Mercury in Aquatic Food Webs of Six National Parks in the Western Great Lakes Region

Kris Rolfhus, Mark Sandheinrich, Roger Haro, James Wiener

River Studies Center, University of Wisconsin-La Crosse

Concerns about mercury pollution

Human health impacts (300,000/yr in USA)

- Neurotoxin is methylmercury (MeHg, CH_3Hg^+)

Mobility/reactivity in the environment

- Global atm residence time ~ 1 yr
- MeHg synthesized by natural aquatic bacteria

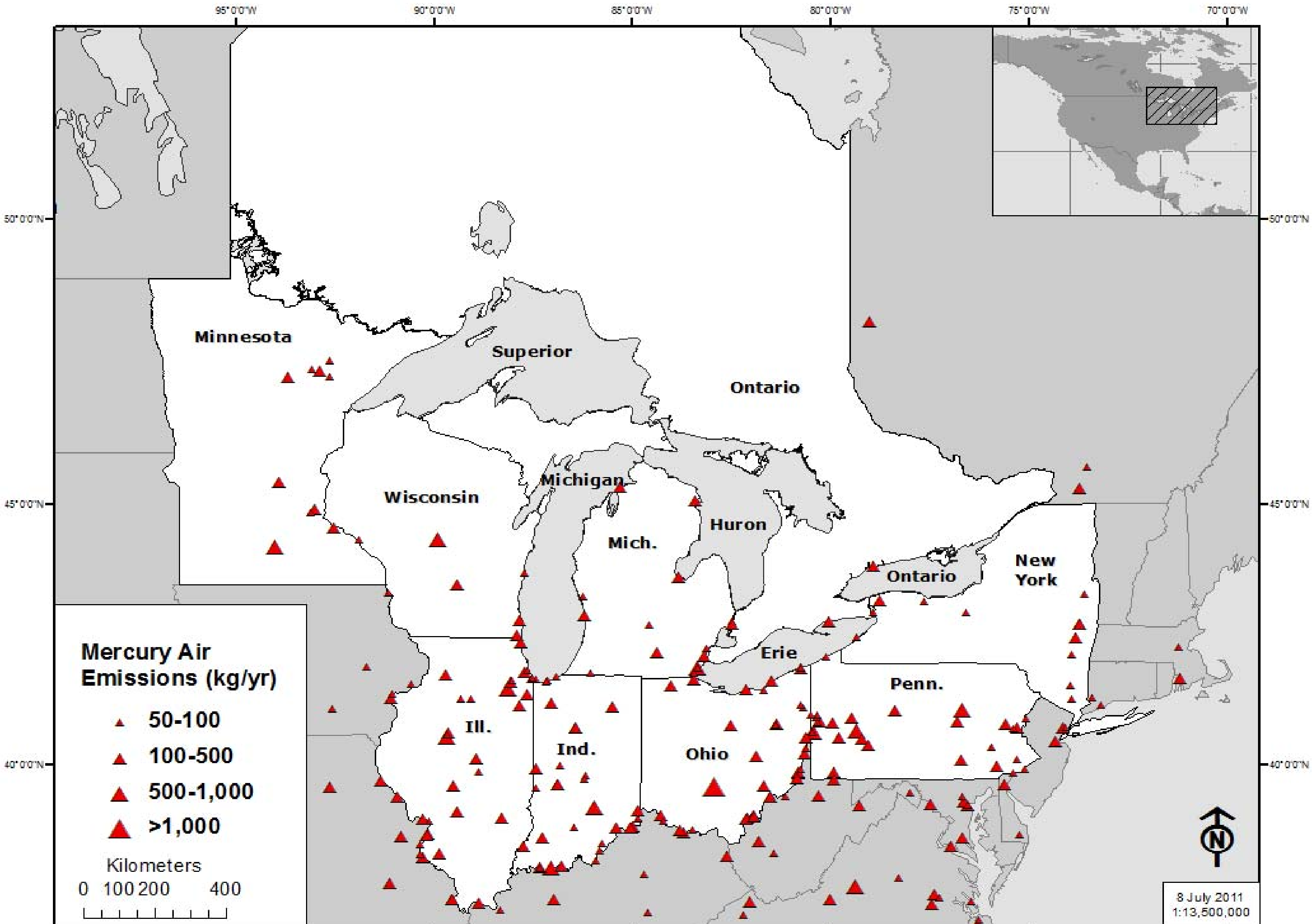
Bioaccumulation through food webs

- Really low environmental levels: pptr in water
- 6-7 orders of magnitude: ppm in fish

Anthropogenic forcing

- Currently 75% of atm. deposition (2/3 recycled)
- > 50% drop in regional emissions since 1990

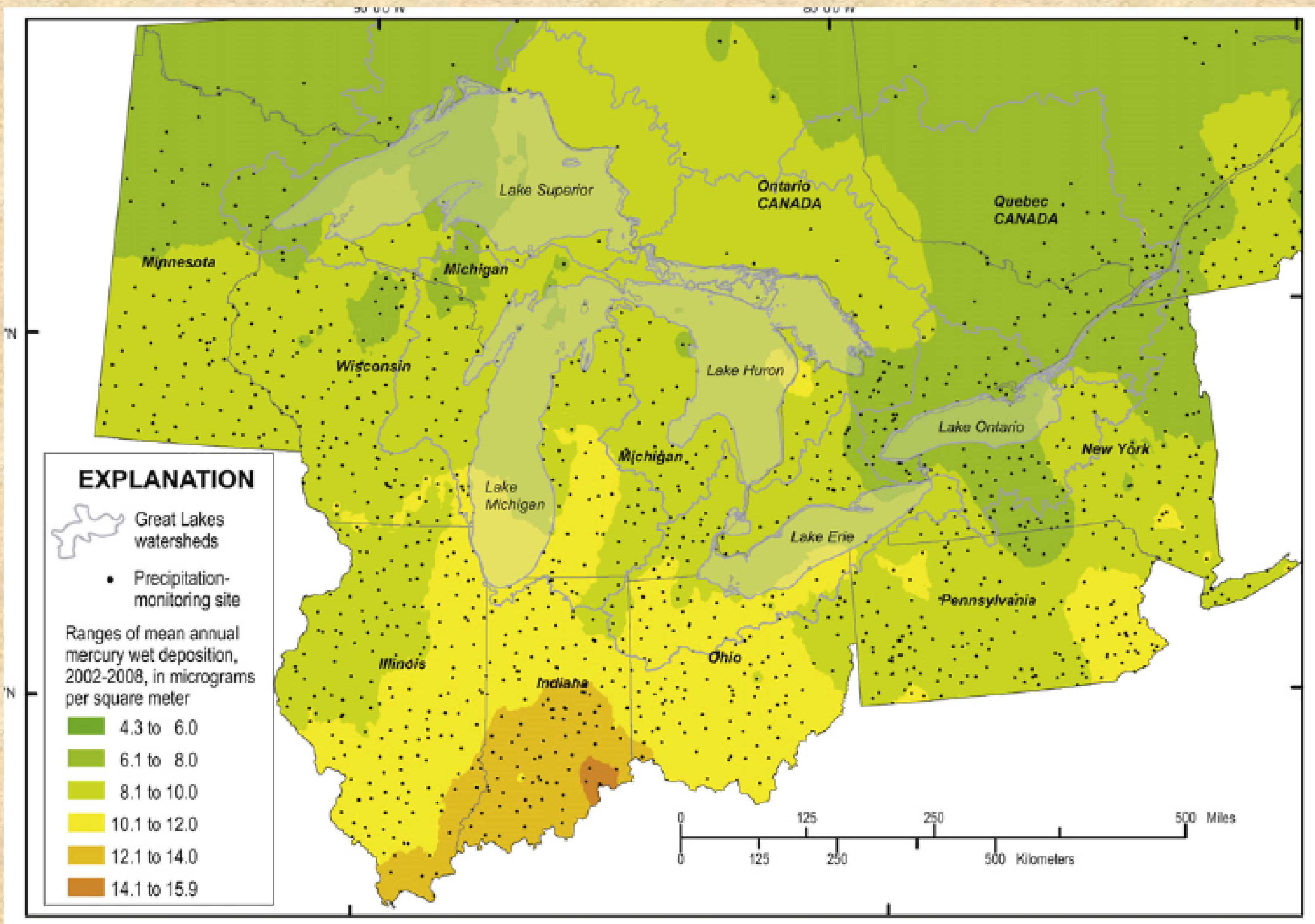
Many Mercury-Sensitive Watersheds and Water Bodies



US EPA

Total Hg in Wet deposition (2002-2008)(ug/m^2/yr)

Risch et al., 2011



Objectives for National Park Study

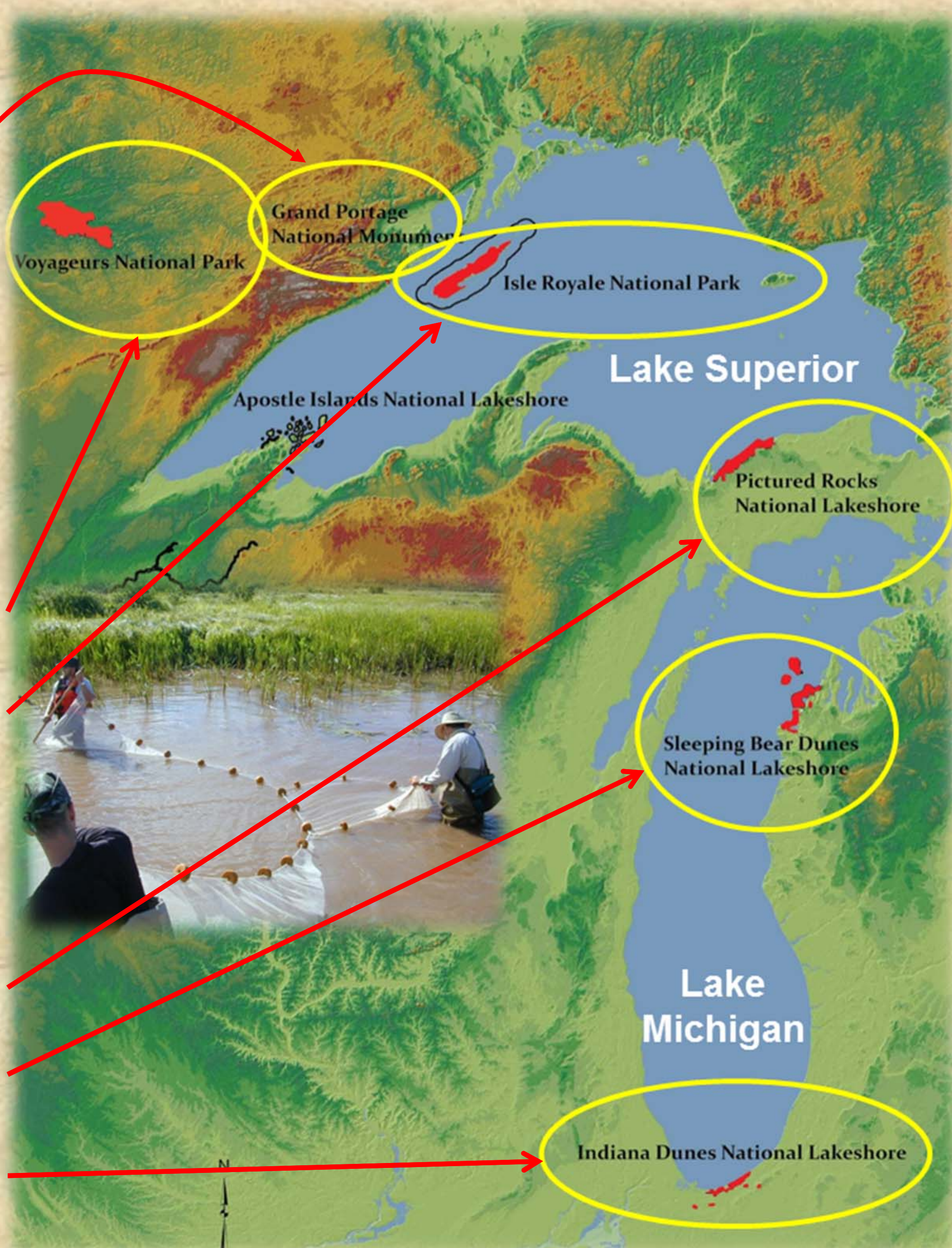
1) To assess spatial patterns for [MeHg] in aquatic food webs

