

Sea Lamprey in Lake Superior and Their Effects on the Fish Community

Mark Ebener, CORA

Todd Steeves, DFO

Chris Harvey, NOAA

Carolyn White, NOAA

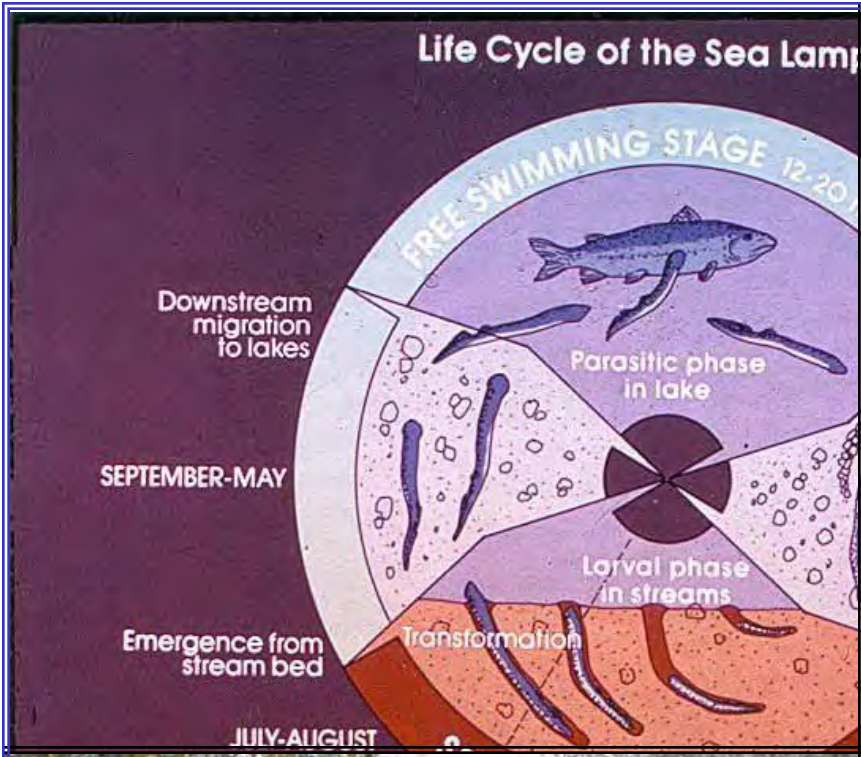
Timothy Essington, NOAA

2 Parts to Talk

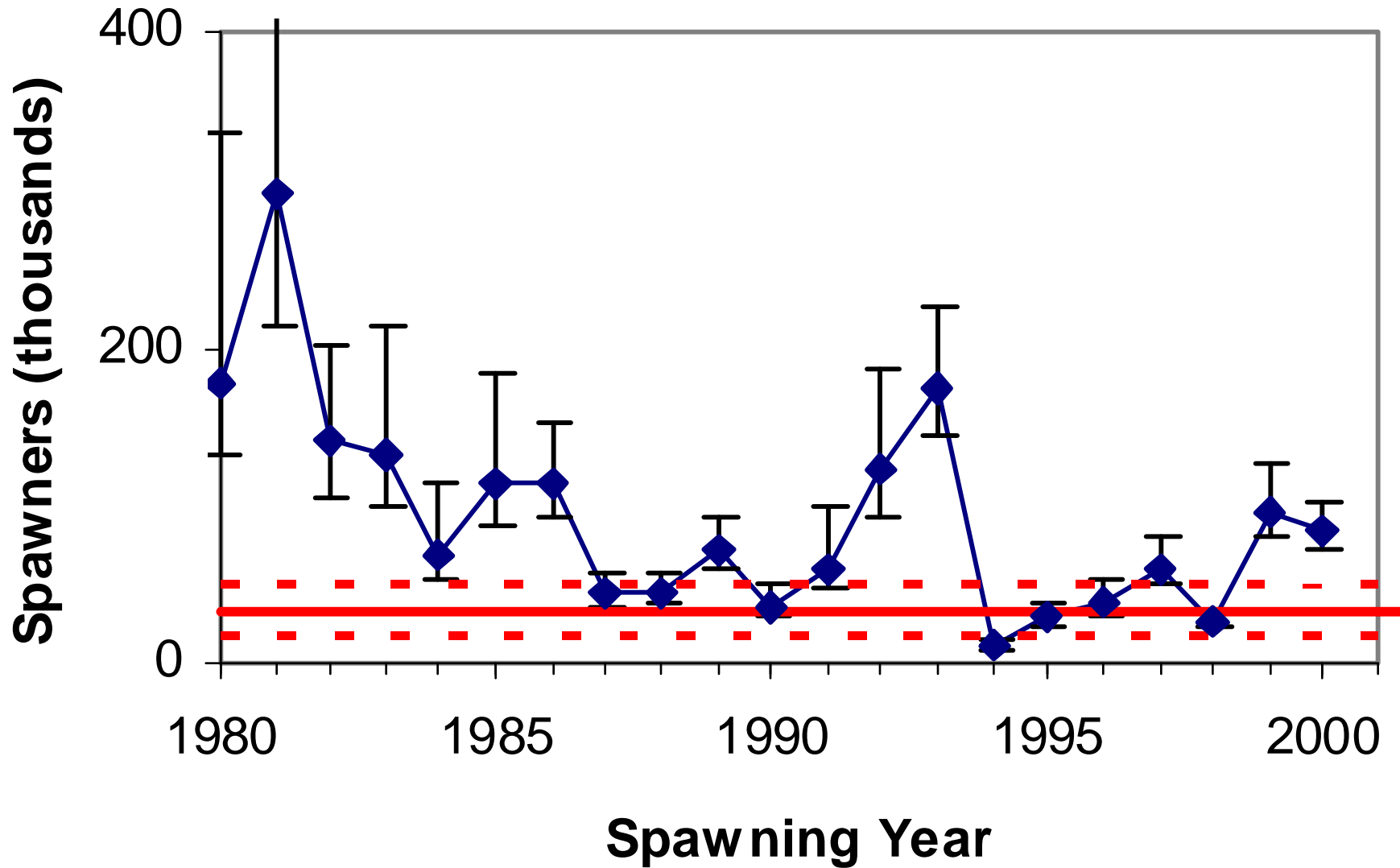
1 - Status of sea lampreys & control

2 - Estimation of their damage to fish

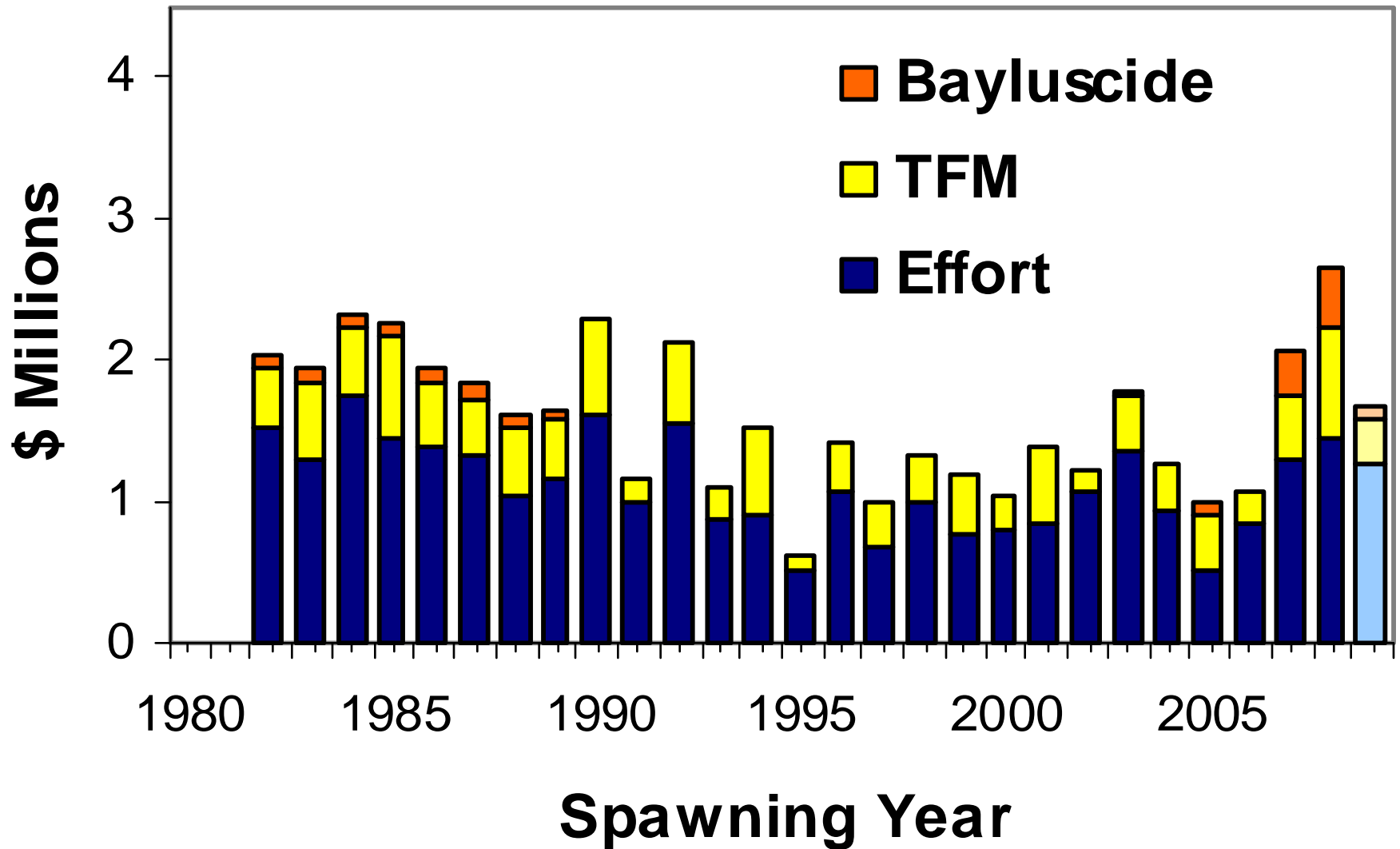
