Site Needs for Program Objectives

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U.S. Geological Survey

On behalf of many!

Types of Sites Needed

- **Trend Sites:** Documents change in concentrations w/out focusing on causal factors or explanations

- **Causality Sites:** Critically assess the role of changes in emissions and other key factors driving changes in environmental Hg concentrations

Trend Sites Continued

- Answer the question “Has there been a change?”
- Apply a core set of indicators to document change
- Minimal emphasis on ancillary data

Trend Sites & Program Objectives

- Establish baselines in multiple ecosystem components prior to anticipated emission control
- Track spatial and long-term temporal changes
- Co-locate with other complimentary monitoring programs

Causality Sites Continued

- Answer the question “What is causing the change?”
- Apply a suite of indicators that can link observed changes to key processes and/or mechanistic models
- Enhances the ability to interpret spatial and temporal trends and provide added confidence in ecosystem benefit assessments

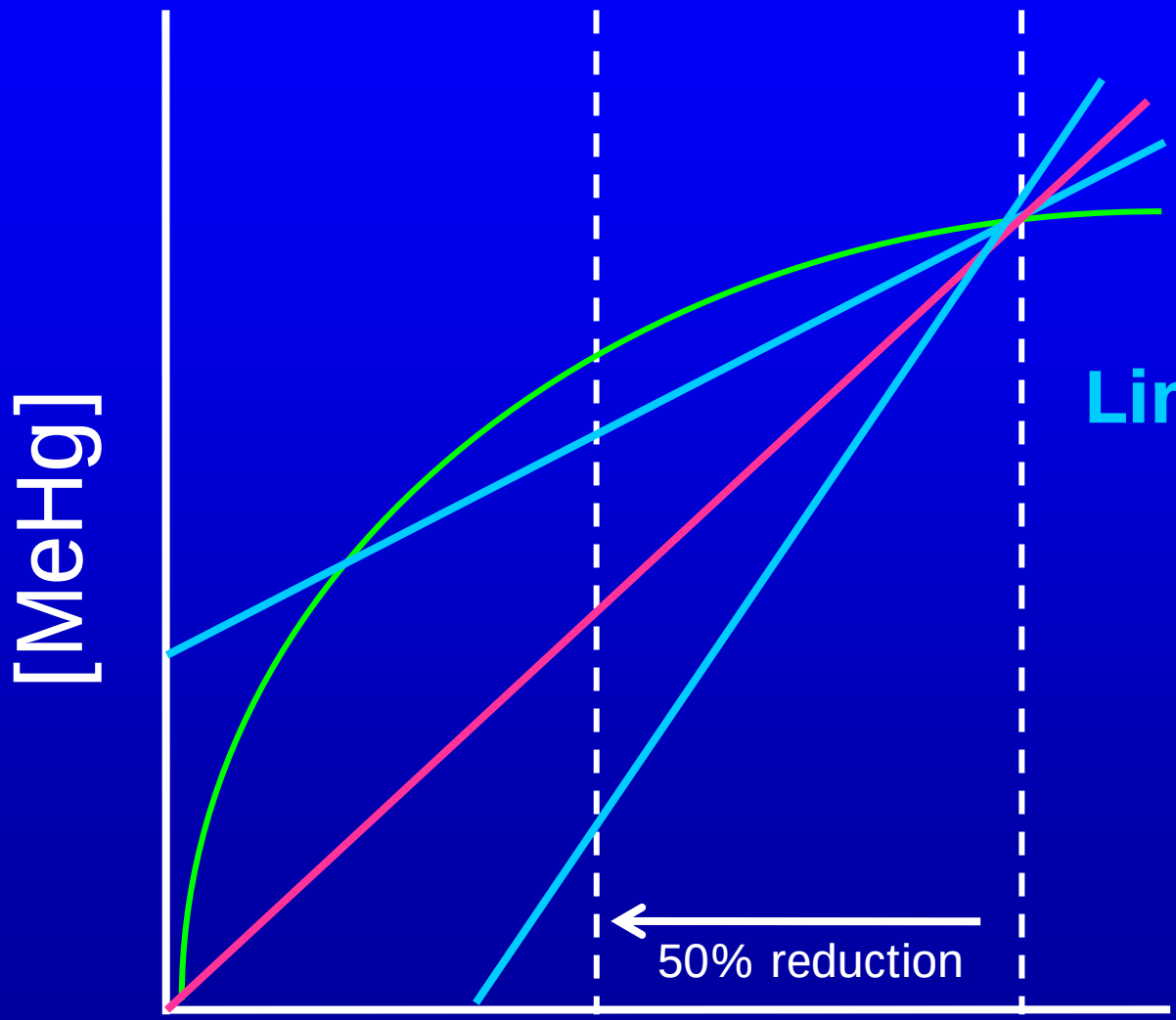
Cauality Sites & Program Objectives

- Provide scientific understanding links between emissions tracking → environmental trends → MeHg in biota and effects
- Assess ecological harm to organisms of concern (threatened and endangered) with links to emissions and other important factors

Siting Criteria

- National distribution, including a wide range of settings (urban to remote); proximity to and inferred impact from local sources; and, ecosystem type/mercury sensitivity (but not too complex).
- Sites exhibiting a wide range of anticipated responses (magnitude and timing): perched lakes, seepage lakes, drainage lakes and reservoirs, streams, and estuaries
- Sites expected to show maximal and minimal responses and not thought to be confounded by co-factors (other than emissions)→ test our current conceptual models and scientific understanding
- Reference sites: probably not a valid concept for Hg contamination (all sites are contaminated to some degree). Only applicable if the intent is to track and quantify impacts from global emissions sources

