Ontogeny of Thiamine Deficiency in Lake Ontario Lake Trout and Potential Implications to Recruitment

John D. Fitzsimons
Fisheries and Oceans Canada
Burlington, Ontario

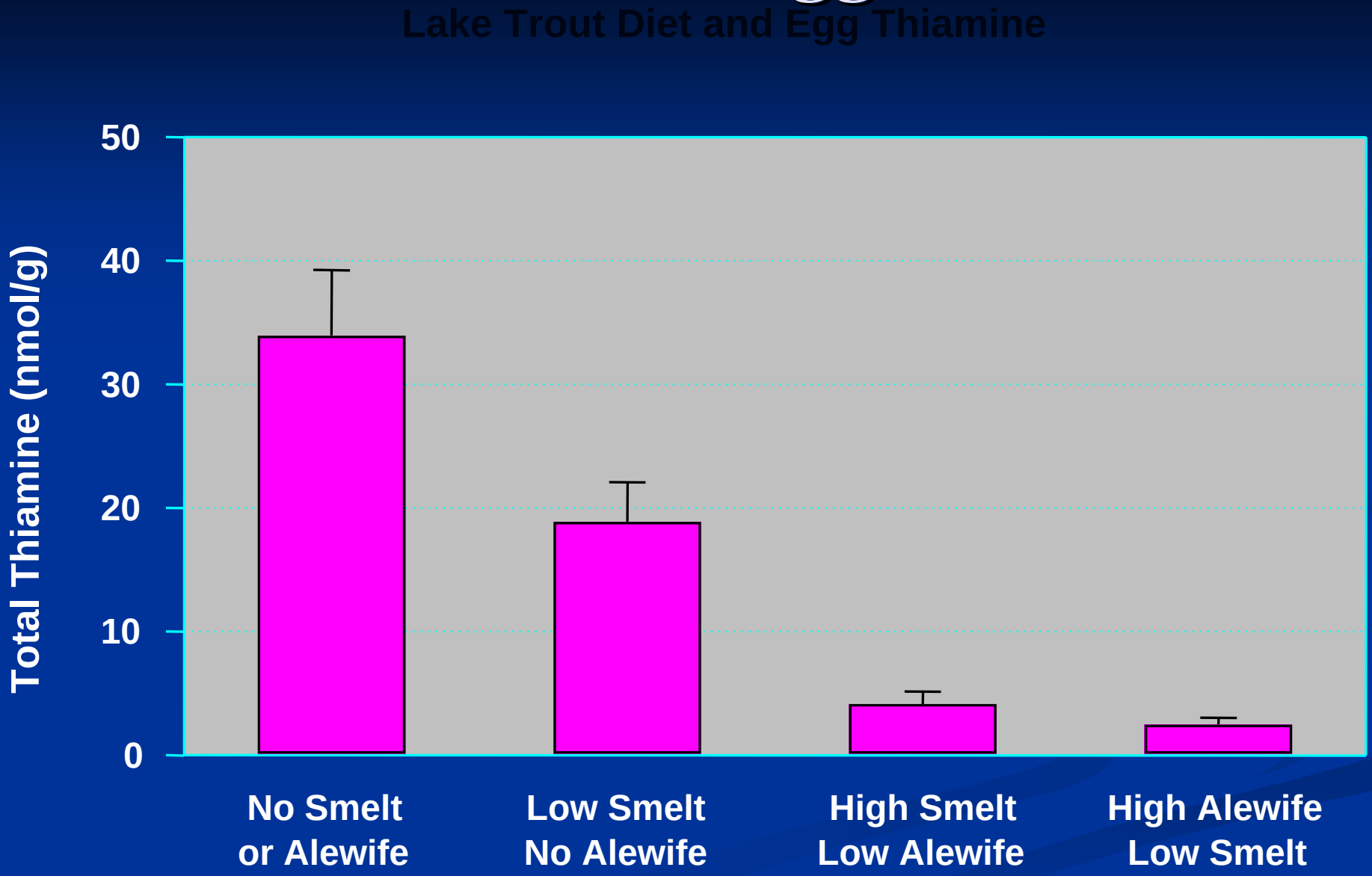
Dale Honeyfield
US Geological Survey
Wellsboro, Pennsylvania

Acknowledgements

Acknowledgements

- Robert O'Gorman (USGS)
- Brian Lantry (USGS)
- Jana Lantry (NYDEC)
- Mike Keir (EC)
- Mandi Clark (EC)
- Abdel El-Shaarawi (EC)
- Jesse Lepak (CU)
- Cliff Kraft (CU)
- Tom Stewart (UT)
- Tara Nicholls (UT)
- Karla Passow (DFO)
- Wayne Andrews
- Paul Paulin
- Brian Lageunesse (ASRD)
- Susan Mann (OMNR)
- Bill Williston

Effect of Diet on Egg Thiamine



Fitzsimons and Brown 1998

Alewife as An Important Prey Fish for Adult Lake Trout in Lake Ontario

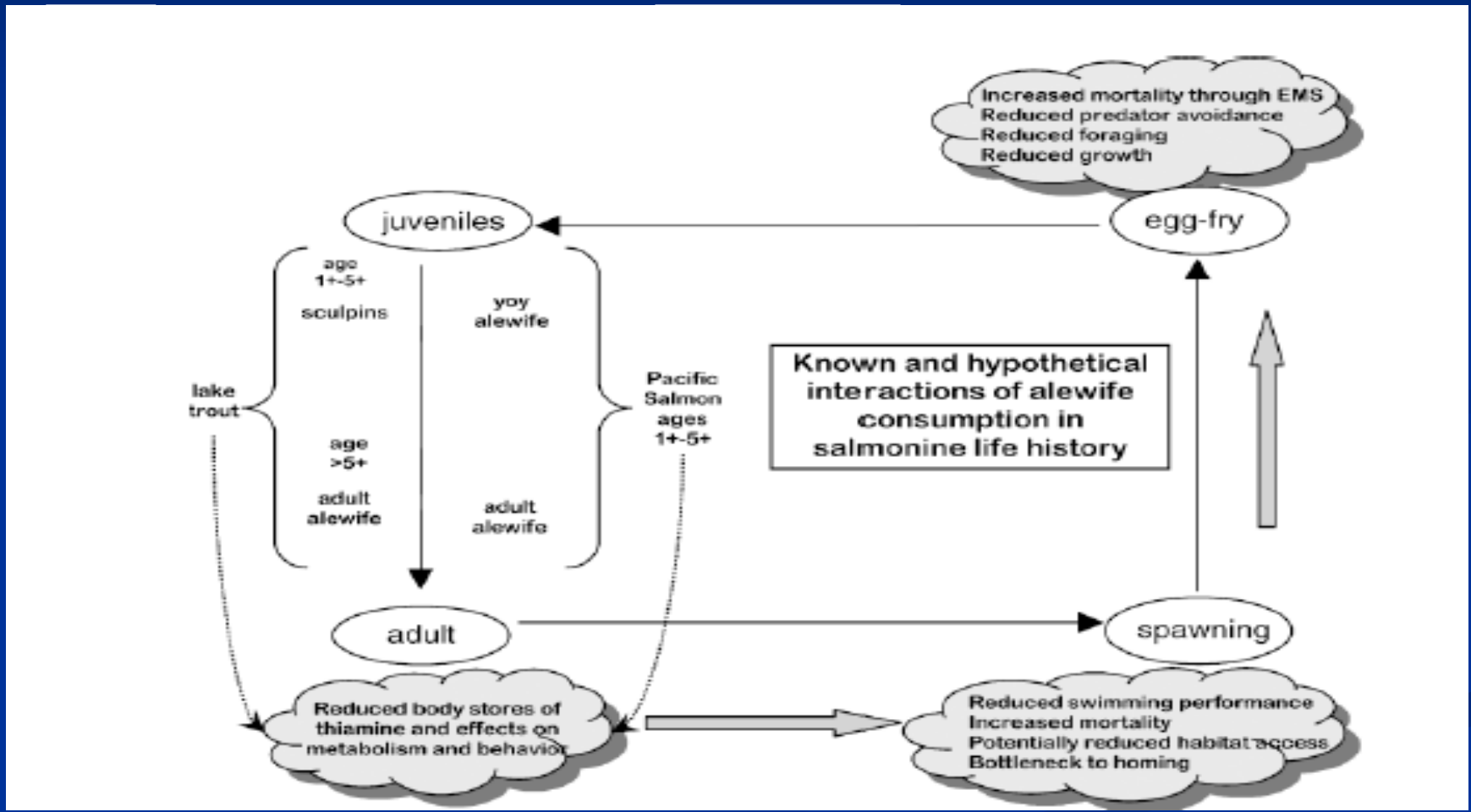
Years	Percent alewives by weight	Author (s)
1983	52	Brandt 1986
1984	78	Brandt 1986
1985	32	Rand and Stewart 1998
1987	37	Rand and Stewart 1998
1988	65	Rand and Stewart 1998
1993	85	Rand and Stewart 1998
1998	70	Lantry 2002
1999	80	Lantry 2002

Summary of Adult Effects of Thiamine Deficiency in Wild

Lake	Species	Effect	Source
Ontario	Chinook salmon	mortality**	Everitt 2007
Ontario	Chinook salmon	spawning	Ketola (unpublished)
Ontario	Coho salmon	lethargy, mortality	Kendell (unpublished data)
Ontario	Lake trout	lethargy	Fitzsimons (unpublished)
Michigan	Coho salmon	mortality	Fitzsimons et al. 2005
Michigan	Coho salmon	lethargy	Brown et al. 2005
Michigan	Rainbow trout	lethargy	Brown et al. 2005
Cayuga	Rainbow trout	migration	Ketola et al. 2005
Baltic Sea	Baltic salmon	lethargy	Amcoff et al. 1999

