

FUNDAMENTAL CHANGES IN  
LAKE HURON AND THE ST.  
CLAIR RIVER: ROLE OF  
INVASIVE SPECIES CHANGING  
FISH COMMUNITIES AND PCB  
DYNAMICS

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# OUTLINE

- LAKE HURON TROPHIC  
CASCADE
- ST CLAIR FISH COMMUNITY  
CHANGES
- PCB DYNAMICS IN THE ST  
CLAIR RIVER/COMPARISON  
WITH OTHER RIVERS

# TROPHIC CASCADE

- IMPROVED SEWAGE TREATMENT PLANTS REDUCED PHOSPHORUS INPUTS
- DREISSENIDAE
- ::::RESULT: OLIGOTROPHICATION

# LAKE ERIE IS DEAD!

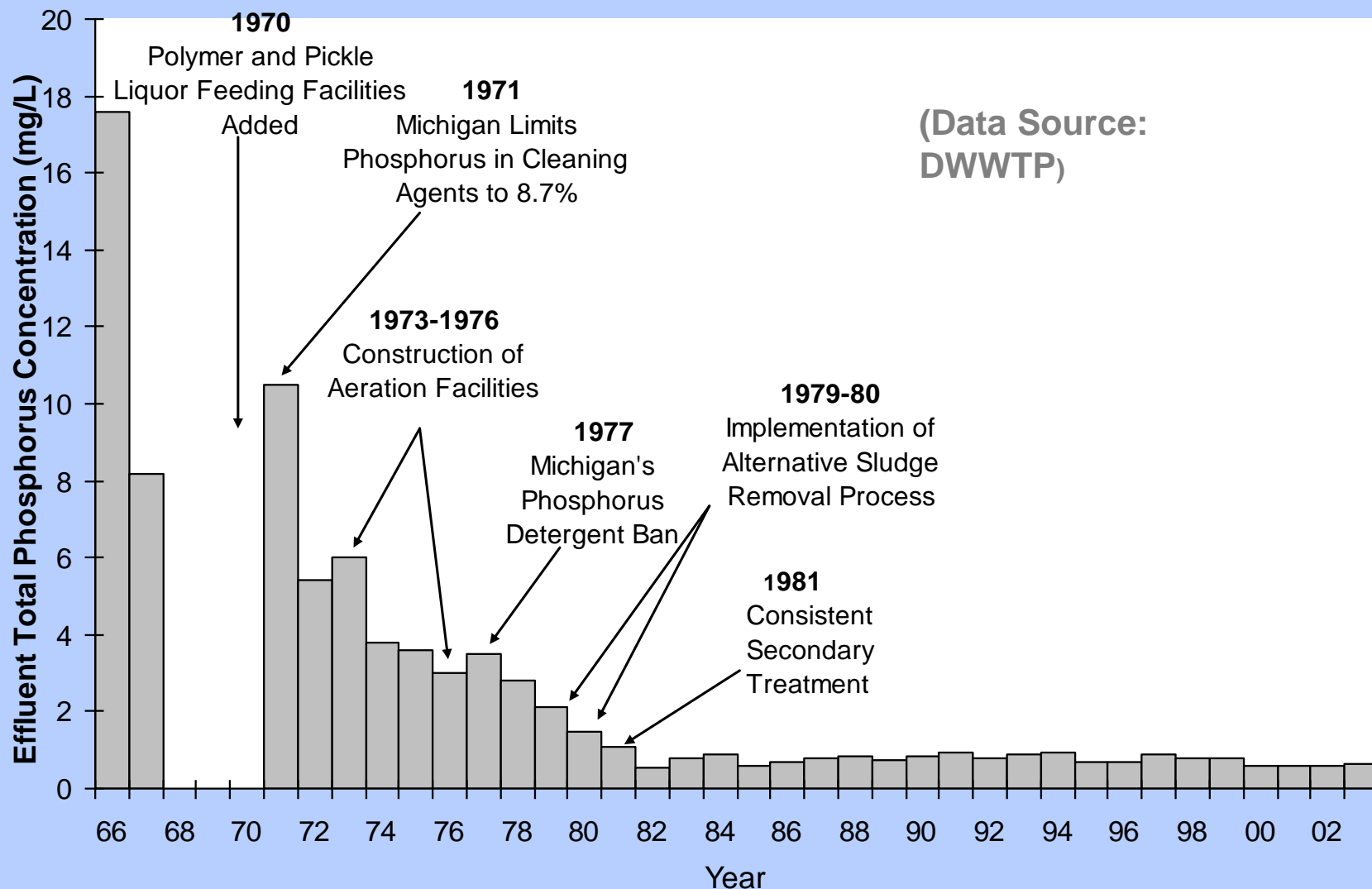
# TIME

August 20, 1965

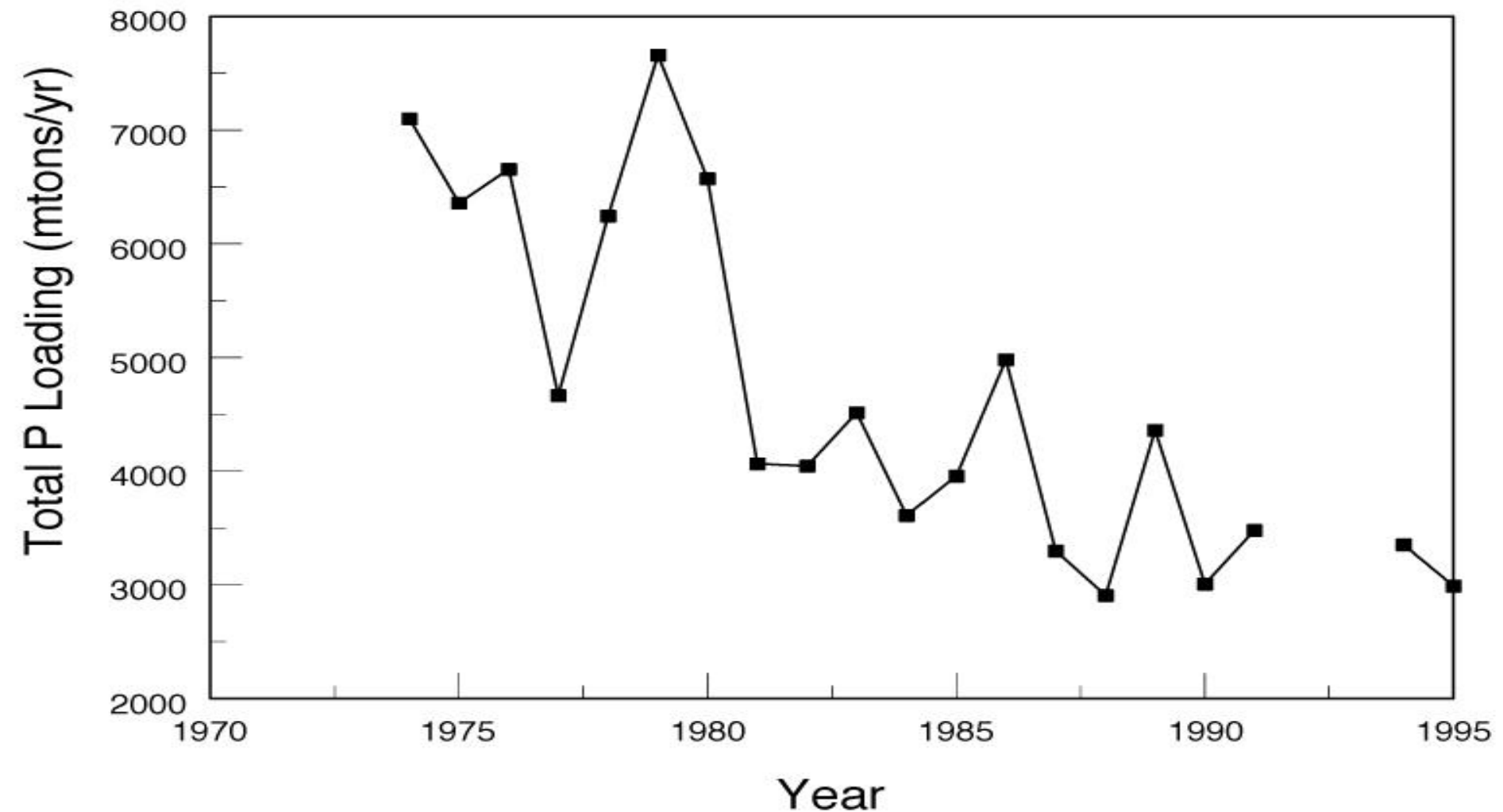


# Detroit Wastewater Treatment Plant

## Total phosphorus concentration: 1966–2003



# LAKE MICHIGAN: TOTAL P LOADINGS





OLUAGA

ZIBRA











# MID-LAKE REEFS - 2001



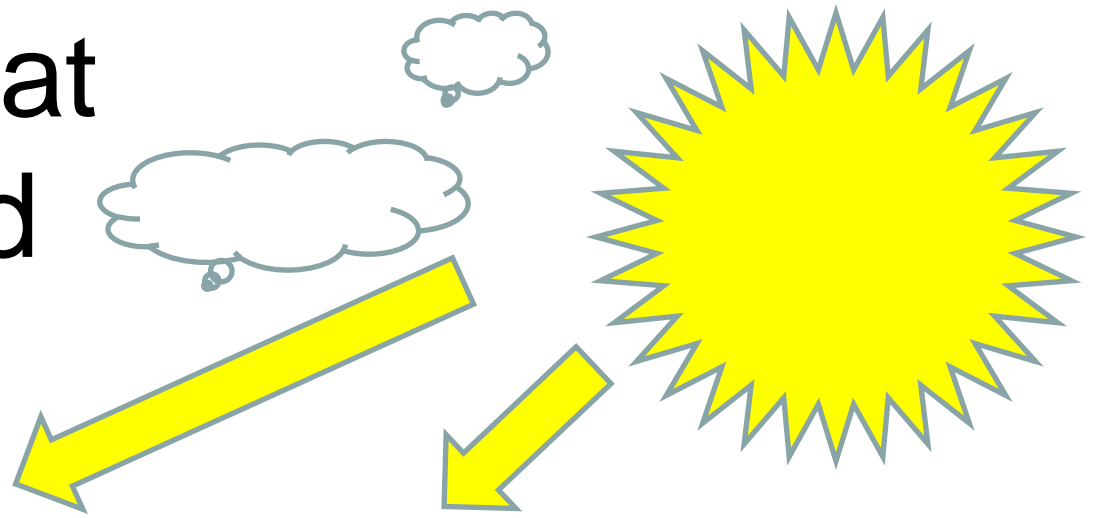
# MID-LAKE REEFS - 2005



# TERRESTRIAL FOOD WEB



# Original Great Lakes Food Web



Phytoplankton (Algae)



