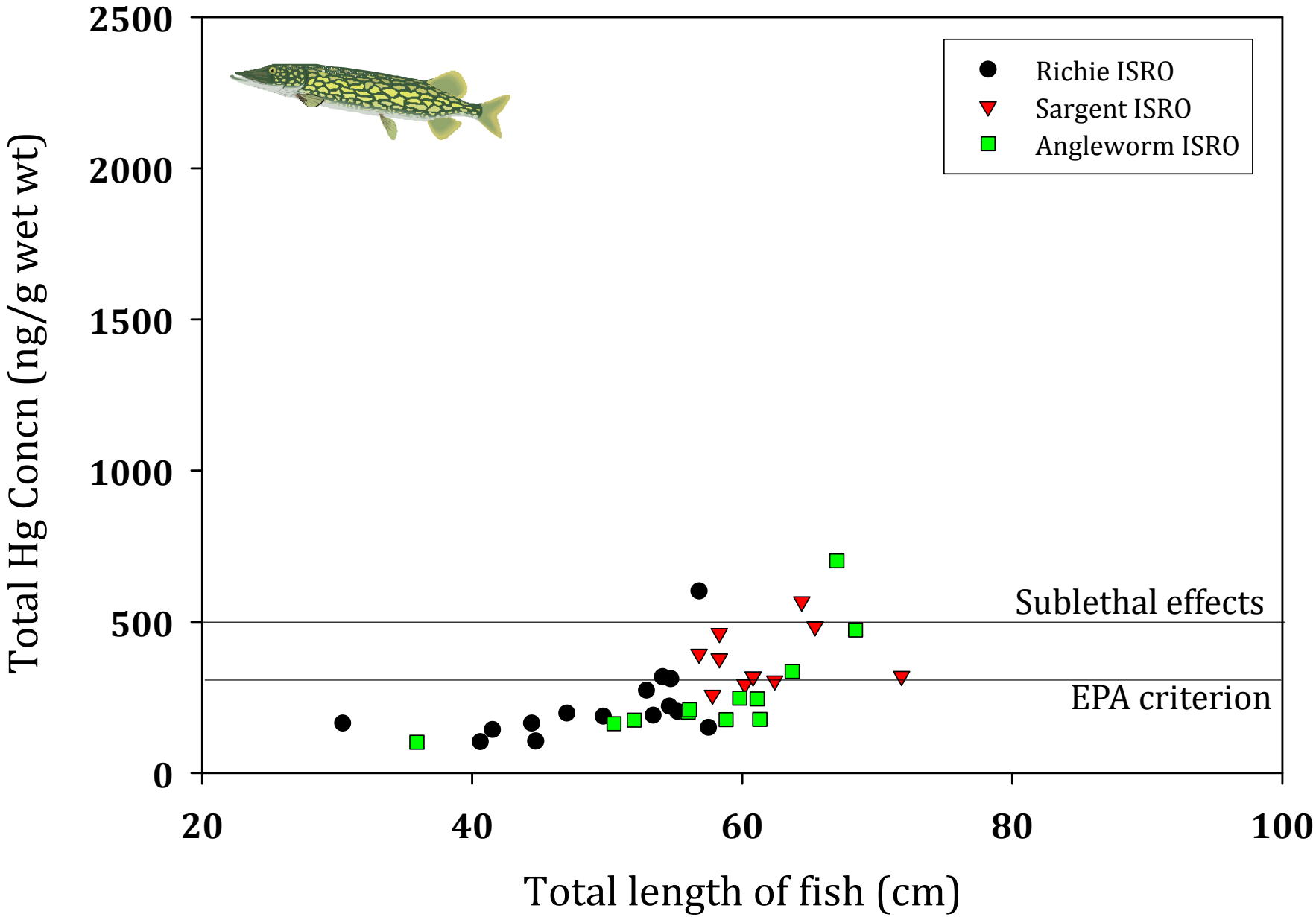
Perch & dragonflies as indicators of Hg in predatory fish (Voyageurs lakes)

Yellow perch (age-1)