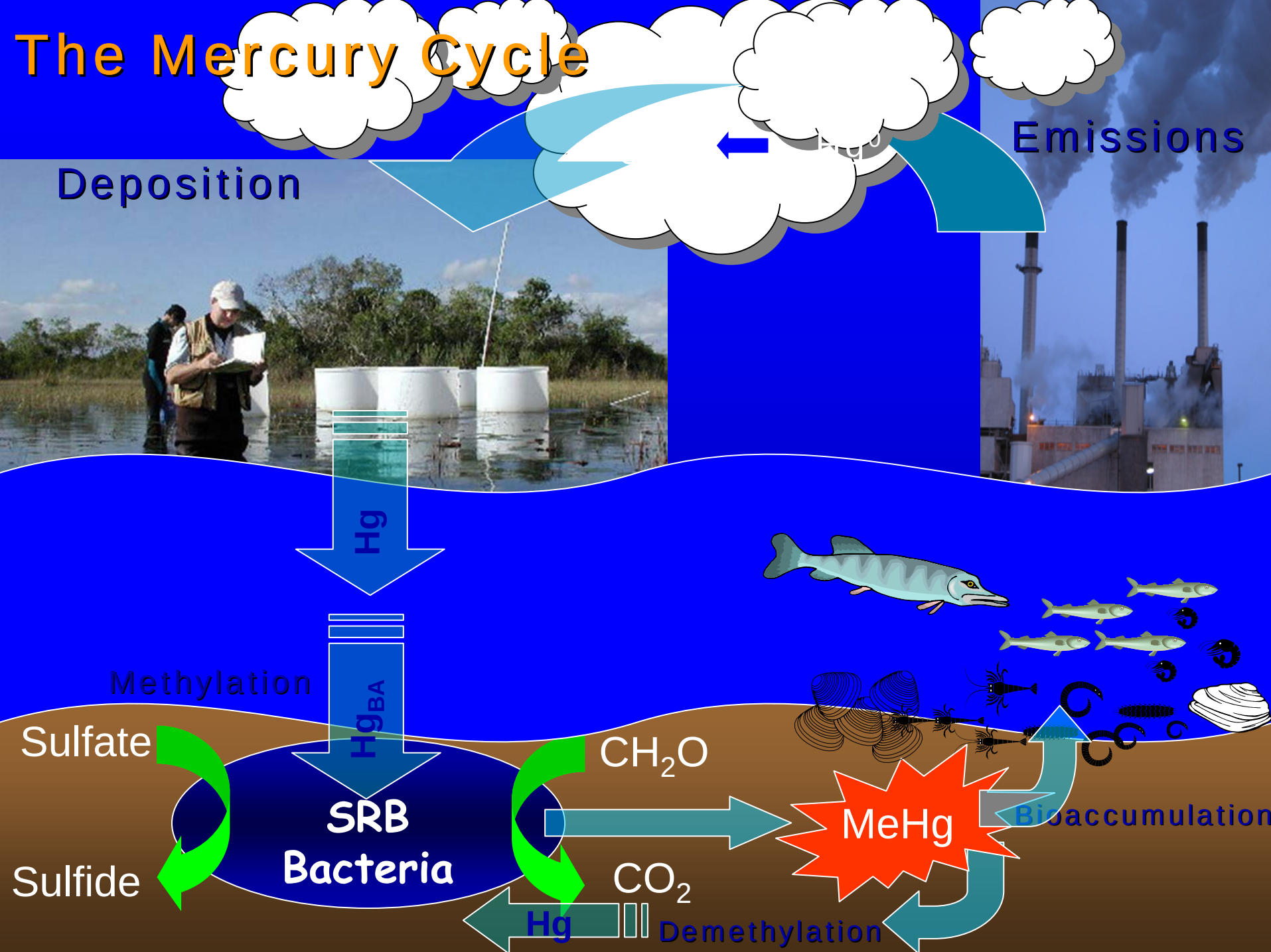
Response to a Declining Load



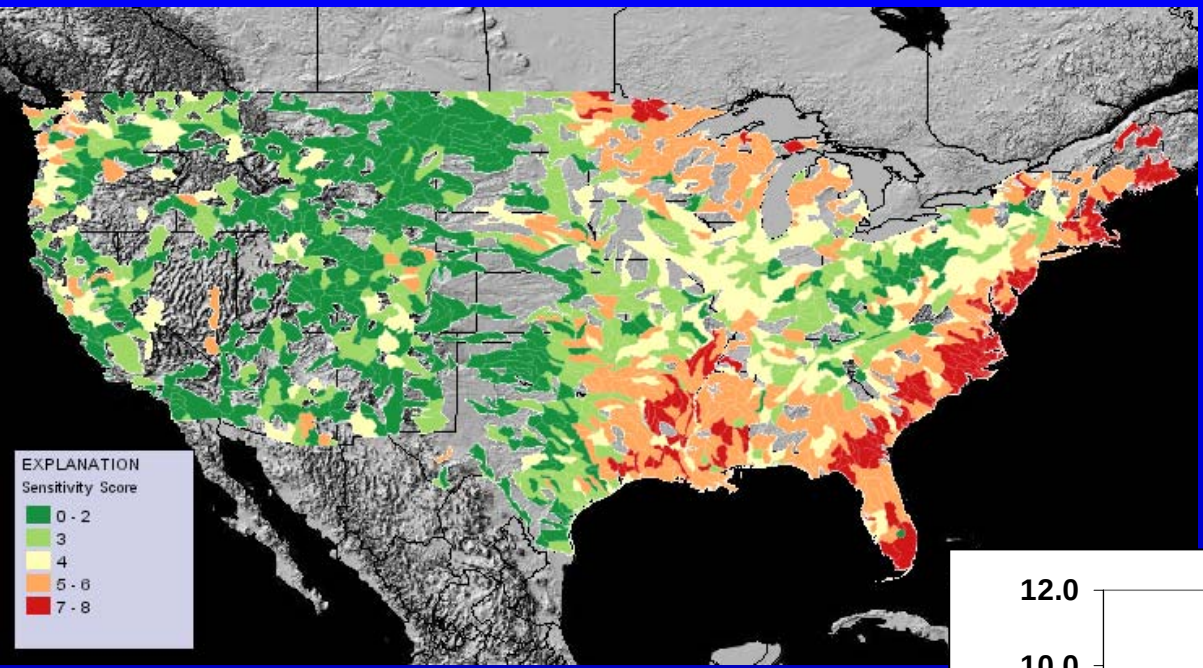
Asymptotic

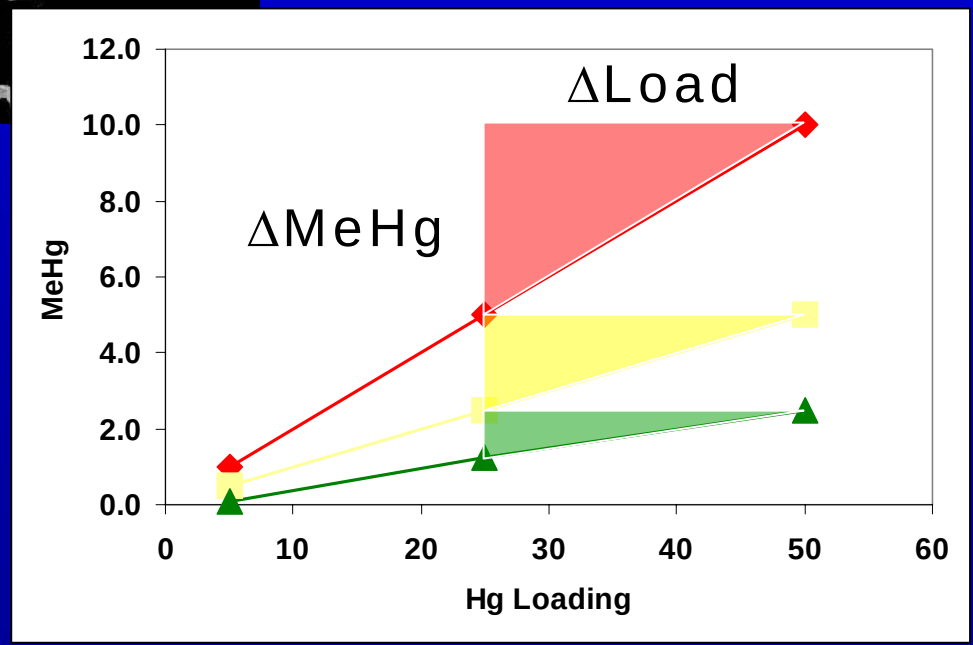
Linear, not directly proportional

Linear, directly proportional

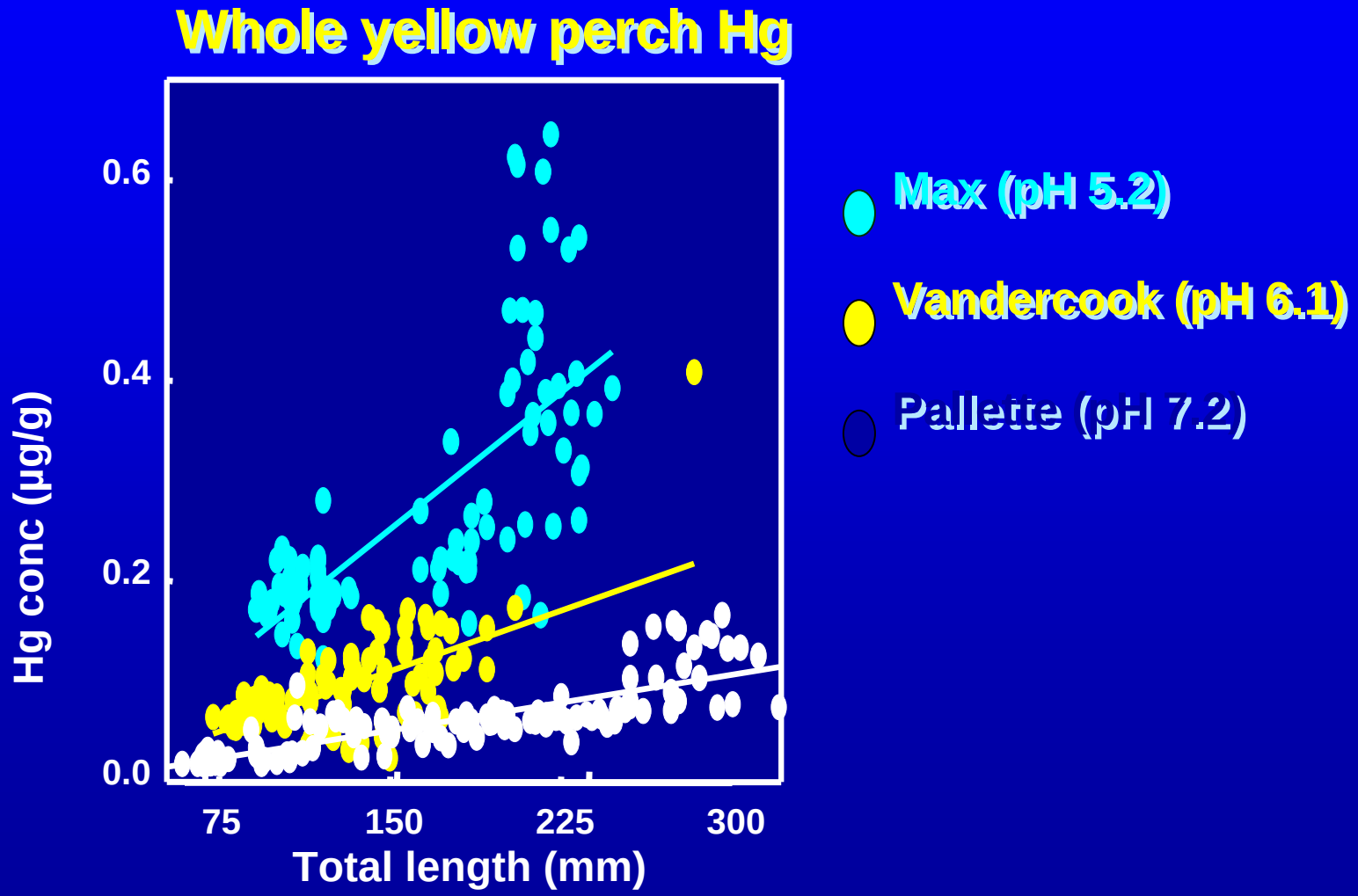

The Mercury Cycle
Deposition
Emissions
Hg
Hg
Methylation
Hg_{BA}
Sulfate
Sulfide
SRB
Bacteria
CH_2O
CO_2
MeHg
Bioaccumulation
Hg
Demethylation

Using Mercury Sensitivity to Anticipate Response



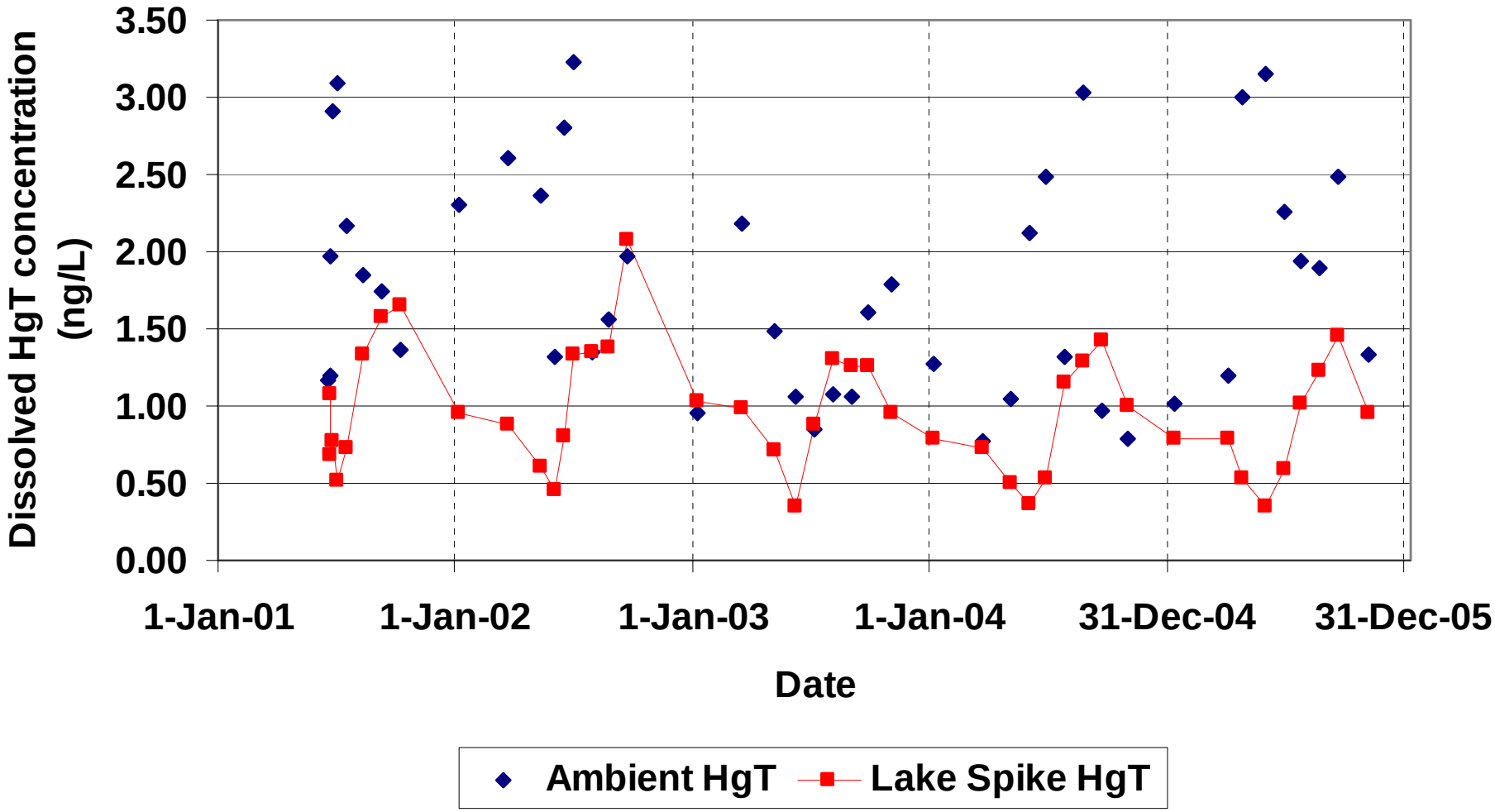


What is "Mercury Sensitivity"?