Zooplankton



Pelagic Fish

*Diporeia*

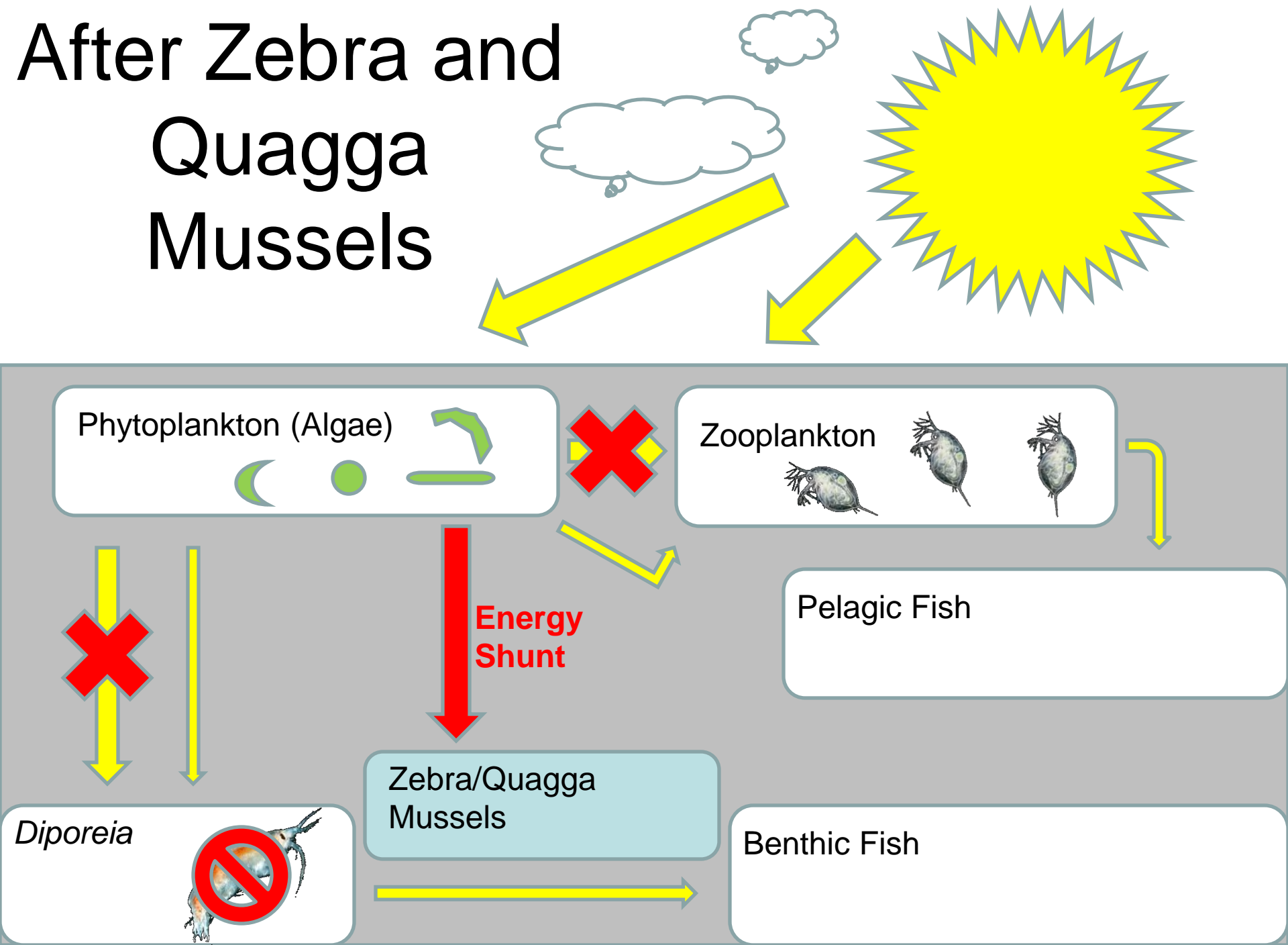


Benthic Fish





# After Zebra and Quagga Mussels



# DECLINE IN P AND ALGAE

- CAUSED A TROPHIC CASCADE THROUGH THE FOOD WEB AFFECTING:
  - ALGAE
  - ZOOPLANKTON
  - DIPOREIA
  - FORAGE FISHES
  - TOP PREDATORS