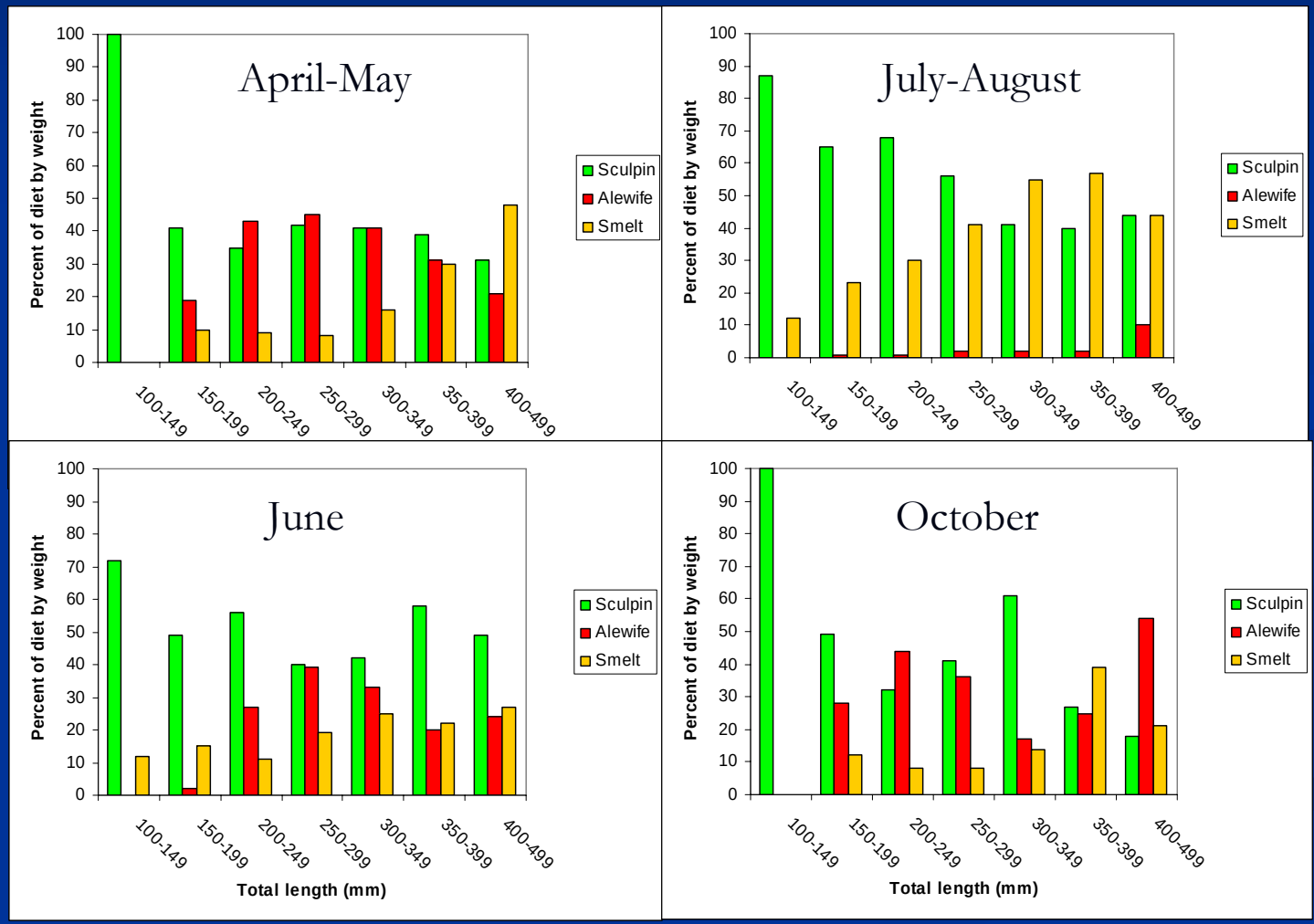
Lake trout-hatchery-lethargy and mortality Honeyfield et al. 2005

Thiamine Deficiency Effects by Life Stage

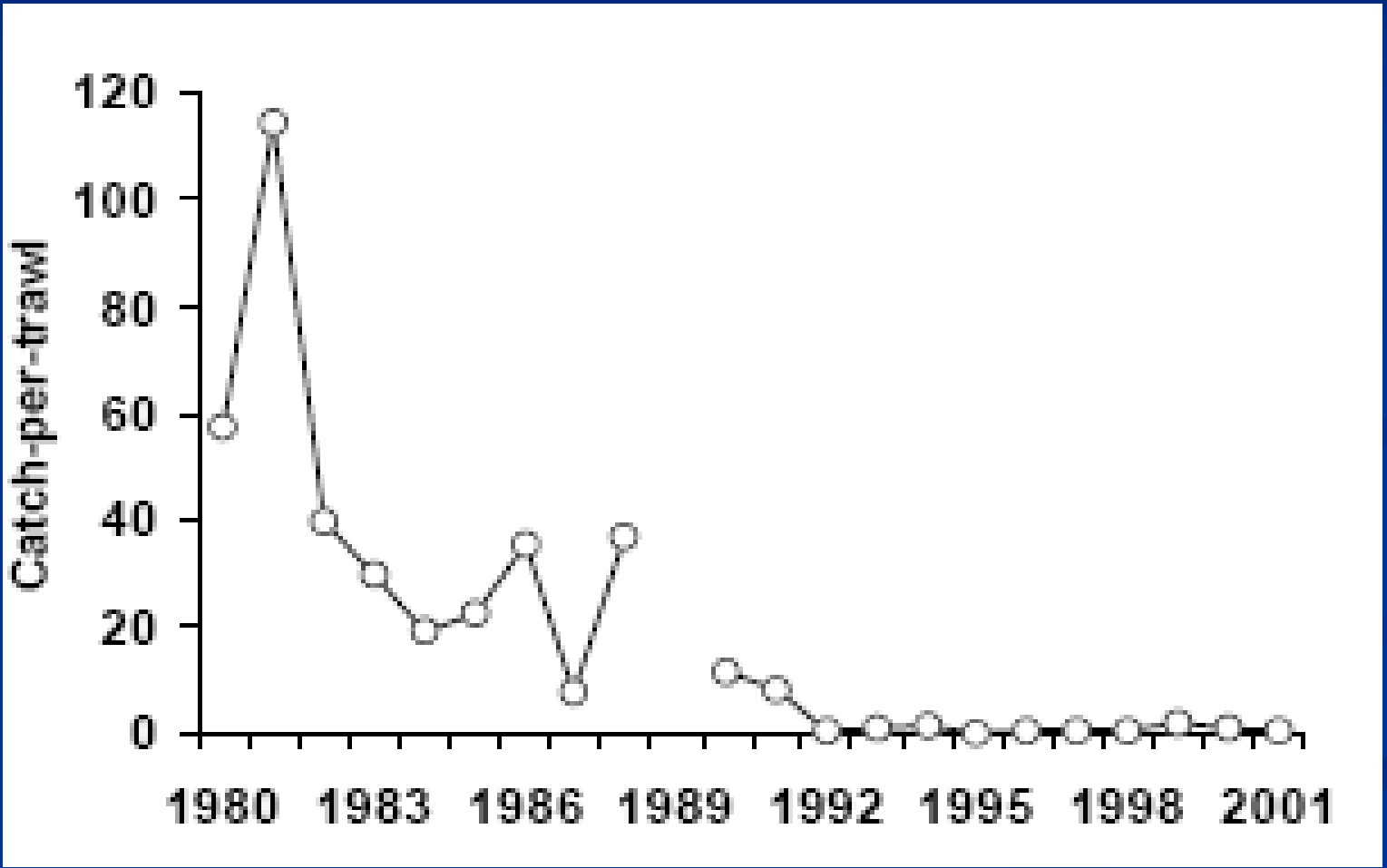


Brown et al. 2005

Diet of Juvenile Lake Trout 1979-1987 (Elrod et al. 1991)