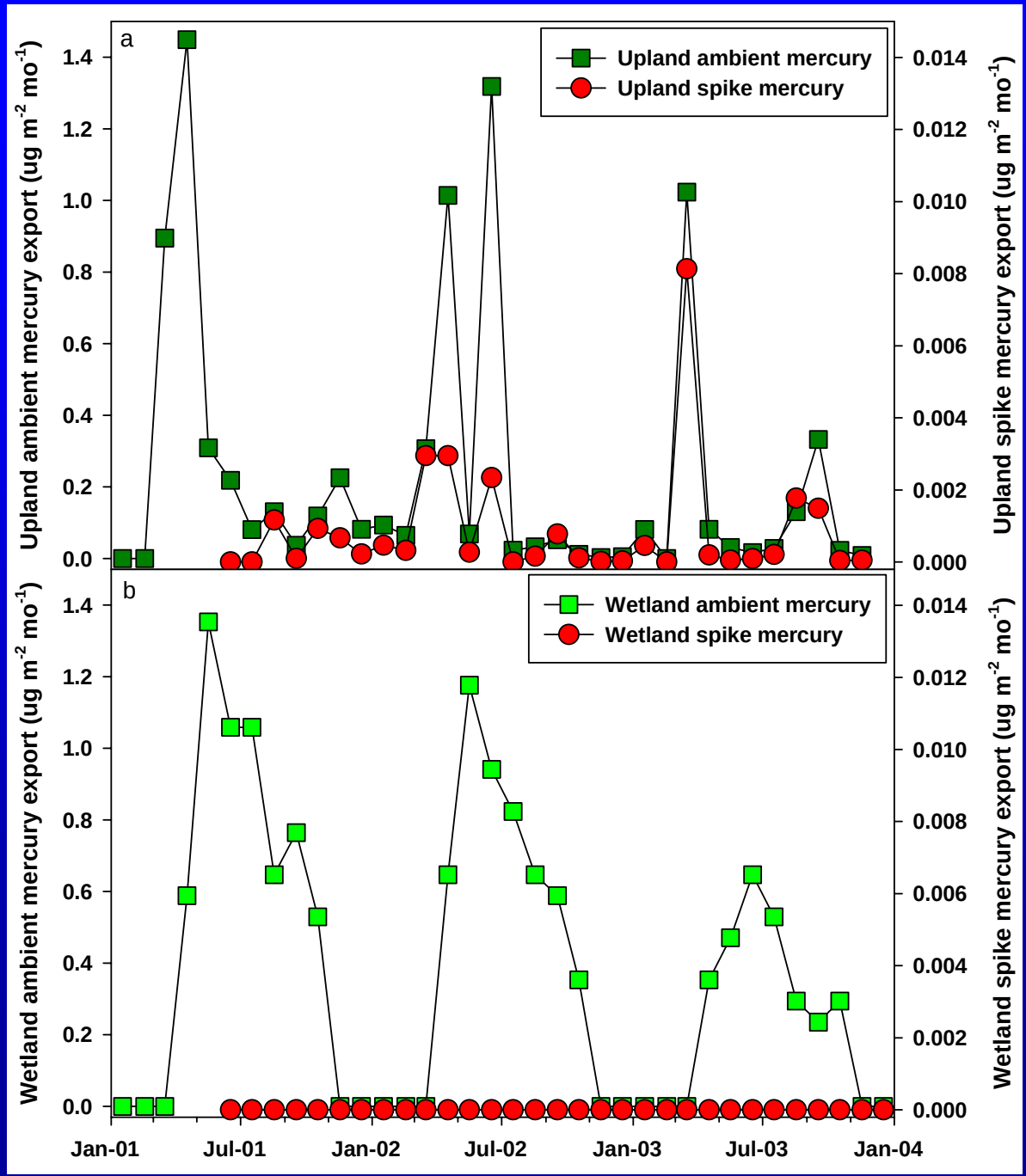


From Wiener et al., 2003

Dissolved HgT Concentrations in L658 Surface Waters (2001-2005)

