PROGRESS MADE IN DEVELOPMENT OF A MULTI-COMPARTMENT MERCURY MODEL FOR THE GREAT LAKES REGION

Presentation for the Lake Ontario Modeling and Monitoring Worskshop

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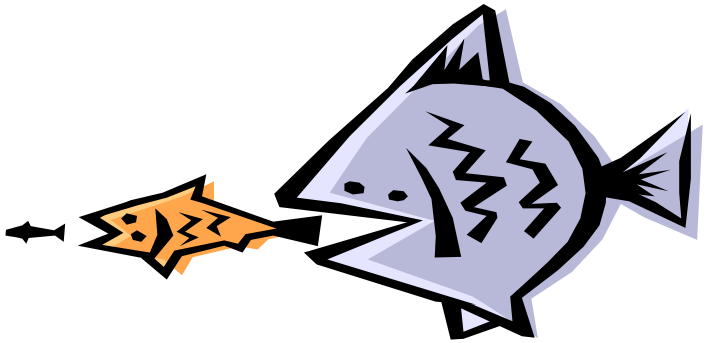
LaMP indicators: Beneficial Uses



- 3 key human uses:
  - Fish consumption
  - Drinking water
  - Recreation (bathing & beaches)

- Walleye & Smallmouth Bass exceed regulatory thresholds for Hg
- In Ontario, 26% of consumption restrictions in Lake Ontario sport fish are due to mercury (2002)
- Wolfgang yesterday: Presently only 7-8% (2005-2006)

Recreational Fisheries in Lake Ontario

Province of Ontario

- >170,000 fish harvested annually
- >140,000 boat trips
- $54 million direct angler expenditures

New York State

- >280,000 fish harvested annually
- >200,000 boat trips
- $131 million direct angler expenditures

Source: Schneider et al., 1990
Stewart et al., 1990

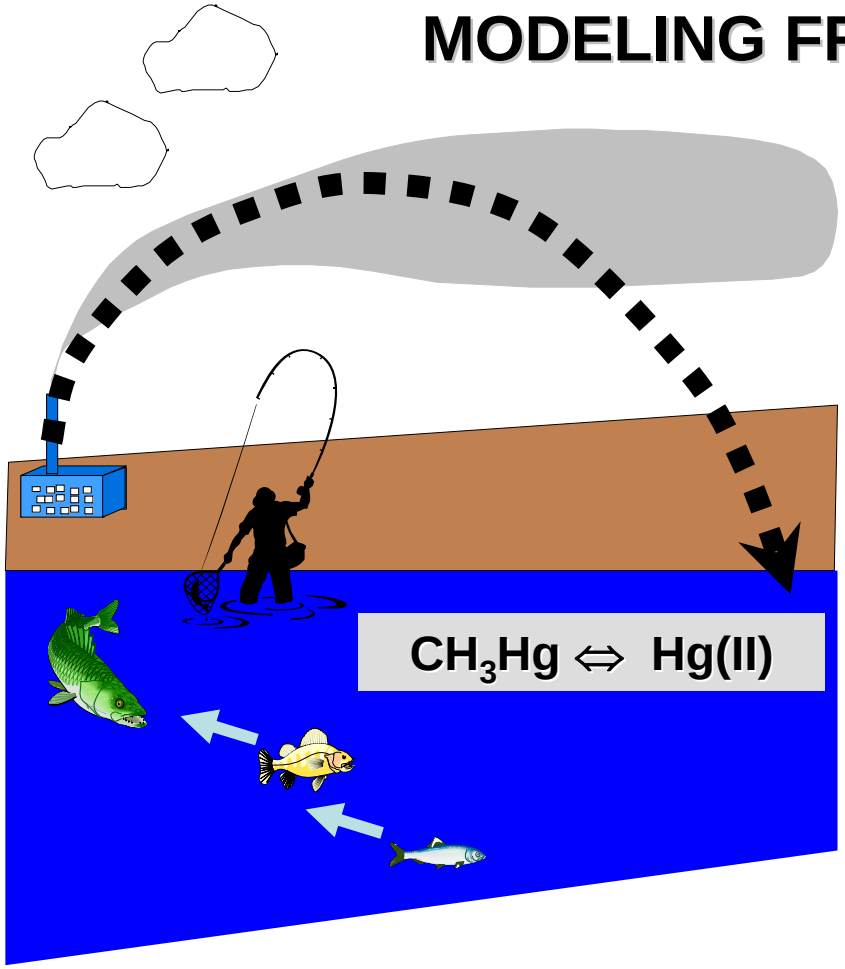
Management Questions

- How will changes in emissions of mercury from human sources affect fish mercury levels in the Great Lakes region?

- Can we evaluate the effectiveness of different regulatory options at reducing exposure of humans and wildlife to mercury?

Integrated Framework

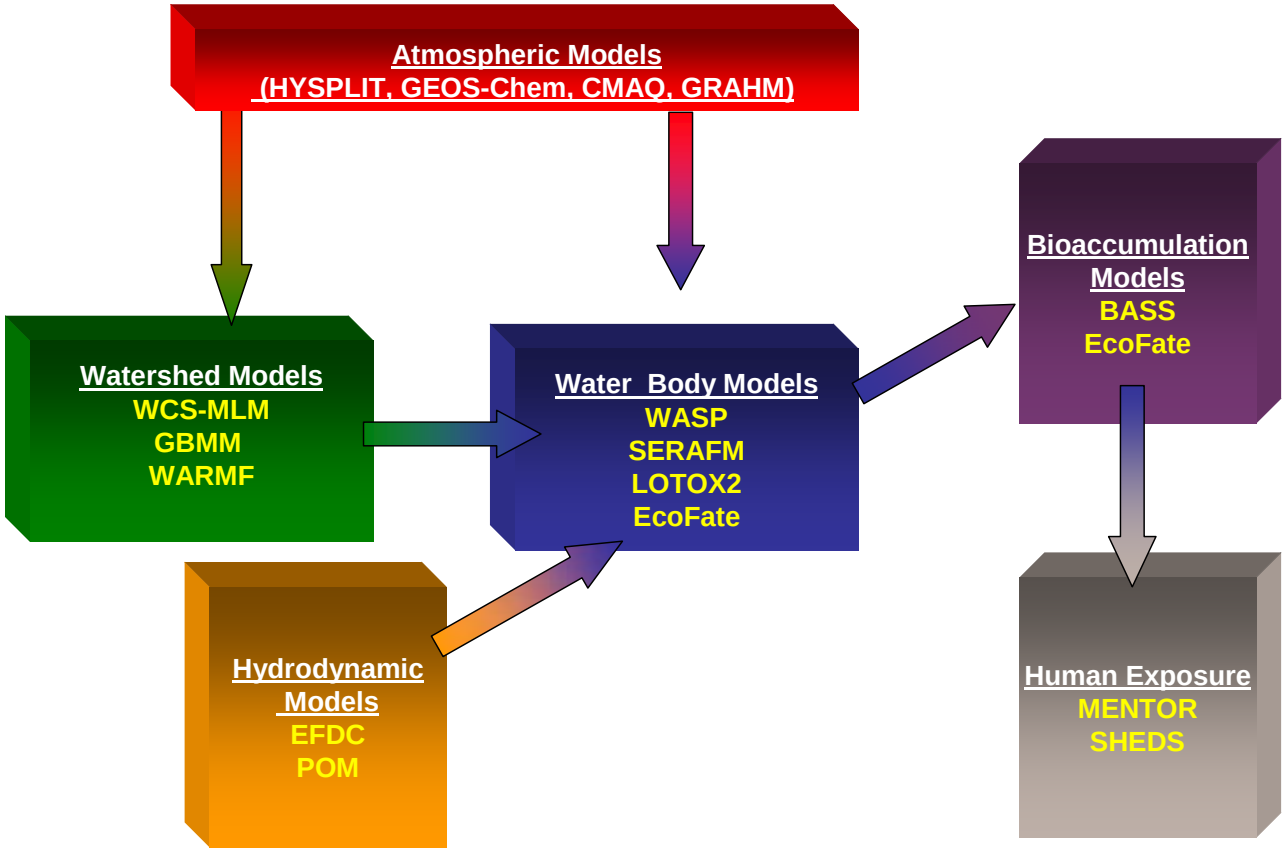
MODELING FRAMEWORK



1. **Source-Receptor:** ***HYSPLIT***
2. **Aquatic Fate and Transport:** ***WASP/EcoFate***
3. **Bioaccumulation:** ***BASS/EcoFate***
4. **Human Exposure:** ***MENTOR-SHEDS-4-M***