Sea Lamprey Status



Number Spawning Sea Lampreys, 1980-2000

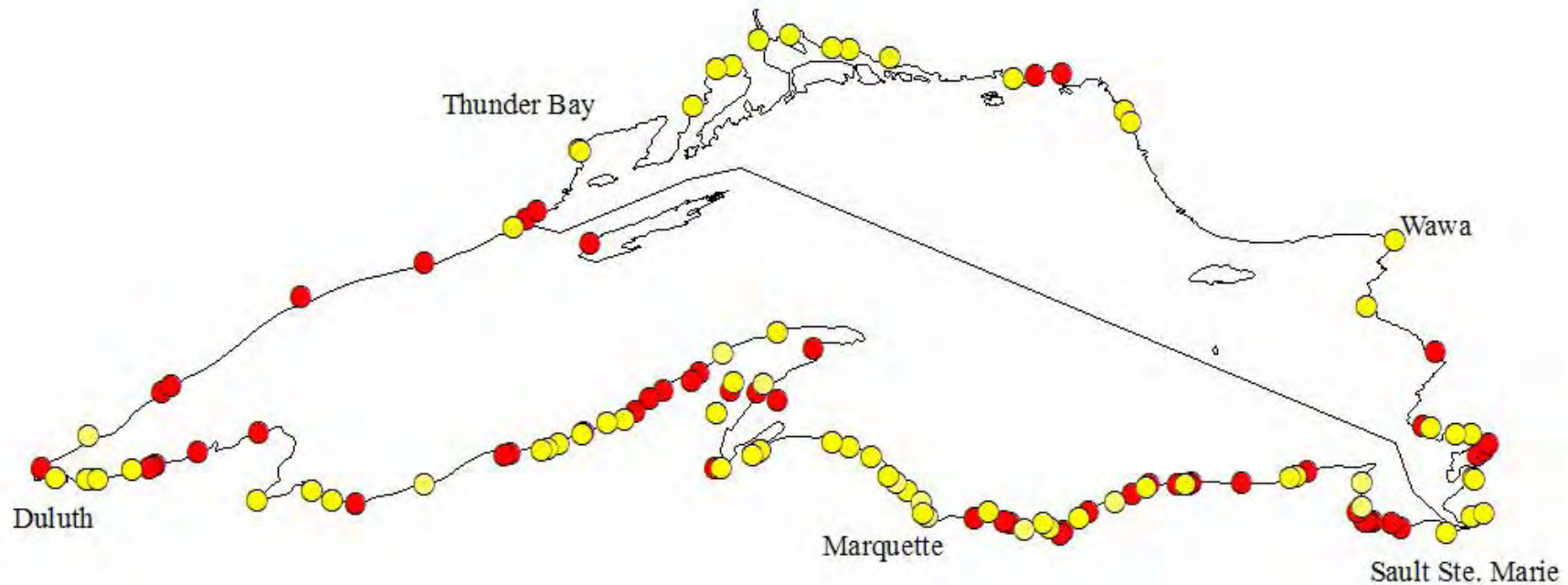


Control Expenditures, 1980-2007

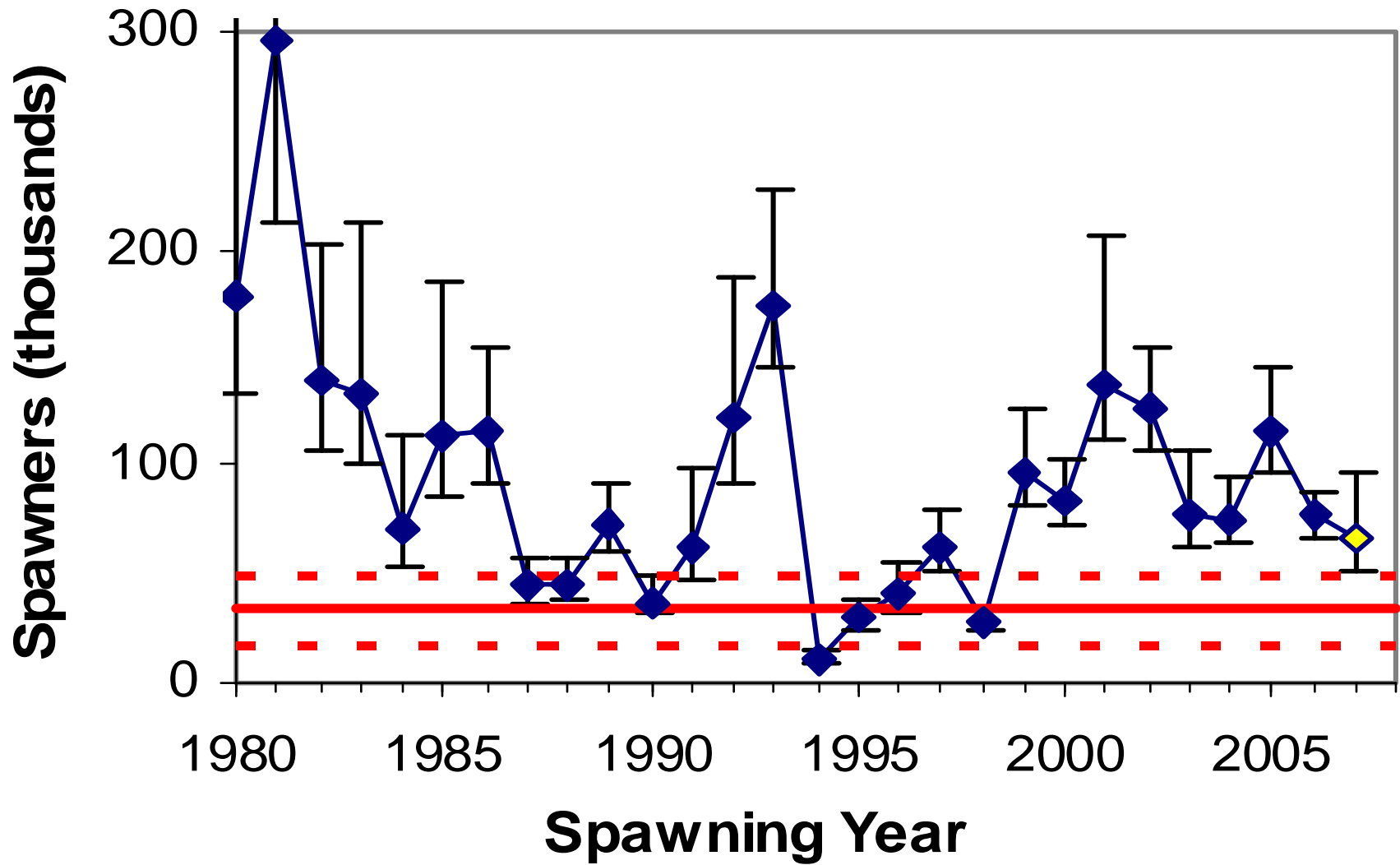


● **Historic Infested Streams**

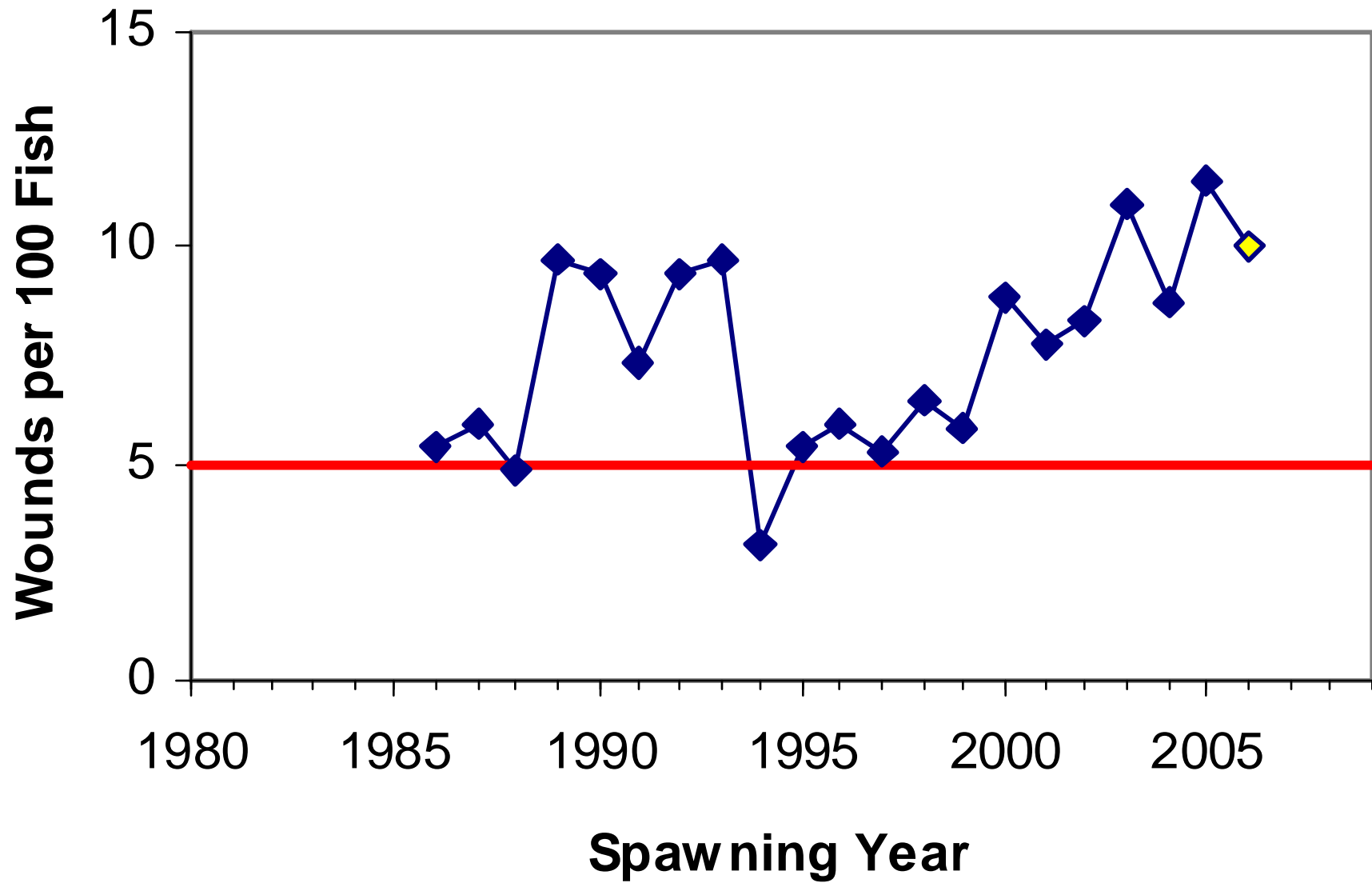
● **Streams Treated Since 2003**



Number Spawning Sea Lampreys, 1980-2007



Sea Lamprey Marking of Lake Trout, 1986-2006



Research Objective