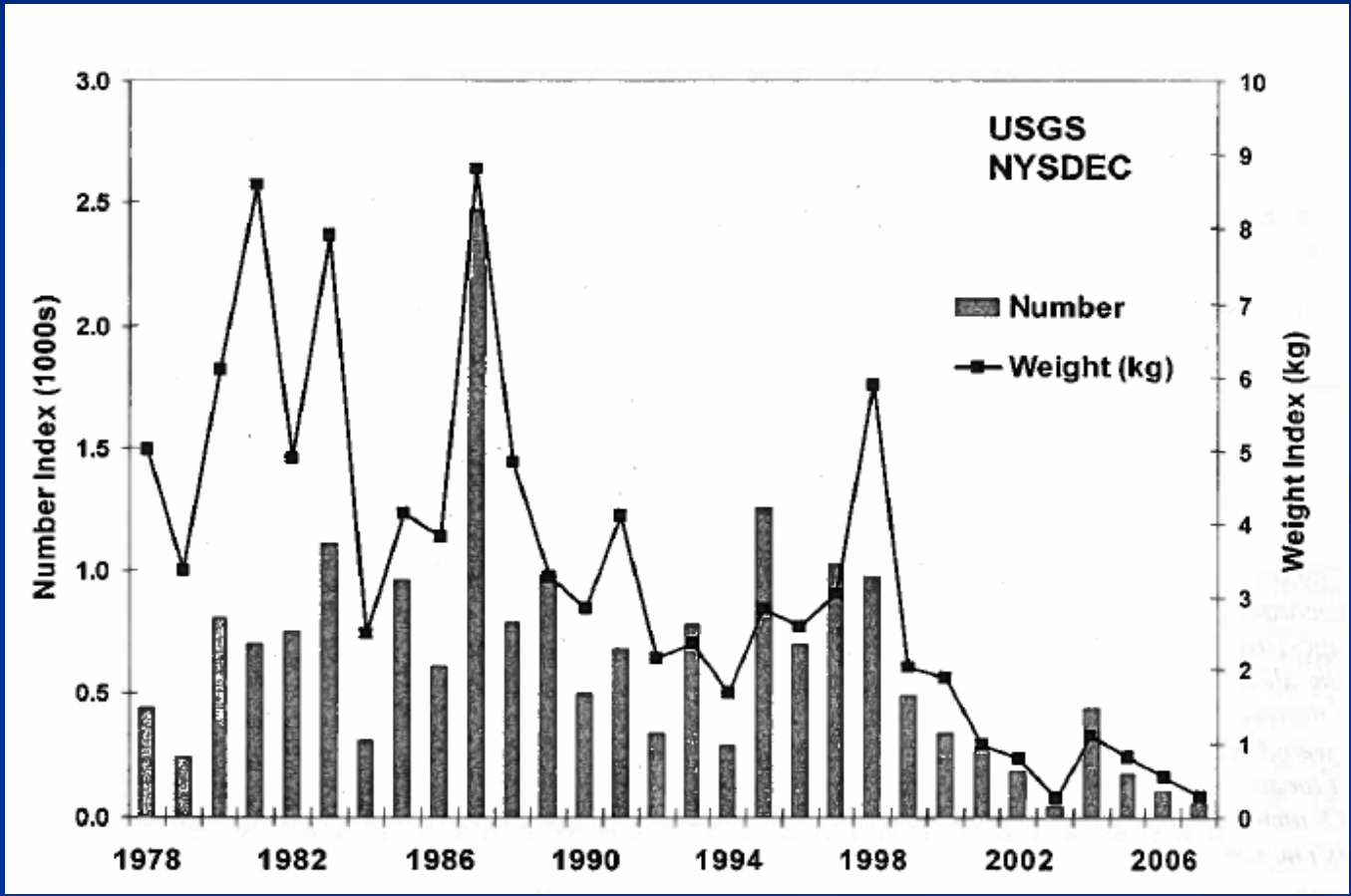


Slimy Sculpin Abundance



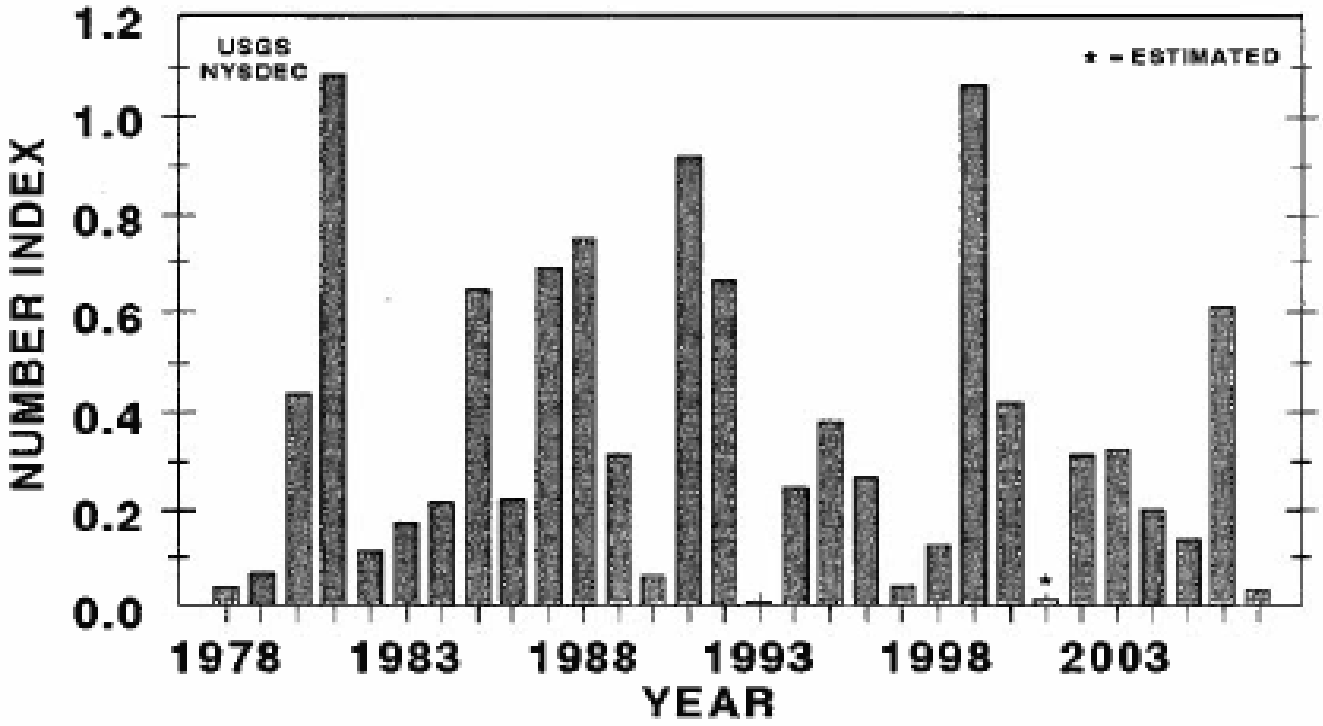
OMNR Glenora

Rainbow Smelt Abundance (Age 1 and older)