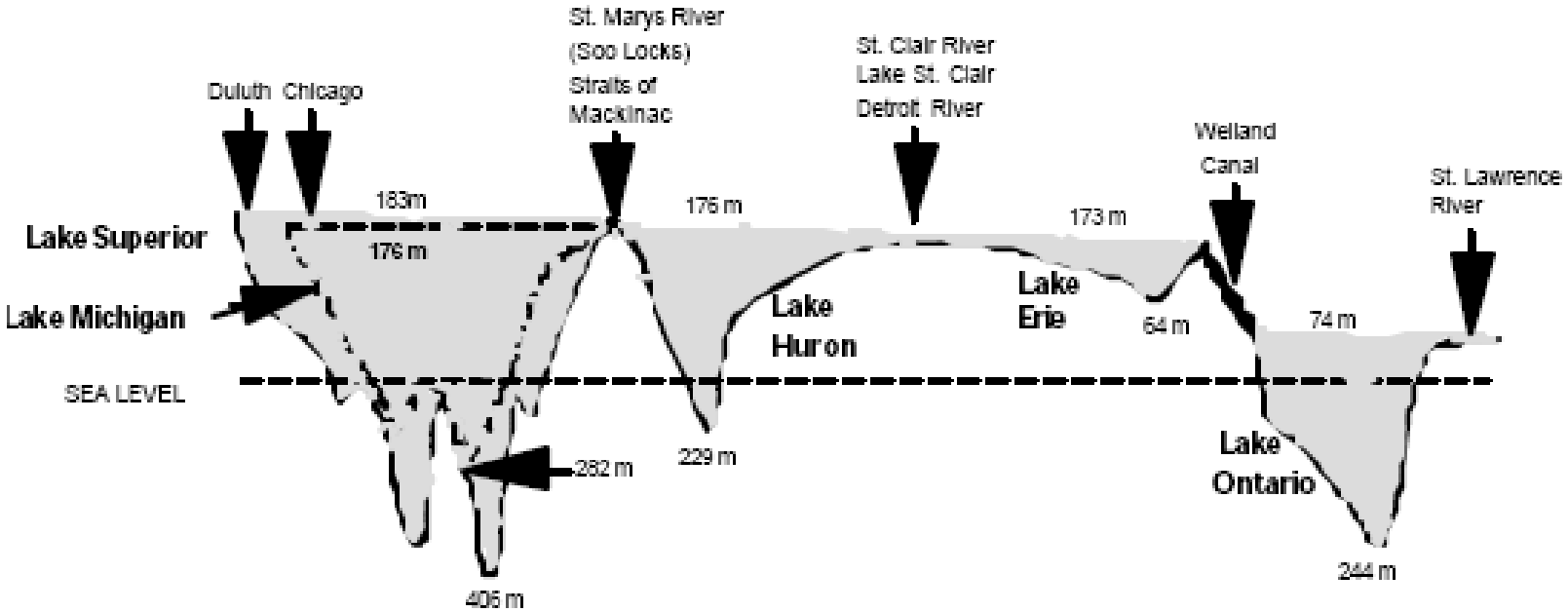
Purpose of Study

- Long-term: Tool Development



Purpose of Study

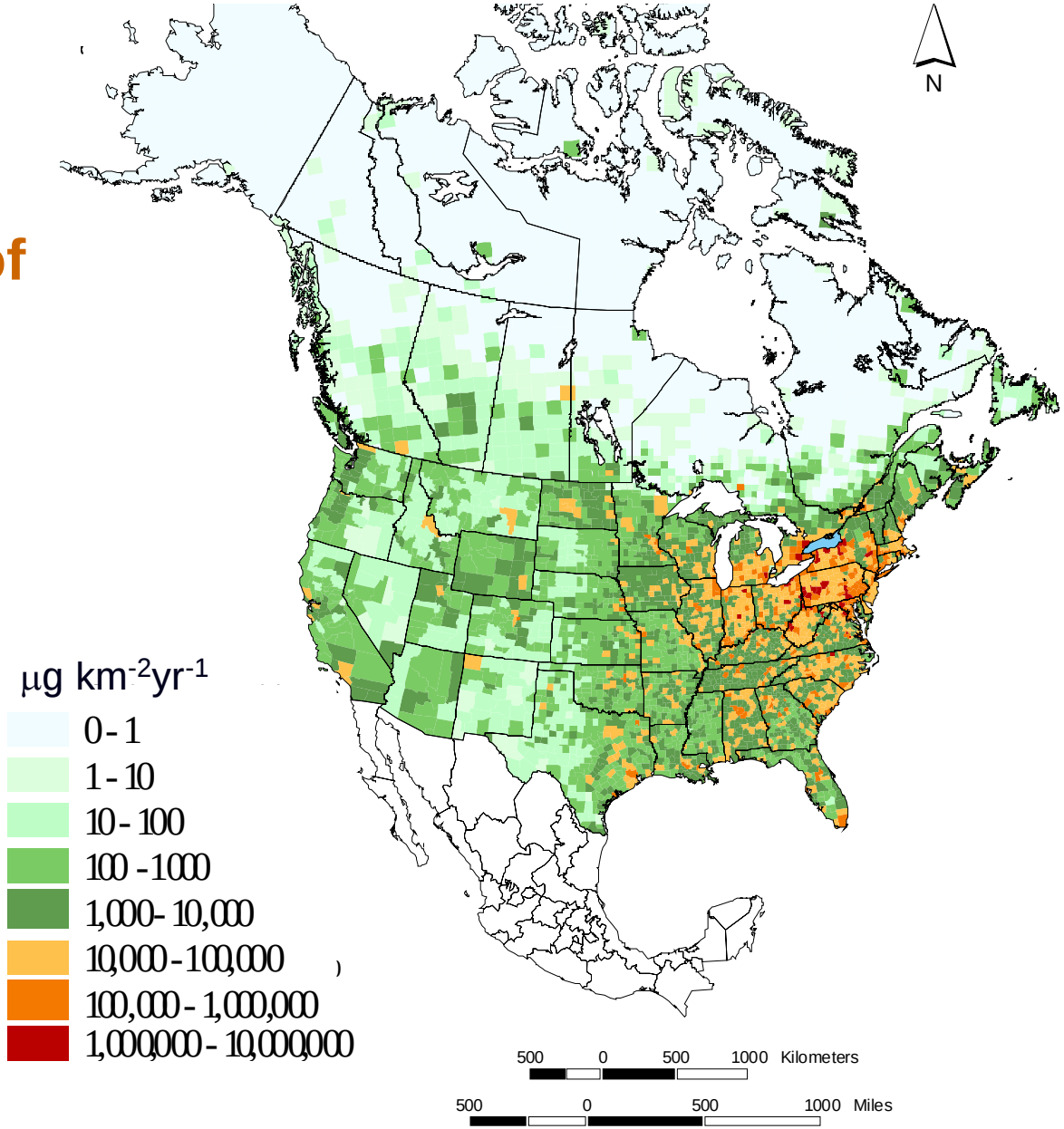
- Short-term: Lake Ontario Pilot



NOTE :
1. The profile is taken along the long axes of the lakes.
2. The vertical exaggeration is 2000 times.
3. Lake surface elevations are above sea level, and maximum depths are below lake surface level.

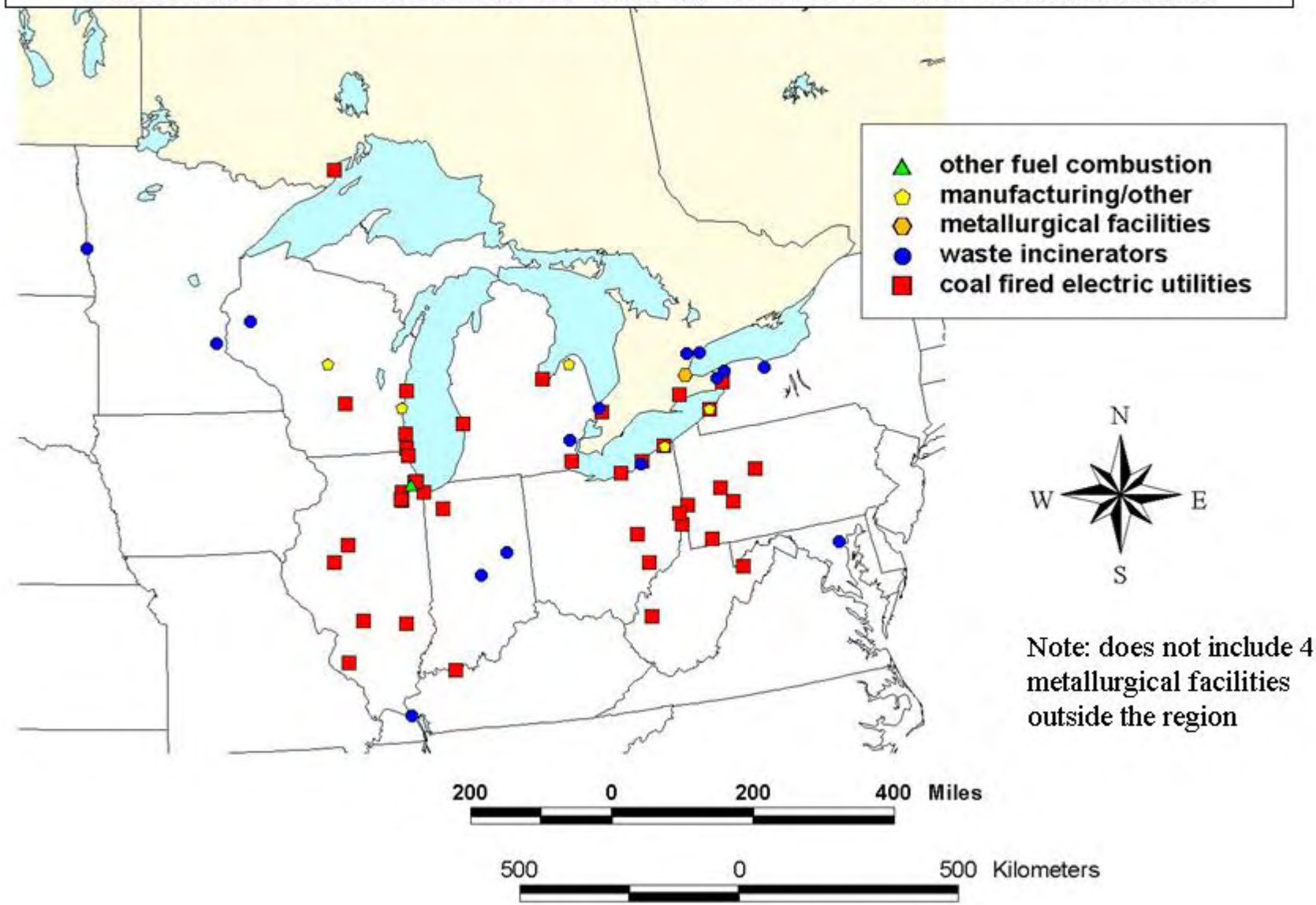
Source: State of the Great Lakes 1997

Model forecasted contributions of different sources to mercury deposition in Lake Ontario