**How is sea lamprey damage
allocated within the fish
community of Lake Superior?**

Methods

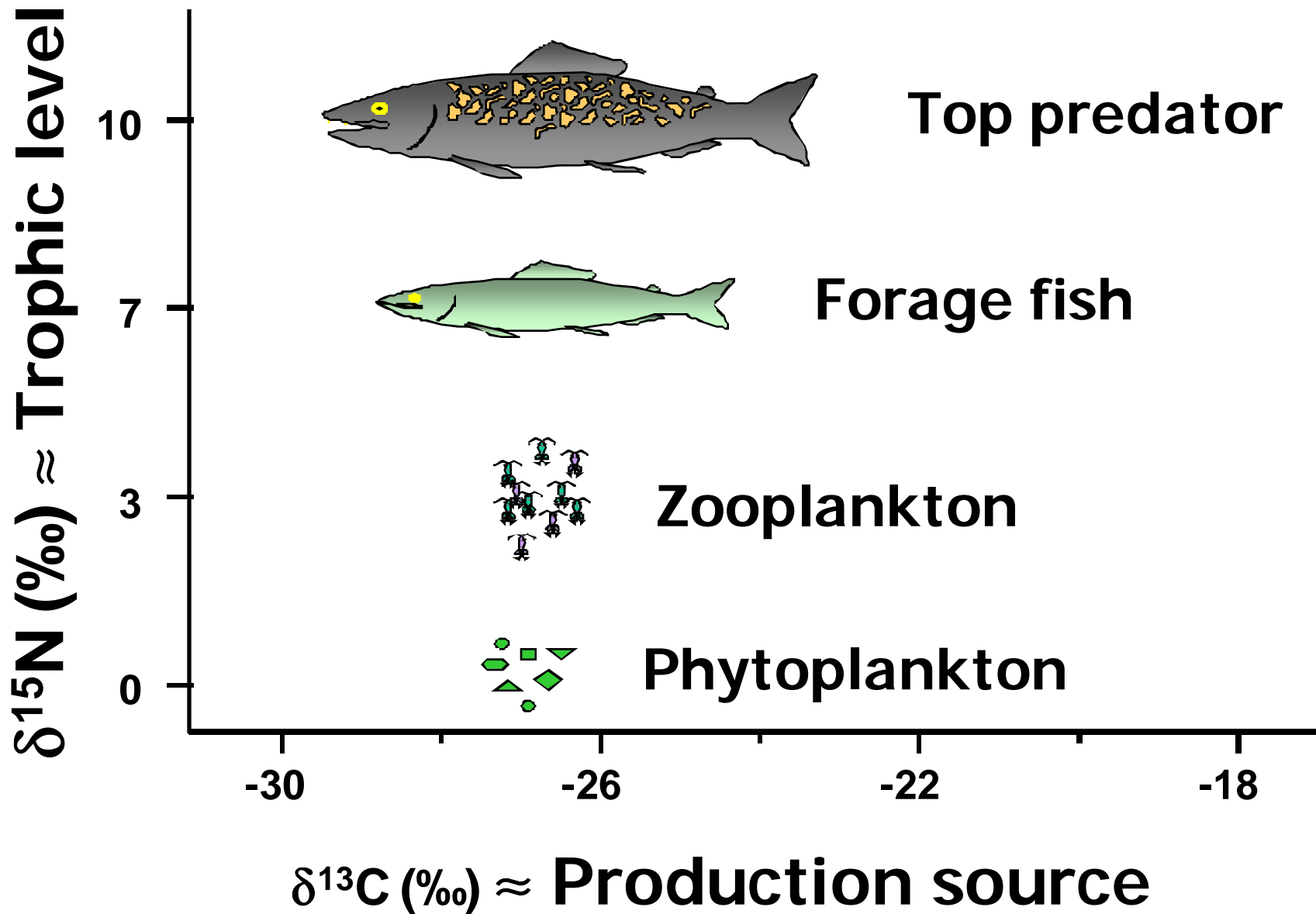
- **Estimate trophic fractionation with dynamic, growth-based stable isotope model (Harvey et al. 2002)**
- **Adjust diet of sea lamprey among hosts until model estimates of stable isotope signatures match observed values**

Trophic structure: Stable Isotopes

What are they?