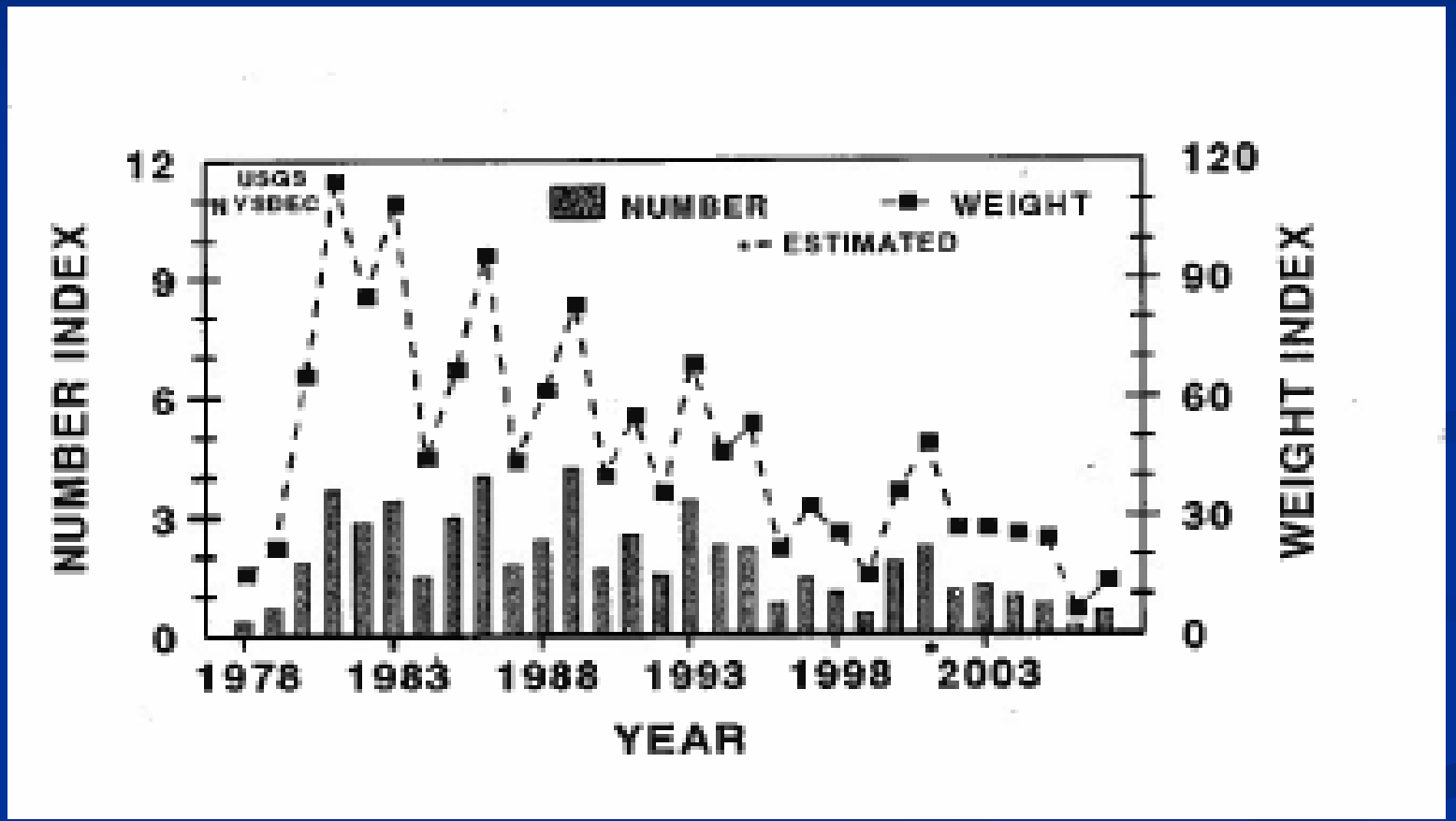
USGS Oswego

Yearling Alewife Abundance



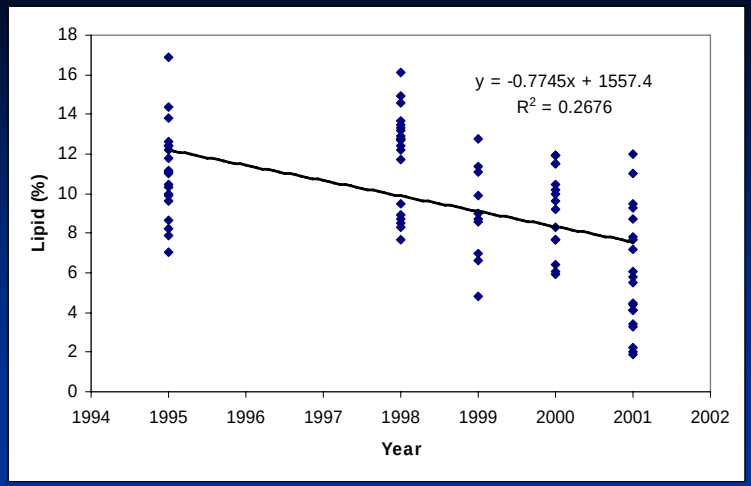
USGS Oswego

Adult Alewife Abundance

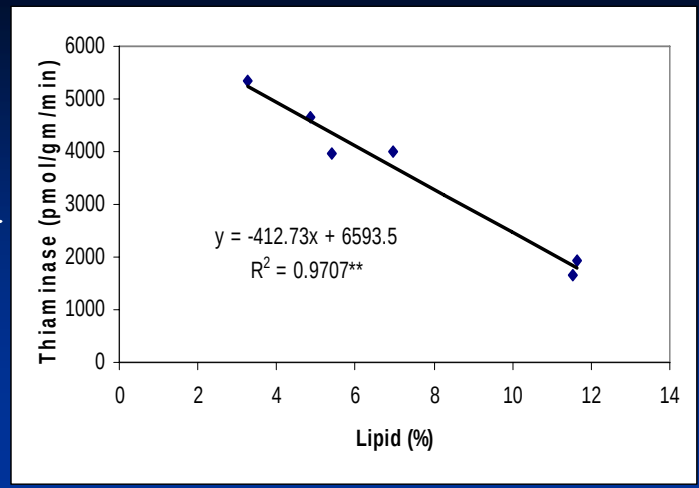


USGS Oswego

Lake Ontario adult alewife lipid



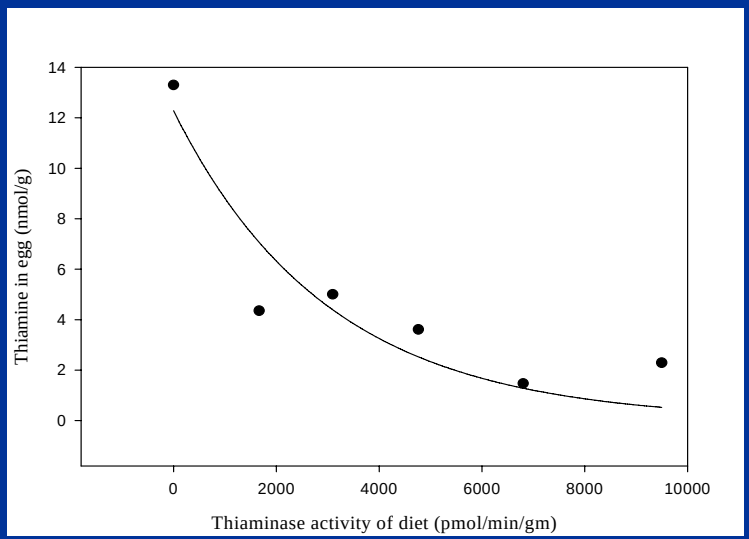
FL alewife lipid and thiaminase



Reduced alewife lipid

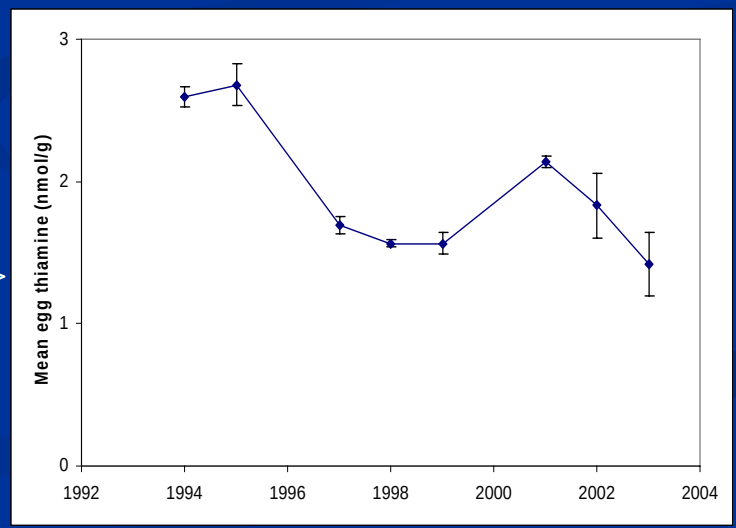
Increased alewife thiaminase

Thiaminase in diet and egg B1



Reduced egg thiamine

Lake Ontario lake trout egg B1



Objectives

- Examine ontogenetic changes in the diet of Lake Ontario lake trout using stomach contents and stable isotopes
- Relate changes in diet to changes in thiamine status
- Determine if patterns are influenced by location, season, or year
- Relate changes in thiamine status to amount of thiaminase-containing prey in diet
- Assess whether thiamine levels are low enough to cause effects and relate to ontogeny

Sampling Locations

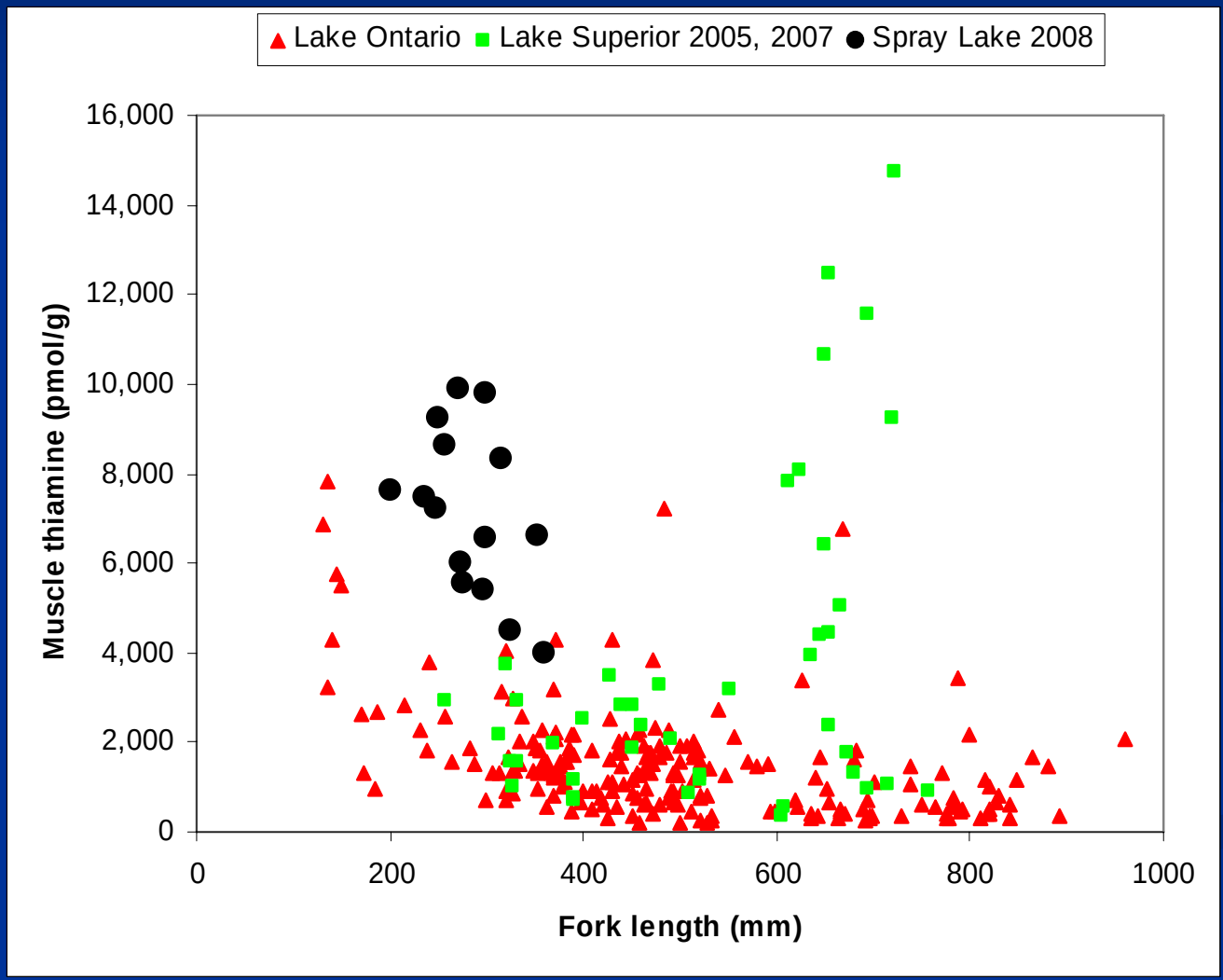
Alewife and smelt absent

Methods

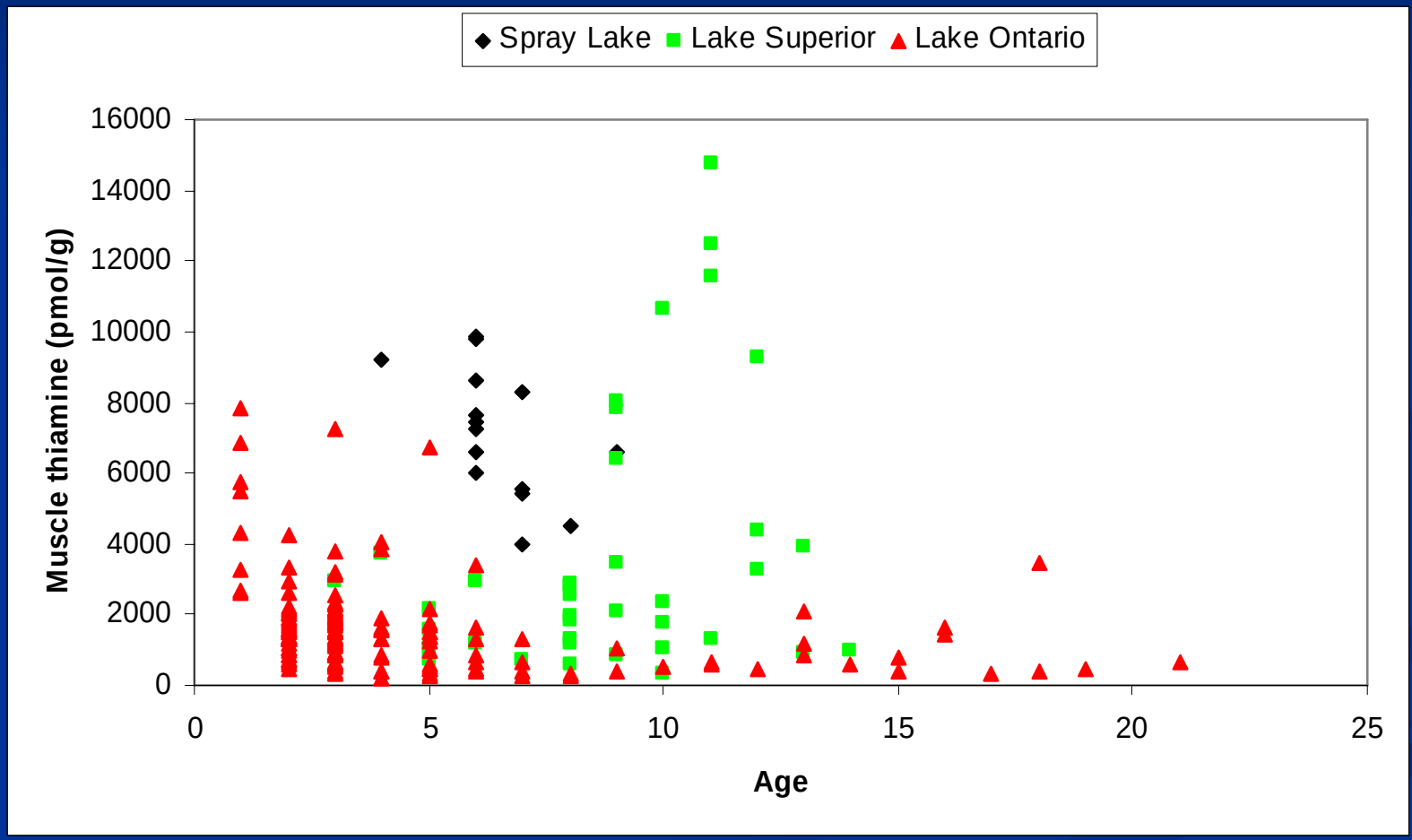
- Collection locations-Lake Ontario (2005-2006), Lake Superior (2005, 2007), Spray Lake (2008)
- Collection methods-lake trout-trawls, gillnets, dip nets, angling

  -forage fish and invertebrates-trawls, sleds
- Diet-stomach contents and stable isotopes
- Stable Isotopes-muscle-^{13}C and ^{15}N-Cornell Isotope lab
- Aging-CWTs or otoliths
- Thiamine-muscle-HPLC-Brown et al. 1998