Source: M. Cohen, NOAA

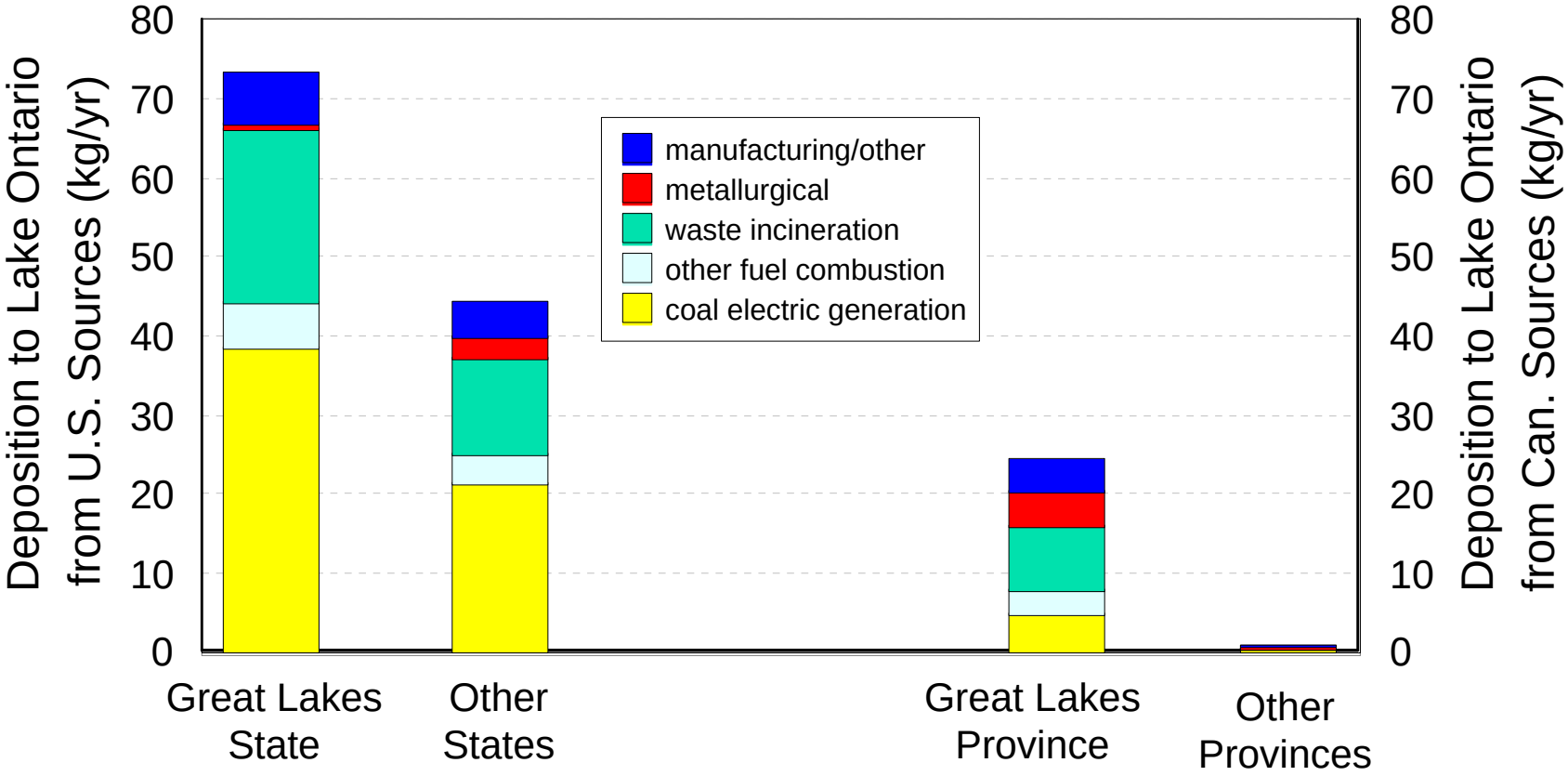
Emissions sources which are among the top-25 model-estimated contributors to one or more of the Great Lakes



Note: does not include 4 metallurgical facilities outside the region

Source: M. Cohen, NOAA

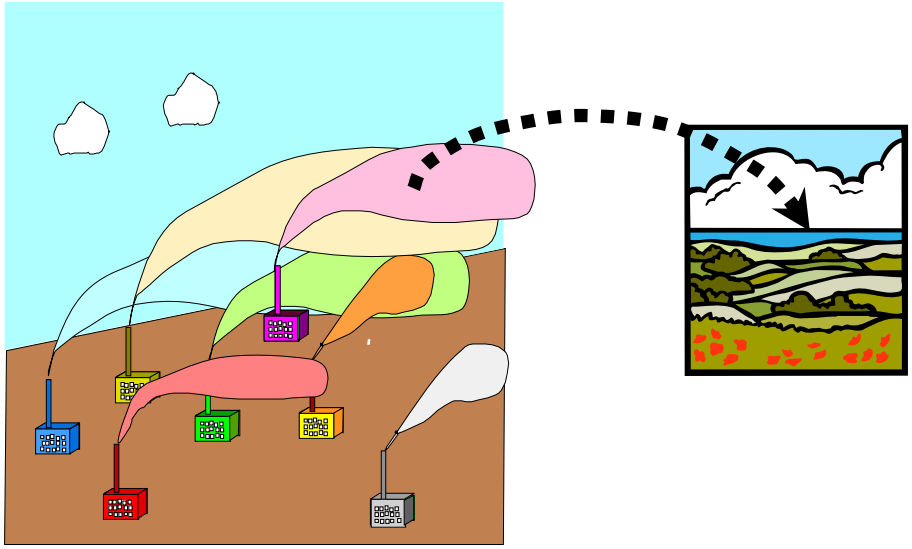
Source Sector Contributions to Deposition & Political Jurisdictions



Source: M. Cohen, NOAA

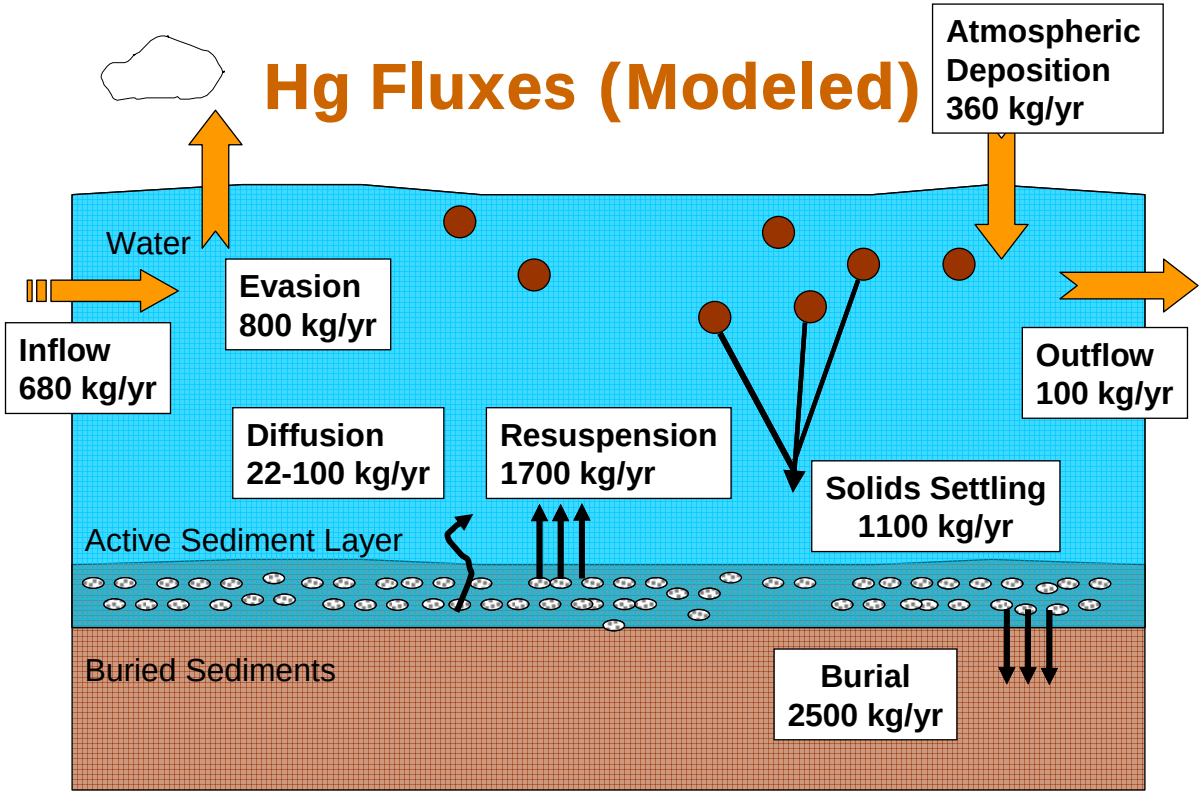
Atmospheric Modeling Needs

- Speciated mercury monitoring data
- Improve emissions inventories
- Data exchange between monitoring programs and modelers