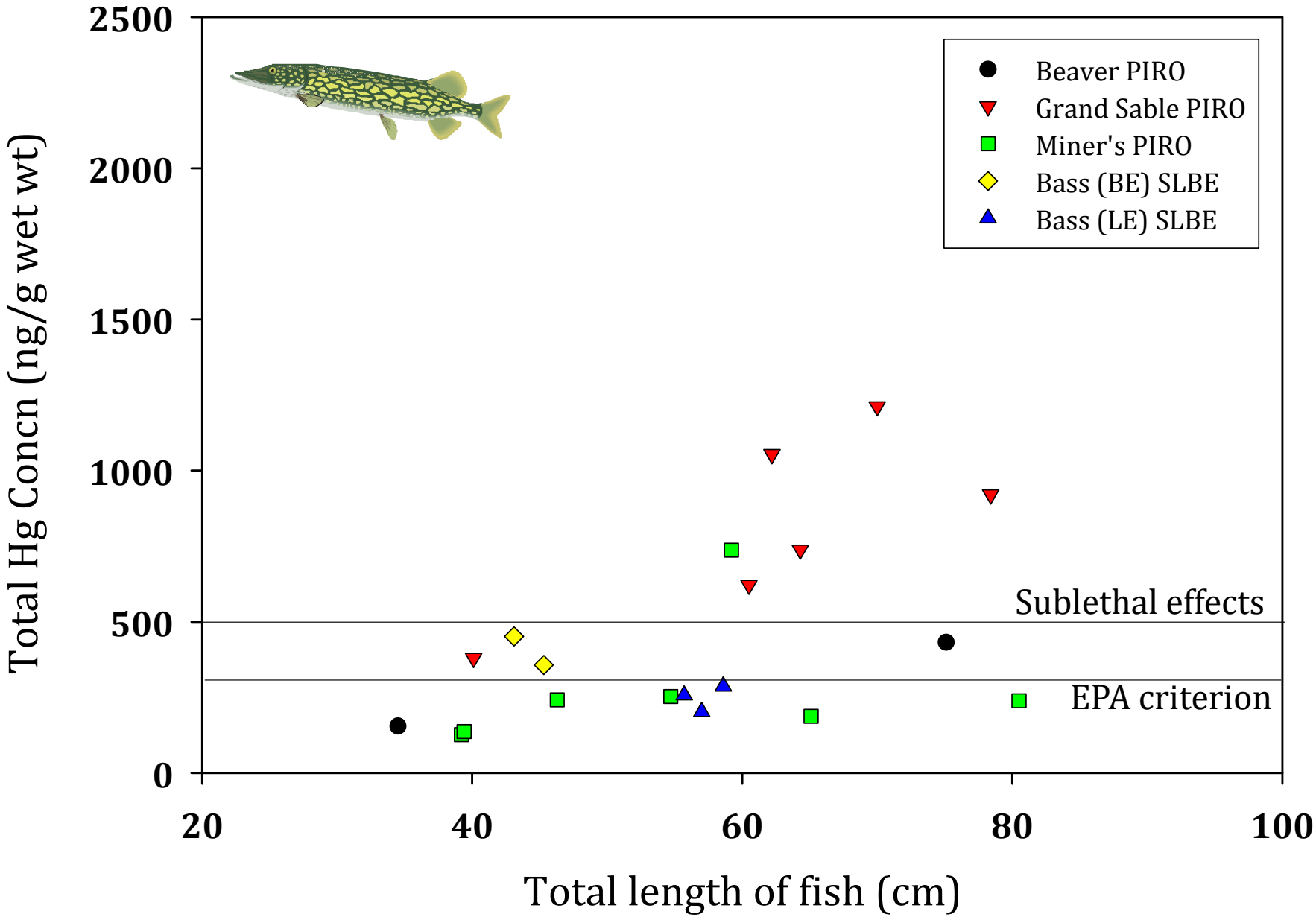
Horned clubtail dragonfly
Arigomphus cornutus
(shown as adult)