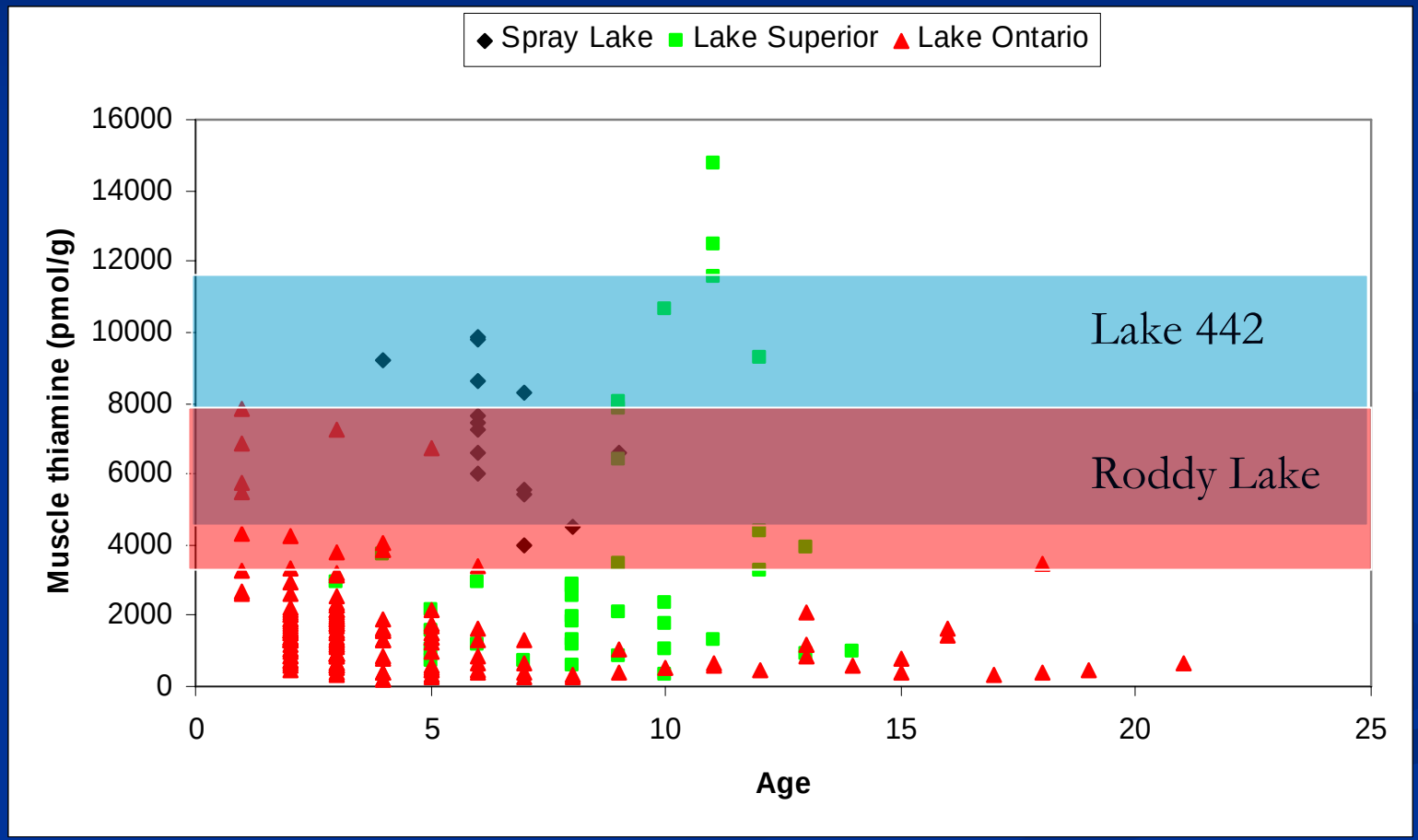
Relationship Between Length and Thiamine Concentration



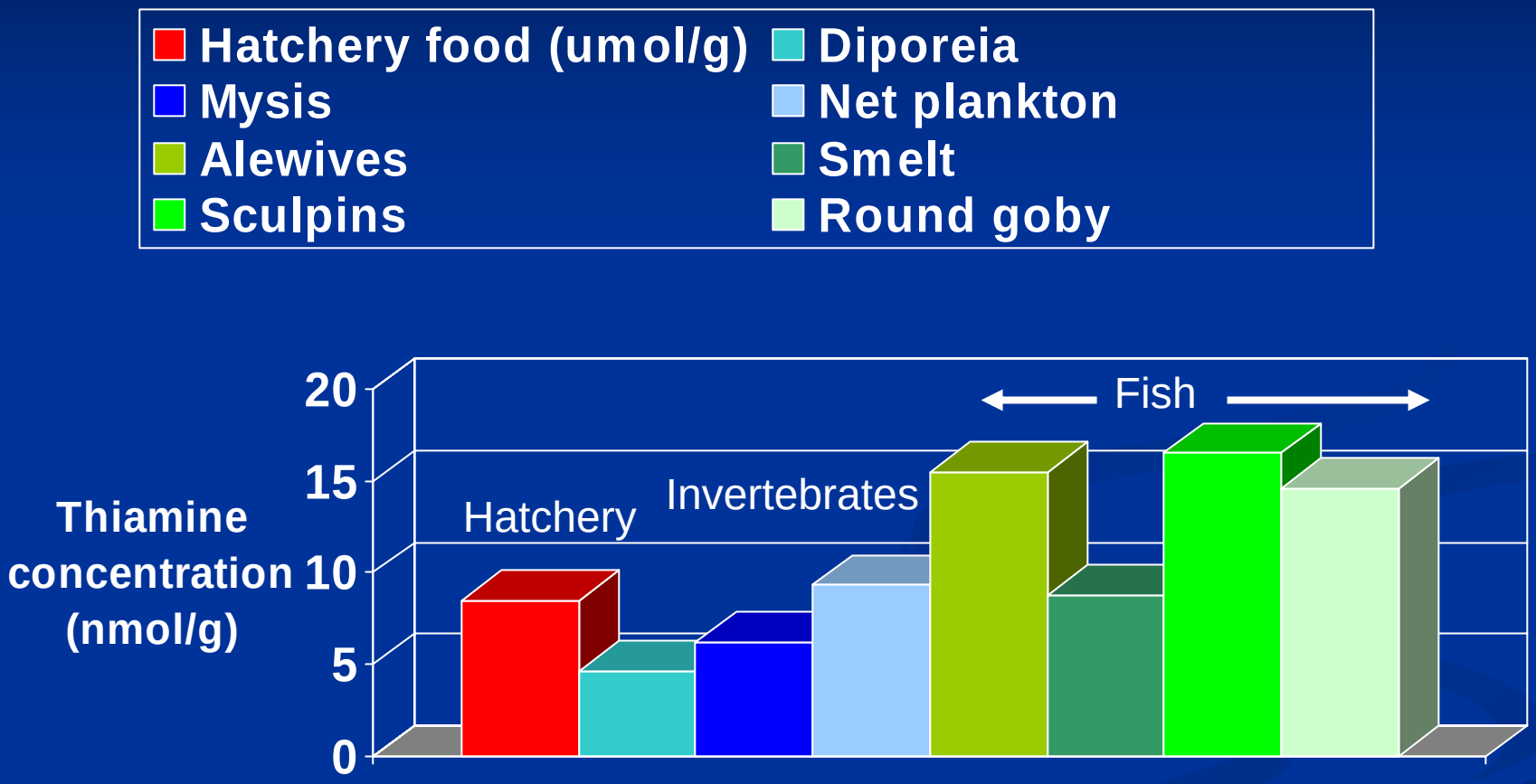
Relationship Between Age and Thiamine Concentration