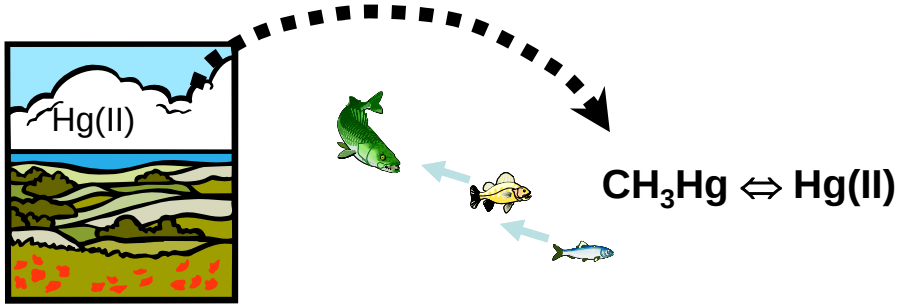
Phase I Model Resolution: Simple Box Model

•Based on Mackay et al., 1994; Gobas 1993; Gobas et al., 1995

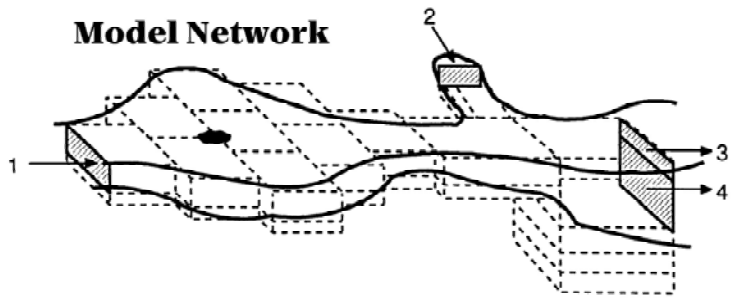


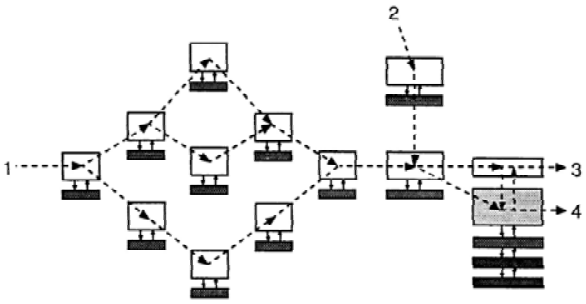
Preliminary Findings

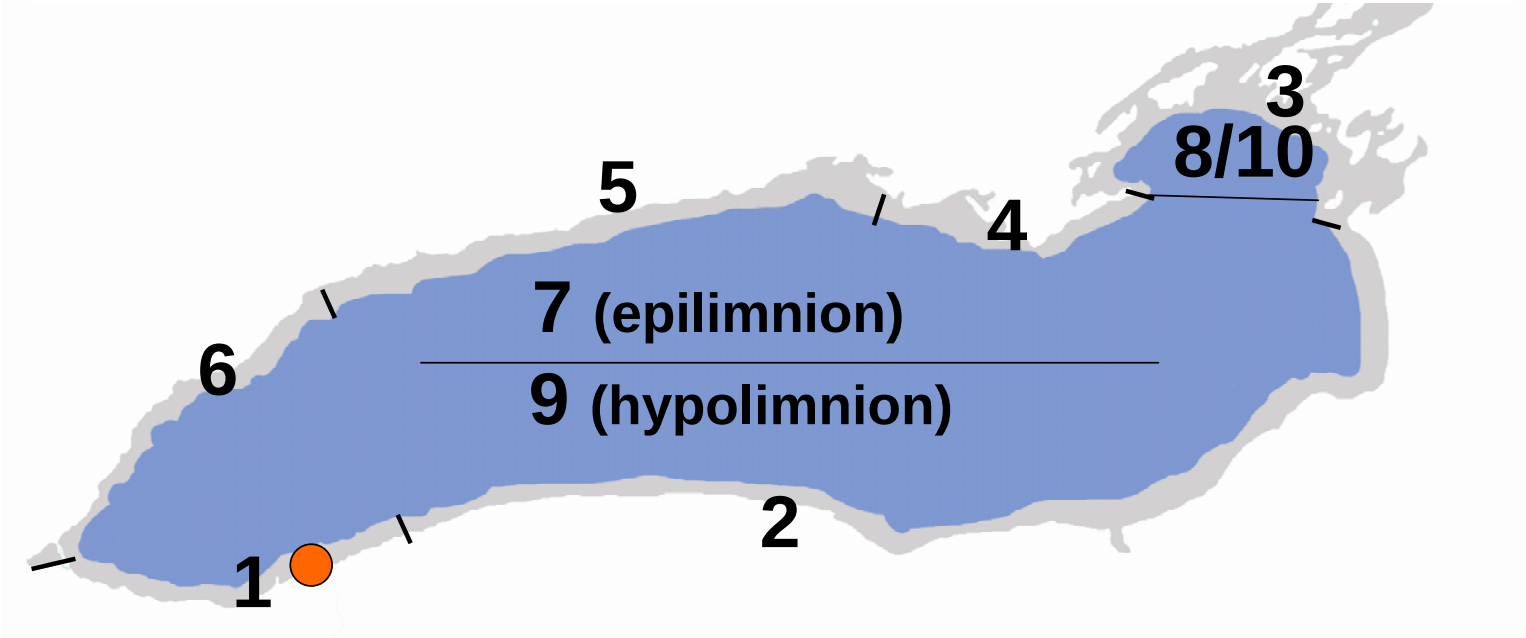
- Long-term reductions proportional to declines in total inputs
- Lake Ontario is not at steady state with current loading
- Decadal scale time-lag in Lake Ontario in response