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

National park units under study…

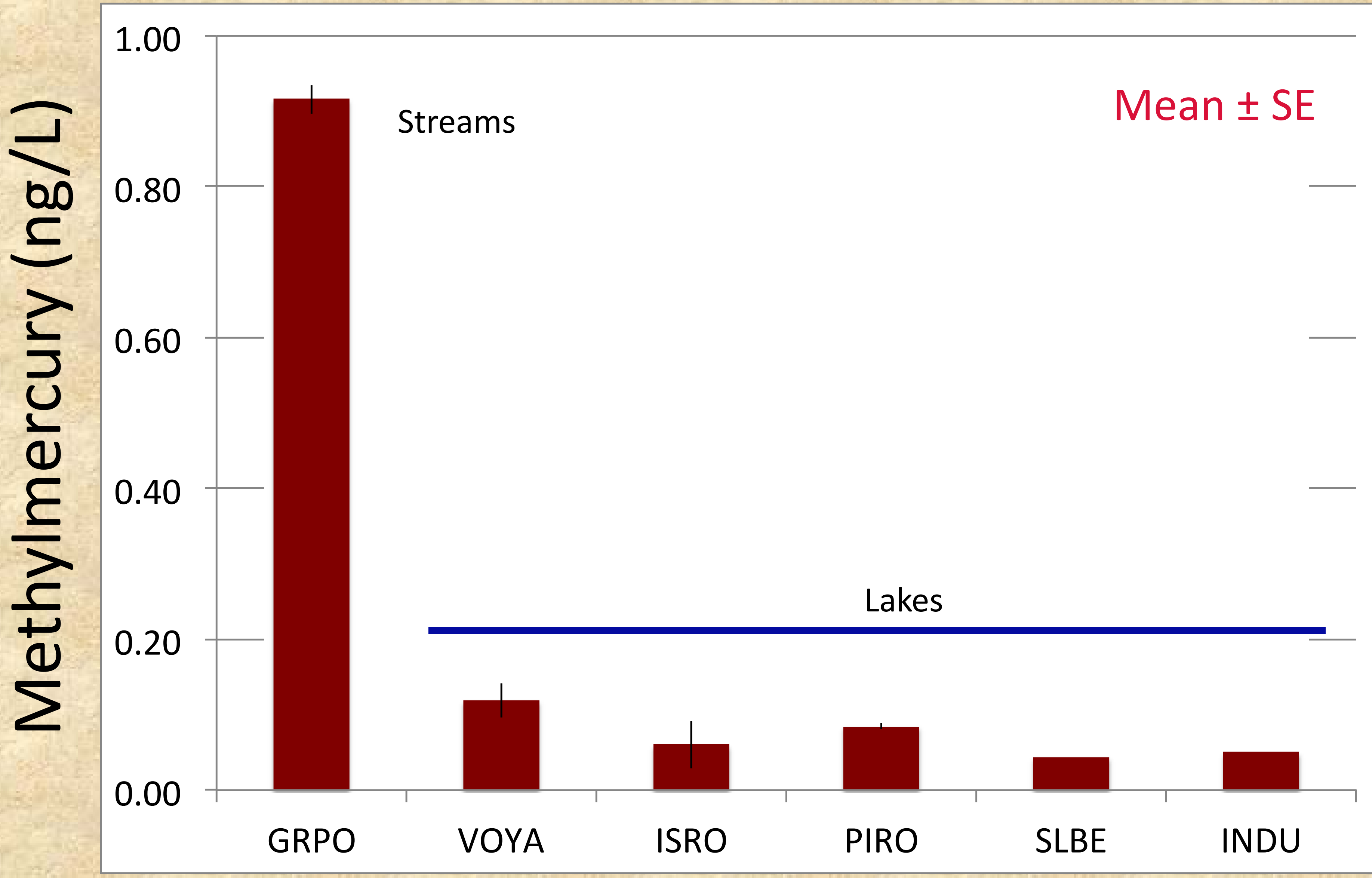
National Monument	**#**
Grand Portage (GRPO)	3
National Parks	
Voyageurs (VOYA)	4
Isle Royale (ISRO)	4
National Lakeshores	
Pictured Rocks (PIRO)	5
Sleeping Bear Dunes (SLBE)	4
Indiana Dunes (INDU)	3



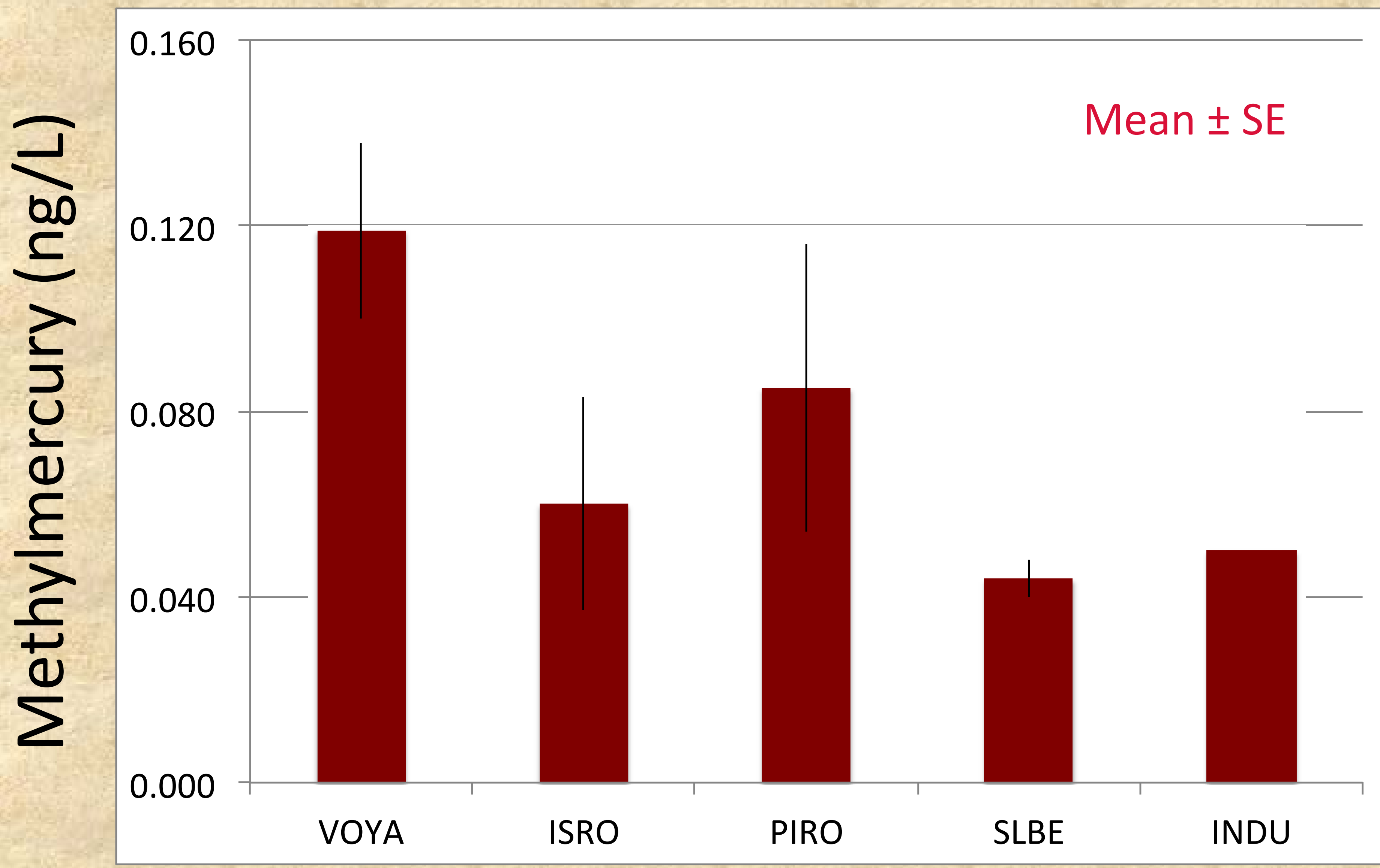
of samples analyzed (2008-2012)

	Total Hg	MeHg
Predatory fish	1485	--
Prey fish	4474	--
Dragonfly larvae	1985	1985
Zooplankton	113	113
Seston	136	136
Water	242	242
Surficial sediment	205	155
Soil	60	60