# WATER QUALITY



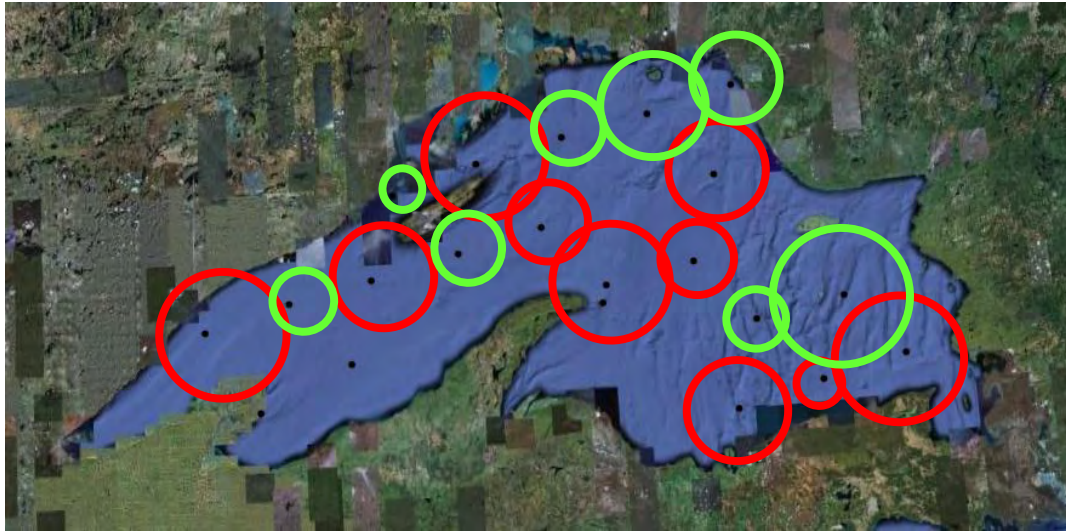






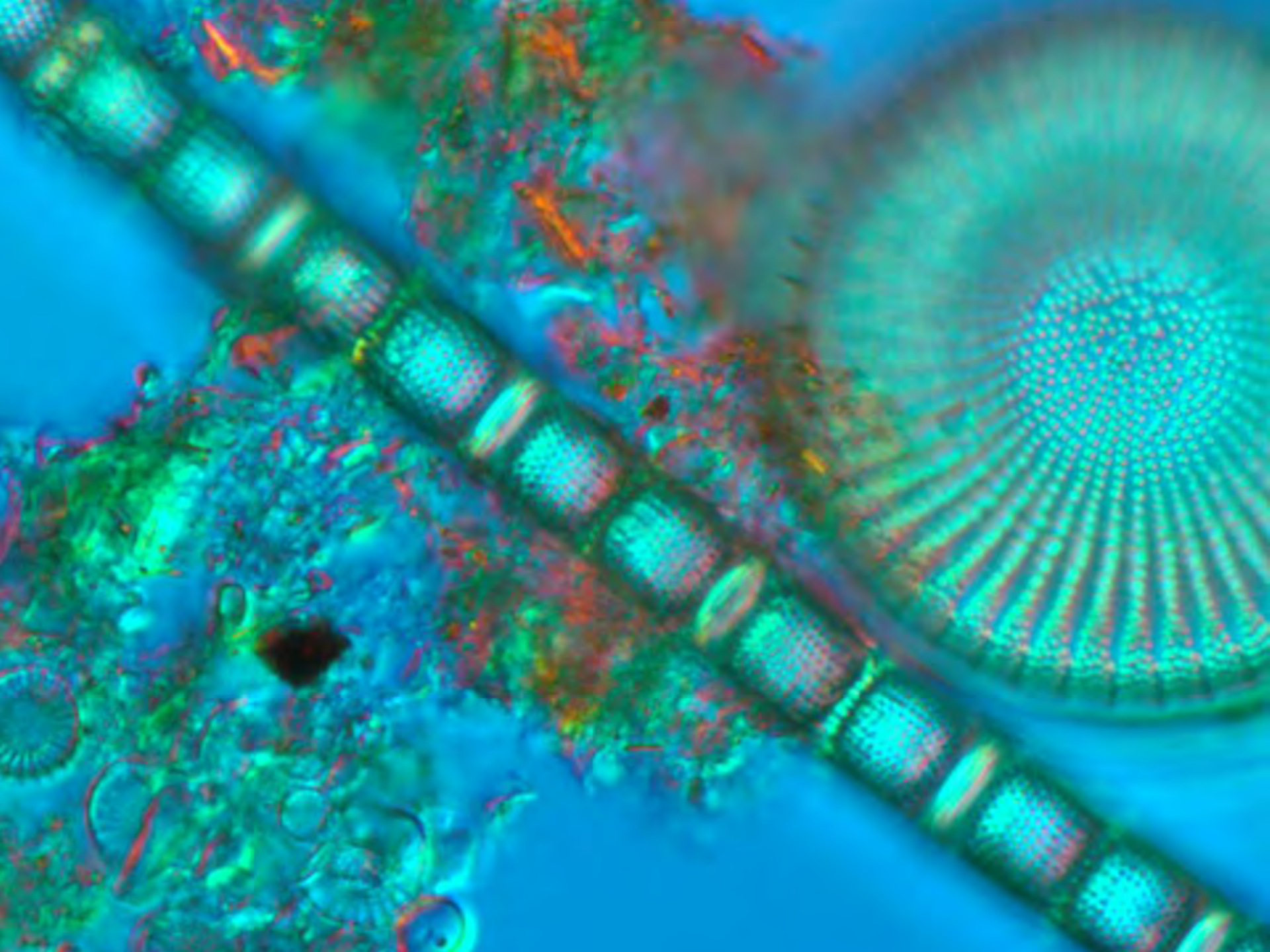


# Bubble plots: 12-yr changes based on slope of monitoring



 **Negative trends**

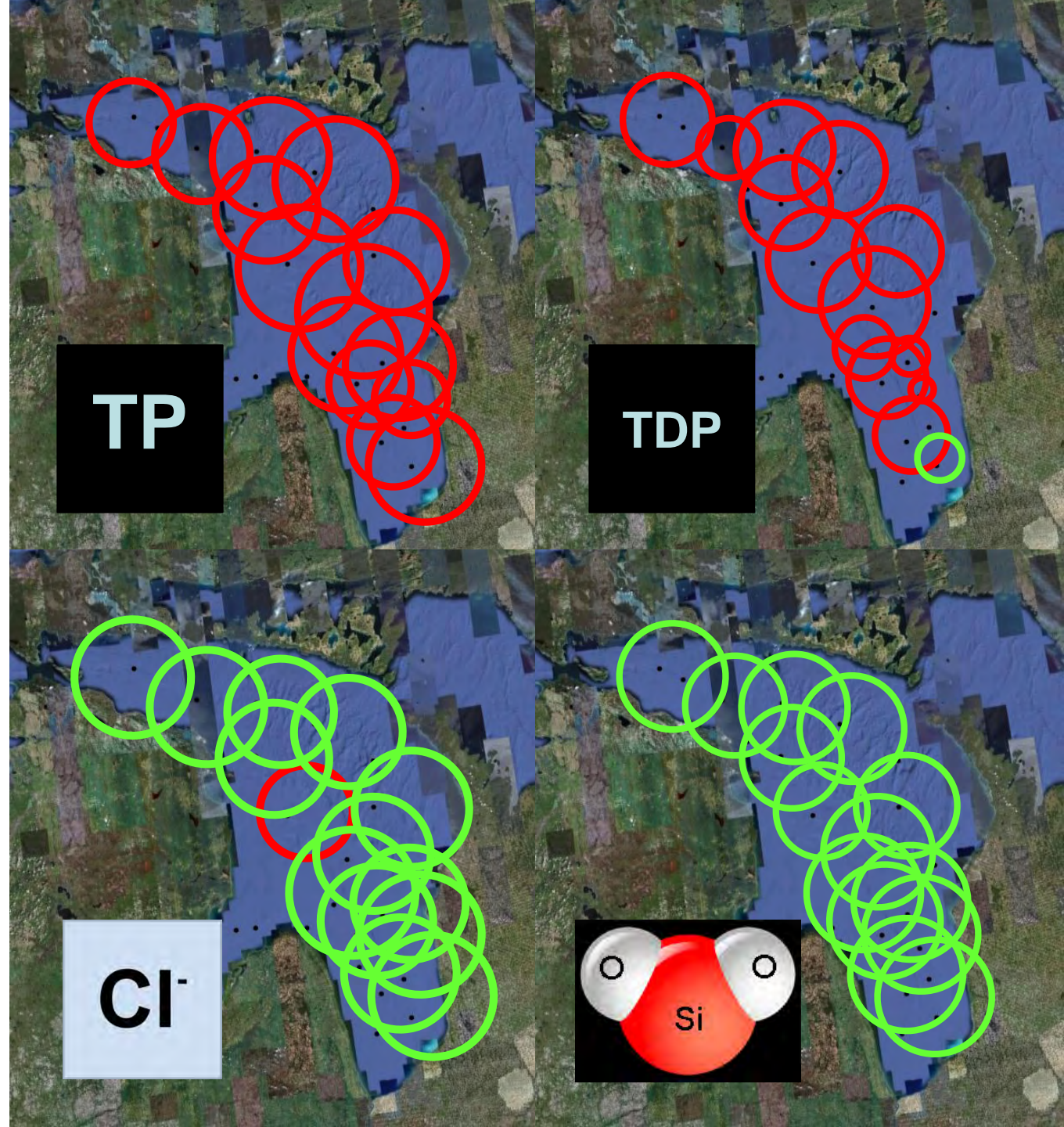