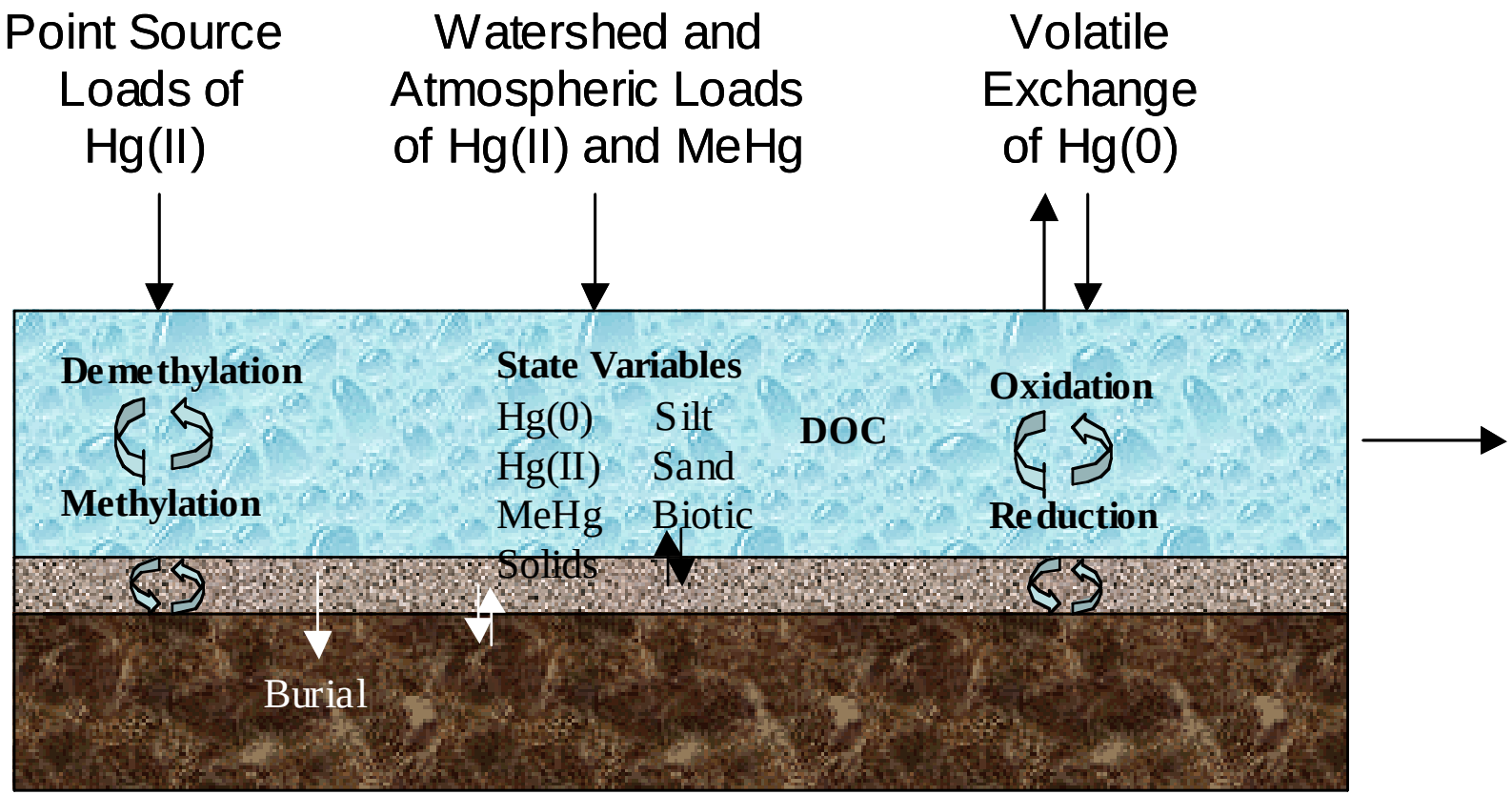
Phase II: WASP Model Application



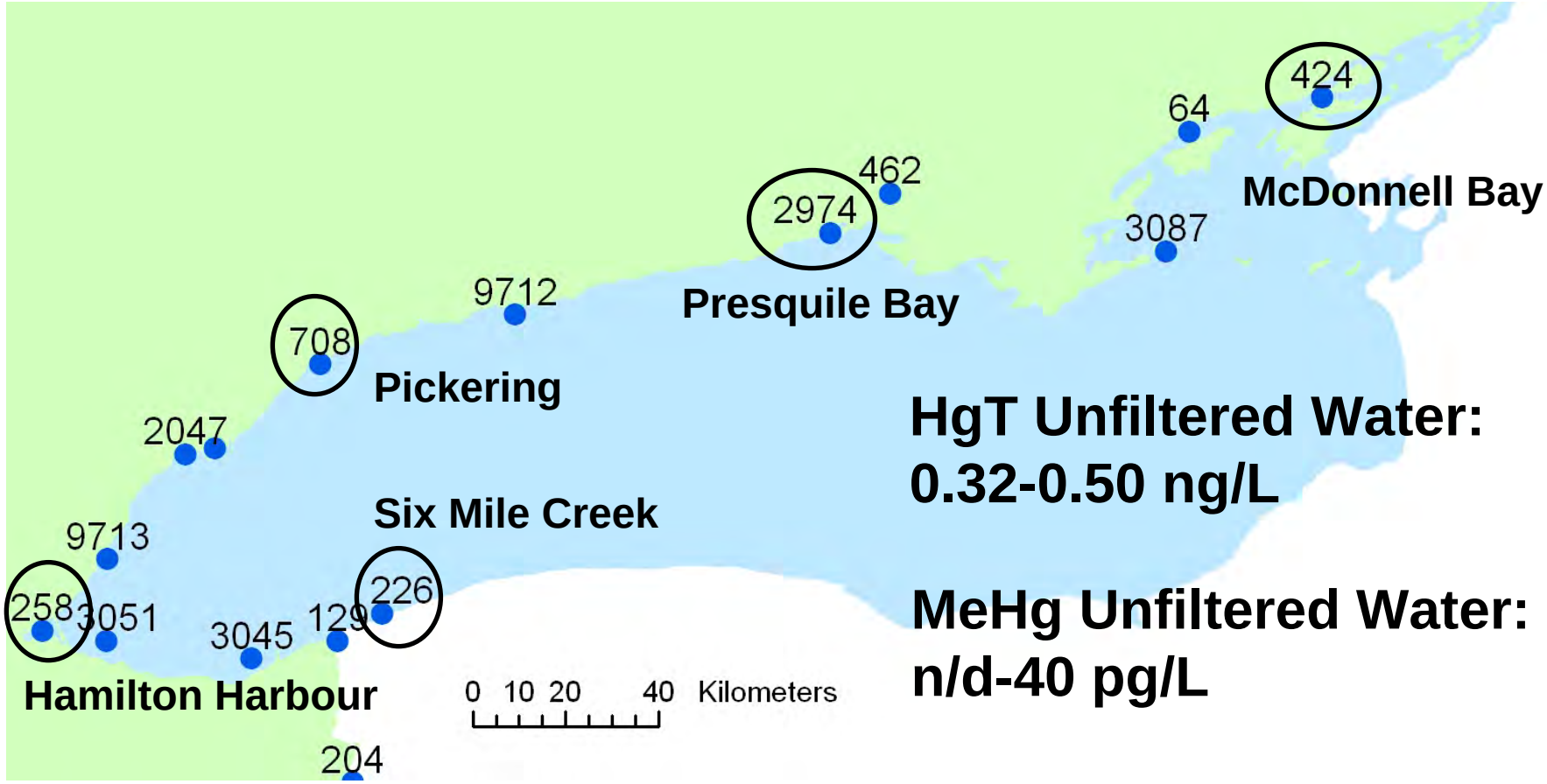




WASP 7 Mercury Module



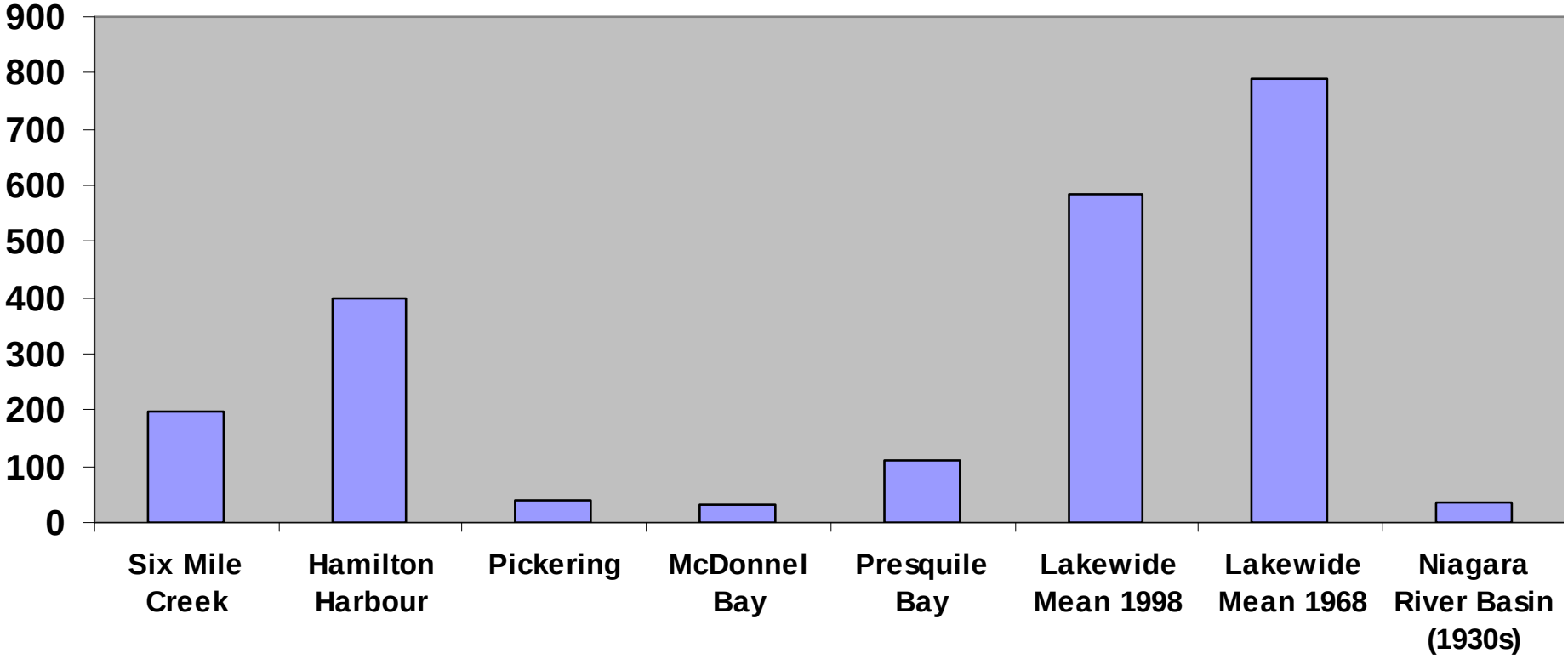
OMOE-Environment Canada Sampling Stations in 2006