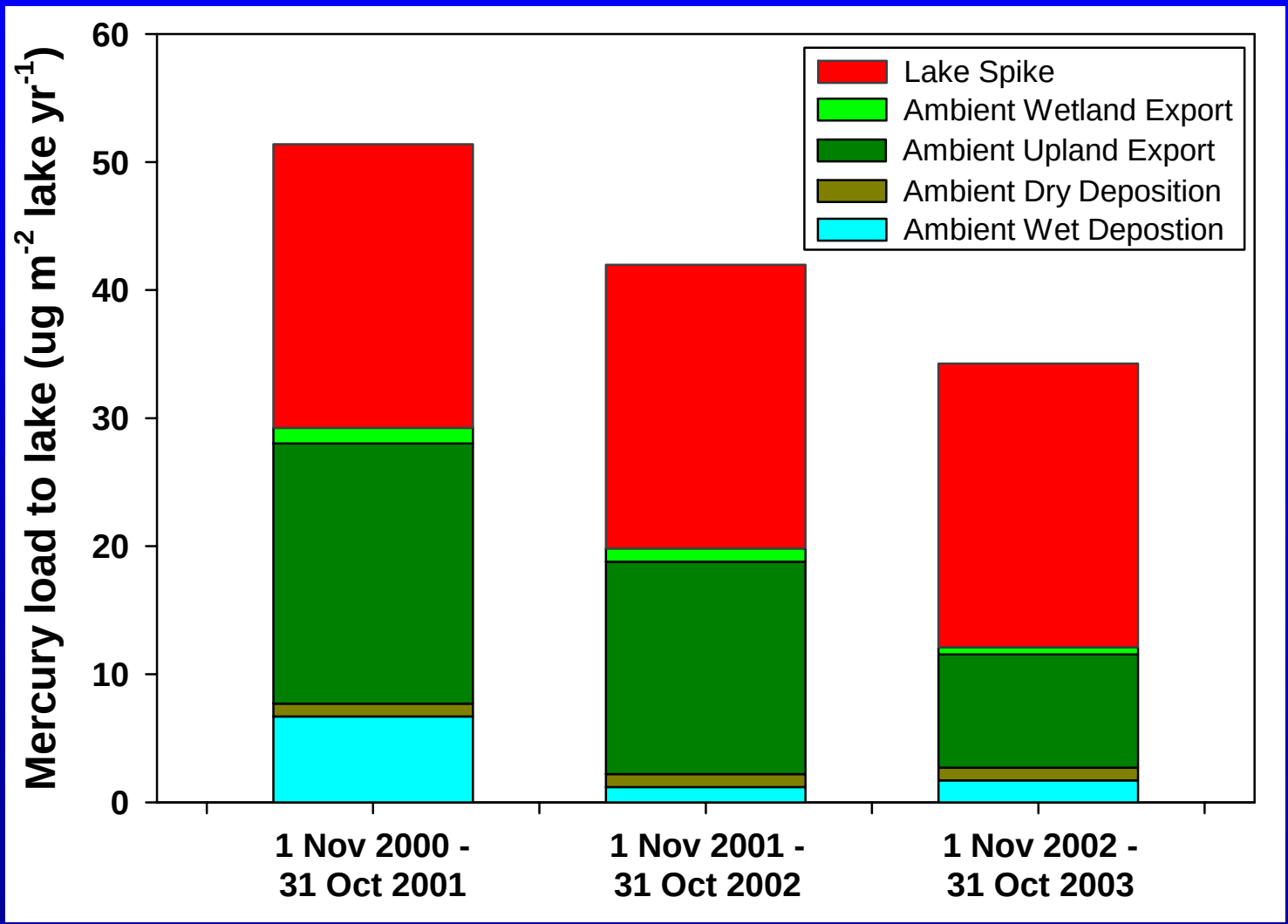


Data source: The METAALICUS project

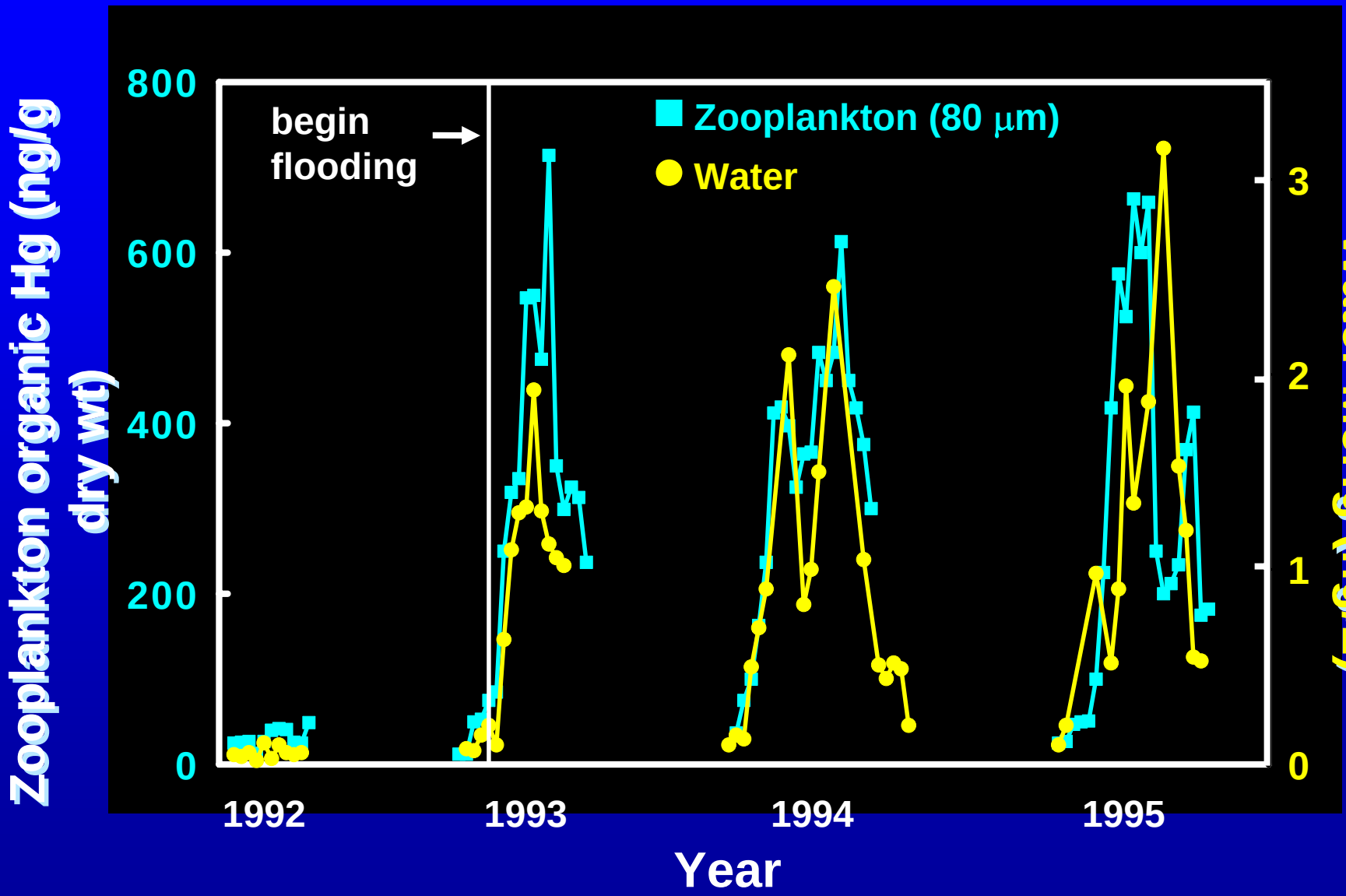


Watershed mercury exports will have a dominating impact on the response at certain ecosystems

Importance of Non-Direct, Atmospheric Hg Loads

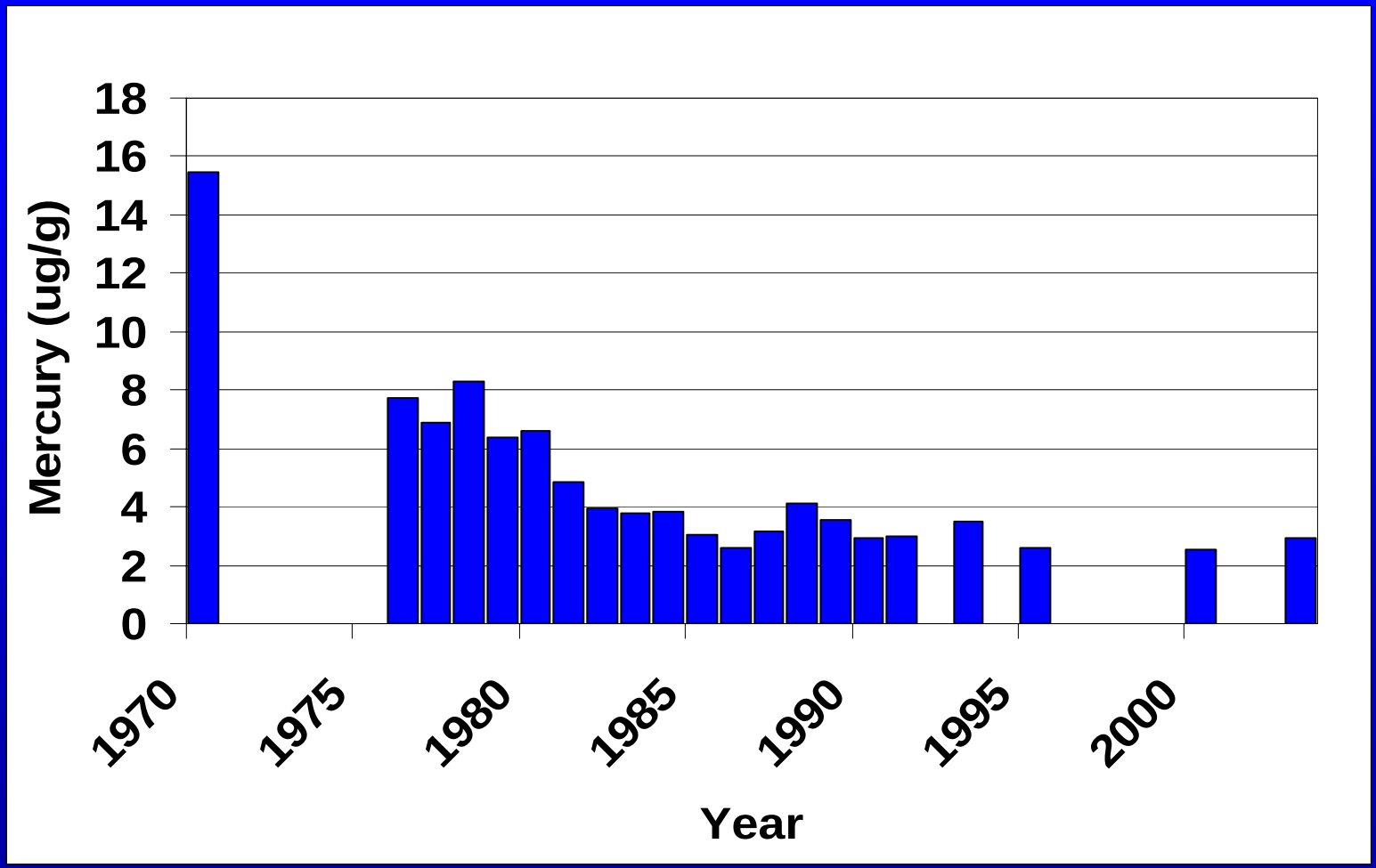


Do we include reservoirs?