 **Positive trends**



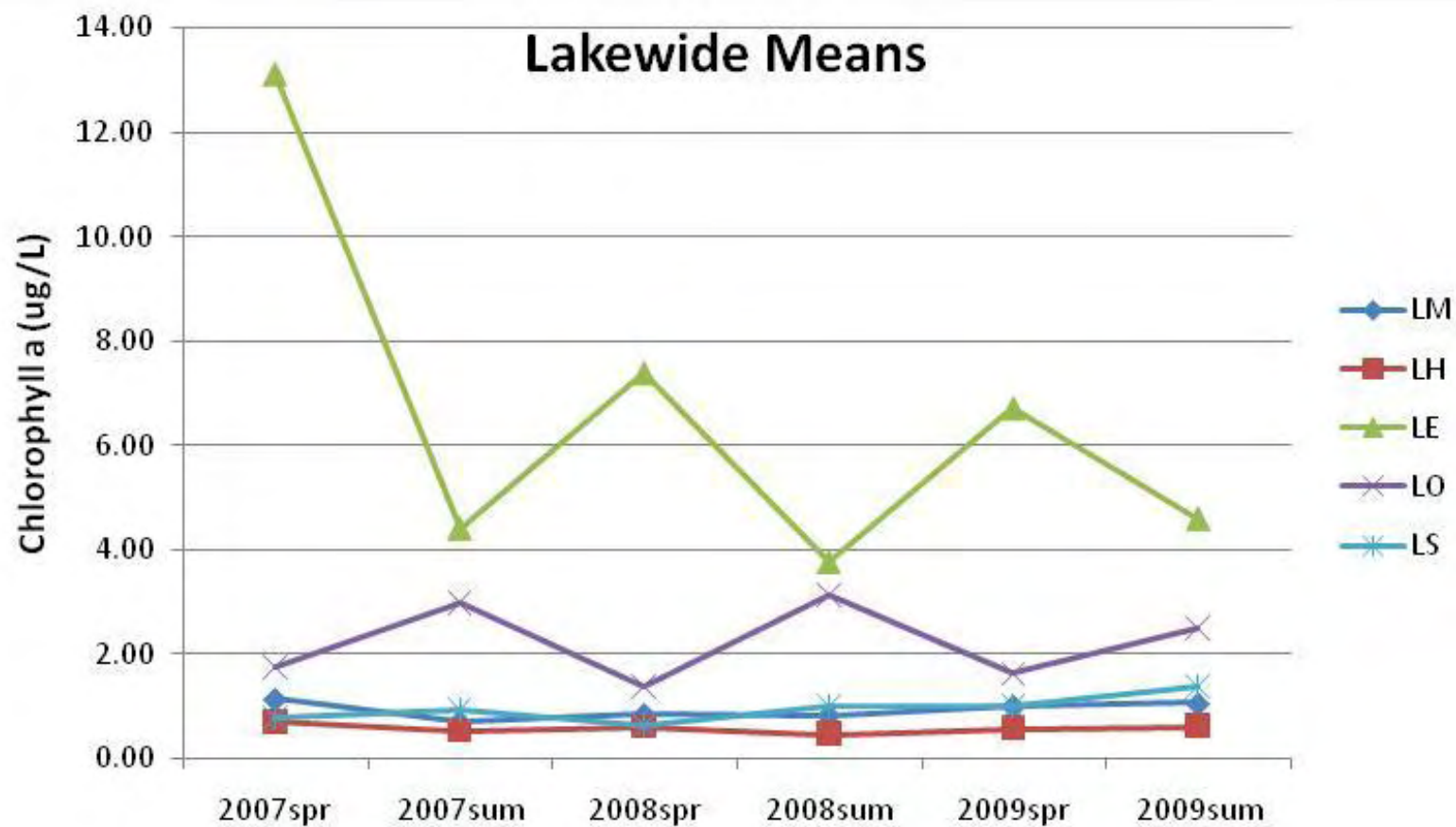


# Huron Spring 12-year trend


chemistry



## Lakewide Means







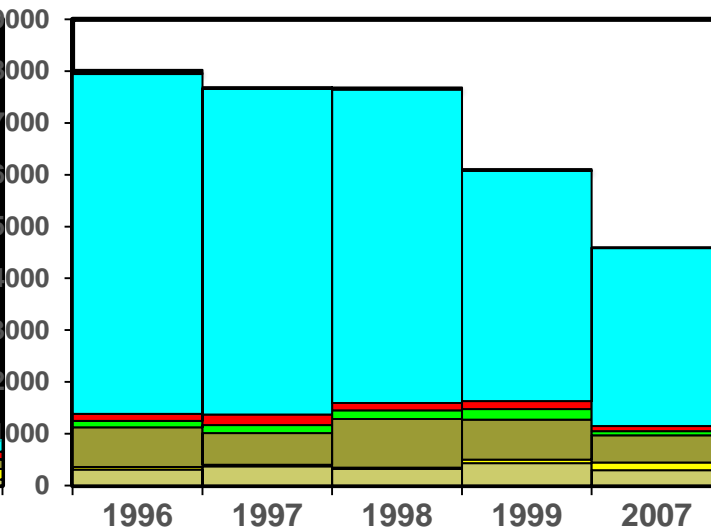
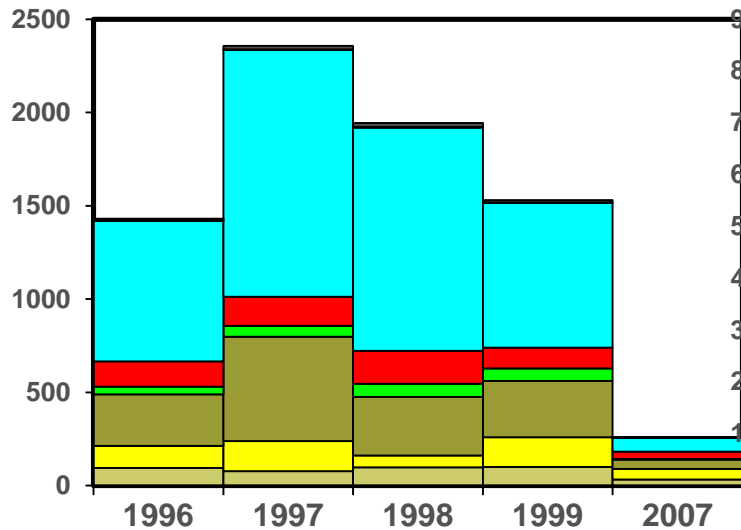
# Great Lakes biological monitoring program – phytoplankton