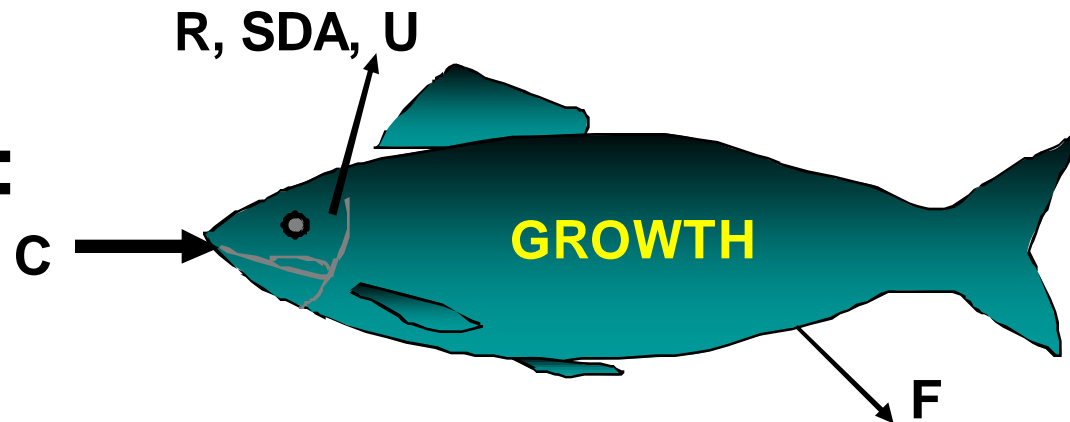
- Ratios of heavy to light isotope ratio in tissues (e.g. $^{15}\text{N}/^{14}\text{N}$ and $^{13}\text{C}/^{12}\text{C}$)
- Tracers of long-term diet (you are what you eat!)
- Fractionate predictably up food chain
 - Nitrogen 2-4‰ greater in consumer
 - Carbon about 0.5‰ greater in consumer

Trophic structure: Stable Isotopes



A Bioenergetics-Isotope Model

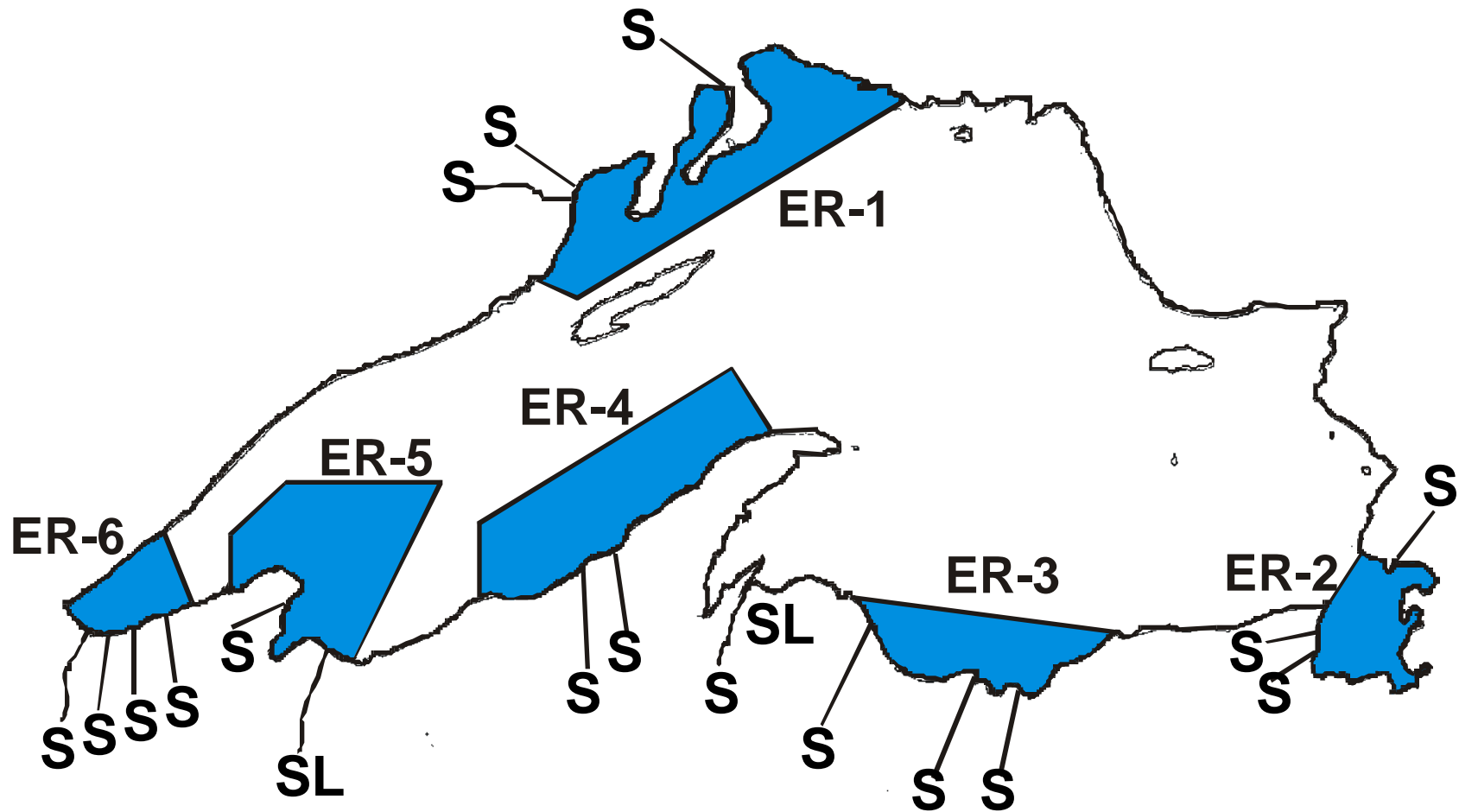
Bioenergetics:



**Describe dynamics of stable isotopes in fishes,
links ratios to:**

- growth
- size
- temperature
- diet
- prey quality

Ecoregion Sampling Areas



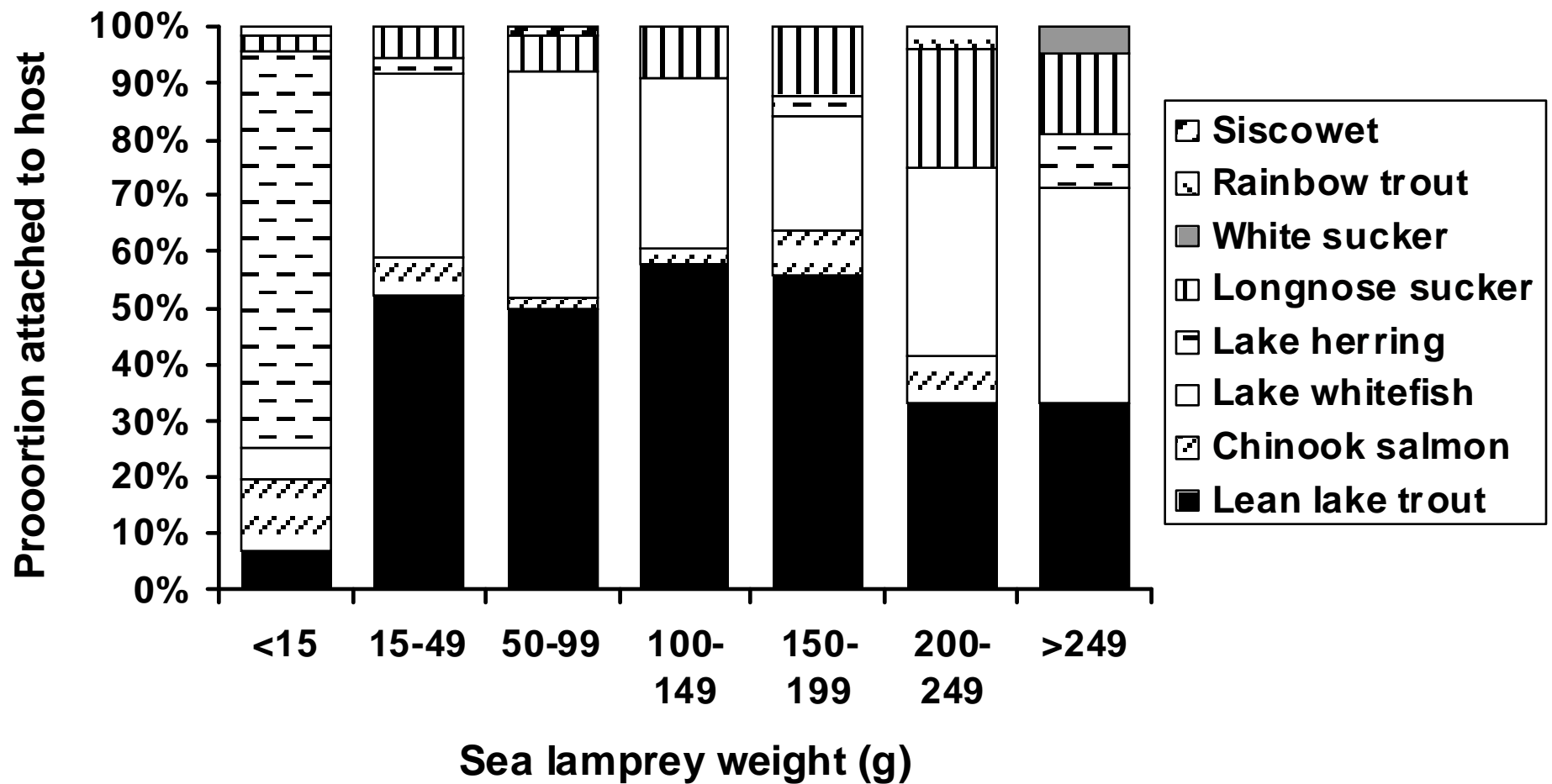
Sea Lamprey Collections

Life Stage	Site	Number Lamprey	Mean weight	Weight range
Transformer	Stream	56	6 g	4-11 g
Parasite	Lake	438	76 g	2–532 g
Adult	Stream	115	190 g	85–340 g