Comparison with Other Thiaminase-free Lake Trout Stocks

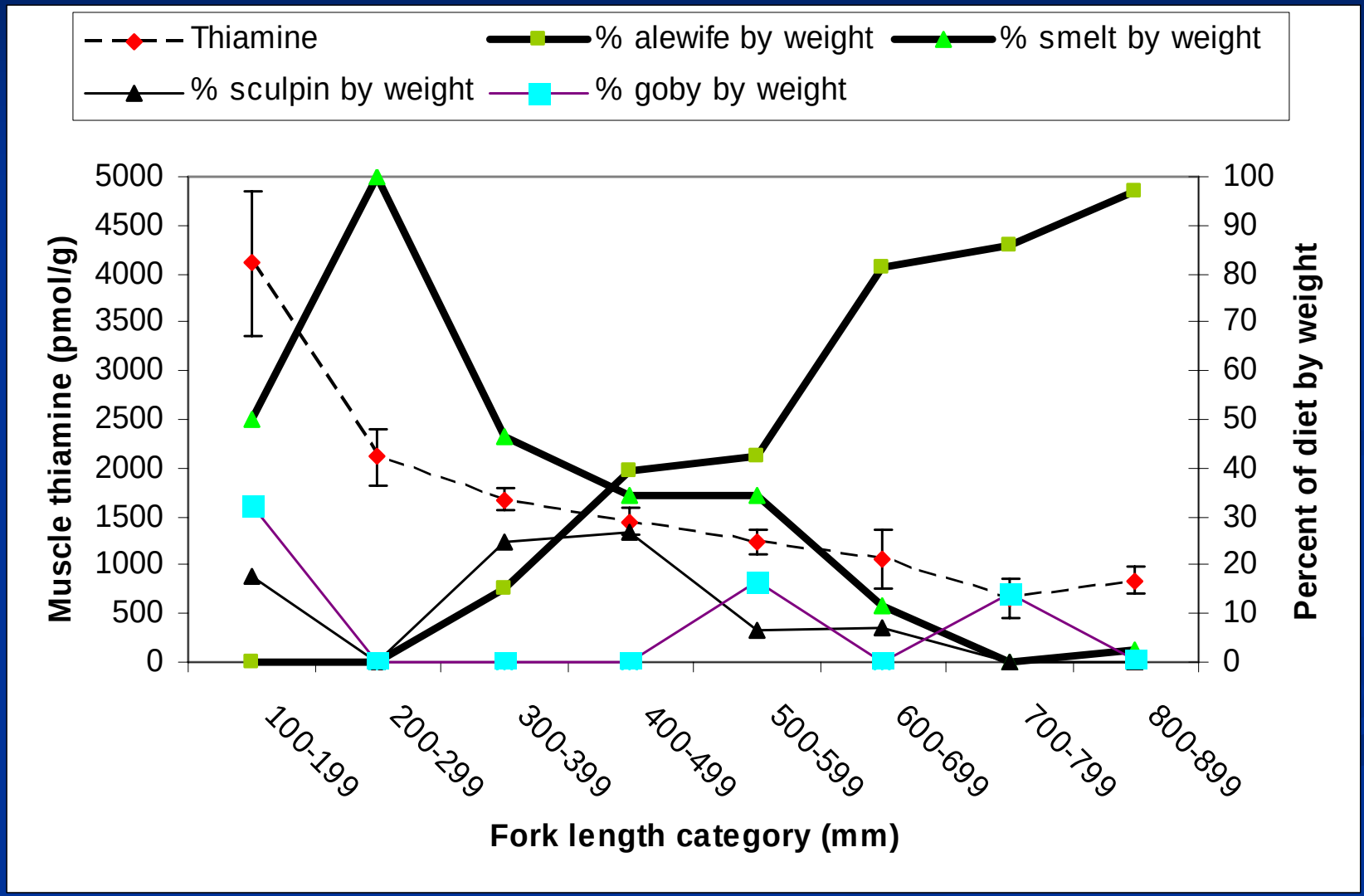


Thiamine in Diet of Lake Trout

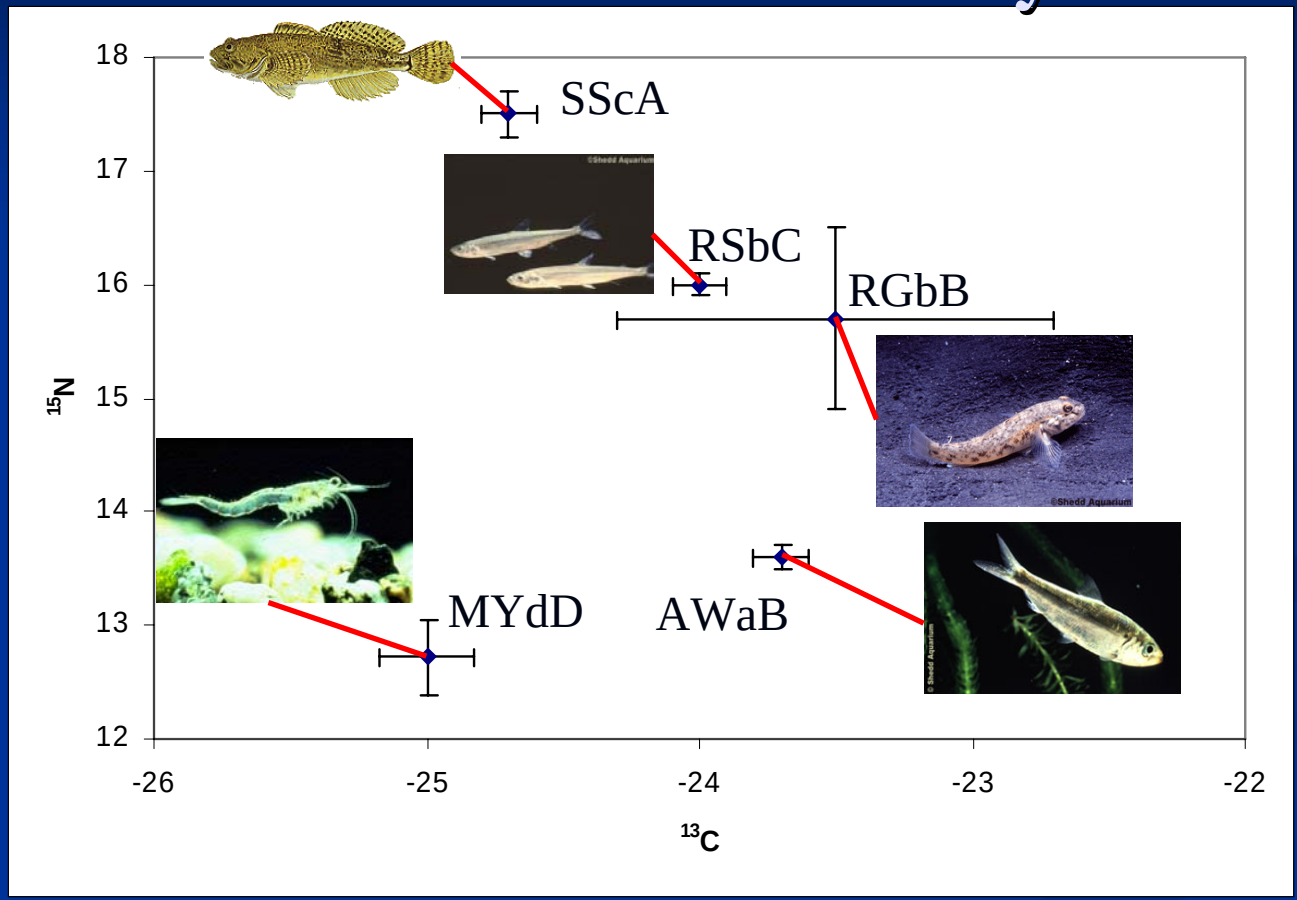


Lake Michigan

Thiamine Related to Diet



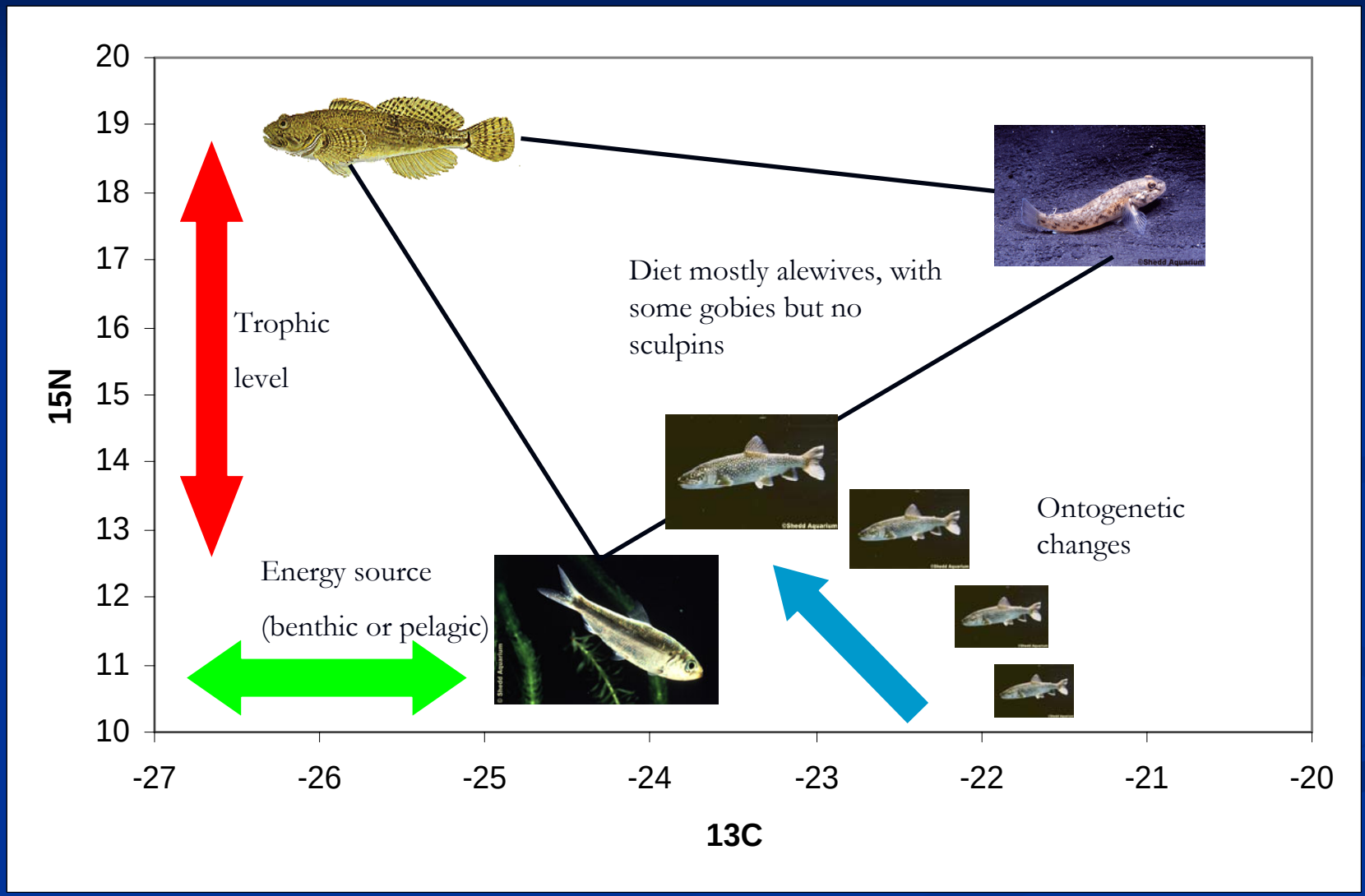
Stable Isotope Signatures for Lake Ontario Prey