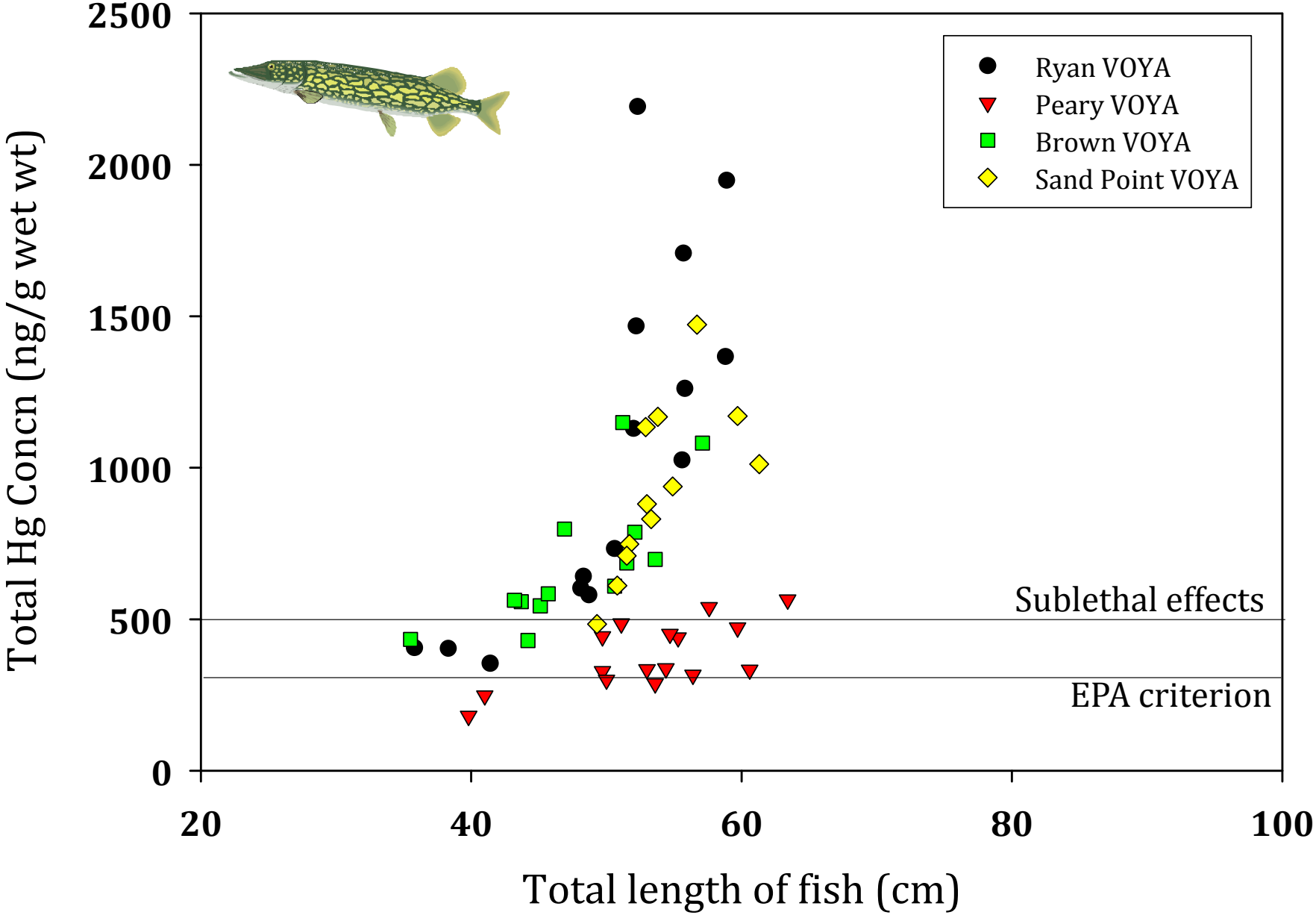
Northern Pike: Isle Royale (2009)



Northern Pike: Pictured Rocks & Sleeping Bear Dunes (2008)