HgT Unfiltered Water: 0.32-0.50 ng/L

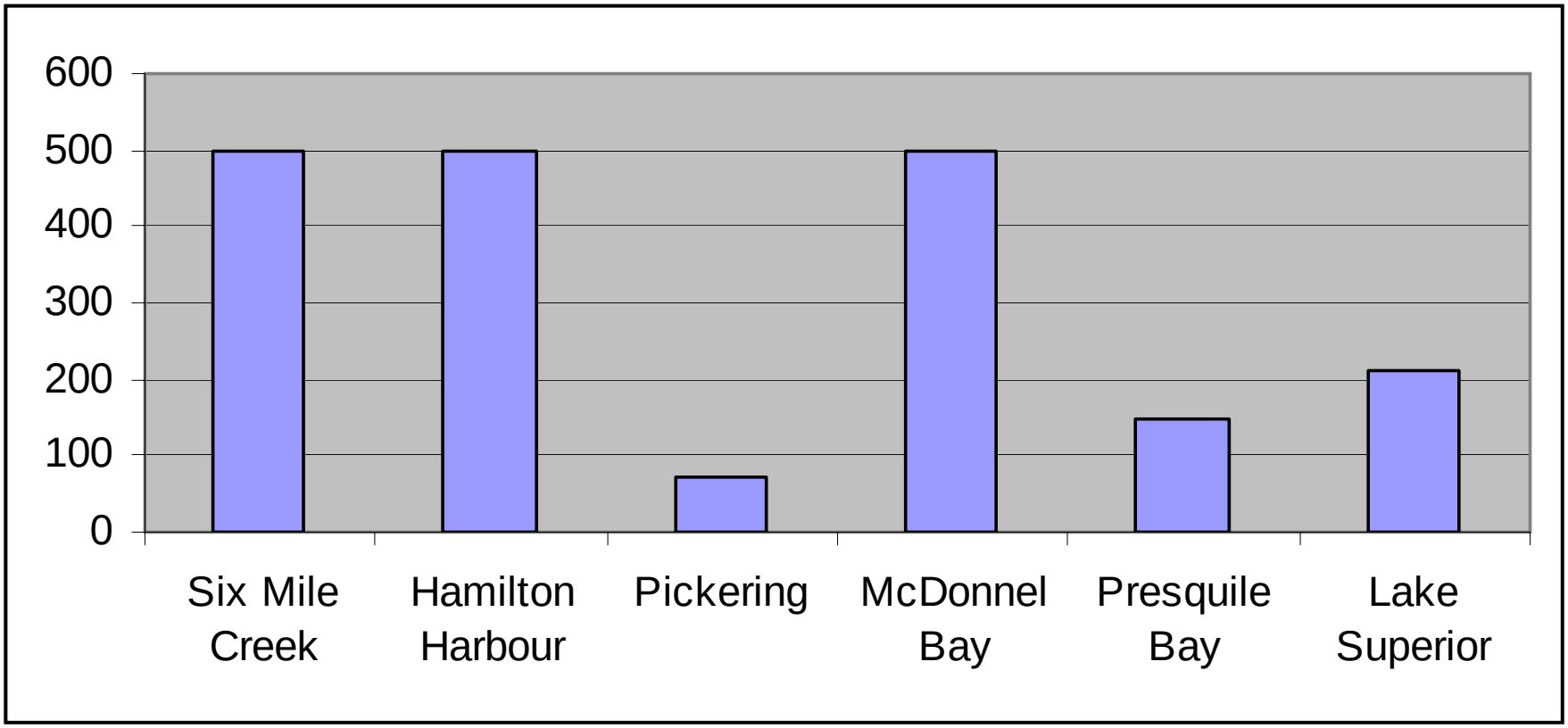
MeHg Unfiltered Water: n/d-40 pg/L

Sediment HgT Levels (ng/g)

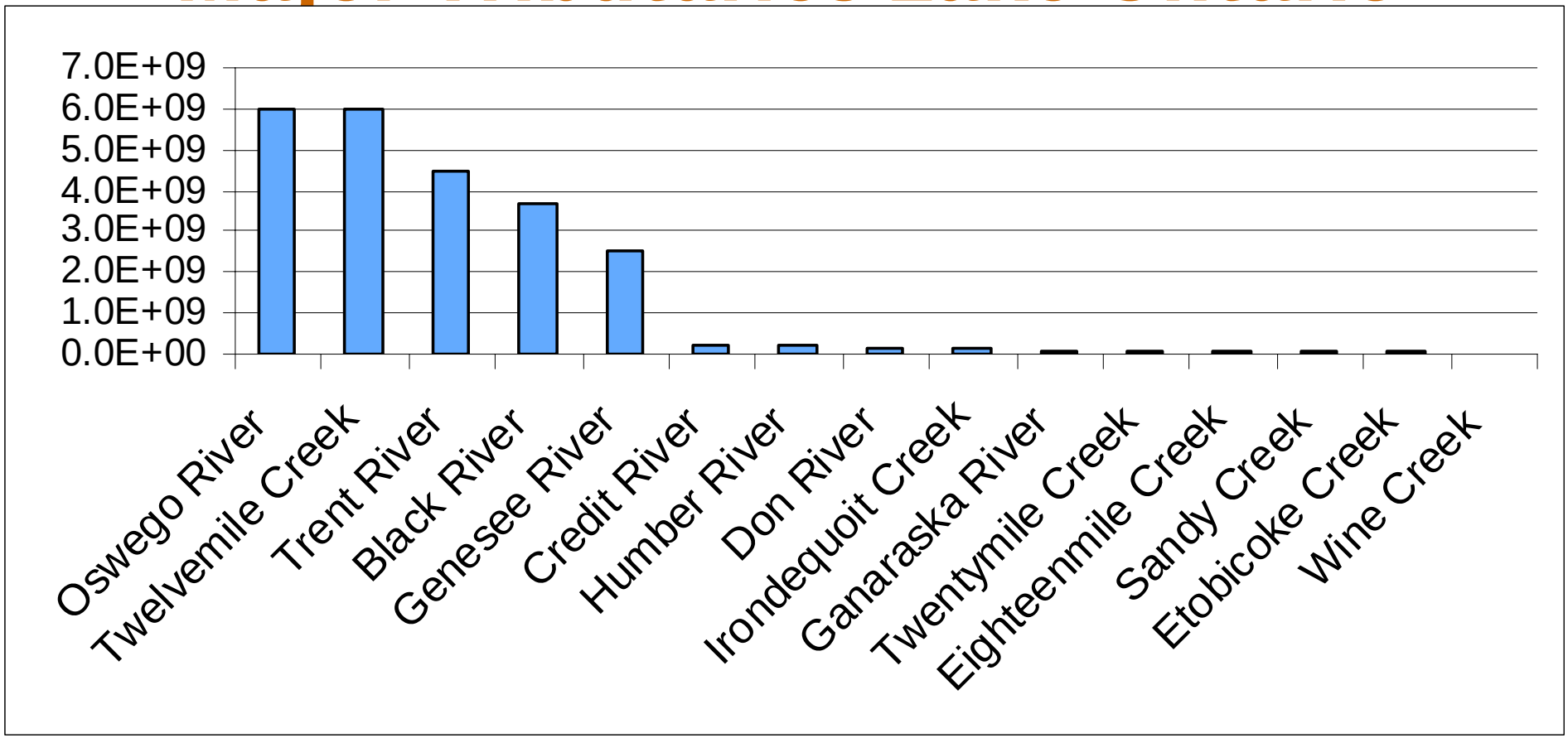


Source: Unpulished data, OMOE; Breteler 1984; Rolfhus et al., 2003; Marvin et al., 2002

Sediment MeHg (pg/g)



Major Tributaries Lake Ontario



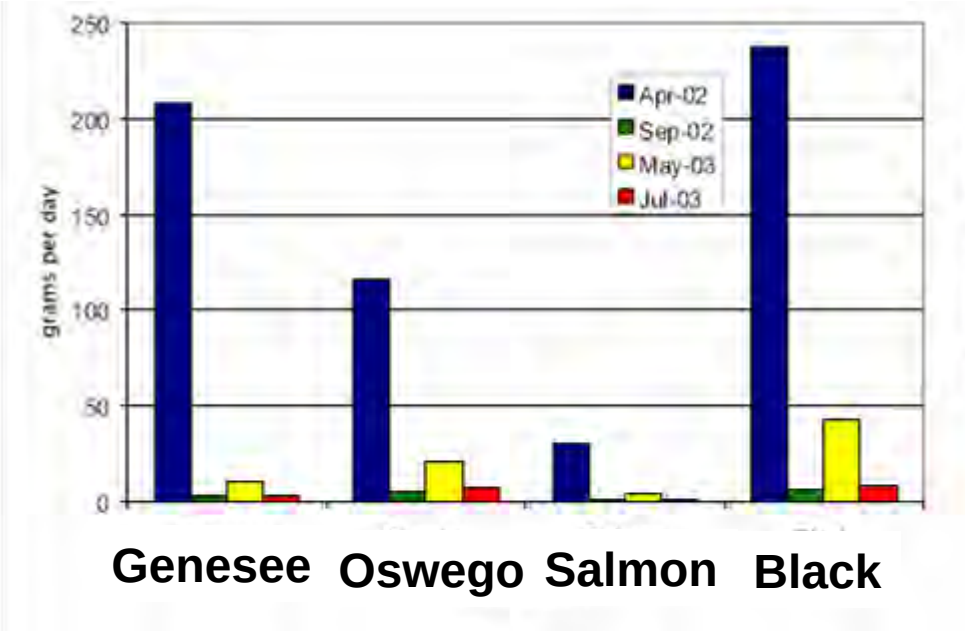
Total Tributaries: New York: 409 Ontario: 371