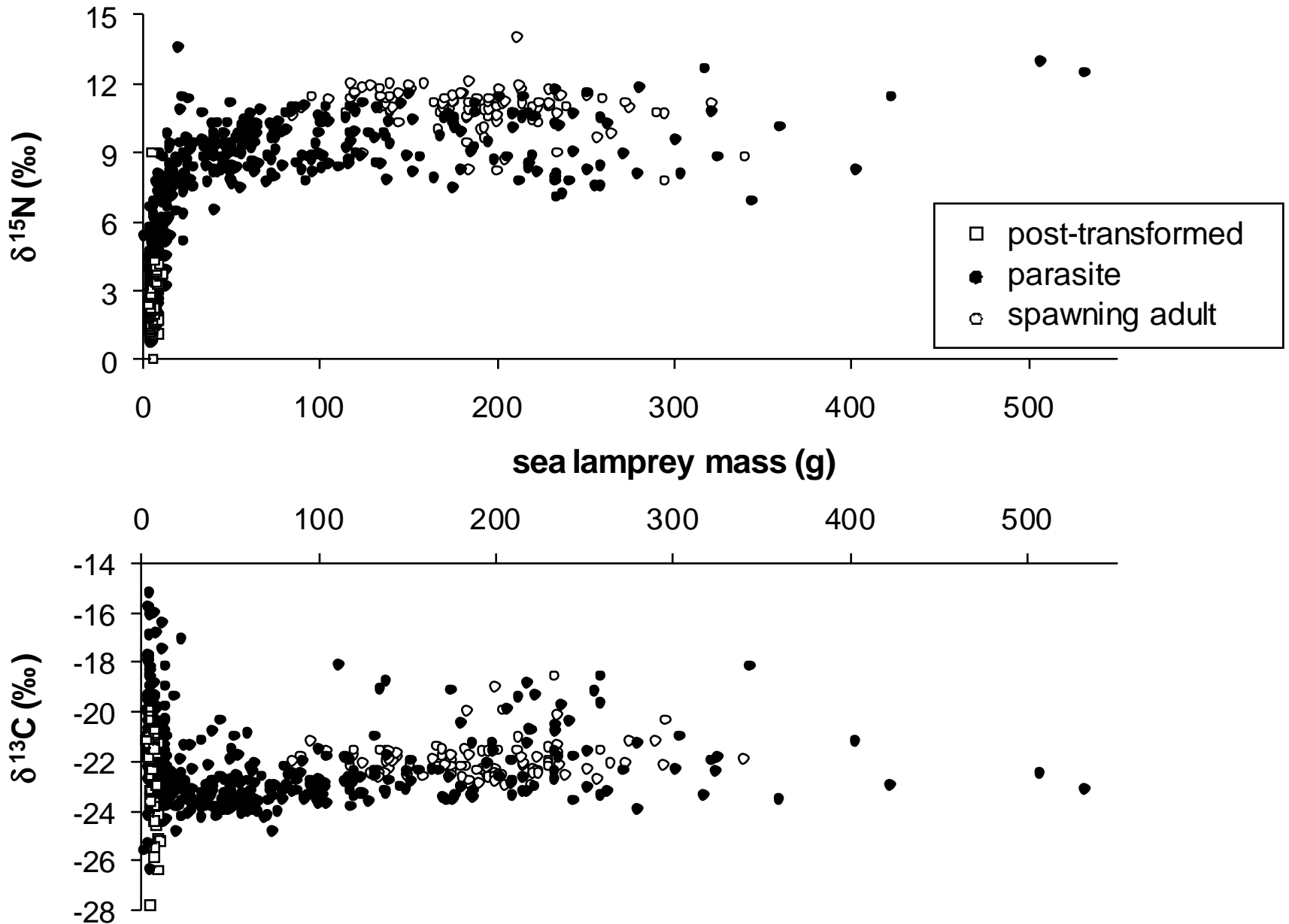
Fish Collections

Fish species	Number	Mean Weight (g)
Chub	43	121
Lake herring	139	347
Coho salmon	27	622
Sucker spp.	134	941
Lake whitefish	161	1071
Burbot	113	1144
Lean lake trout	150	1360
Siscowet	98	1658
Rainbow trout	10	2191

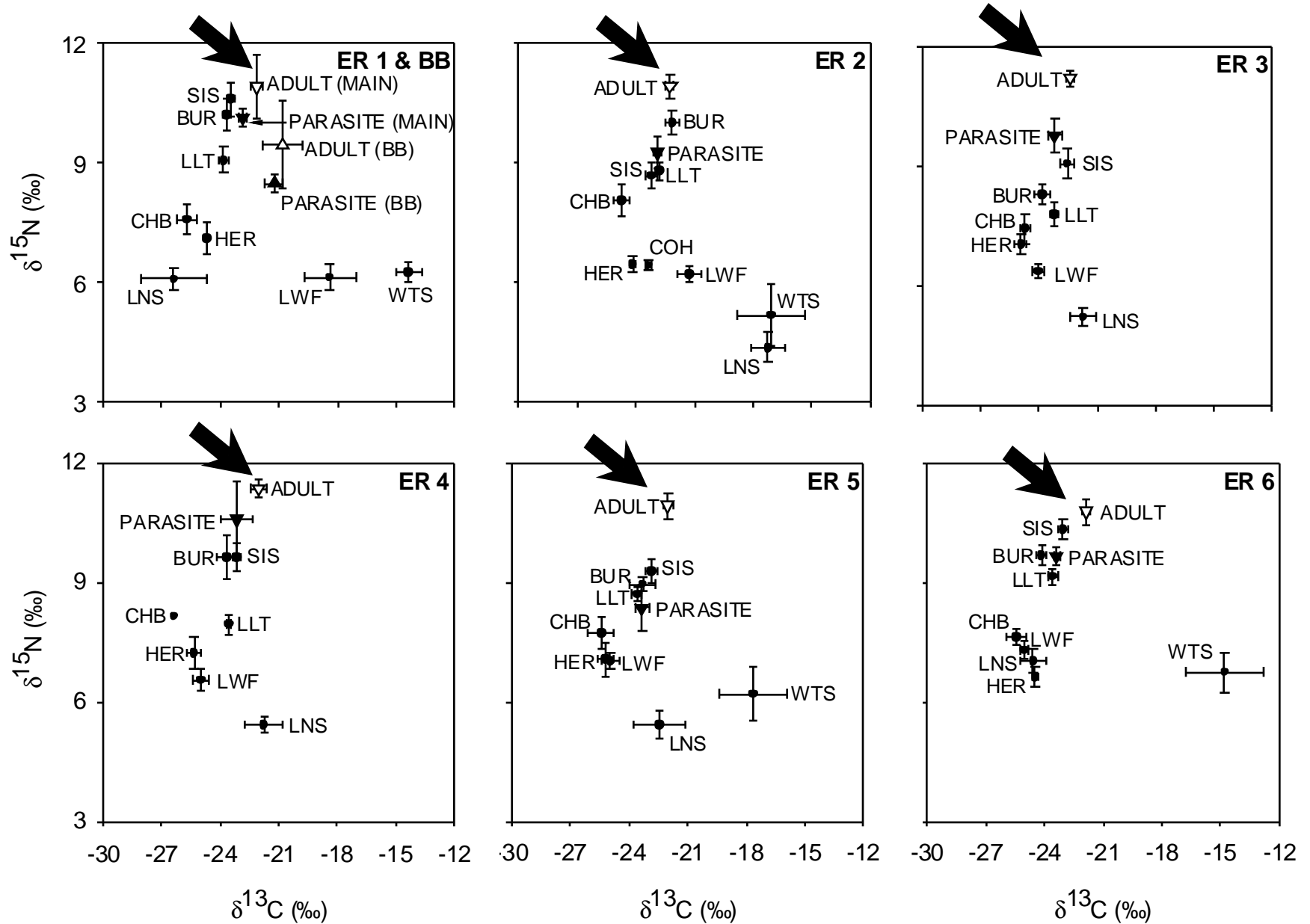
Sea Lamprey Attachment Frequencies - Host & Lamprey Size -