Code SS-slimy sculpin, RS-rainbow smelt, RG-round goby, AW-alewife, MY-*Mysis*

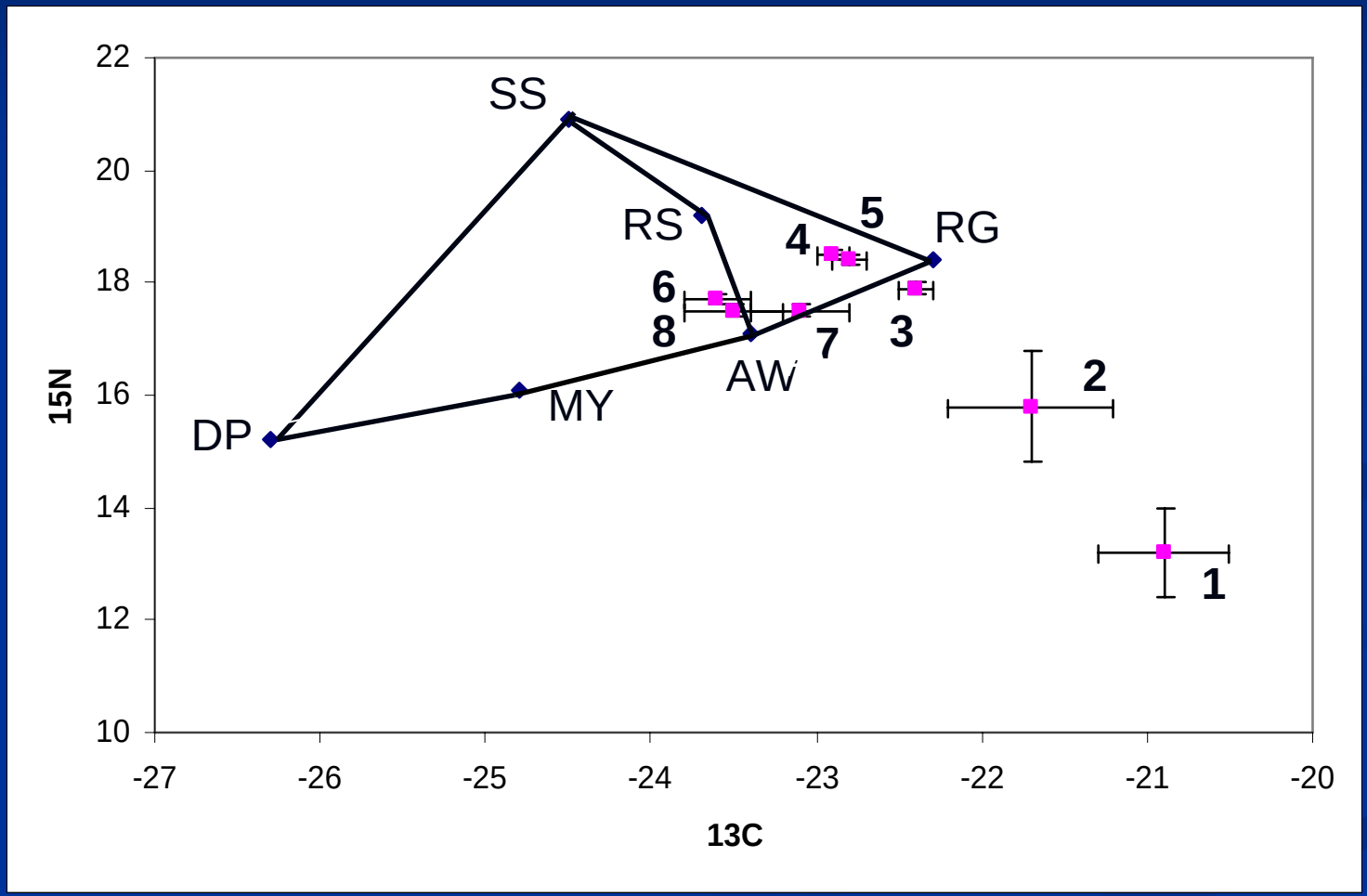
Format Species code/ANOVA ^{15}N/ANOVA ^{13}C

Stable Isotope Mixing Models to Infer Diet Hypothetical Case (after Phillips 2001)



Trophic enrichment ^{15}N-3.4‰ Vander Zanden and Rasmussen 2001, ^{13}C-0.2‰ France and Peters, 1997