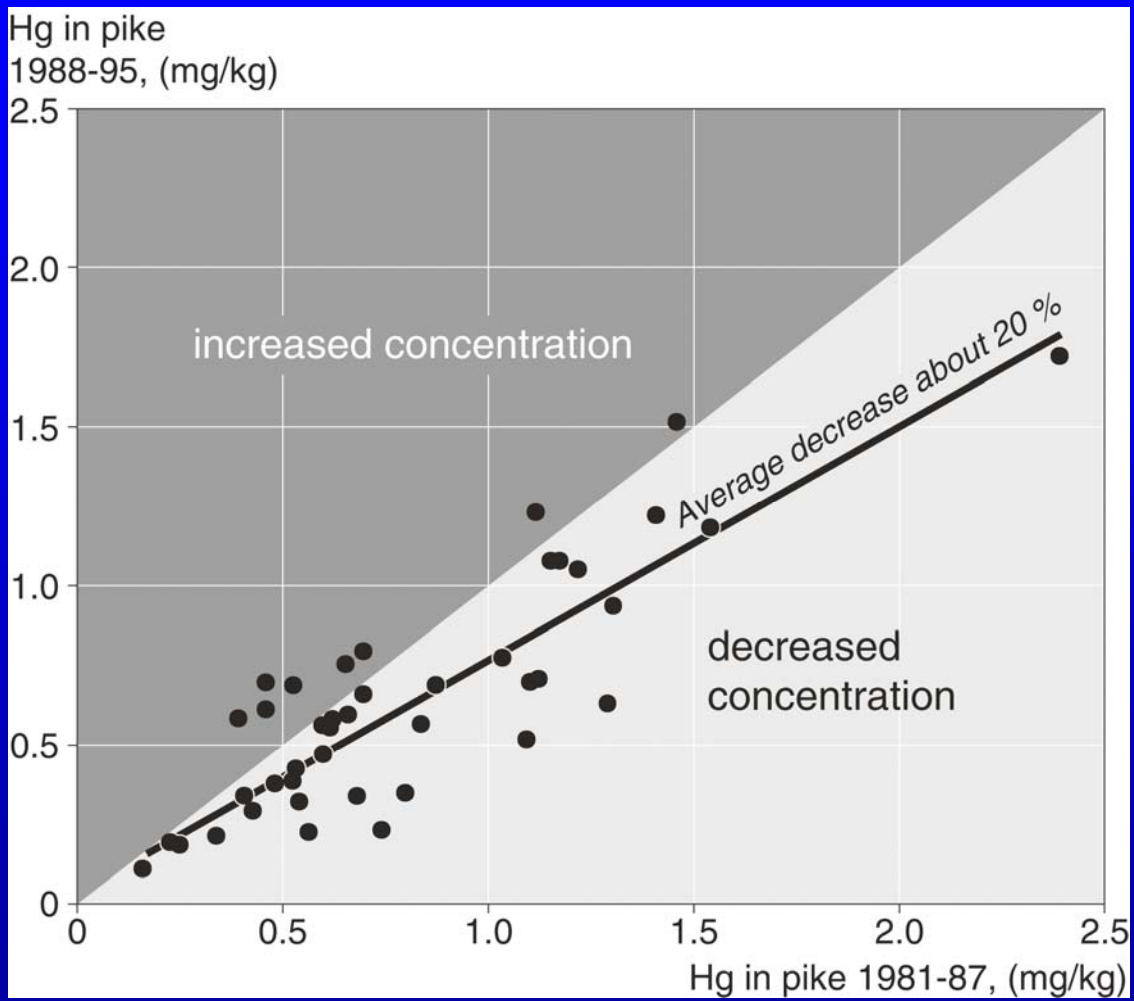
Source: Paterson et al. 1998

Mercury source reduction



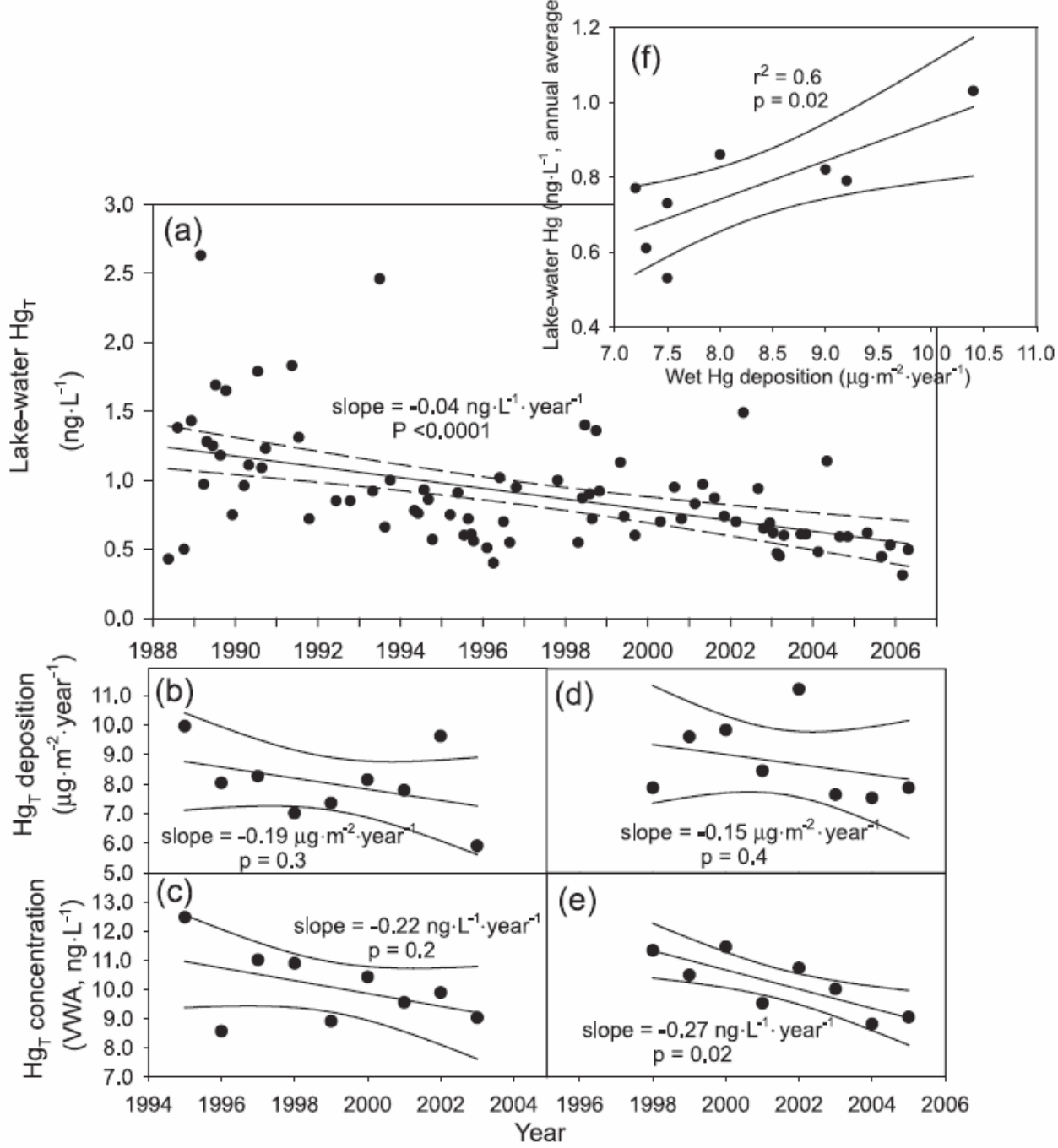
Walleye Hg concentrations in Clay Lake, Canada, following reduced releases of Hg from a chlor-alkali facility 80 km upstream (standardized 50 cm fish)

Swedish study of fish Hg following 50% drop in wet Hg deposition



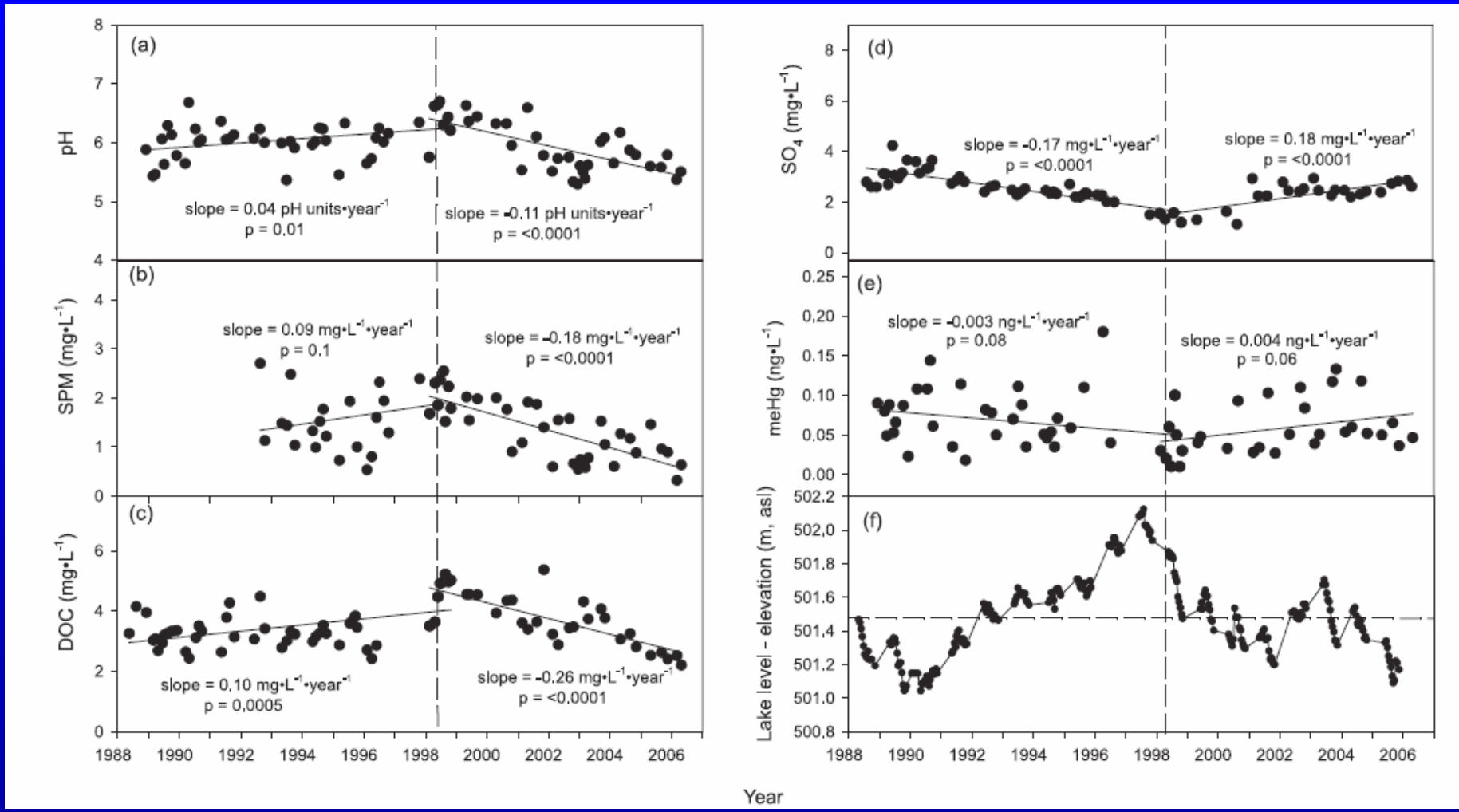
Were fish Hg decreases driven by less Hg deposition or other less acid deposition.. or less sulfate, or..?

An Example from Wisconsin, Little Rock Lake



From Watras and Morrison, 2008

An Example from Wisconsin, Little Rock Lake



From Watras and Morrison, 2008

Siting Needs for Model Development

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Tetra Tech, Inc

Oakville, Ontario

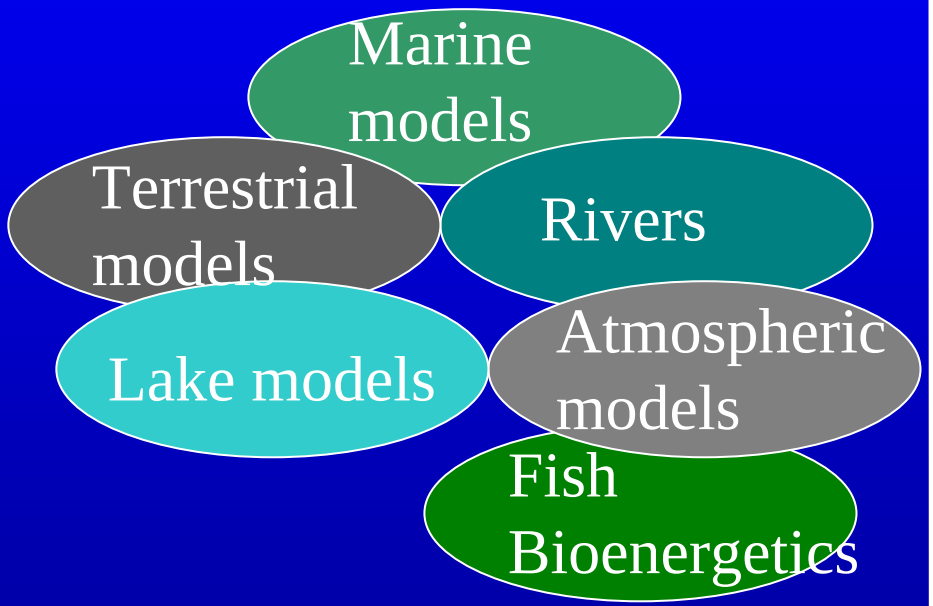
Siting needs for modeling

What questions will the models will try to answer?

- Predict, then explain, the observed magnitude and timing of the response of MeHg in fish to changes in Hg emissions
- Separate these effects from confounding factors (climate, land use, etc.)