Euan D. Reavie  
– University of Minnesota Duluth



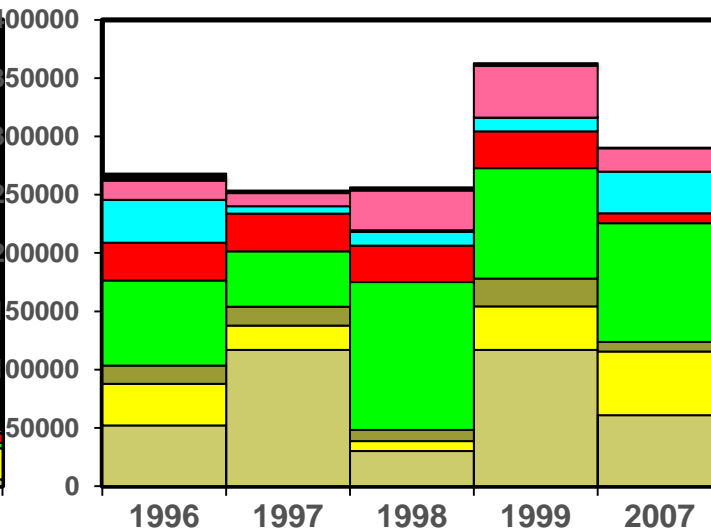
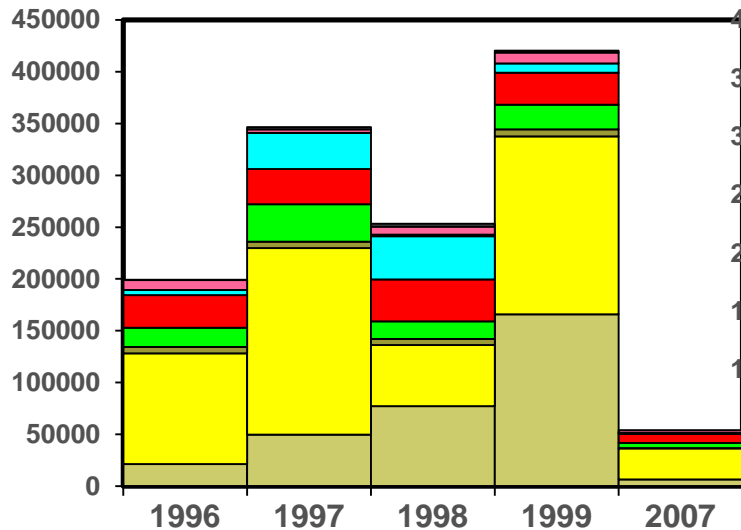
Huron Spring (cells/ml)

Huron Summer (cells/ml)



Huron Spring ( $\mu\text{m}^3/\text{ml}$ )

Huron Summer ( $\mu\text{m}^3/\text{ml}$ )

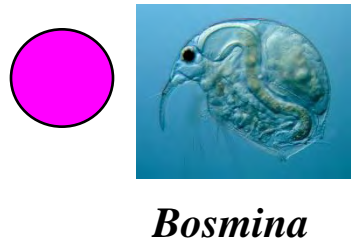


**Lake Huron comparison of pre-2000 and 2007 phytoplankton data. Data are presented for spring (left) and summer (right) sampling events based on cell density (top) and biovolume (bottom).**