Mixing Model
Western Lake Ontario



Size Groups

1-100-199 mm

2-200-299

3-300-399

4-400-499

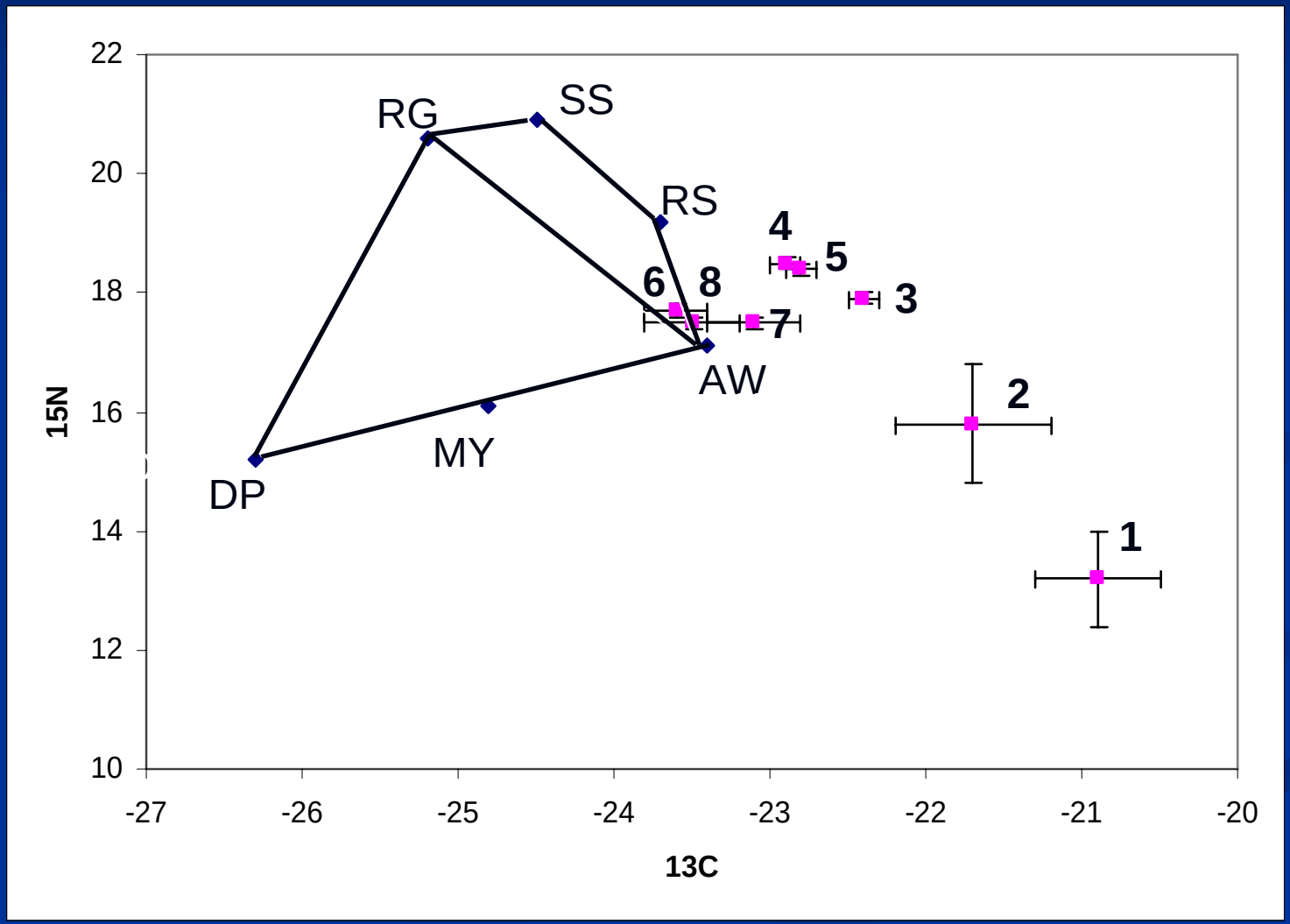
5-500-599

6-600-699

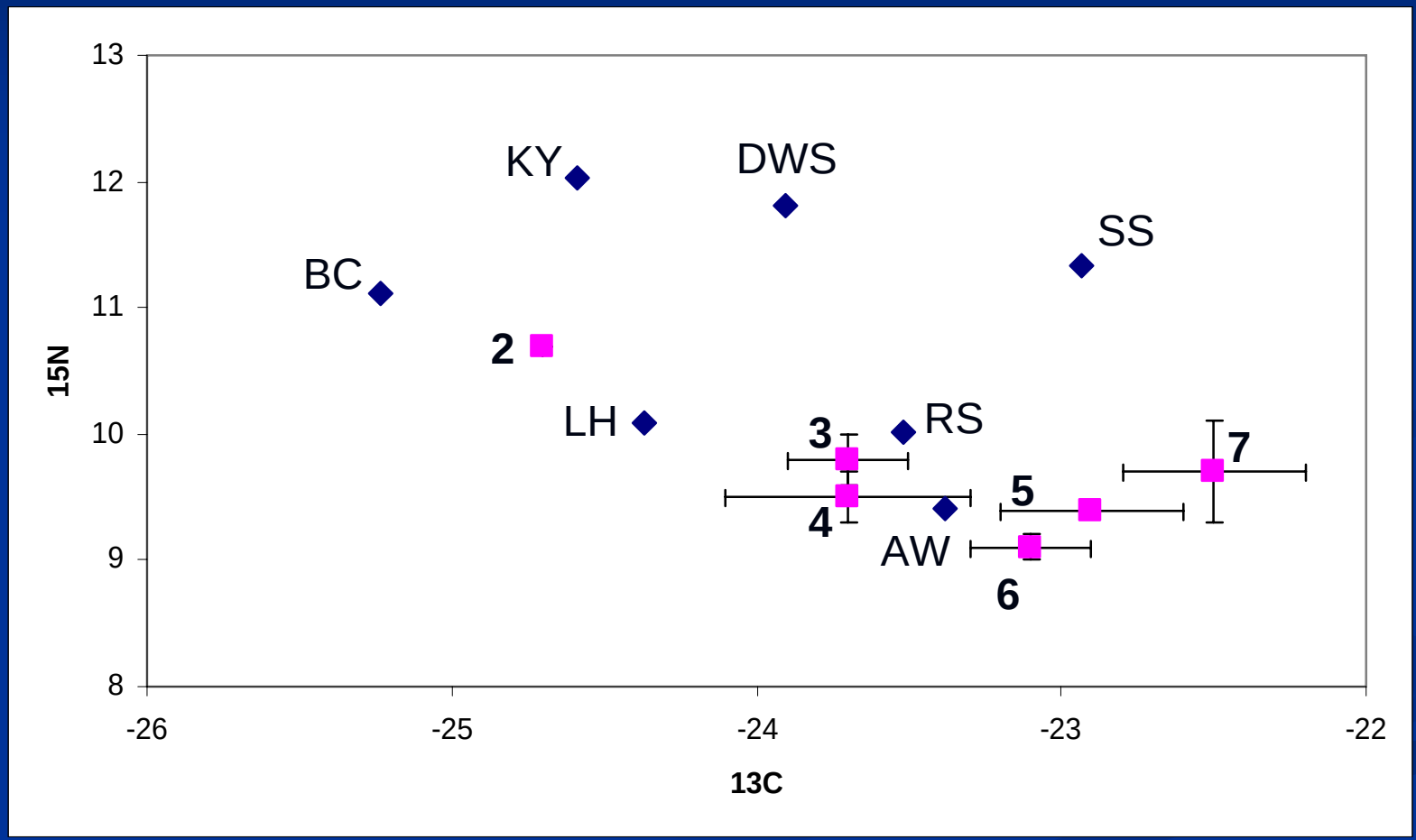
7-700-799

8-800-899

Mixing Model
Eastern Lake Ontario

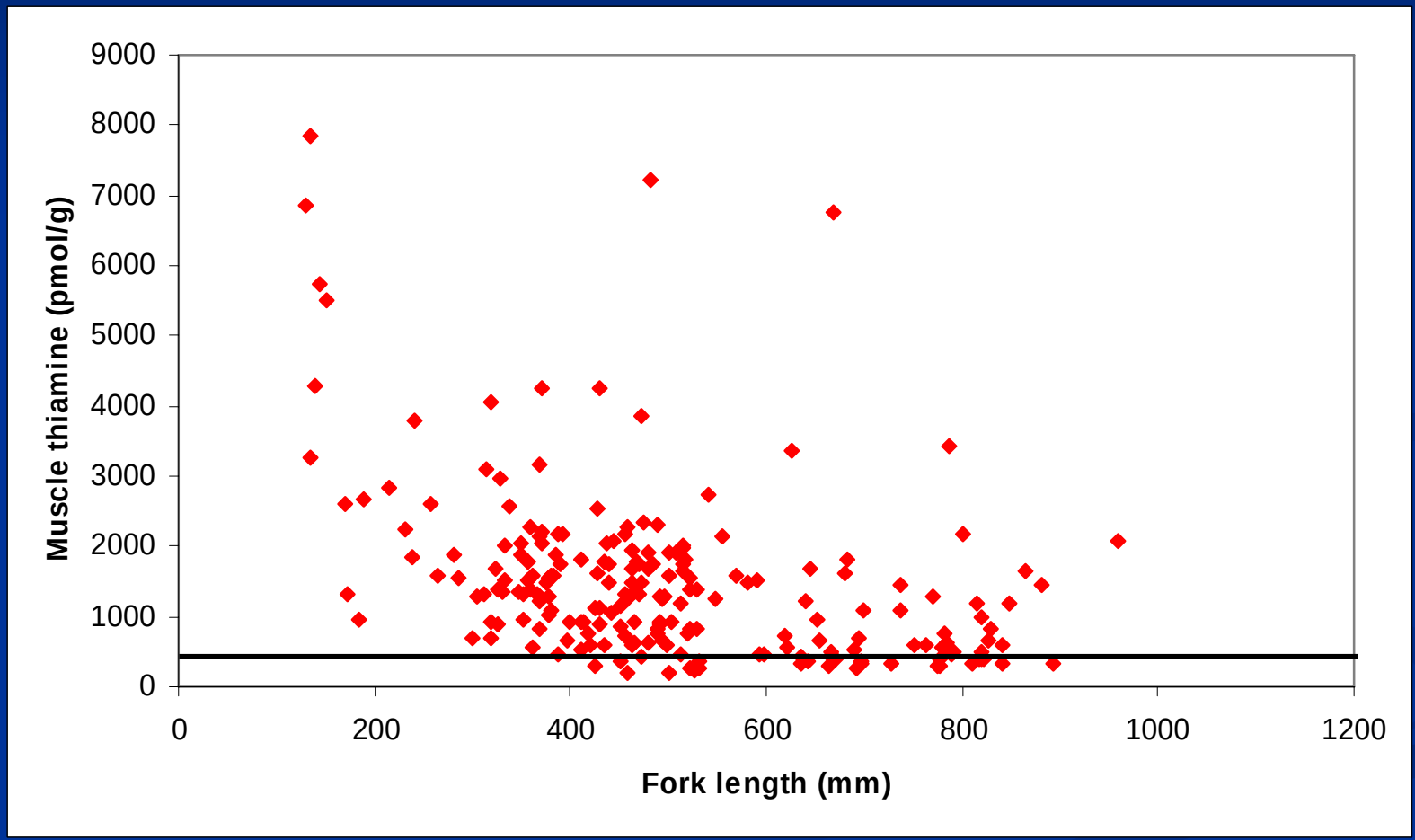


Mixing Model
Eastern Lake Superior

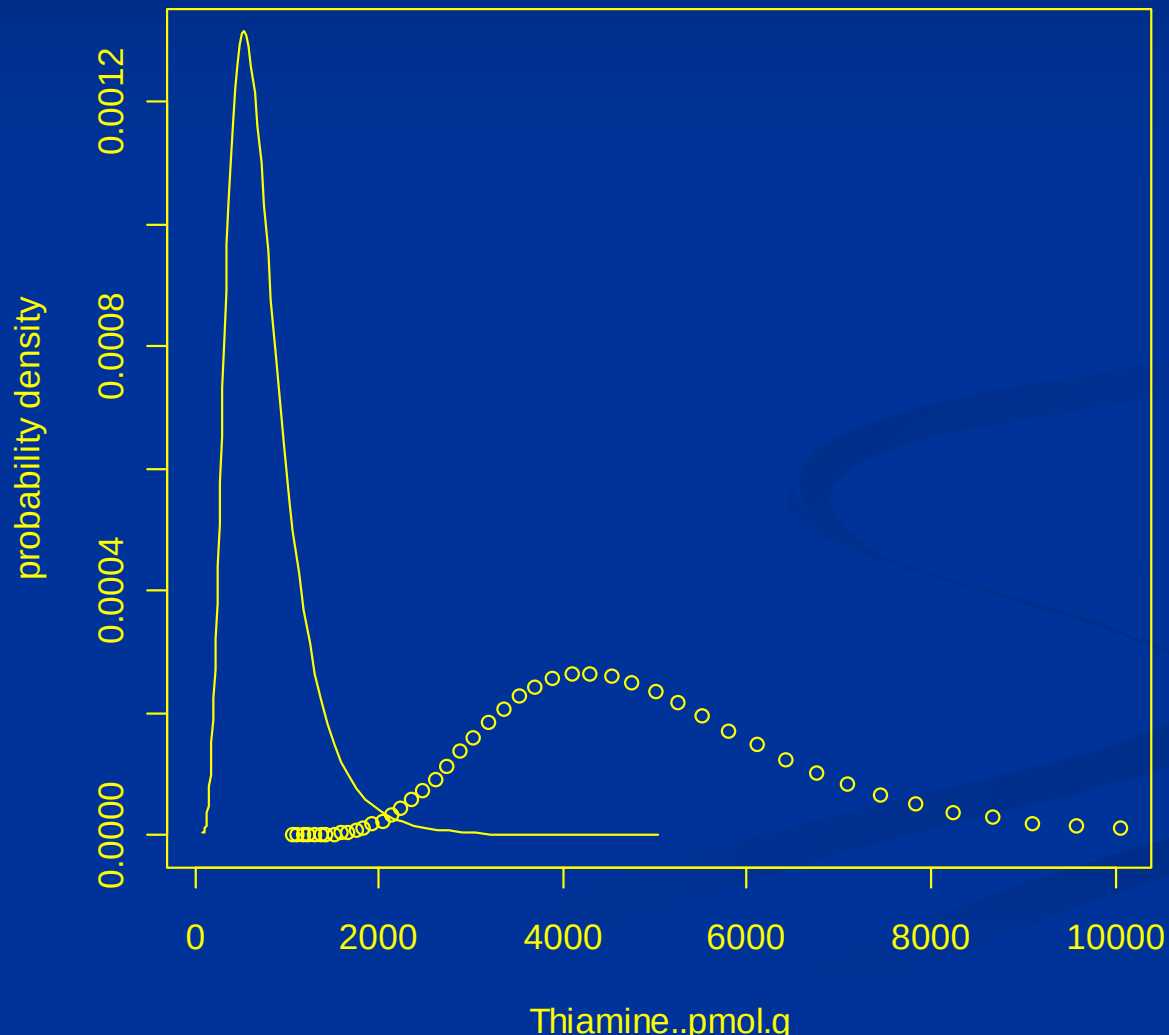


Code SS-slimy sculpin, RS-rainbow smelt, RG-round goby, AW-alewife, KY-kiyi BC-bloater, LH-lake herring

Muscle Thiamine Relative to Mortality Threshold

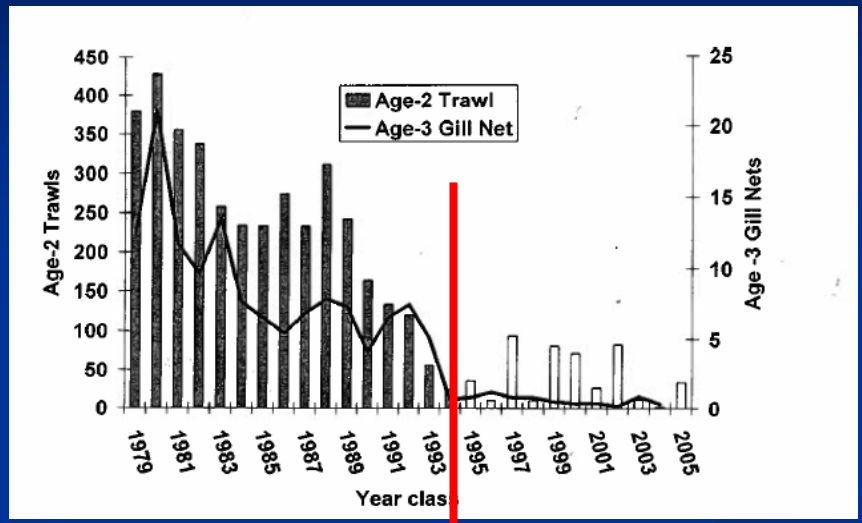


Effect of Thiamine Level on Distribution

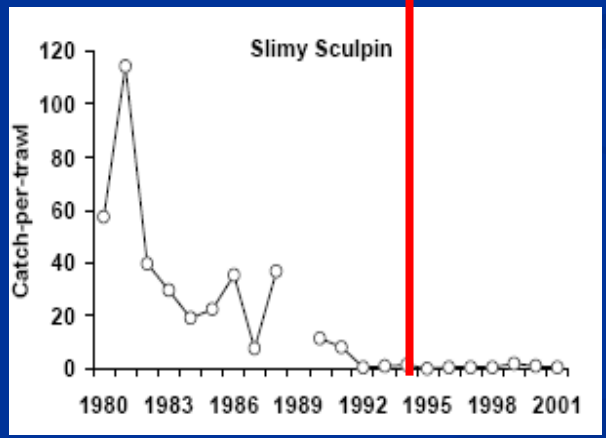


Lake Trout Survival and Sculpins

USGS Oswego



OMNR Glenora



MORTALITY

Increasingly thiamine deficient

REDUCED GROWTH

LETHARGY

ALTERED SWIMMING

PREDATION

thiamine replete

Conclusions

- Lake Ontario lake trout exhibit some level of thiamine deficiency almost from the outset of piscivory that is related but not proportionately to consumption of alewives.
- The lower limit of thiamine in the wild is generally consistent with a lab derived acute mortality threshold level.
- Thiamine deficiency effects at thiamine concentrations above acute mortality thresholds may be possible although indirect possibly involving greater susceptibility to predation.