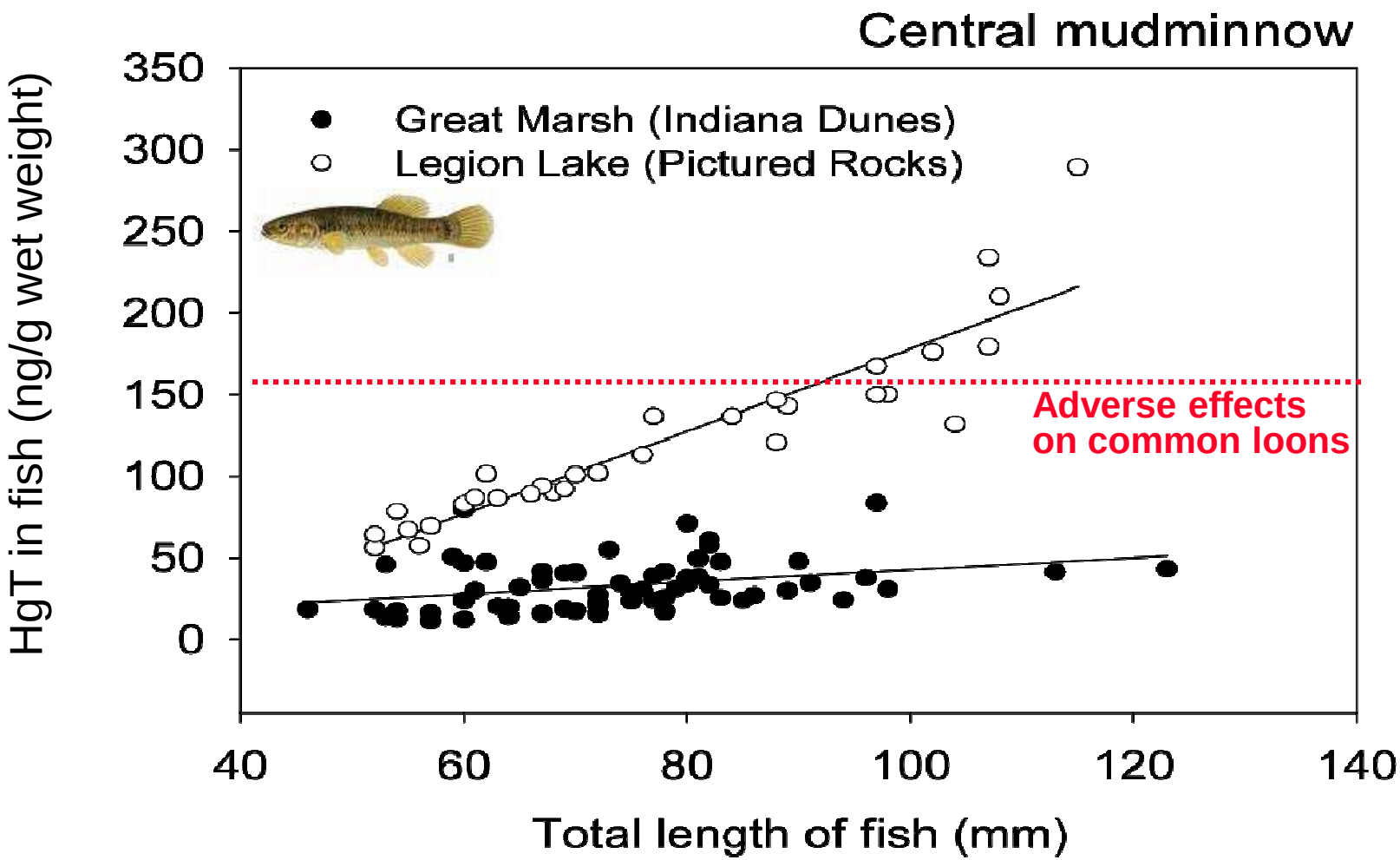
Northern Pike: Voyageurs (2009)