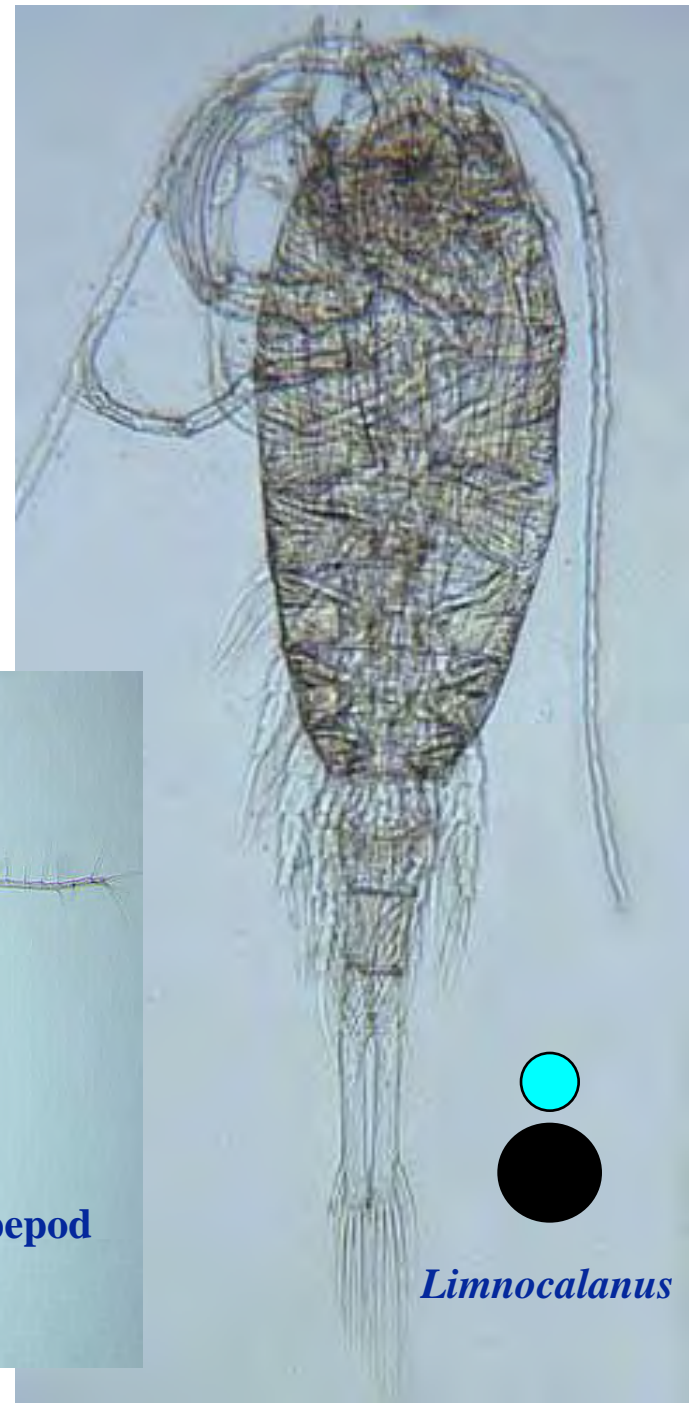
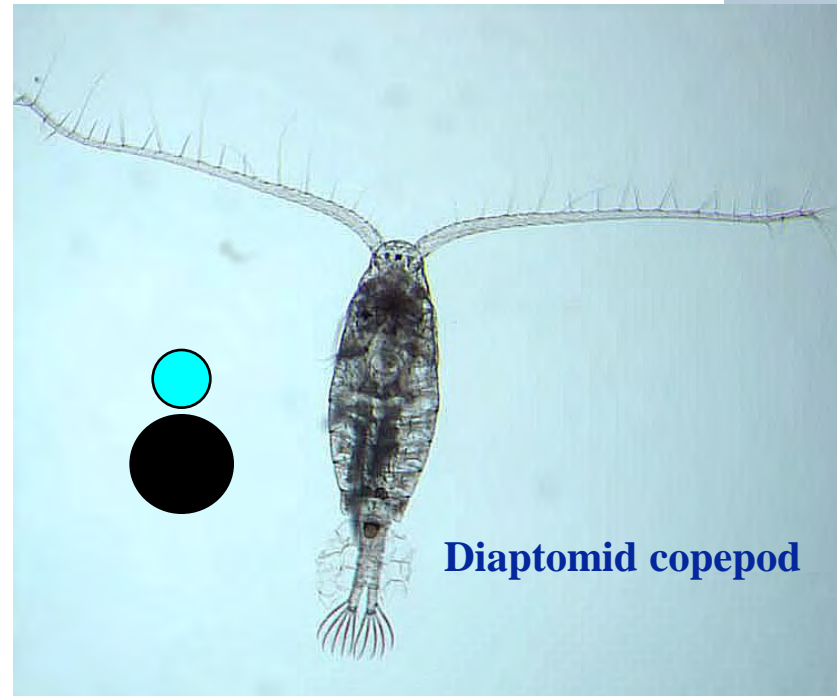
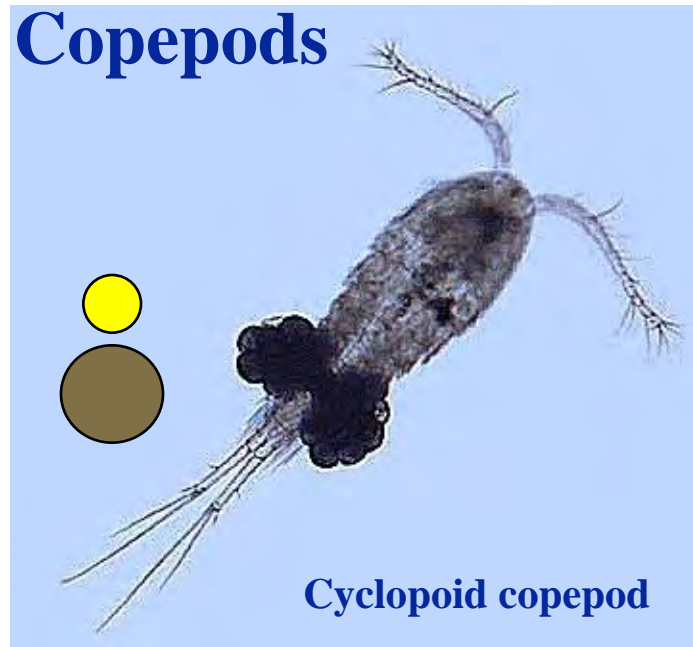
# Trends suggest...

- Chemistry and biology are shifting!
- Shifts are concordant due to interactions among trophic levels.