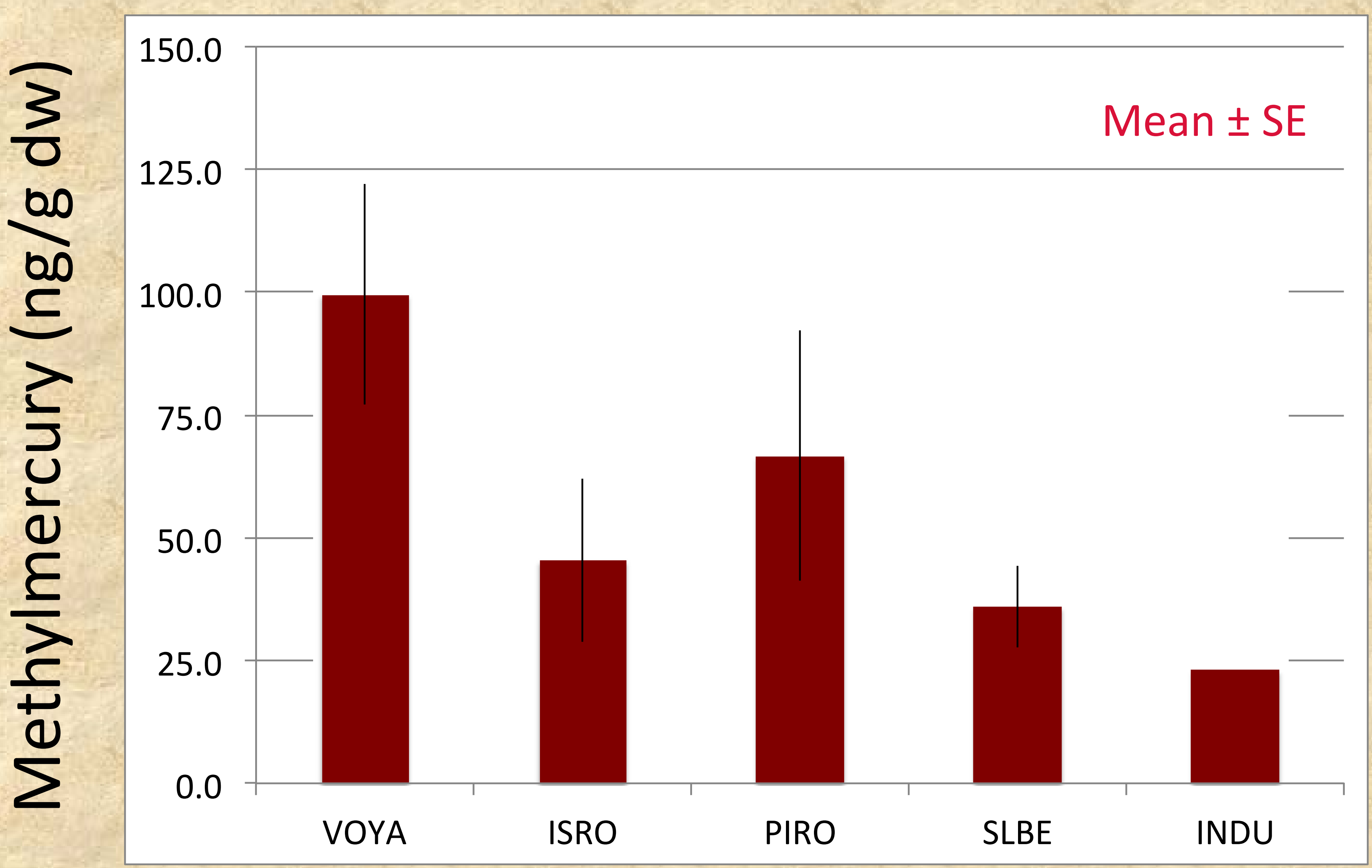
MeHg in 0.45 µm-Filtered Water



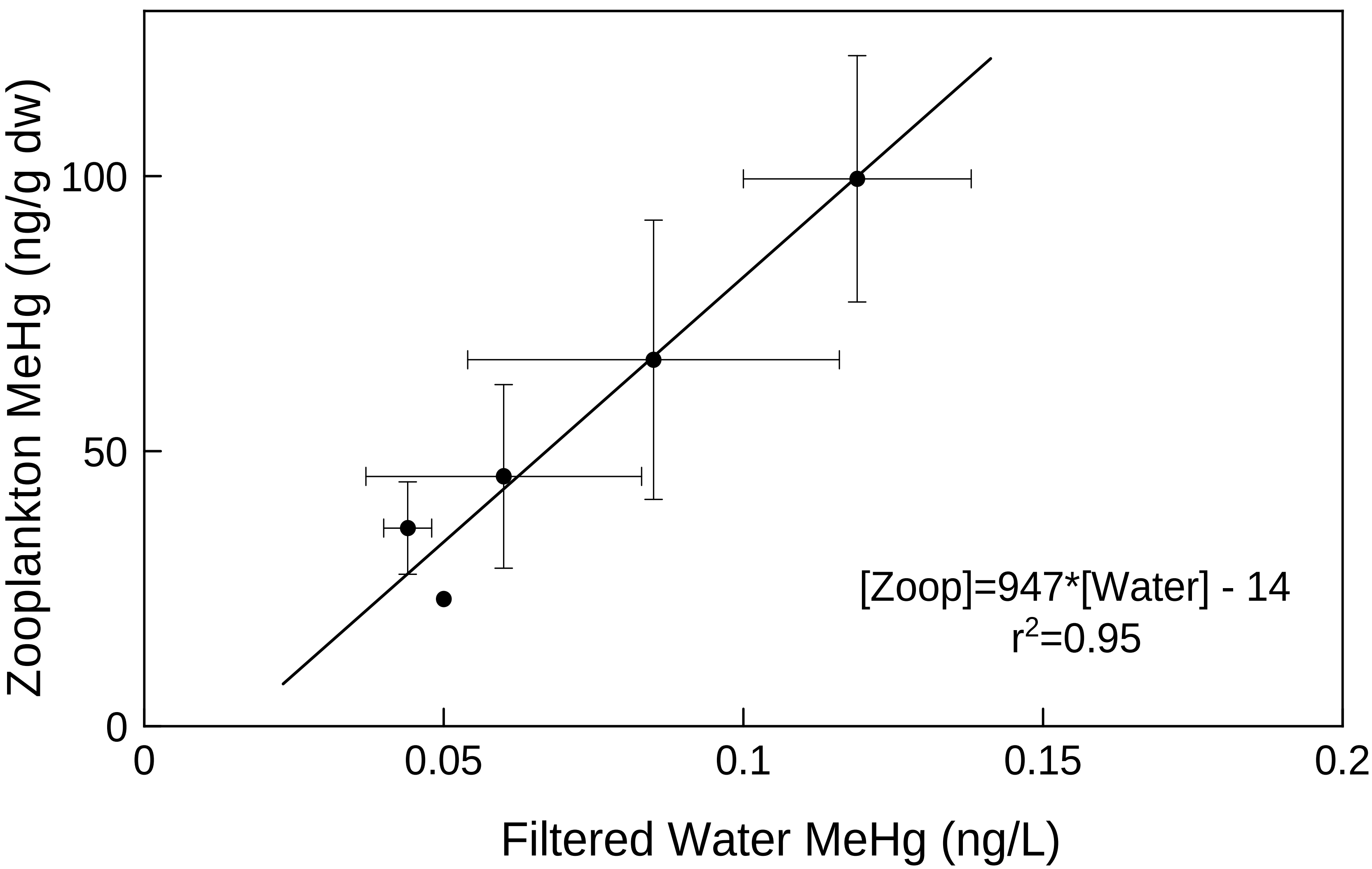
Lakes: MeHg in 0.45 μm-Filtered Water



Lakes: MeHg in Bulk Zooplankton

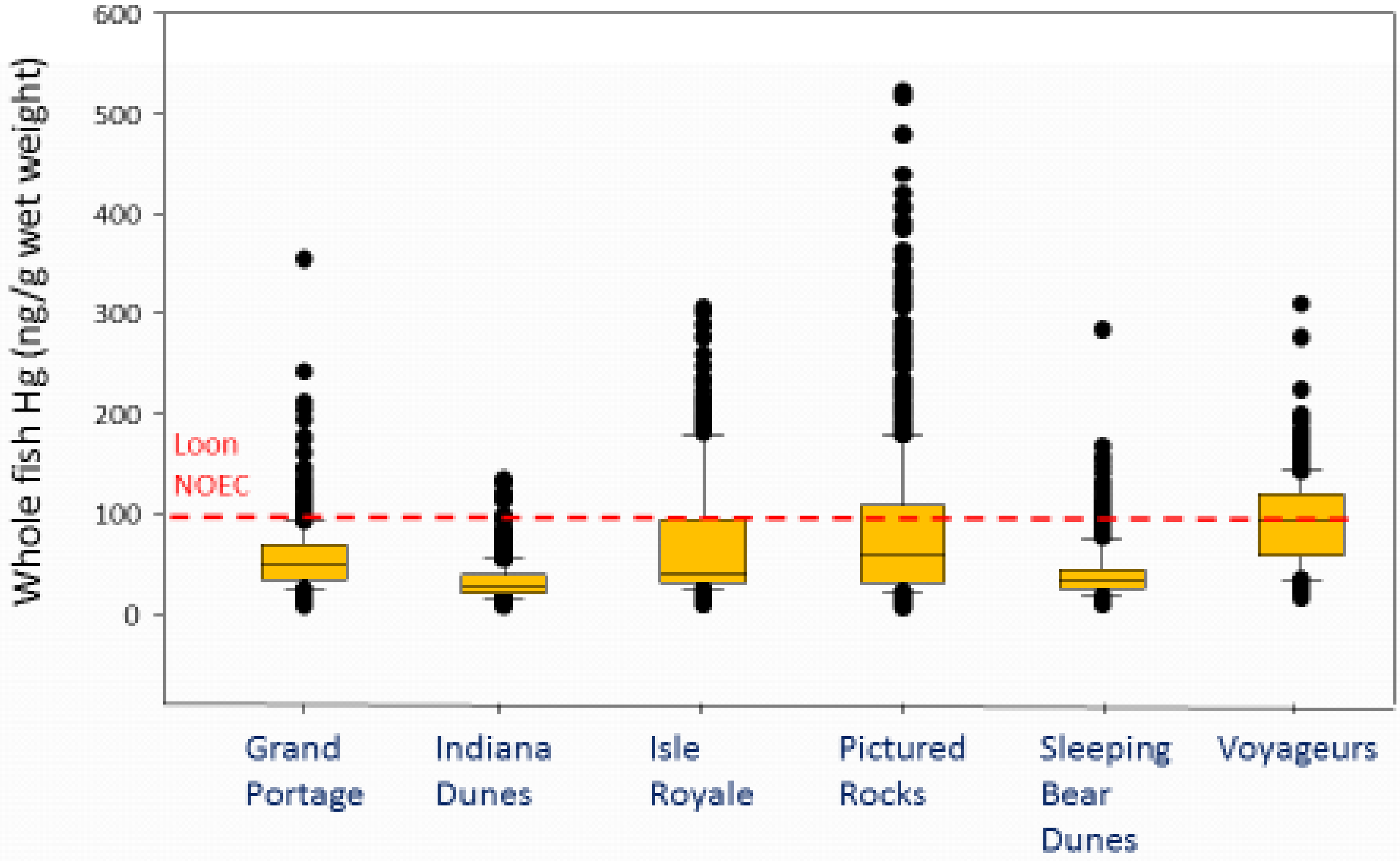


Aqueous Control of MeHg in Bulk Zooplankton



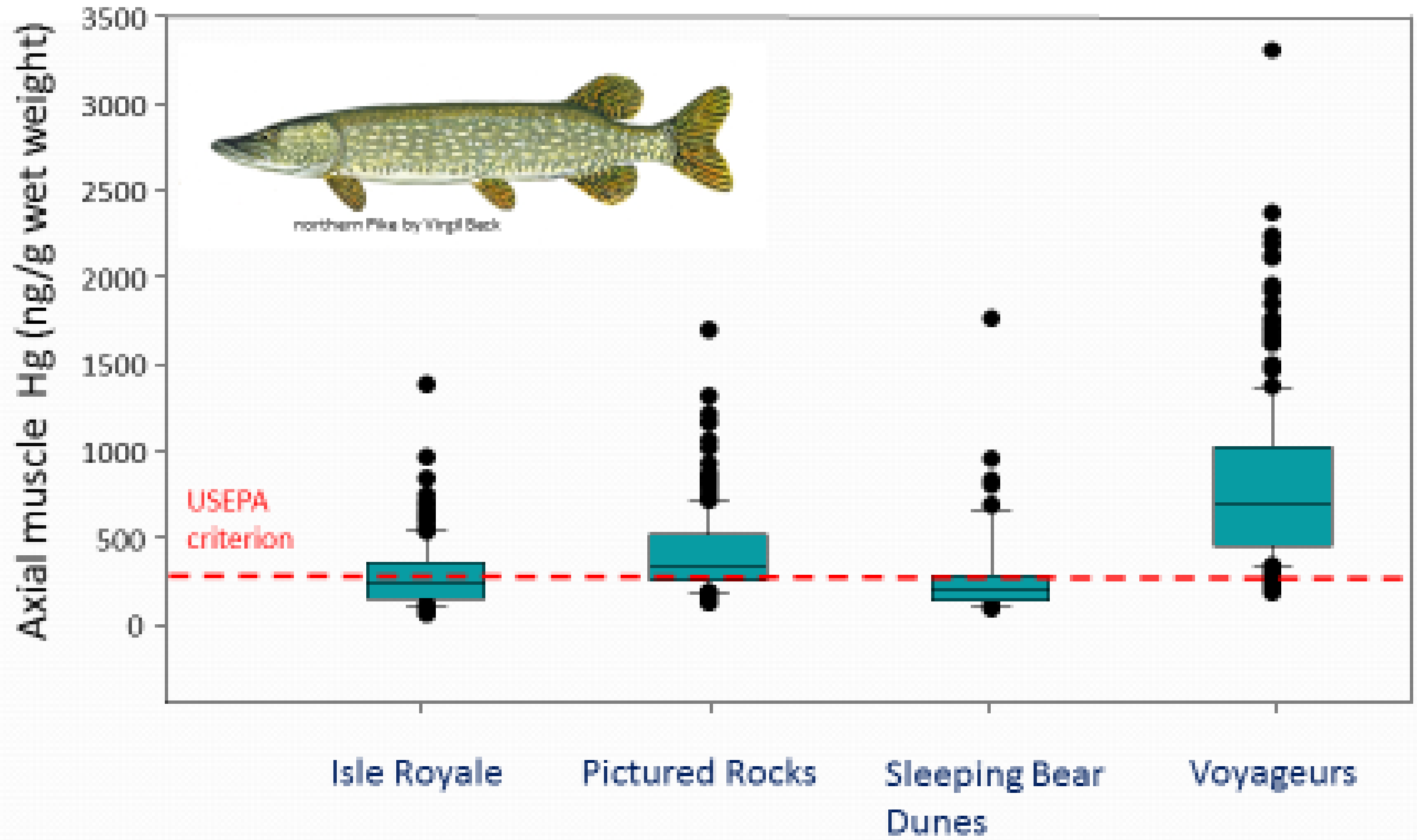