Current capability of Hg models

R&D tool to improve understanding



→ Conceptual model development and incorporation of new R&D

→ Model calibration

→ Model validation

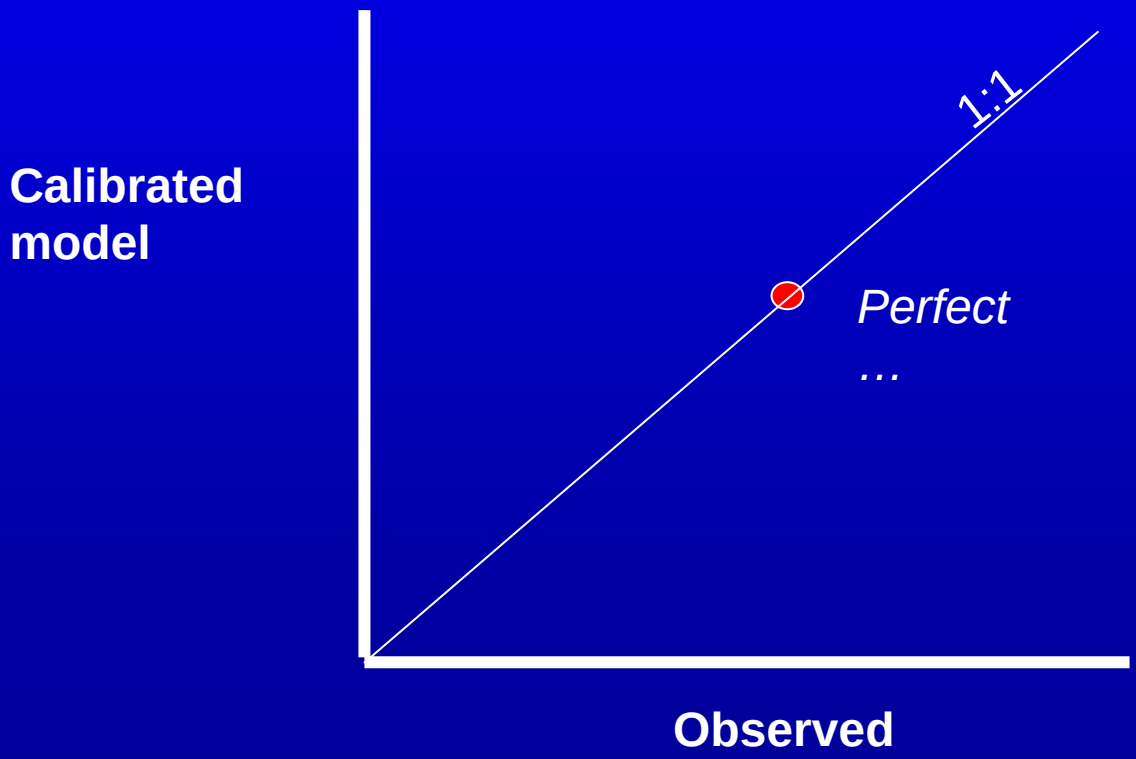
Predictions & explaining observed trends

Intensive sites well suited to process model development:

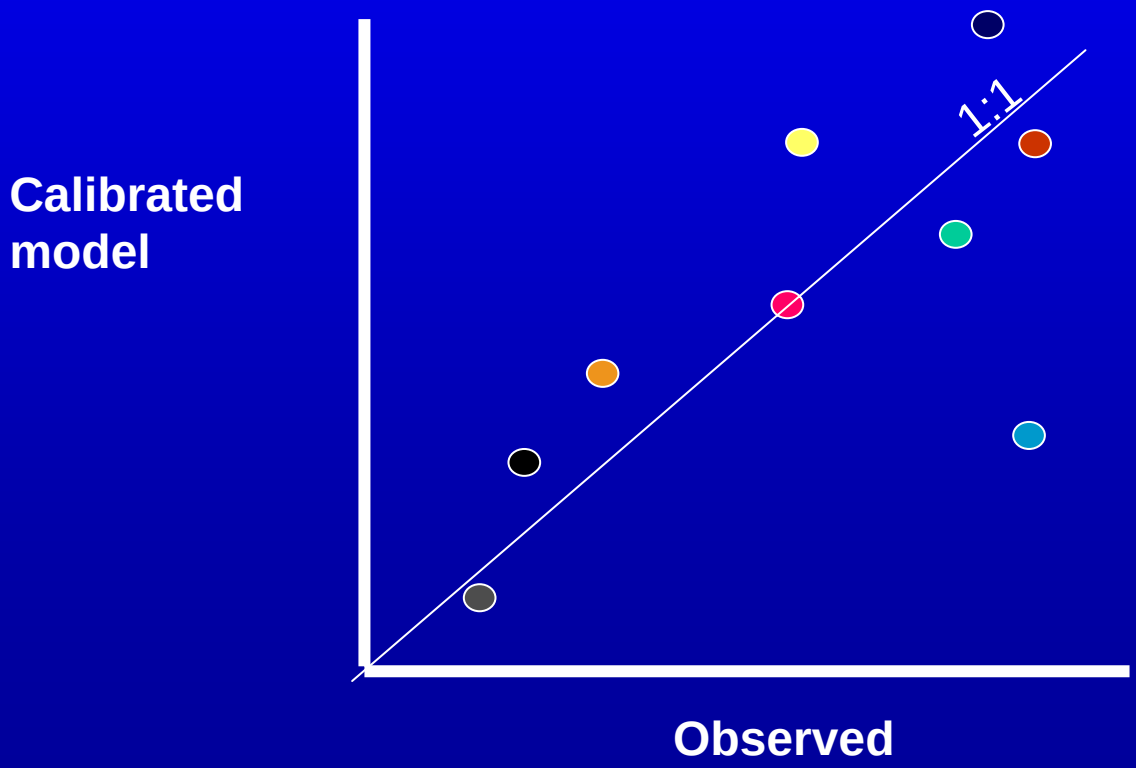
- ✓ Process level research
- ✓ Many steps from Hg emissions to fish. The more compartments that are monitored, the better to evaluate each step in models
- ✓ Ancillary data to deal with confounding factors
- ✓ Manageable scale
- ✓ Long term datasets
- ✓ Mutually benefit to modelers and researchers

One type of site is not enough….

Models can be forced to fit any one system

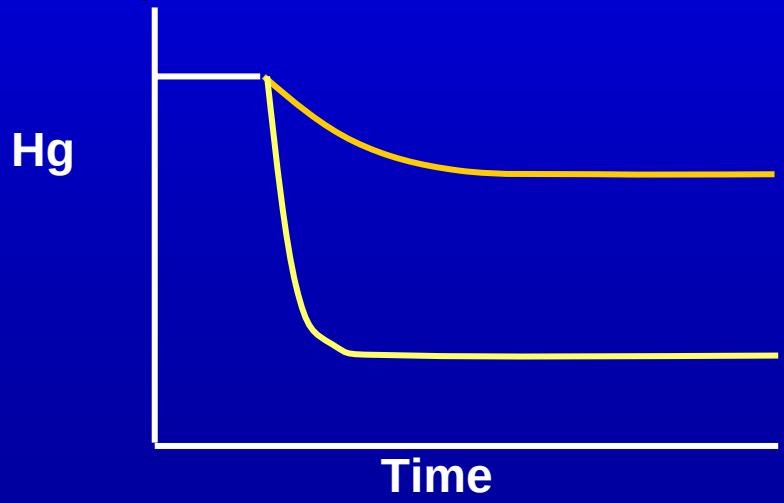


Need multiple sites to test model ability to predict without retuning each time.....



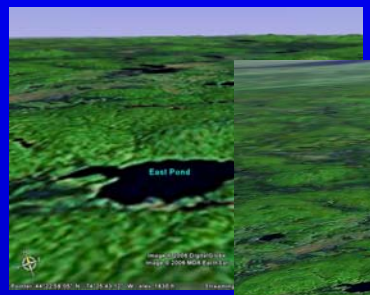
Multiple sites should encompass an anticipated range for the:

- Magnitude of response
- Rate of response

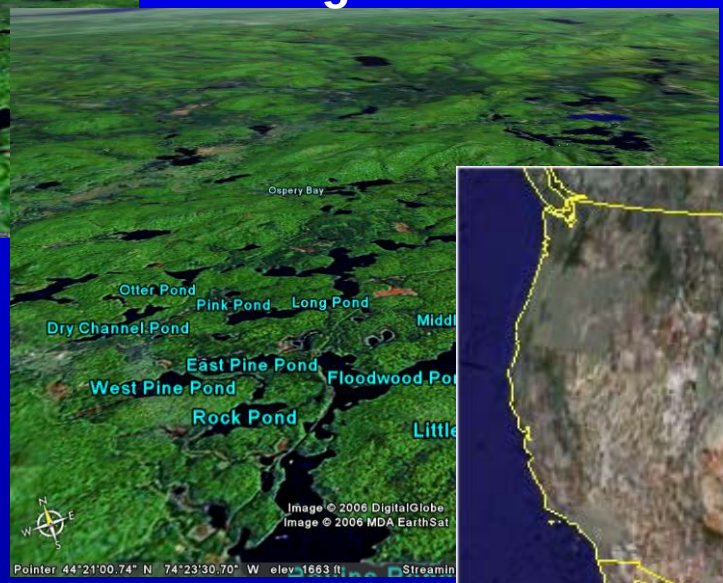


Hg modeling:
Scaling up to national scale

Local



Regional



National

Models will likely be applied to intensive sites to help explain trends but what approach and data are needed to extrapolate to regions or nationally?

Fig. 2. Annual cycle of waterborne Hg_T in LRL (●) and annual cycle of wet Hg deposition (shaded bars), 1994–2004: (*a*) stratified north basin; (*b*) unstratified south basin. Precipitation data are the seasonal running averages (13 weeks).