Lake-wide Sea lamprey Stable Isotope Ratios vs. Body Mass



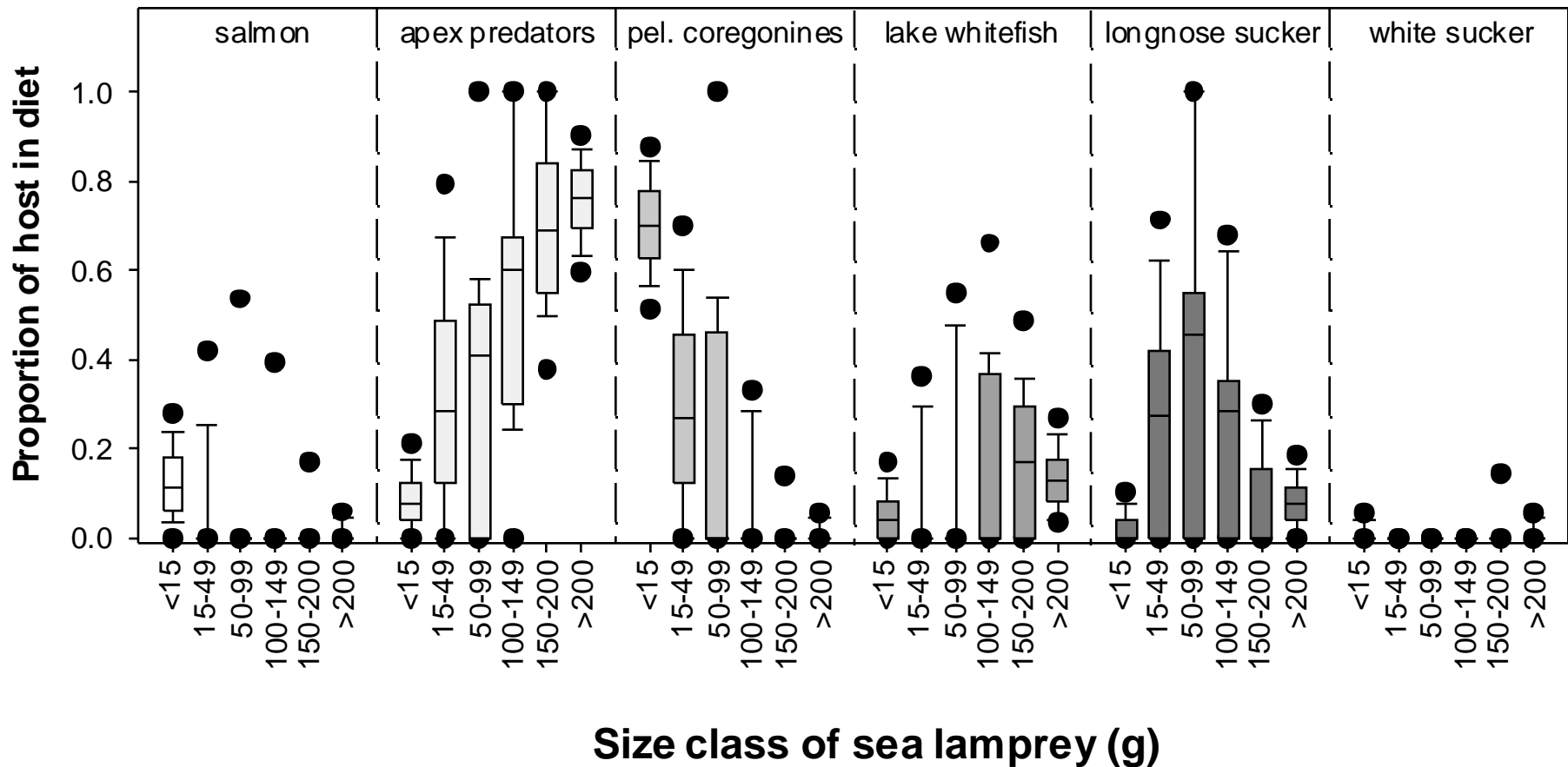
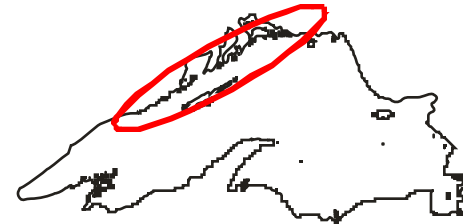
Regional Stable Isotope of Lamprey Muscle & Host Blood



Estimates of Lamprey Diet by Size

- Bioenergetics & Stable Isotope Modeling -

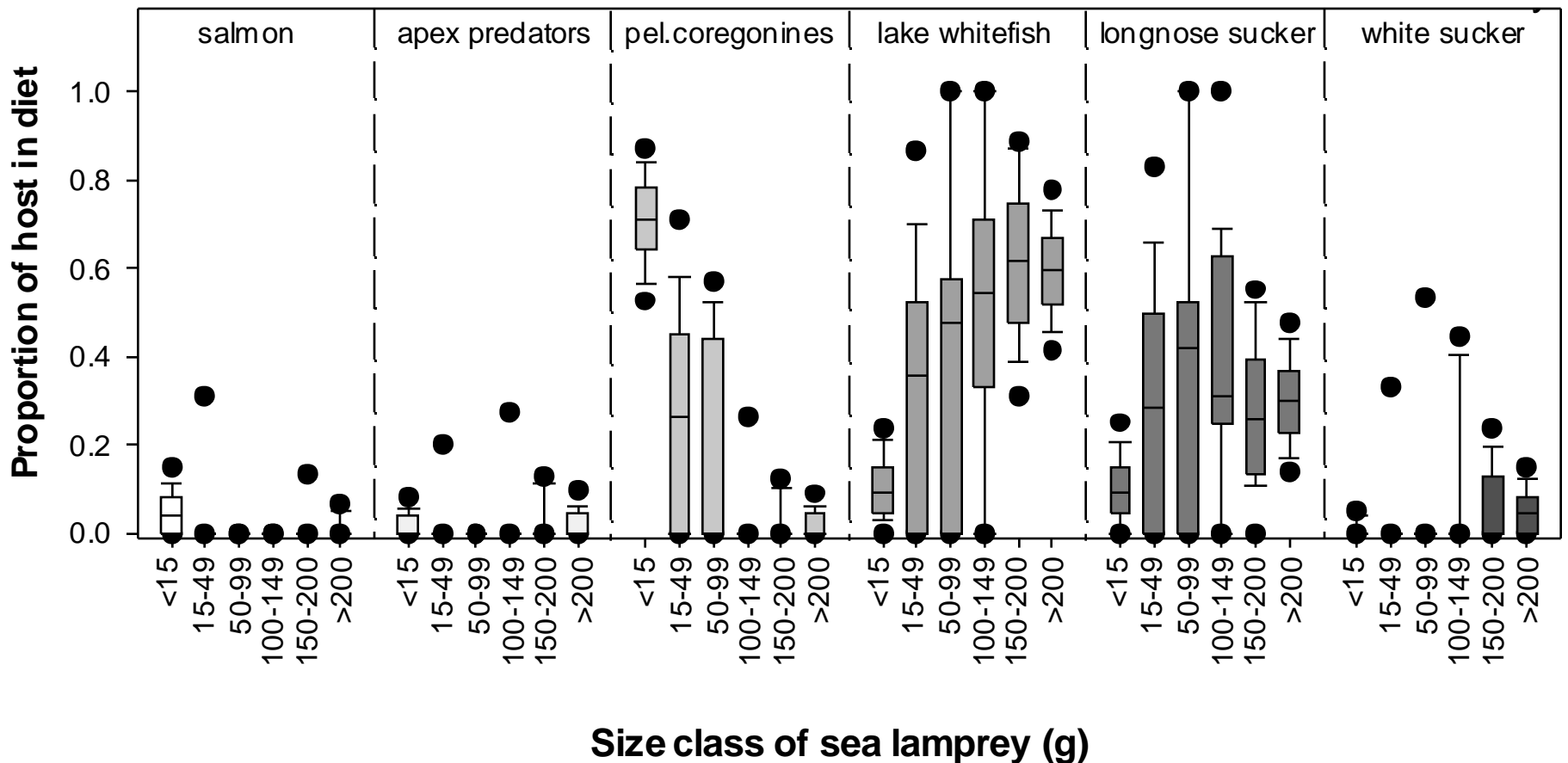
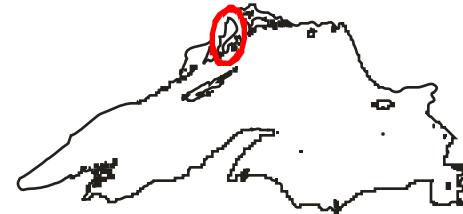
Ecoregion 1
(main)