Addressing concerns of park managers

Great Marsh: wetland-restoration project

Legion Lake: low-pH lake with nesting loons



Mercury in Nestling Bald Eagles

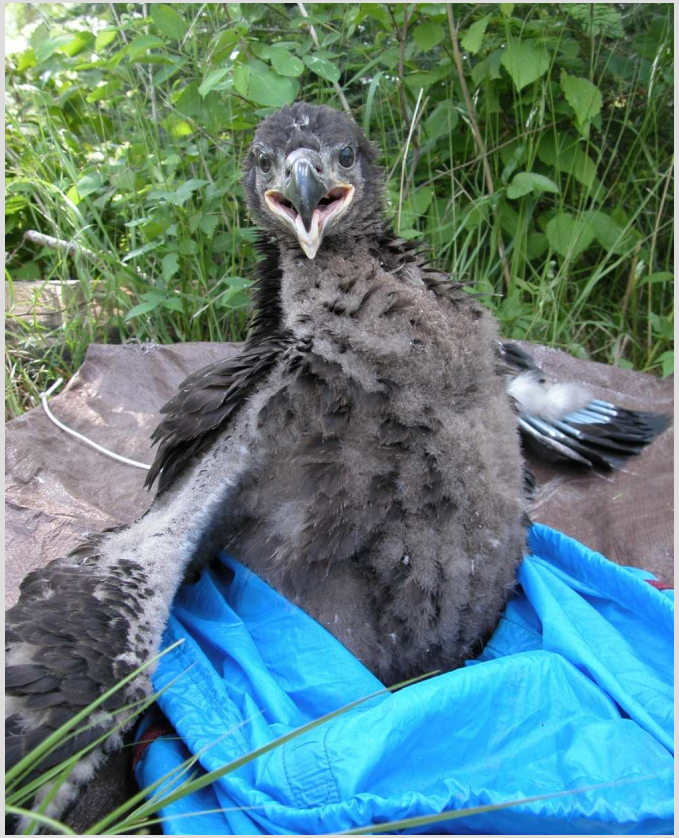
Bill Route (PI), NPS

Sampling in three parks

- Apostle Islands
- St Croix Scenic Riverway
- Mississippi River

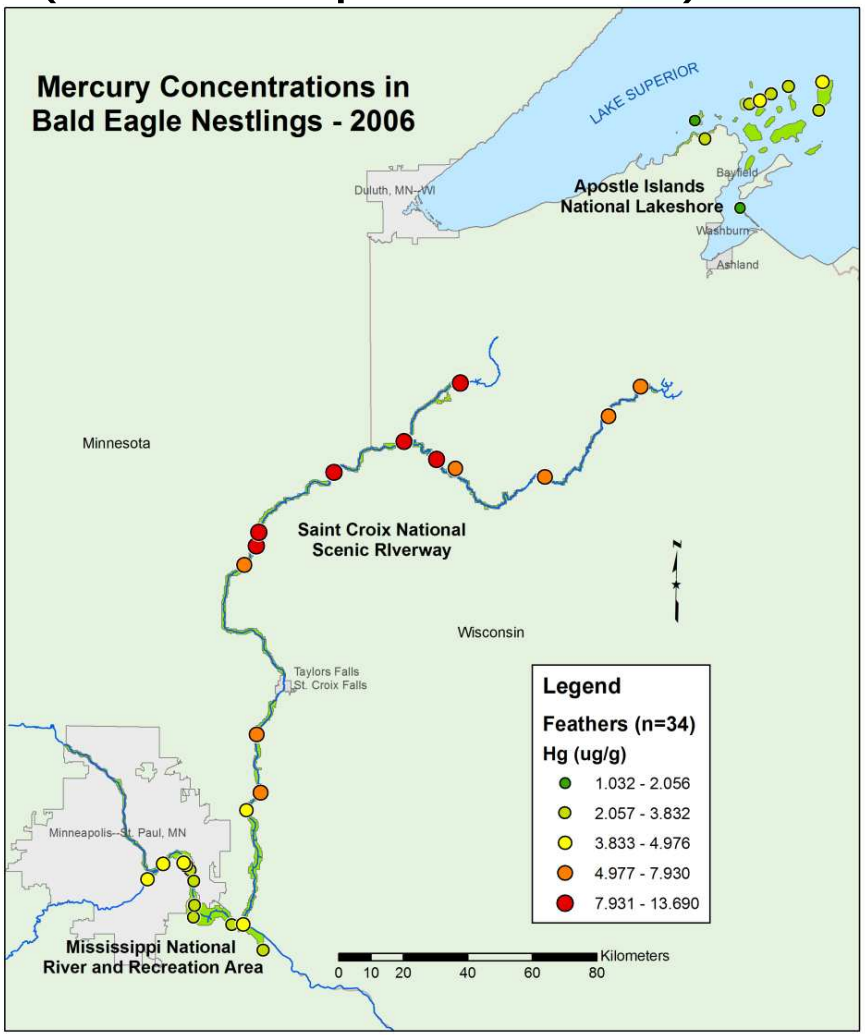
Chemical analyses

- THg in feathers

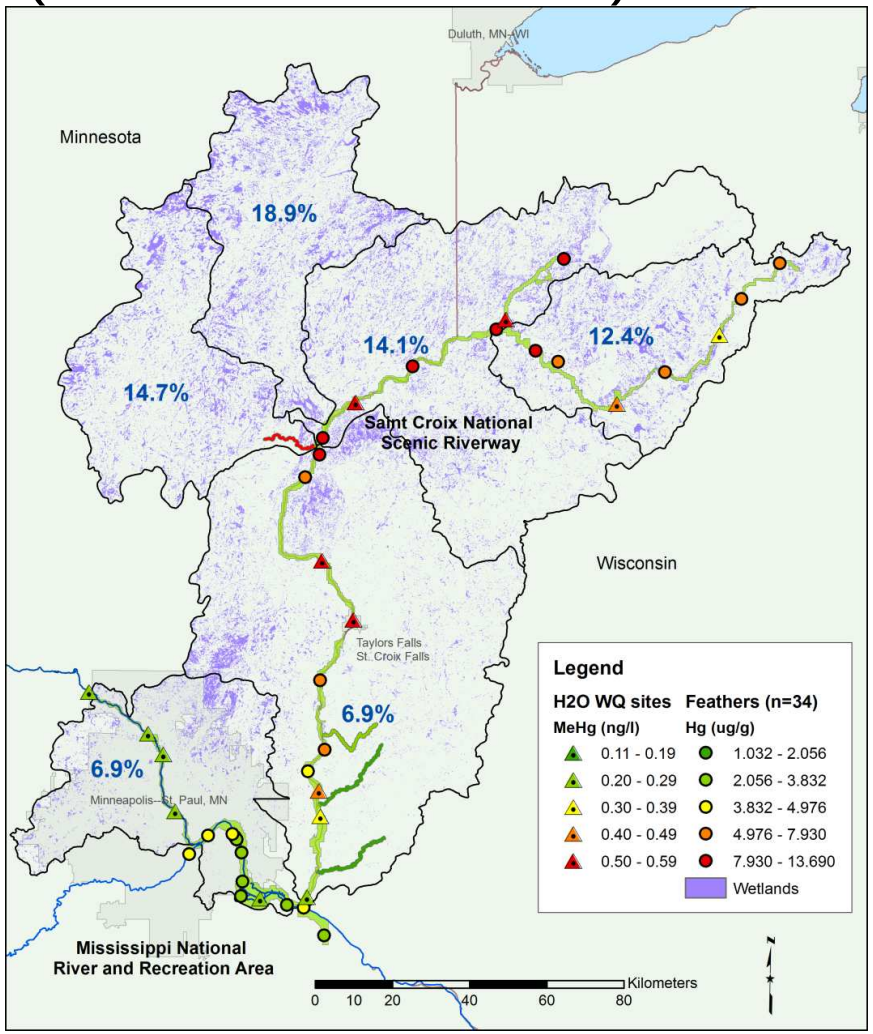