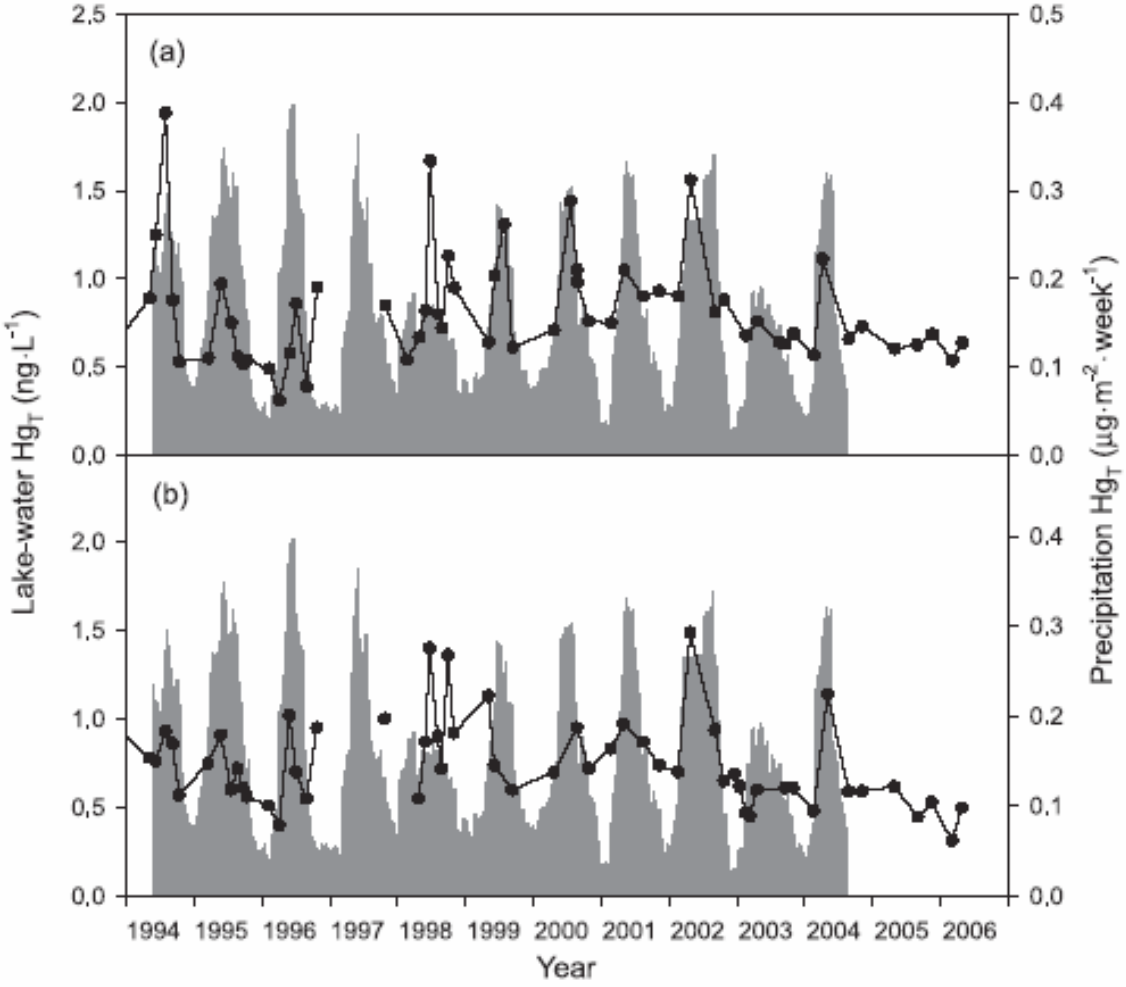
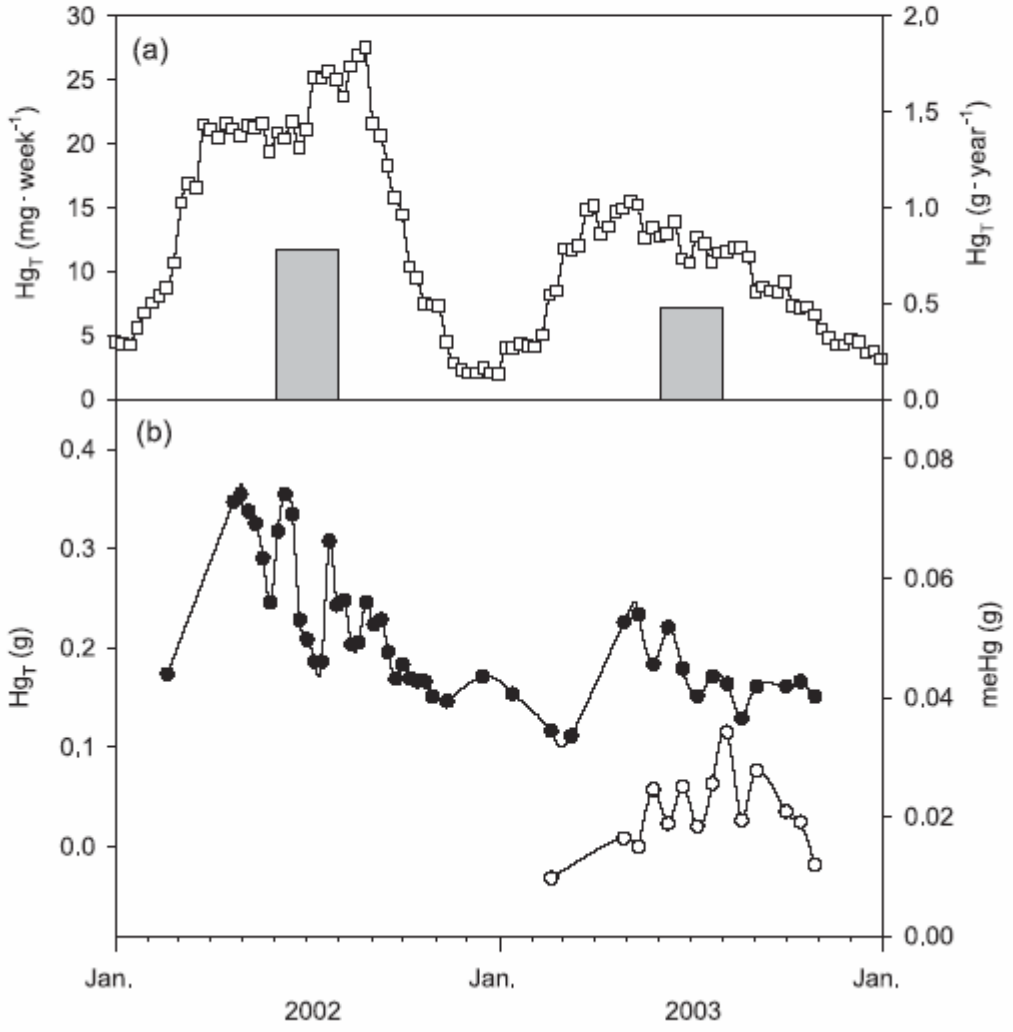
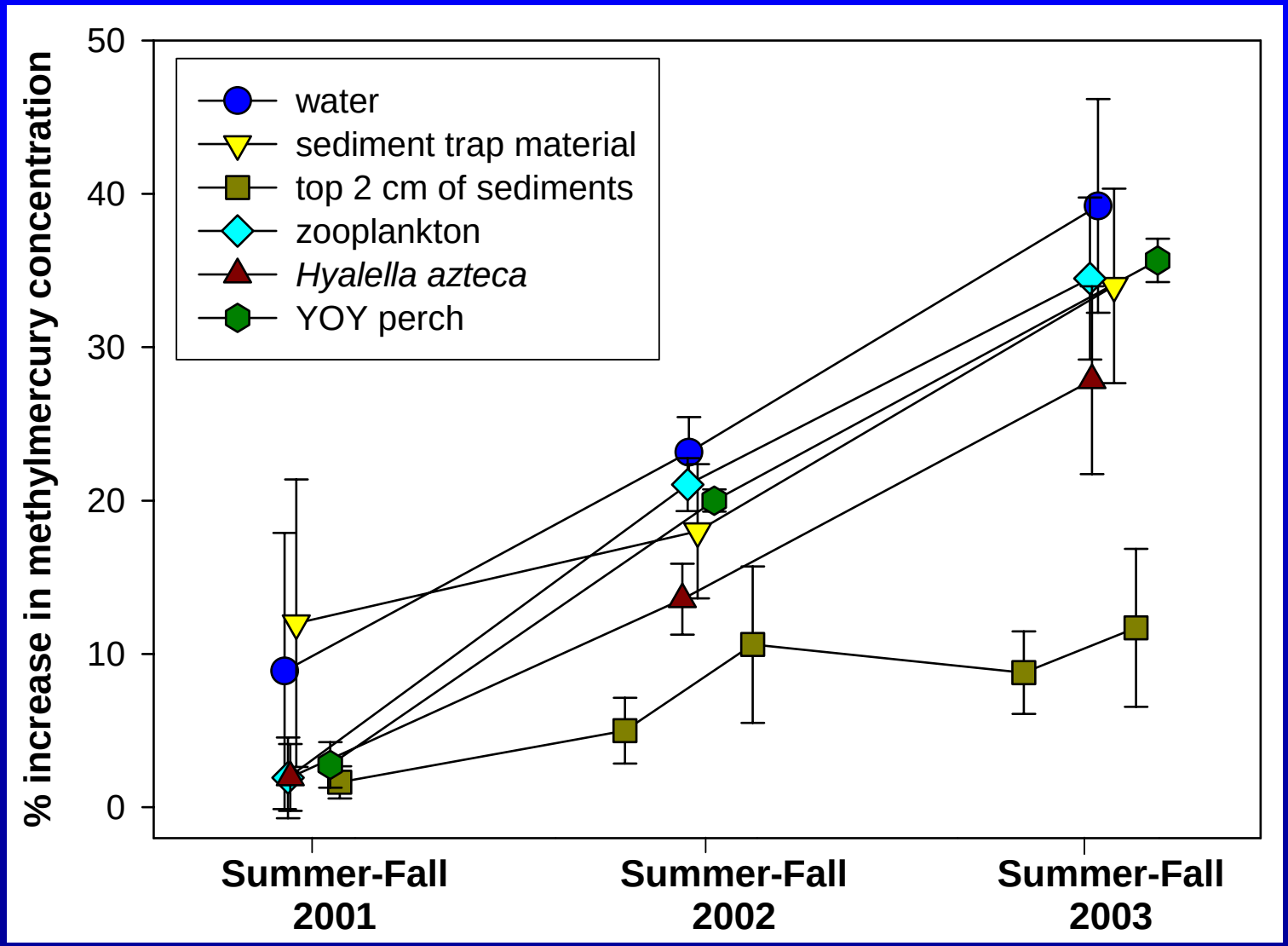