Estimates of Lamprey Diet by Size

- Bioenergetics & Stable Isotope Modeling -

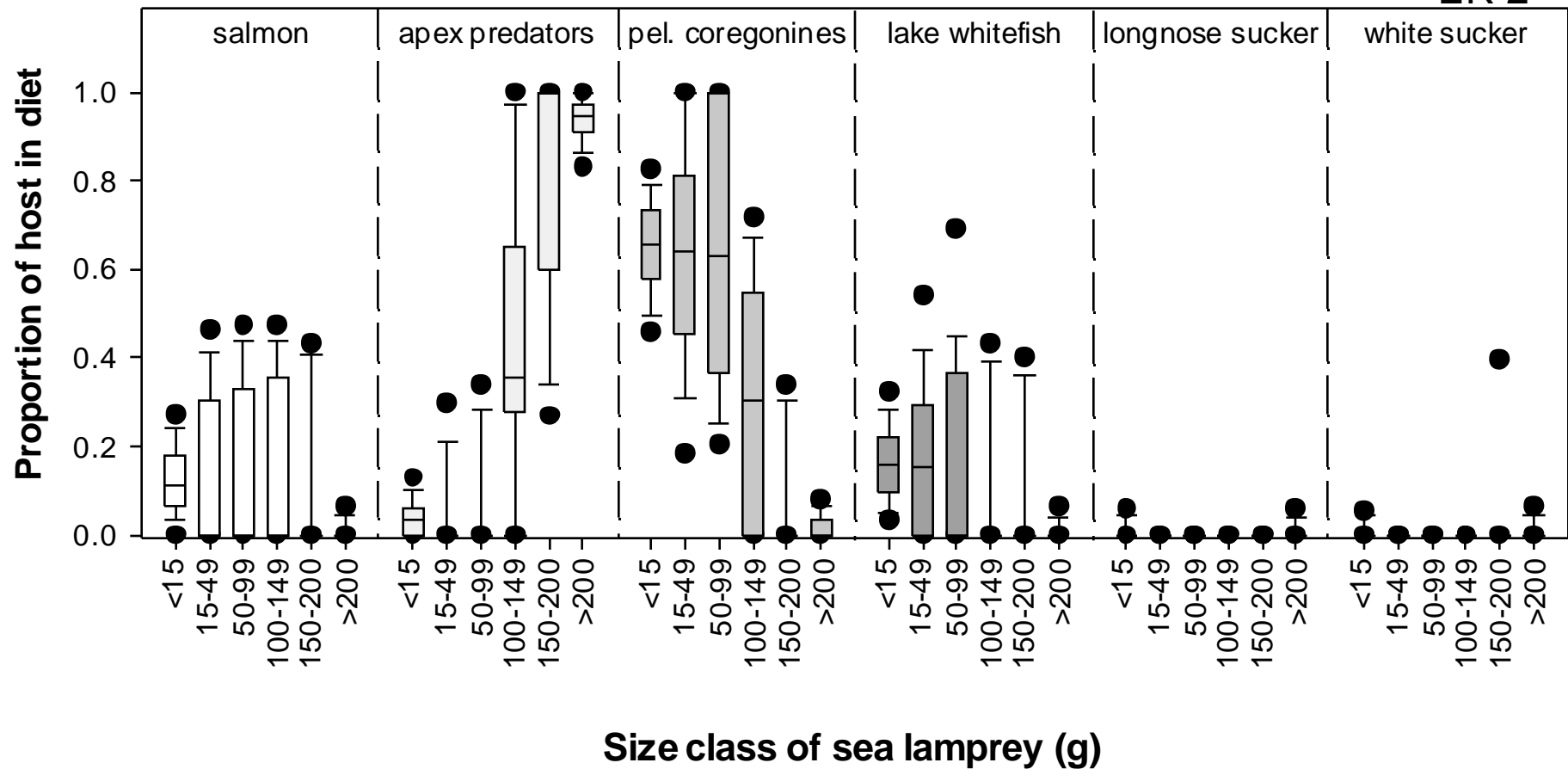
Black Bay



Estimates of Lamprey Diet by Size

- Bioenergetics & Stable Isotope Modeling -

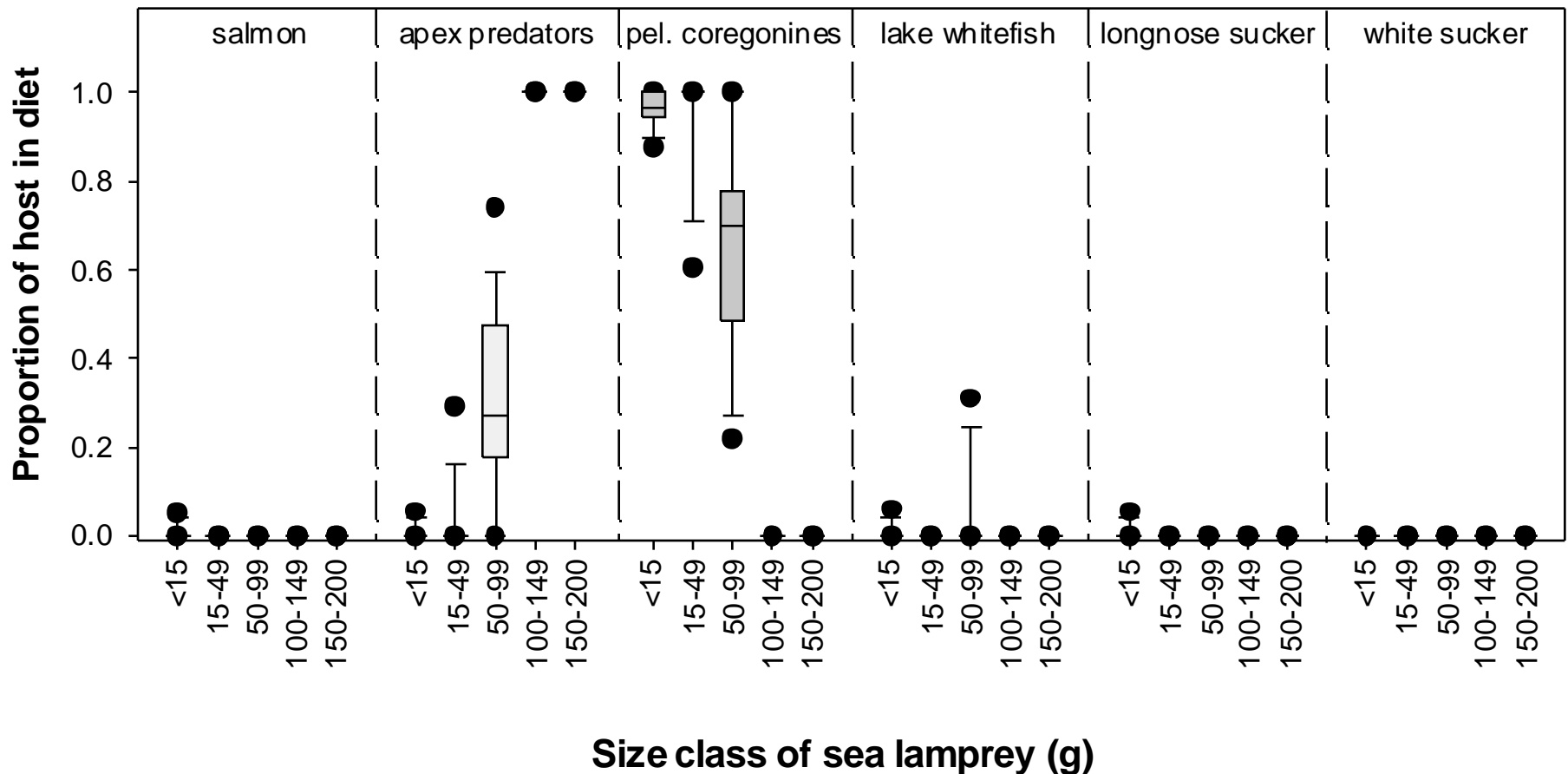
Ecoregion 2



Estimates of Lamprey Diet by Size

- Bioenergetics & Stable Isotope Modeling -

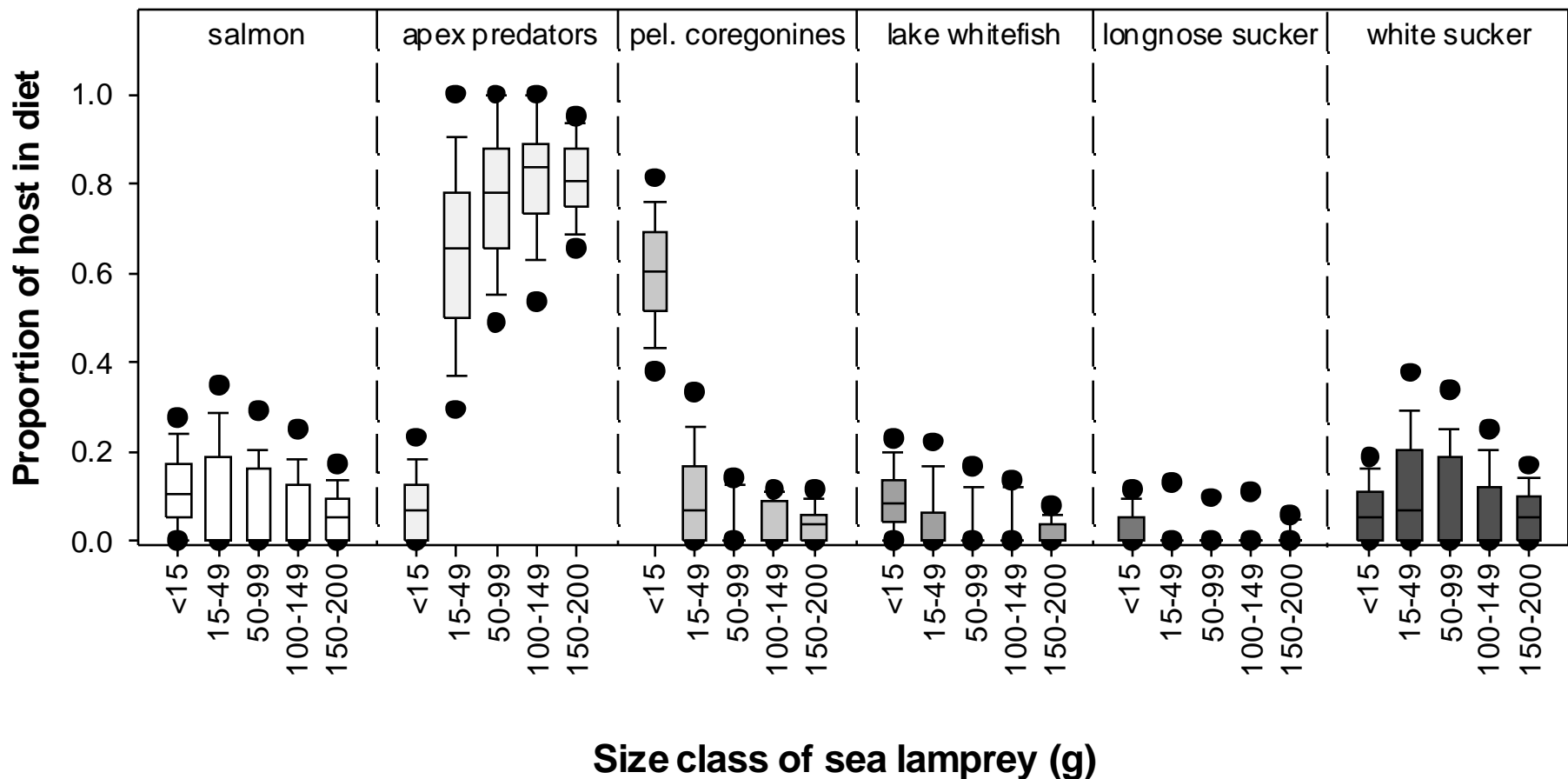
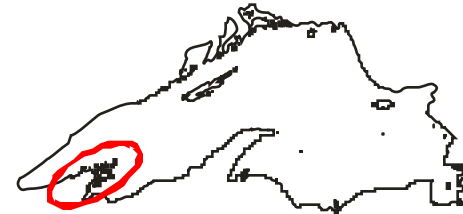
Ecoregion 3



Estimates of Lamprey Diet by Size

- Bioenergetics & Stable Isotope Modeling -

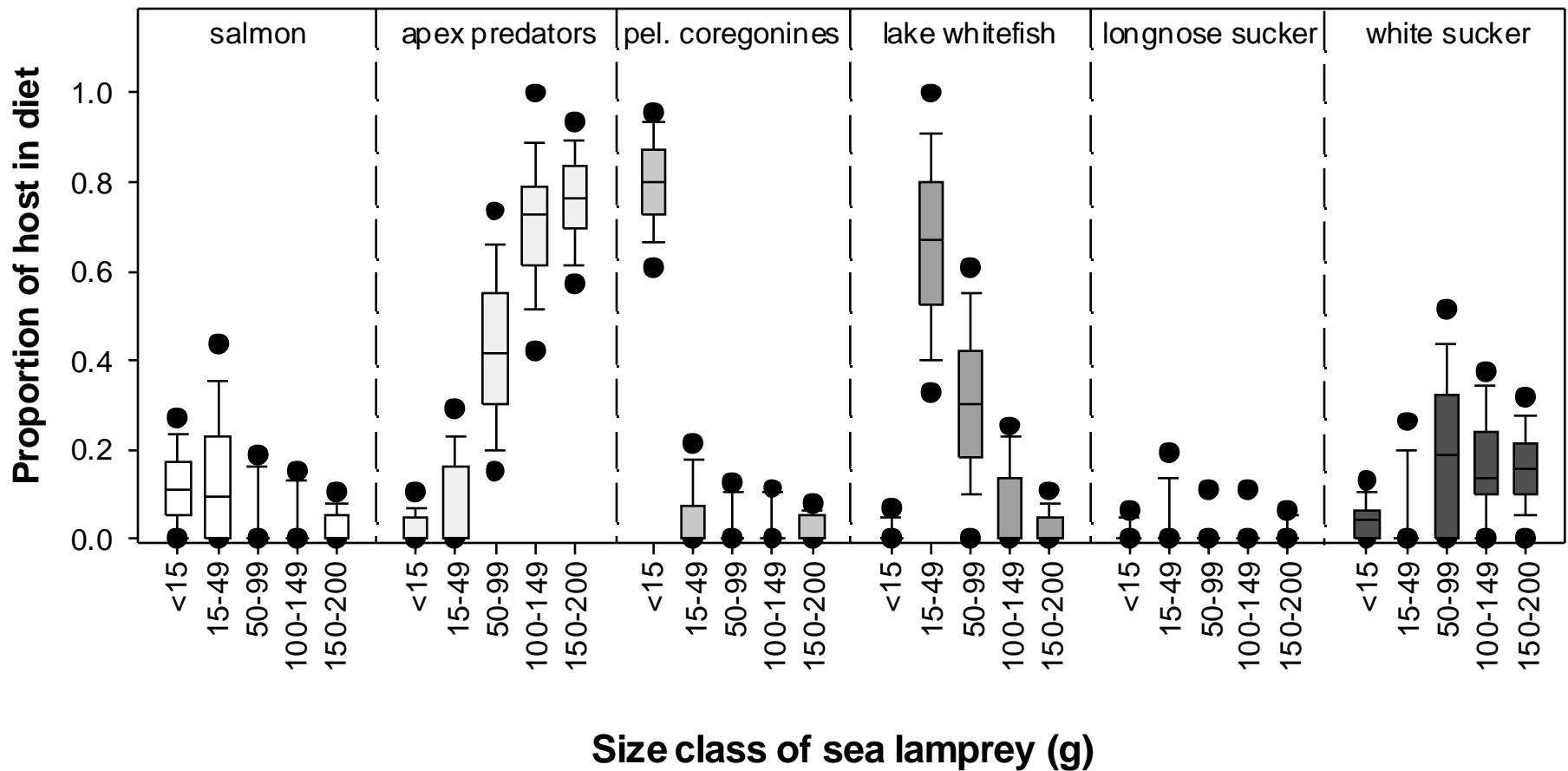
Ecoregion 5



Estimates of Lamprey Diet by Size

- Bioenergetics & Stable Isotope Modeling -

Ecoregion 6



Sea Lamprey Marking of Fish

Eco-region	Species	Years	Number fish	Marking rate
5 & 6	Burbot	1989-2004	6,000	0.02
3 & 4	Longnose sucker	1972-2004	7,142	0.06
2 & 3	Lake herring	1982-2004	1,011	0.27
All	Lean lake trout	1986-2006	94,000	7.1
3-6	Siscowet	1996, 2000, 2003	8,300	9.1

Conclusions

- 1. Lamprey diet changes with age from pelagic coregonines to apex predators**
- 2. 60-90% of lamprey diets was apex predators**
- 3. Lake whitefish most important host Black Bay**
- 4. Suckers more important in western than eastern waters of Lake Superior**