Spatial Patterns: Mercury in Bald Eagles

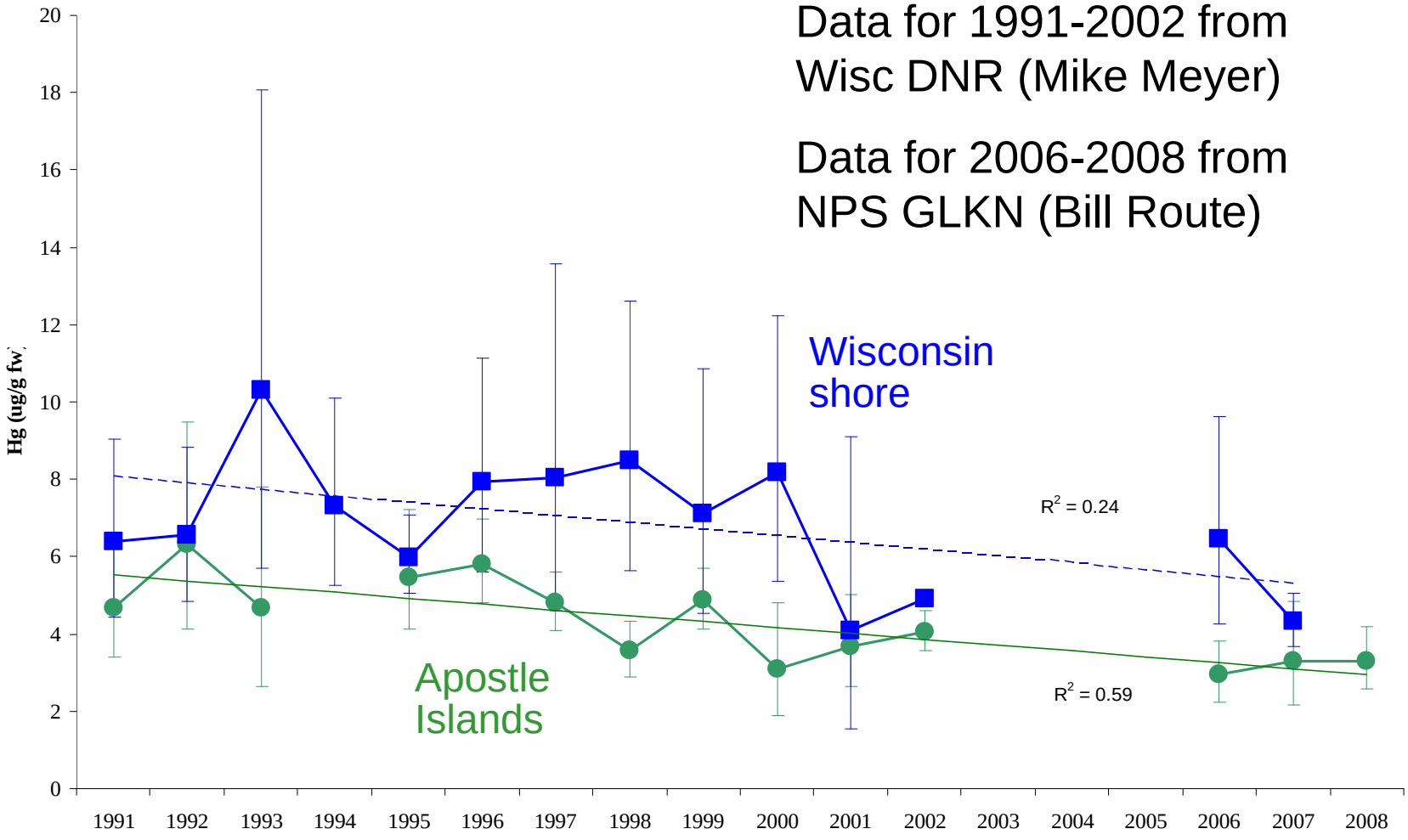
HgT in breast feathers
(birds sampled in 2006)



Relation to wetland density
(St Croix River basin)



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



Great Lakes parks as monitoring sites

- **Hg-sensitive landscapes** with significant MeHg exposure of piscivorous fish, wildlife
- **Protected landscapes** managed by National Park Service
- **Strong interest & public support**
- **Substantial existing data** (Hg + ancillary)
- **Regionally distributed sites** ranging from lightly impacted (Isle Royale) to heavily impacted (Indiana Dunes)

Future Work (2010-2014)

Great Lakes Restoration Initiative

- Intensive analyses of aquatic food webs
- Assess controls on MeHg production and bioaccumulation
- Assess sublethal effects of MeHg exposure on fish