Niagara River 1.80 x 10^{11} m^3/yr ~ 80% total inflow/yr

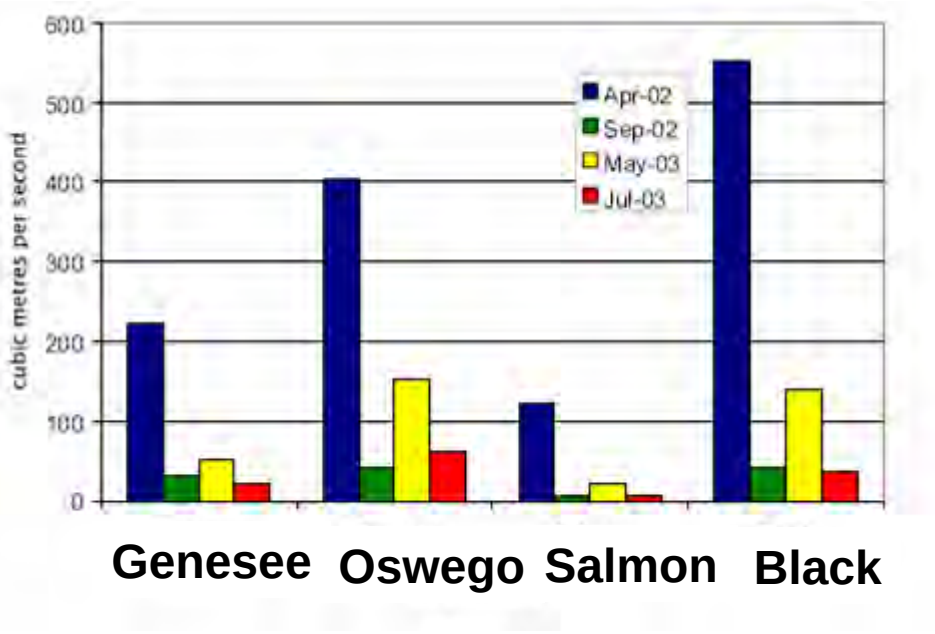
Boyd & J Biberhofer, 1999; Bannister& Bubeck, 1978; Edsall & Charlton, 1997; State of NY Water Board, 2000; LaMP Update, 2004.

US Tributary Loading

Dissolved Hg (g/d)

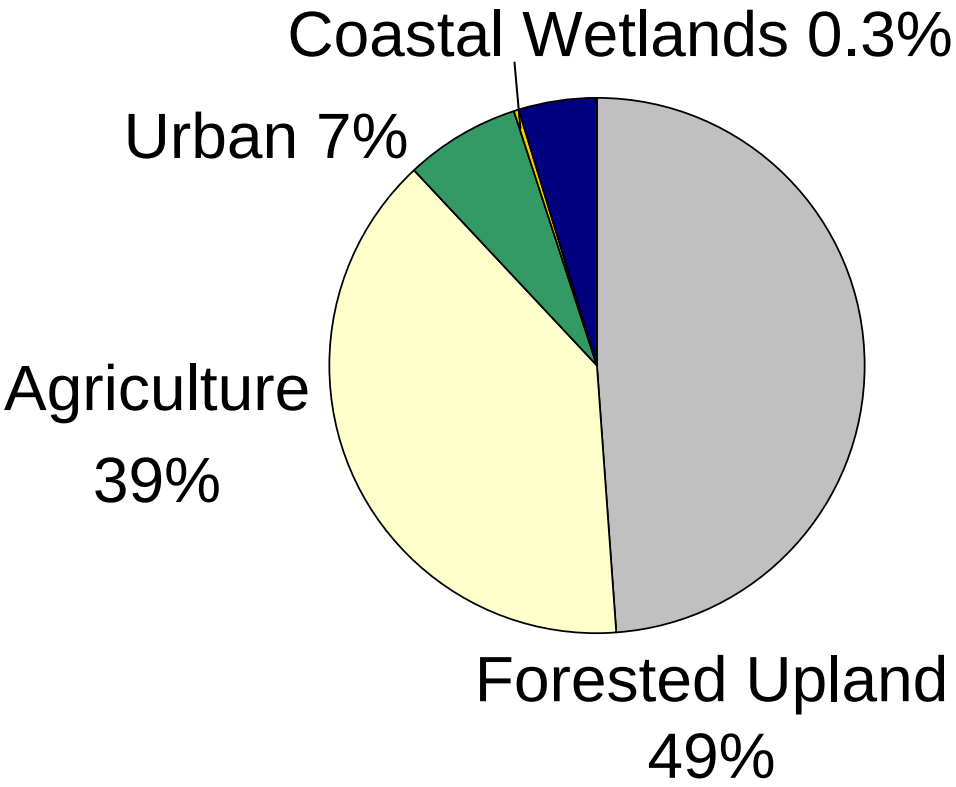


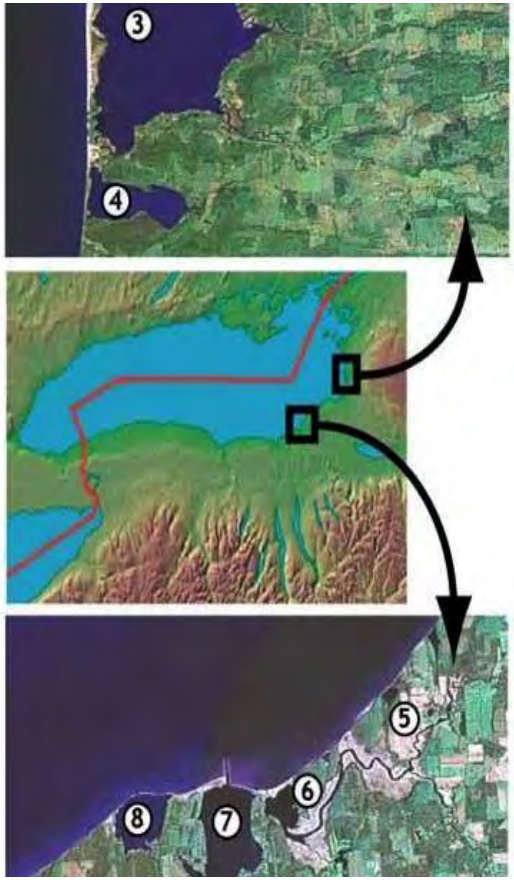
Flow (m^3/s)