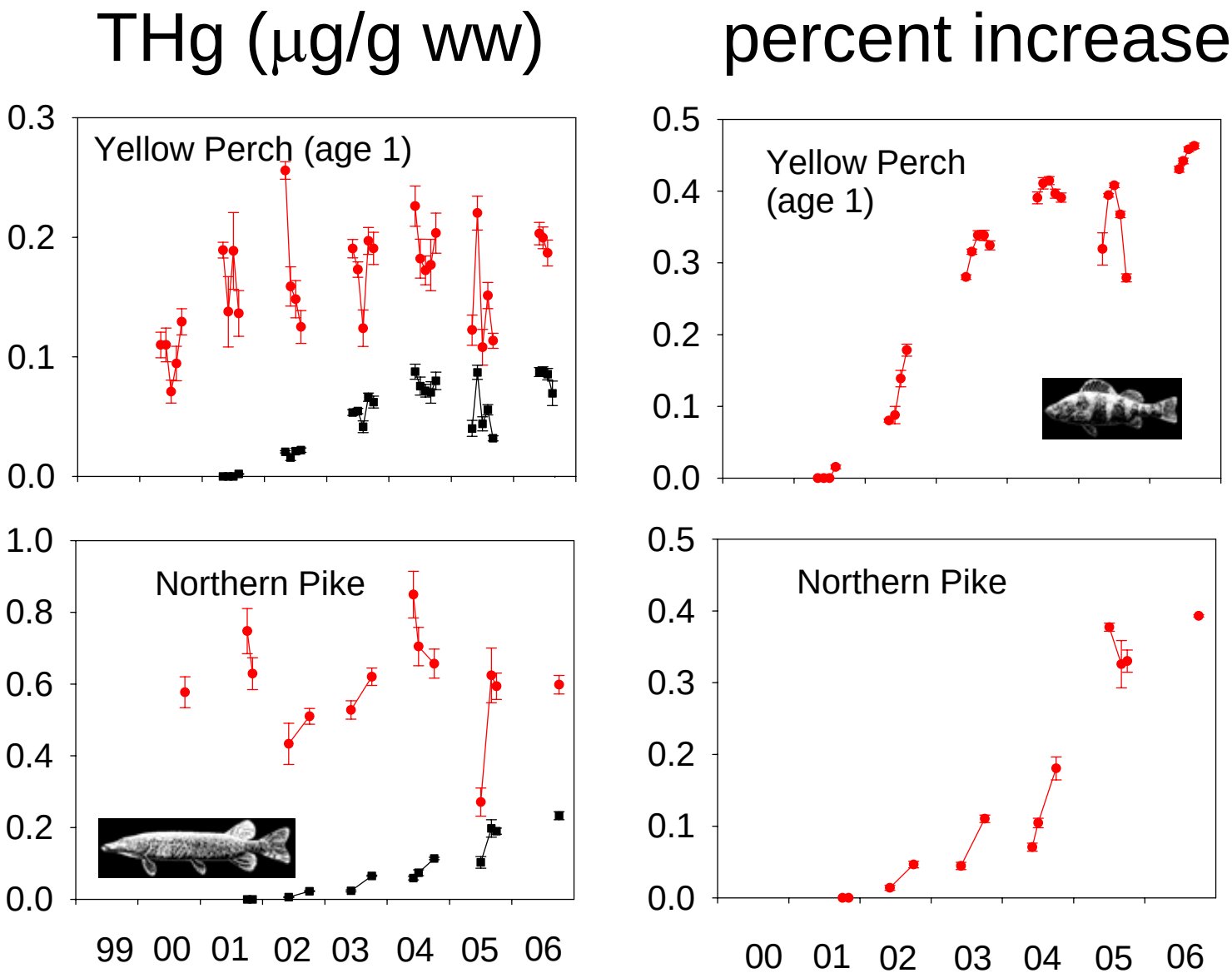
Fig. 3. Weekly changes in (*a*) atmospheric Hg_T deposition (□) and (*b*) waterborne Hg_T (●) and meHg (○) in LRL, 2002–2004. Shaded bars in (*a*) are annual atmospheric Hg_T deposition. Lake data in (*b*) are whole-lake masses for the unstratified south basin.

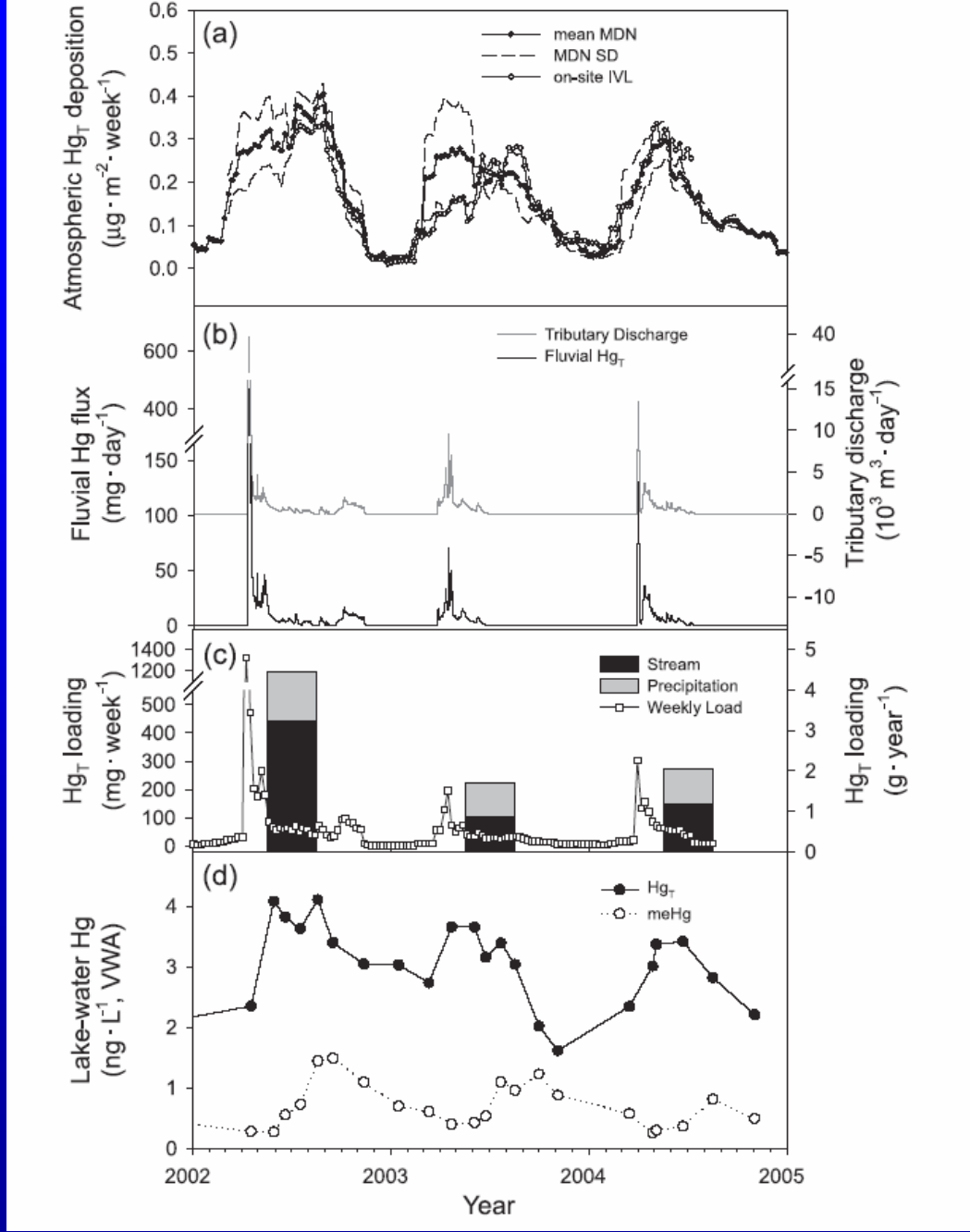


Percent increase in methylmercury concentration due to the 120% extra loading of Hg(II) to the lake



Examples from the METAALICUS project





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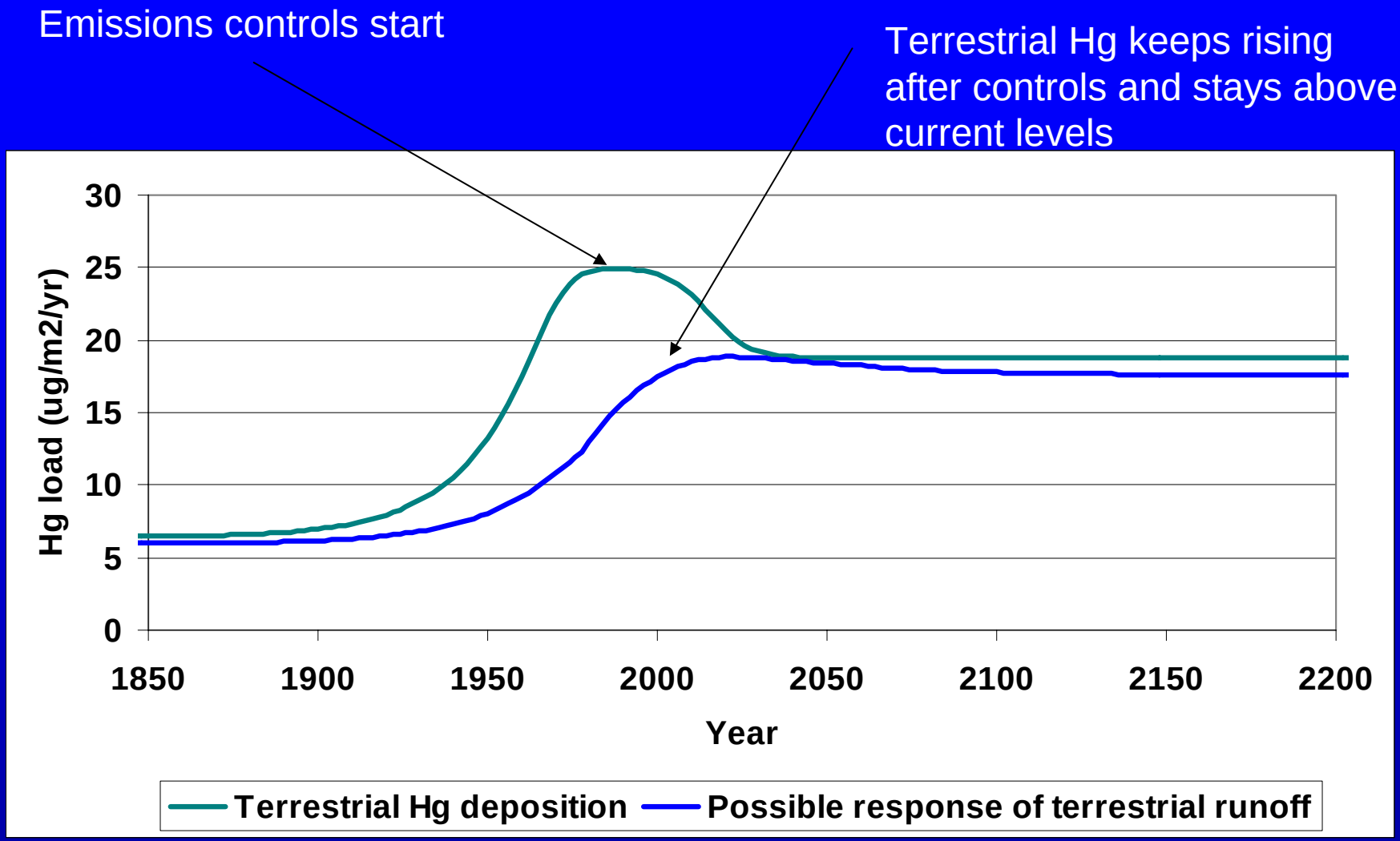

Possible response of terrestrial Hg export after 25% reduction in Hg deposition