THg in Preyfish (TL<120 mm)

% > 100 ppb	6	1	24	24	4	43
No. fish	454	530	308	730	492	514
No. waters	3	3	4	4	4	4

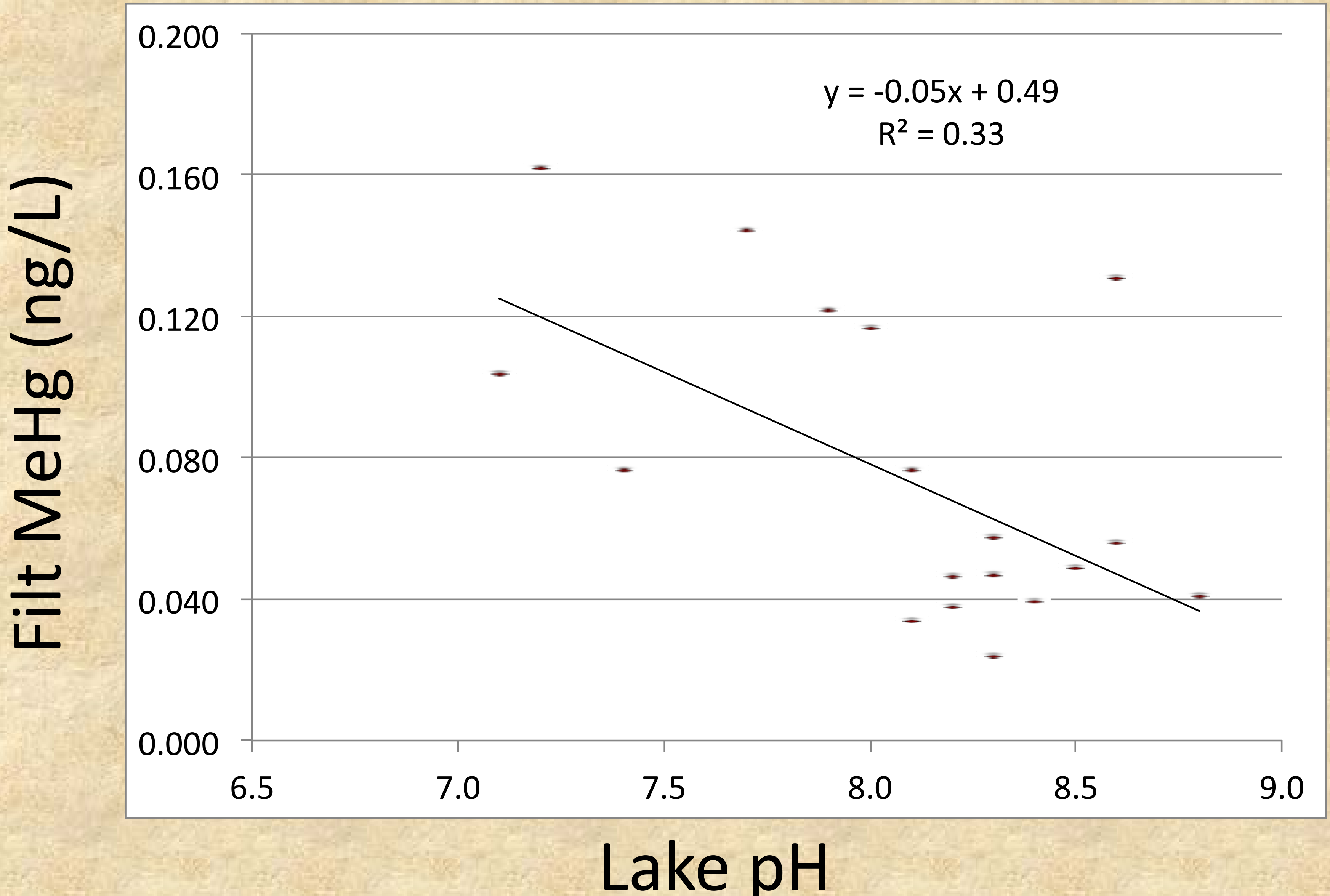


Total Hg in Northern Pike

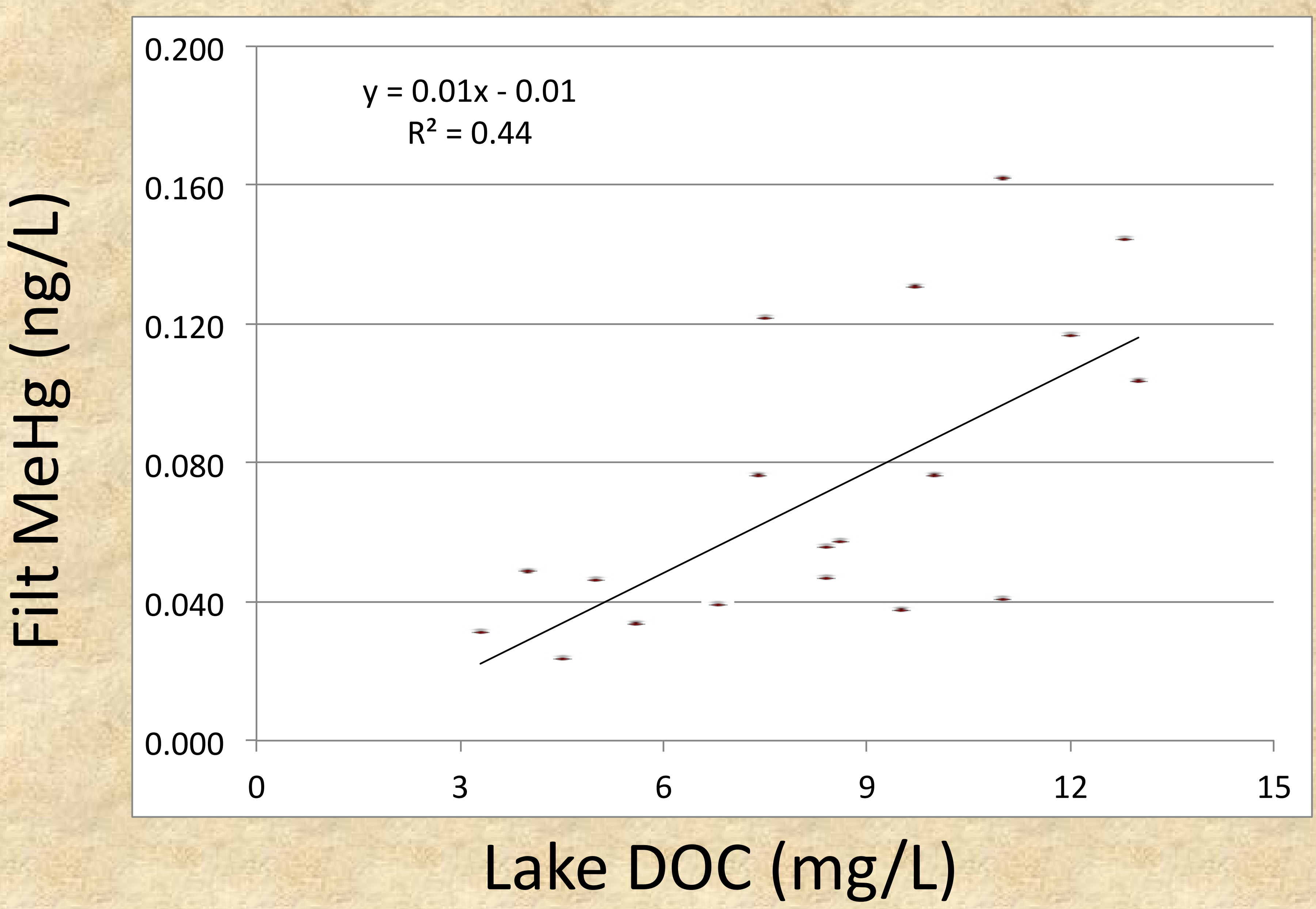
% fish > 300 ppb	38	59	22	94
# fish	176	181	62	248
# waterbodies	3	3	2	4