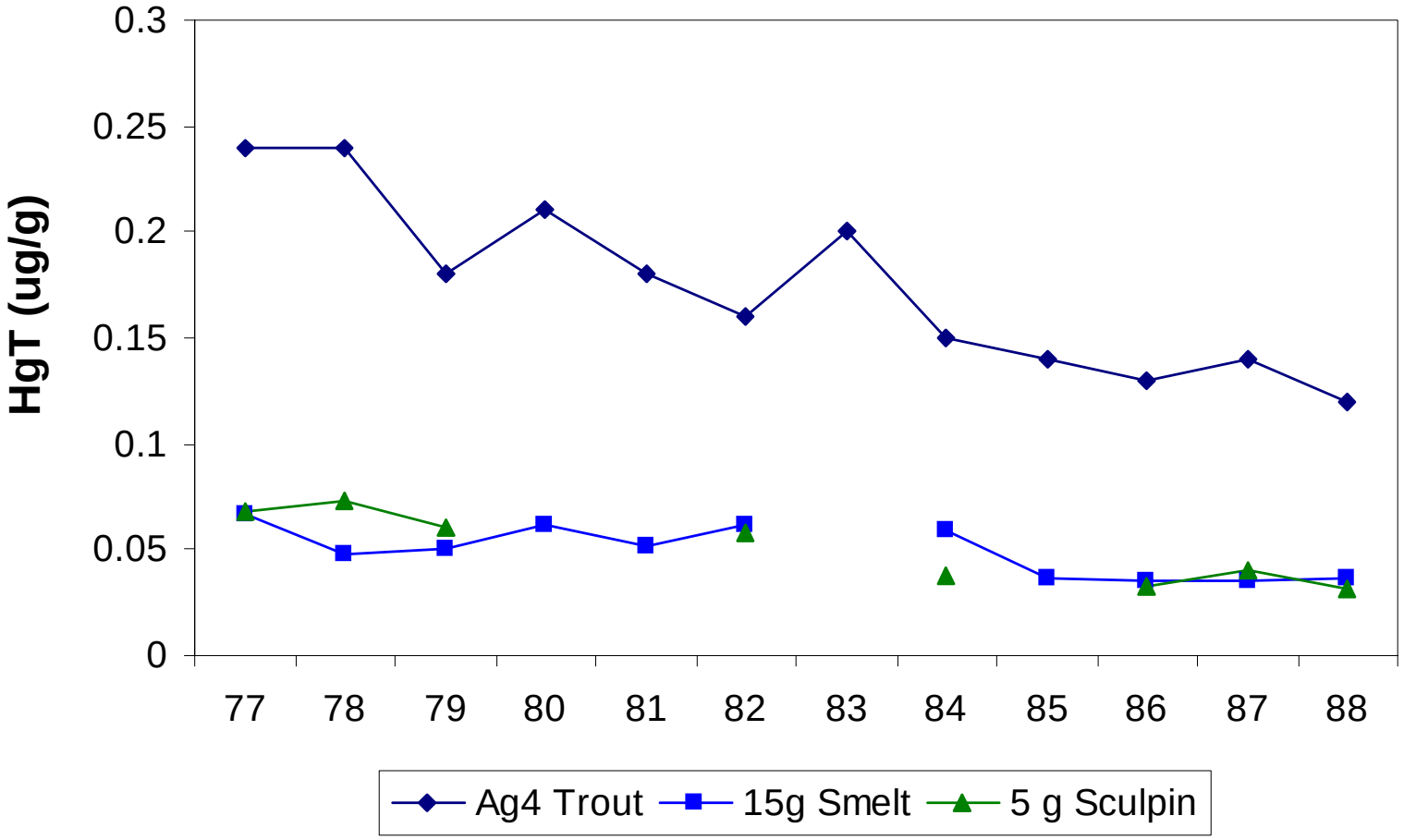
Source: 2006 Lake Ontario LaMP update

Watershed Cycling:
Land Use Lake Ontario Basin



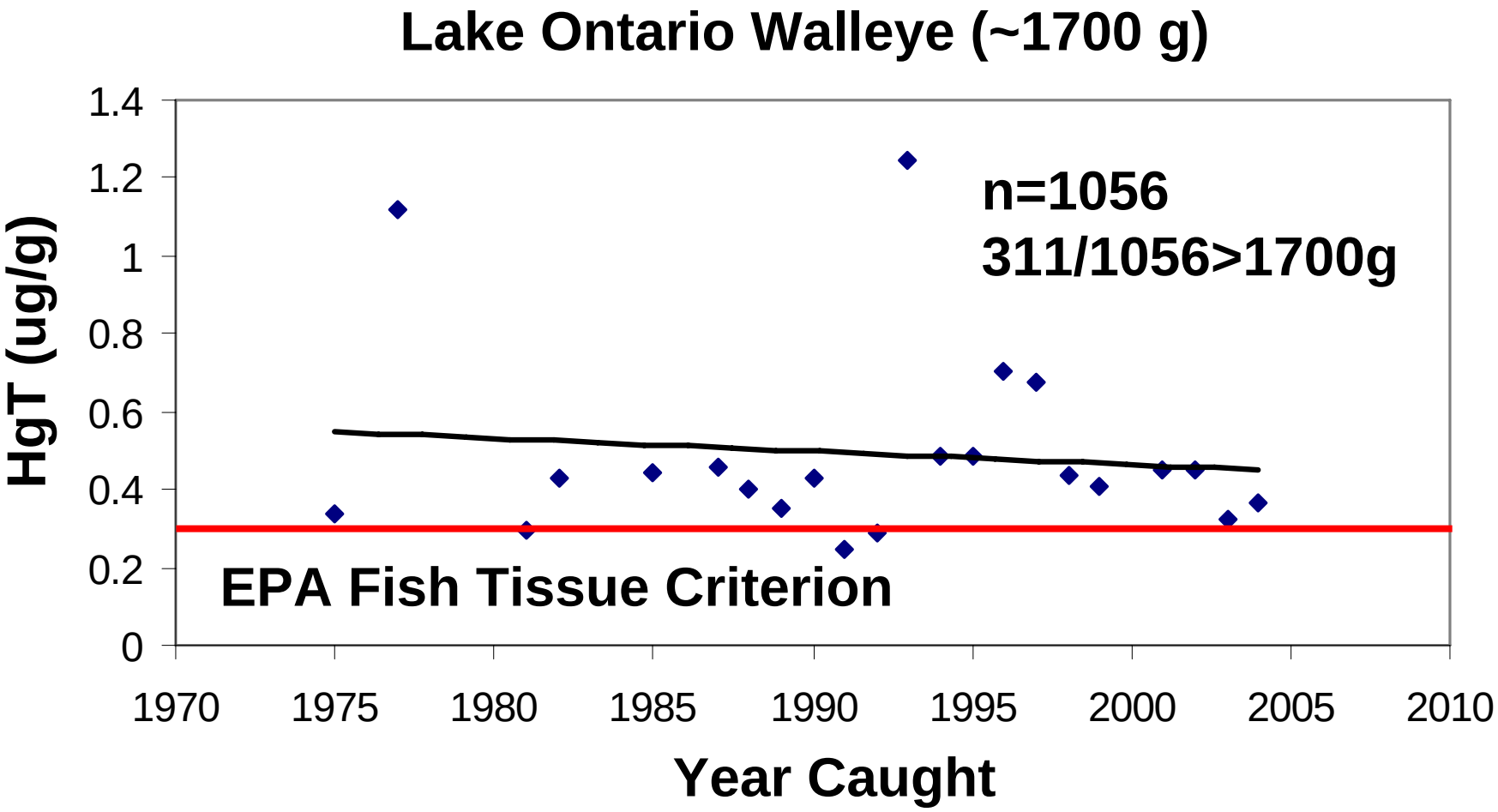


Fish Mercury Concentrations

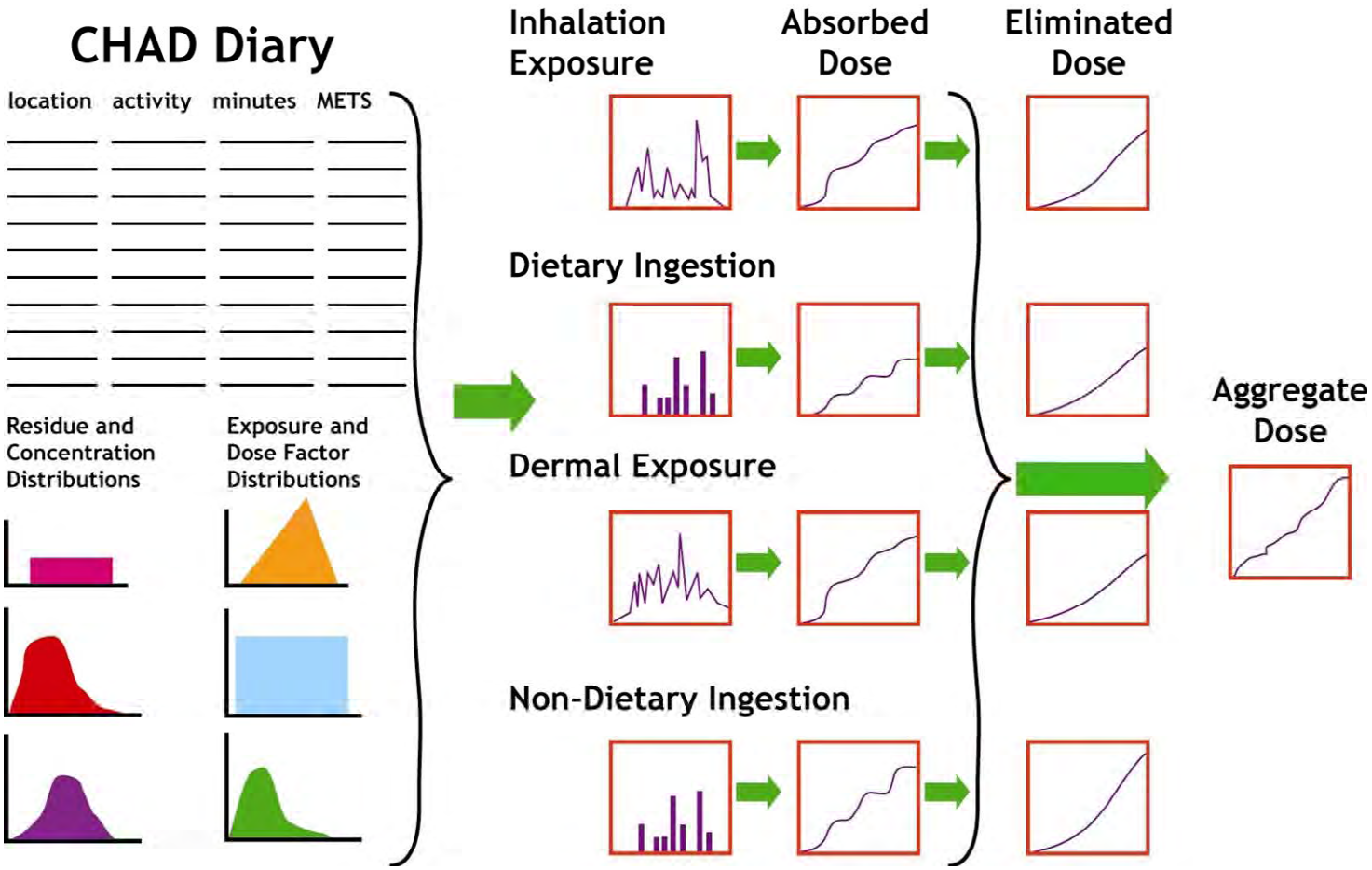


Source: Borgmann & Whittle, 1992

Recreationally Caught Species



MENTOR-SHEDS-4-M Application



Source: S-W. Wang et al., Rutgers/EOHSI and USEPA/NERL

Oswego County, NY

- MENTOR/SHEDS-4M evaluation case study
- Simulate dietary exposure to total and methylmercury
- Identify susceptible populations

Source: S-W. Wang et al., Rutgers/EOHSI and USEPA/NERL