What is Controlling Aqueous MeHg?



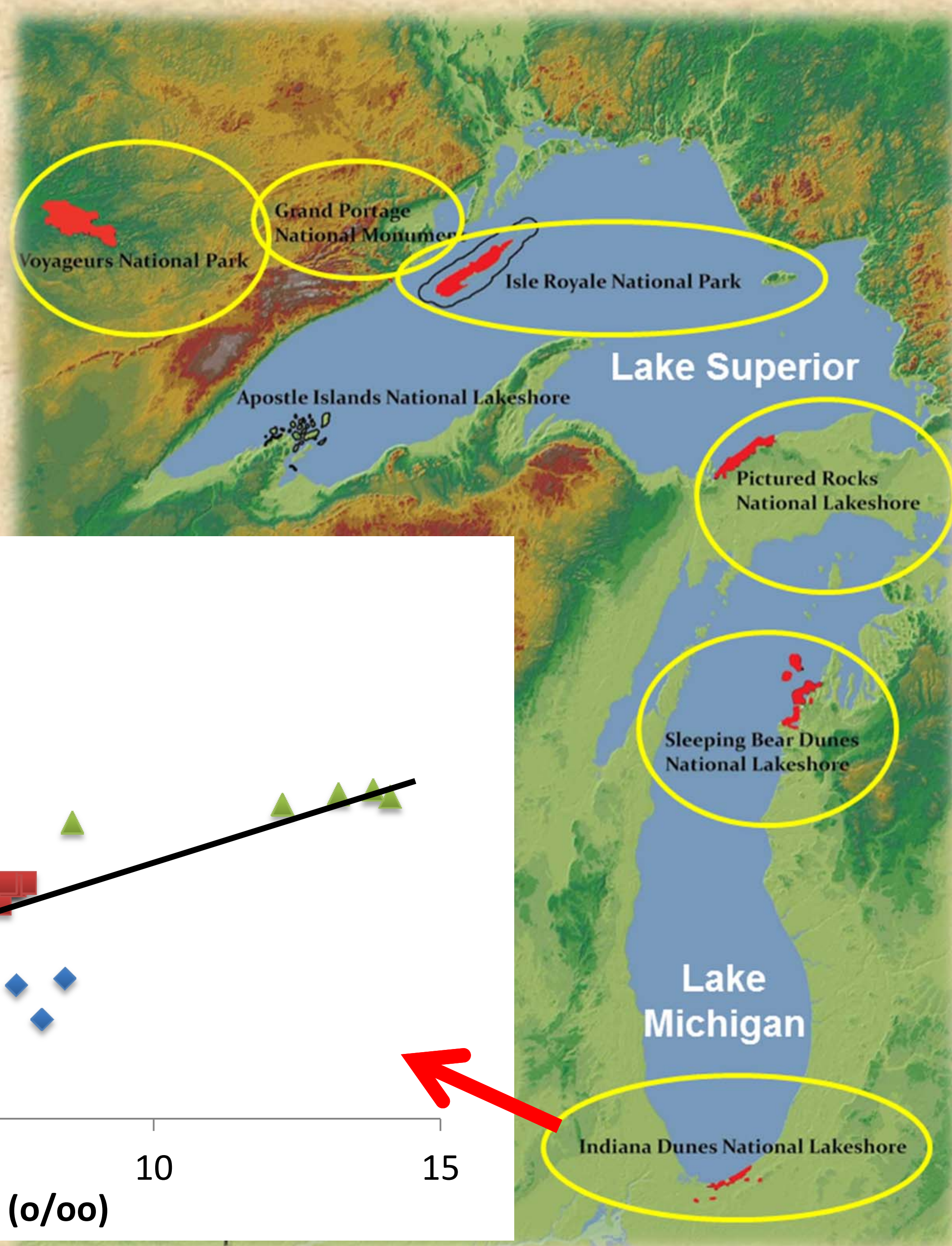
What is Controlling Aqueous MeHg?

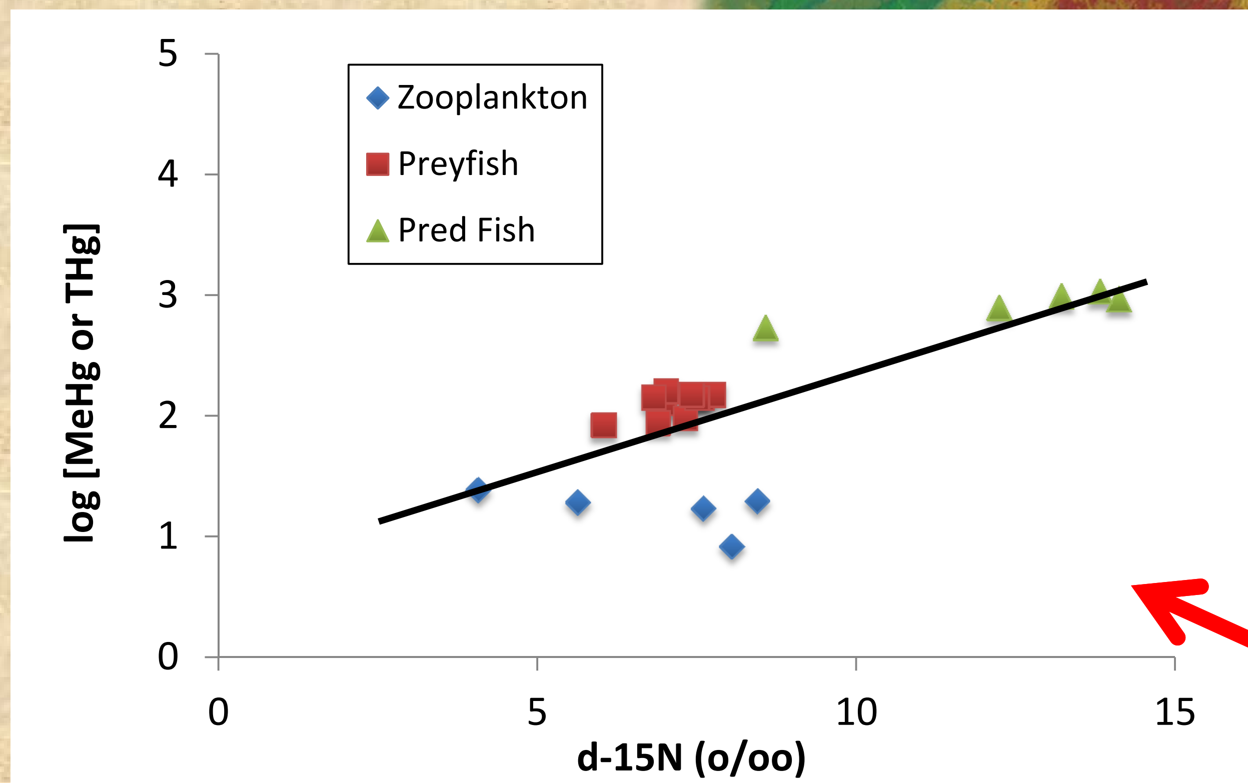


INDU:

TMS = **0.17**

r^2 =0.54

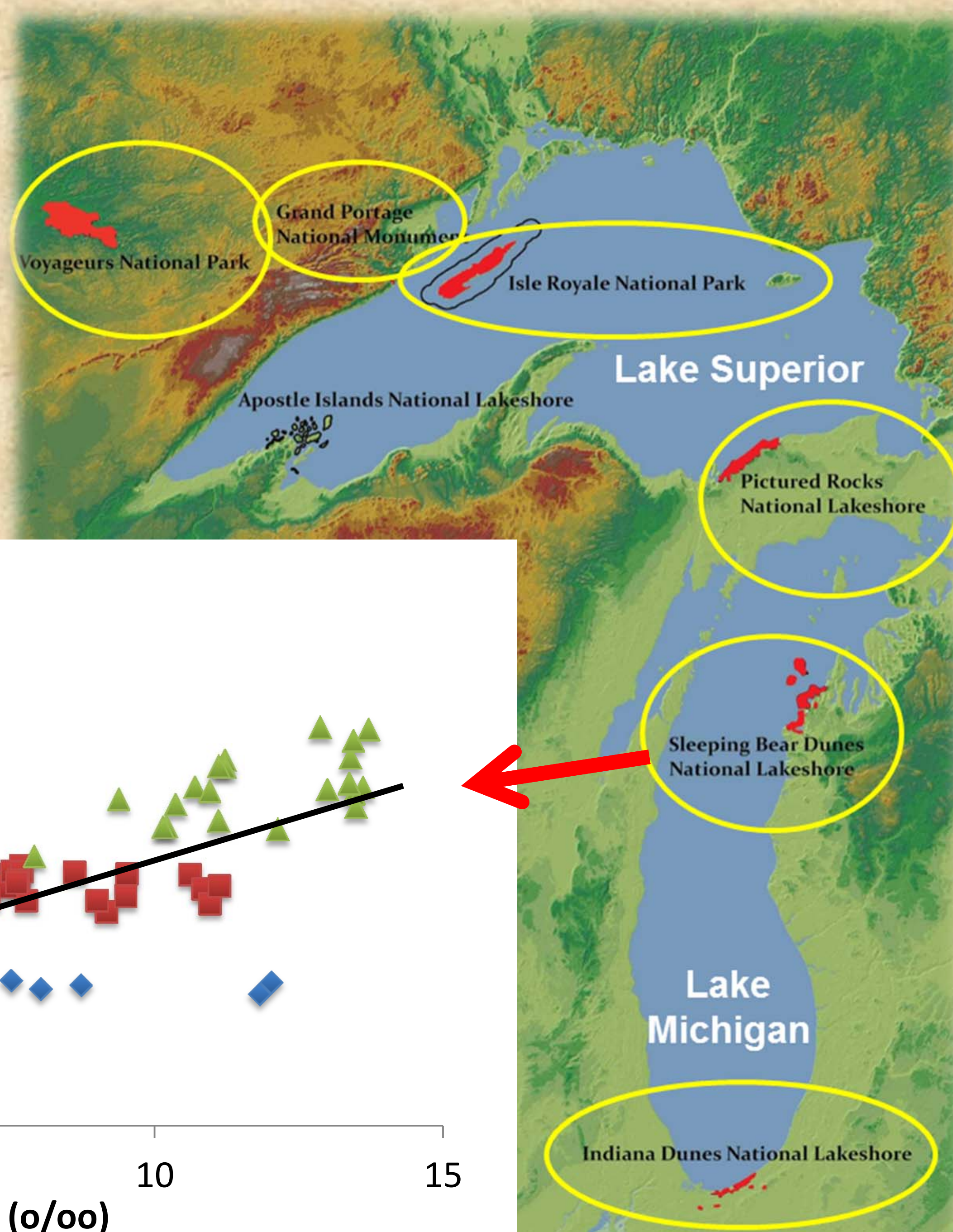


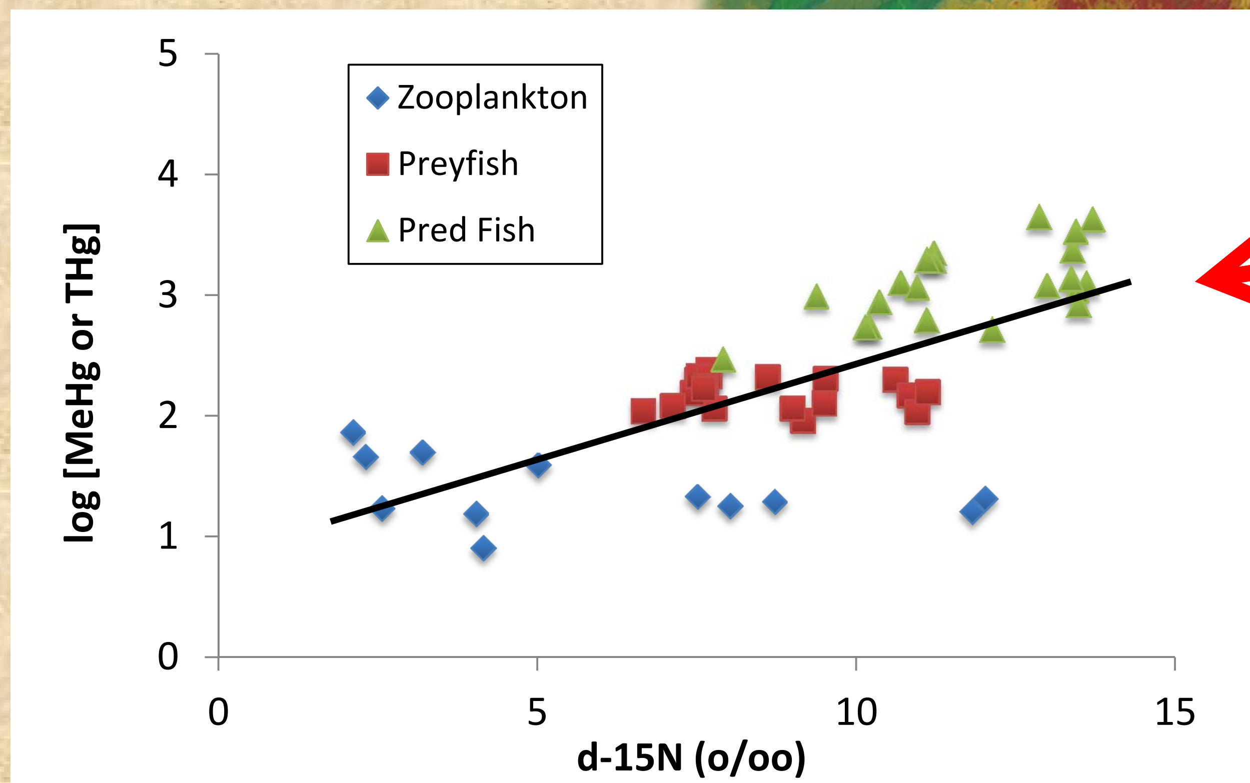


SLBE:

TMS = **0.16**

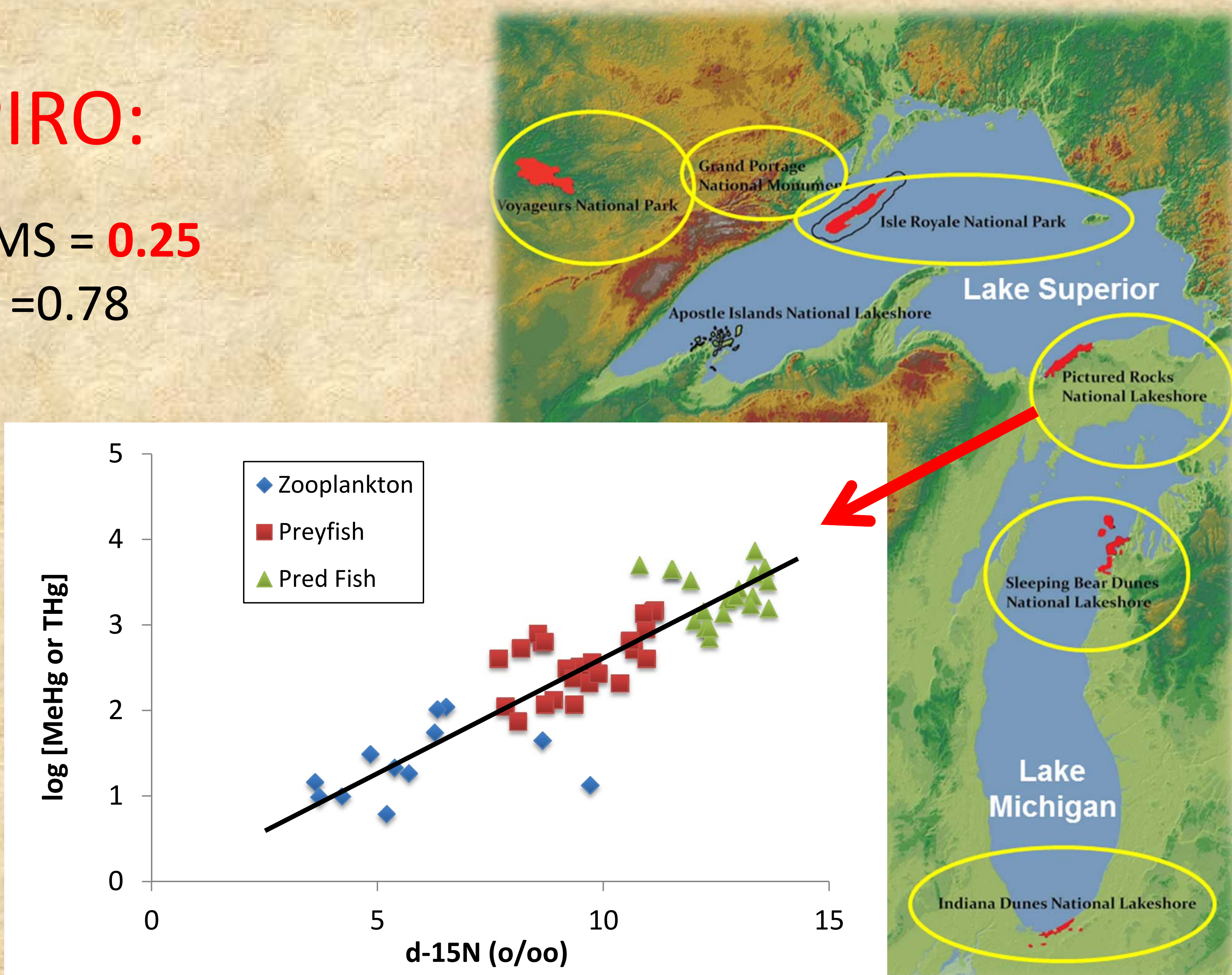
$r^2 = 0.49$





PIRO:

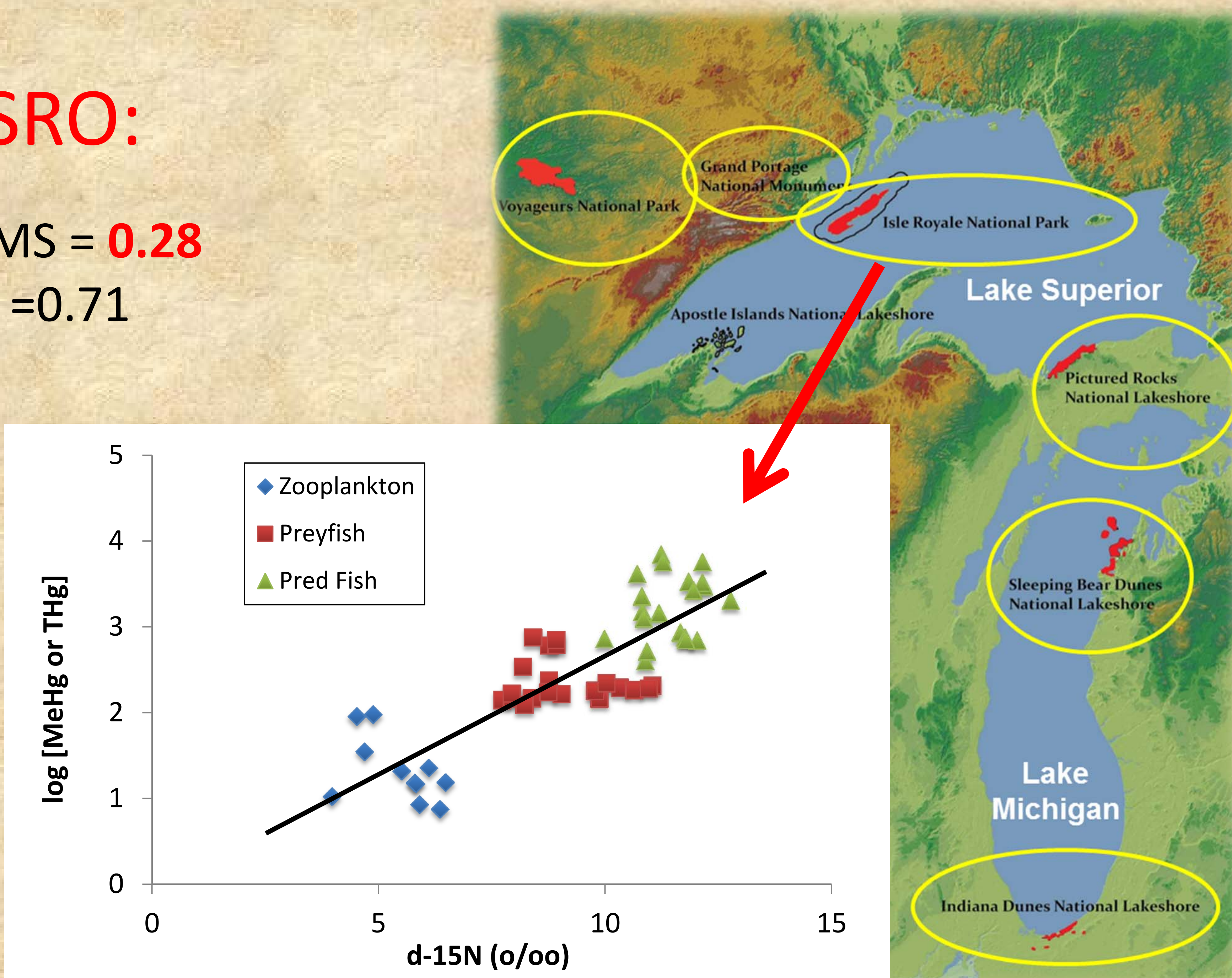
TMS = **0.25**
r^2 =0.78



ISRO:

TMS = **0.28**

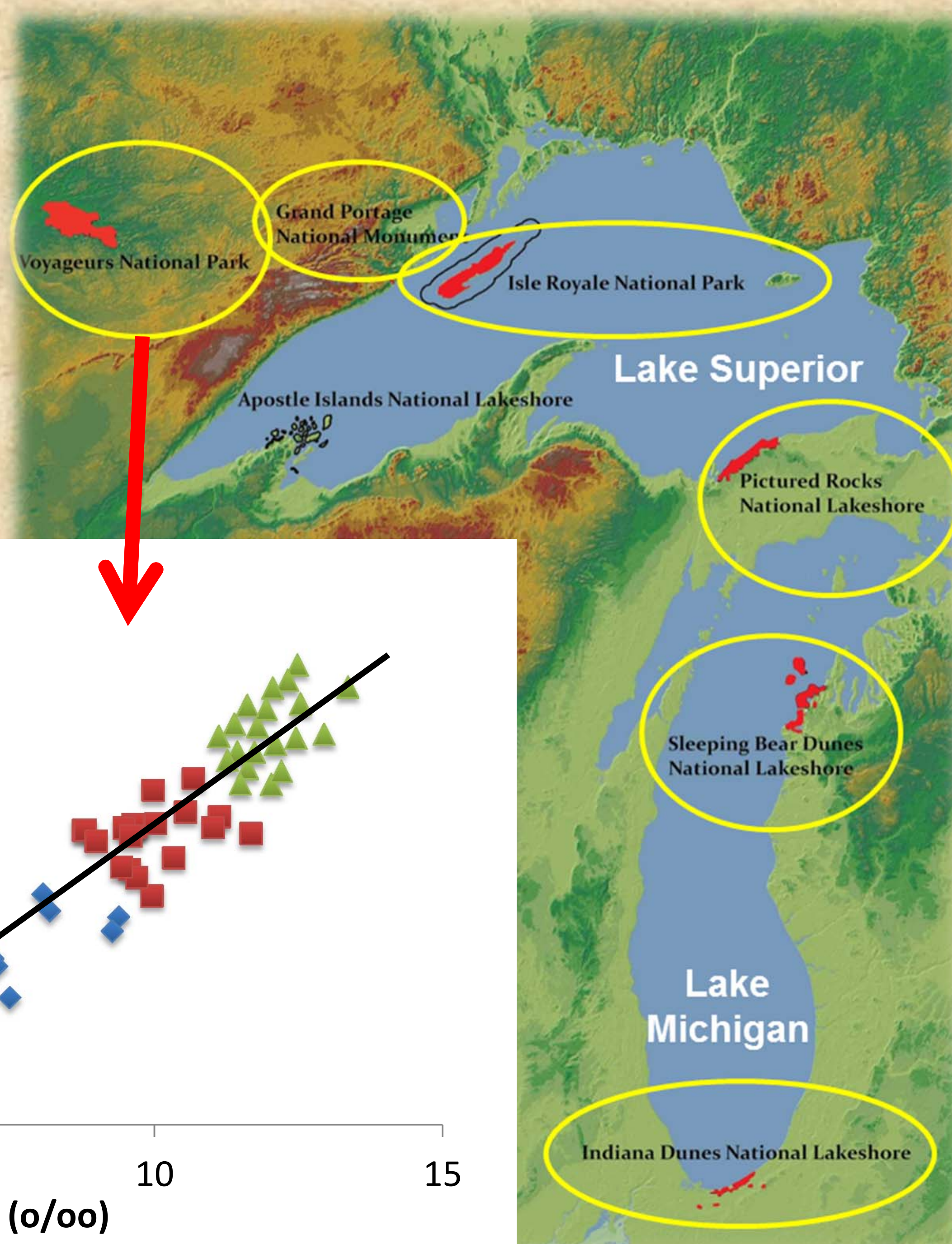
r^2 =0.71

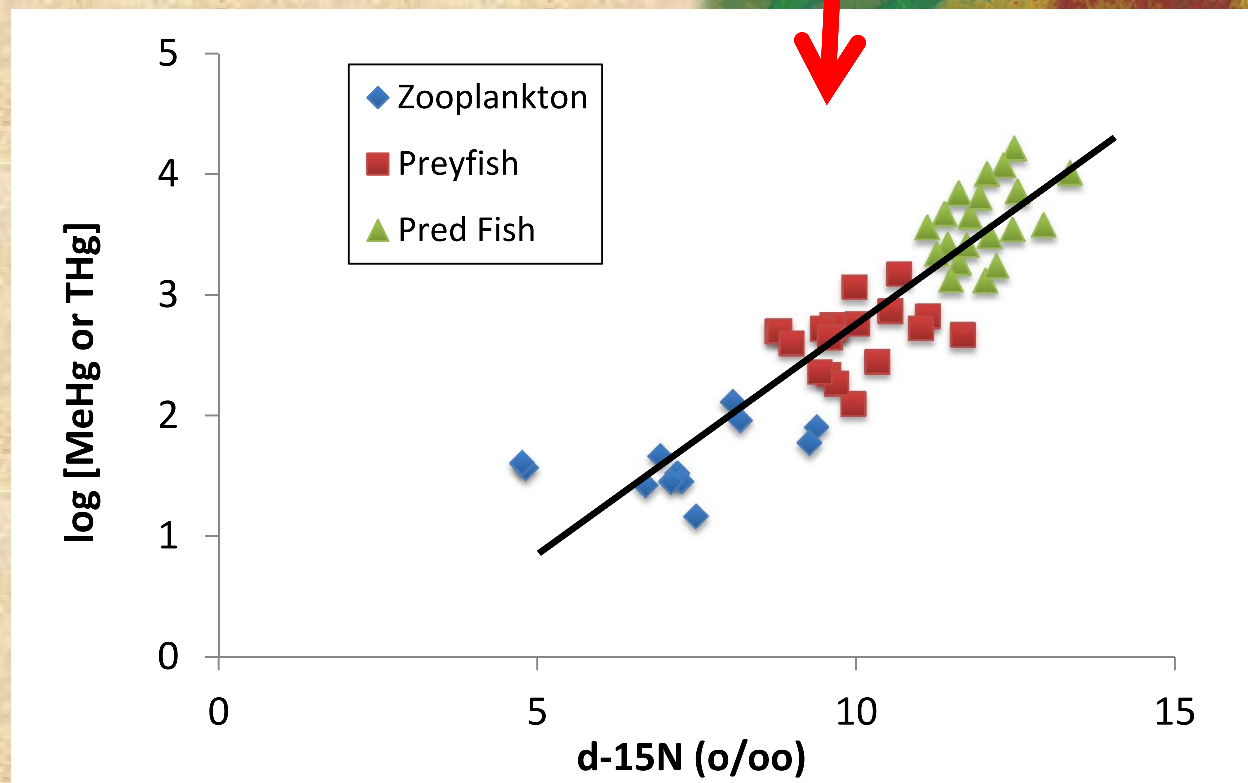


VOYA:

TMS = **0.36**

r^2 =0.80





At Higher Latitudes:

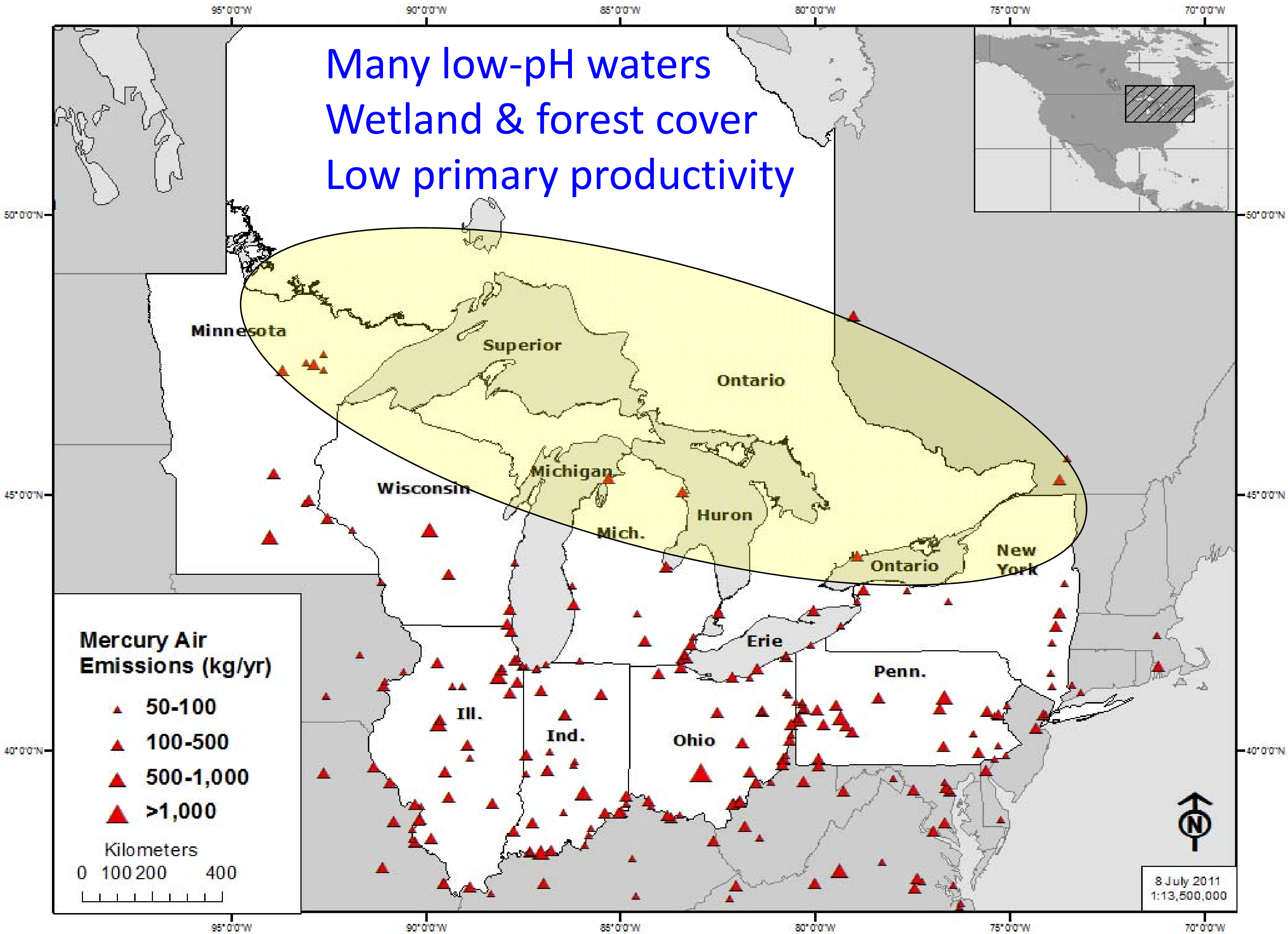
Lavoie et al., 2011

- Lower productivity….bioconcentration
- Slower excretion of MeHg
- Simpler food webs

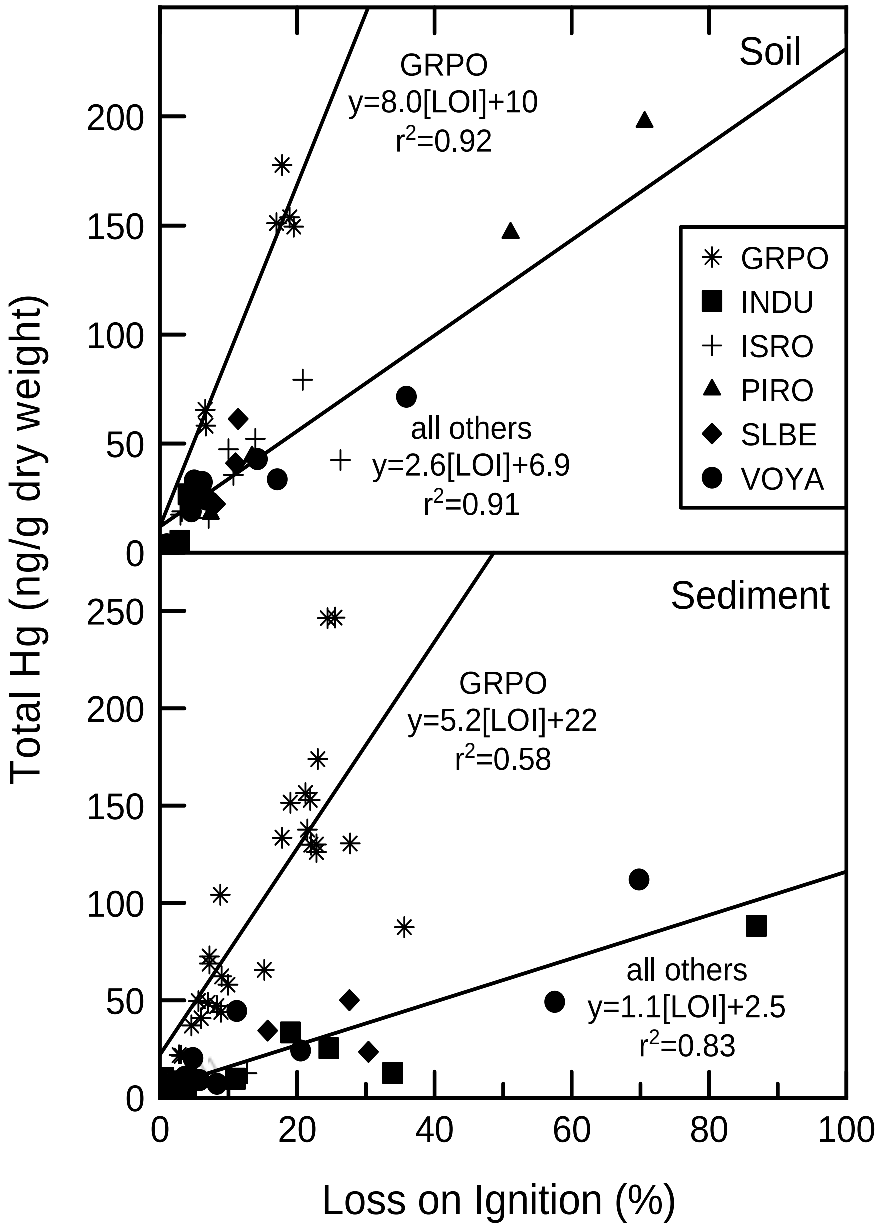
Our study

- Greater wetland and forest cover in watershed
- Higher DOC, lower pH

Many Mercury-Sensitive Watersheds and Water Bodies



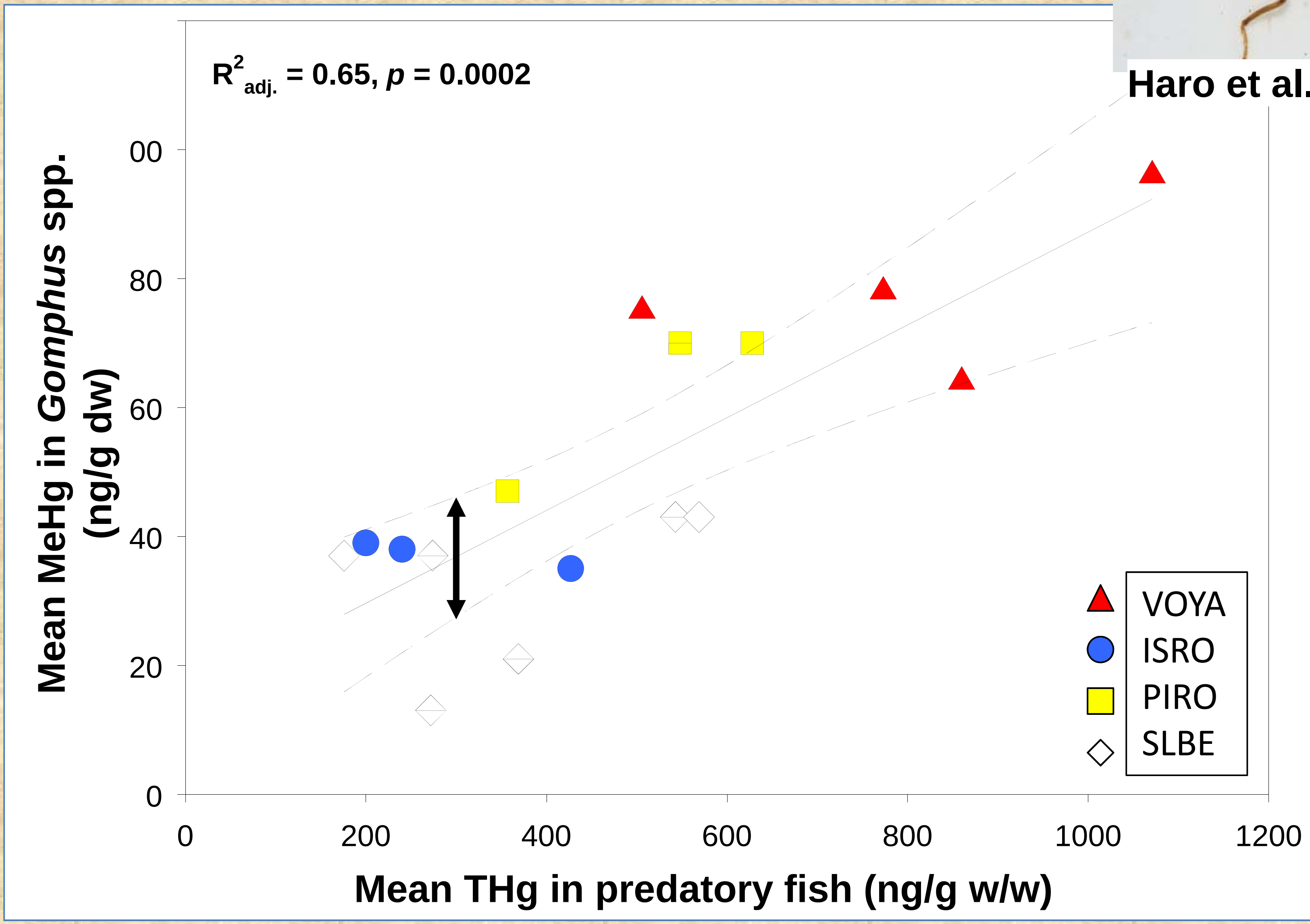
Legacy Hg at GRPO?



Rolfhus et al., 2015

Dragonfly Larvae as Biosentinels

Haro et al. (in prep)



Conclusions

- A general trend of increasing MeHg and trophic transfer efficiency was observed SE to NW
- Substantial % of fish exceeded exposure guidelines
- Data support bottom-up control of MeHg levels in lower food web: land cover, pH, DOC

- Management implications:
  - Landscapes vary in mercury "sensitivity"
  - Strive to lower methylation efficiency
  - New tools available for sourcing/bioassessment

Financial & Logistical Support

- National Park Service
- US EPA GLRI
- Wisconsin Distinguished Professors Program
- Univ. Wisconsin-La Crosse
- UW-L student researchers

NATIONAL PARK SERVICE

GREAT LAKES INVENTORY AND MONITORING NETWORK

UW-L

Great Lakes RESTORATION