# Cladocerans



# Copepods

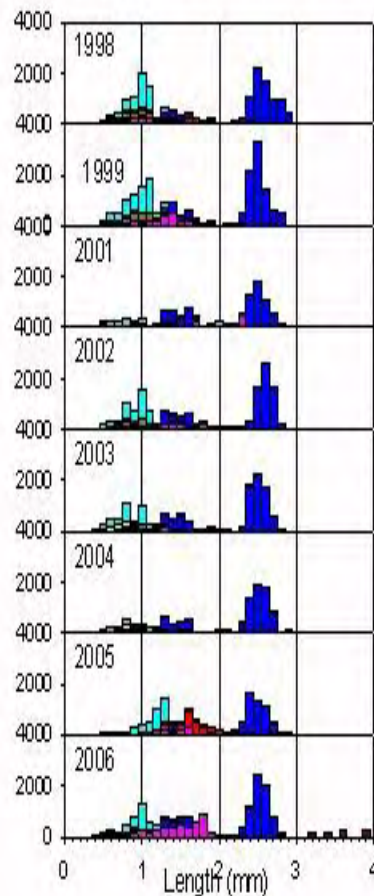




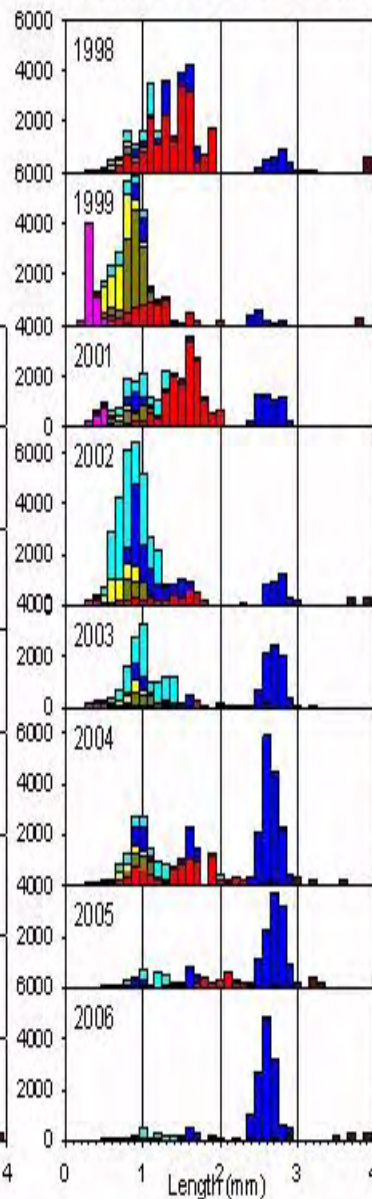
**Biomass by size category for Upper lakes**  
**Summer, 1998-2006**  
**Only 153  $\mu$ m tows**

- immature calanoids
- adult calanoids
- immature cyclopoids
- adult cyclopoids
- predatory clads
- daphnid clads
- non daphnid clads

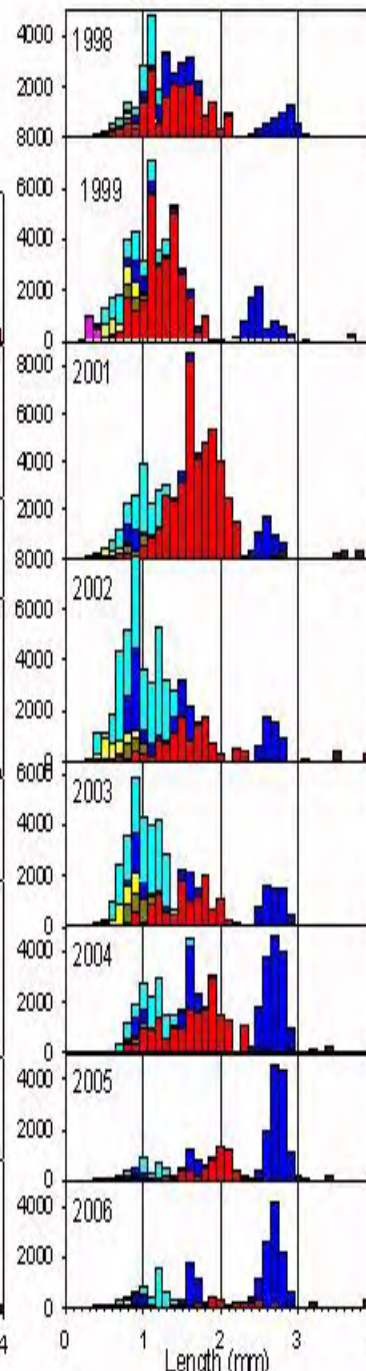
Superior Central Basin



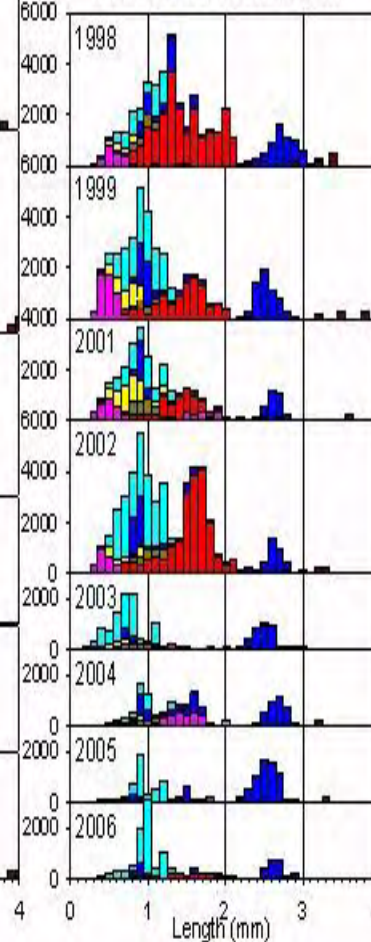
Michigan Northern Basin



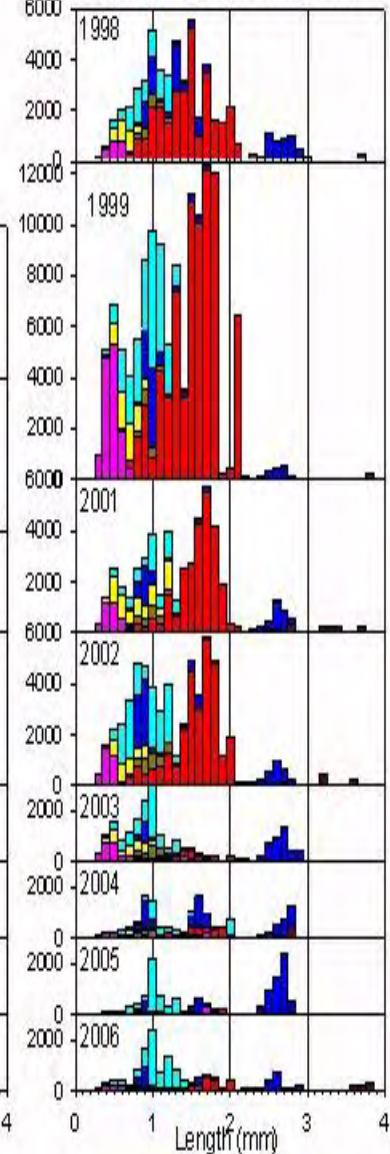
Michigan Southern Basin



Huron Northern Basin

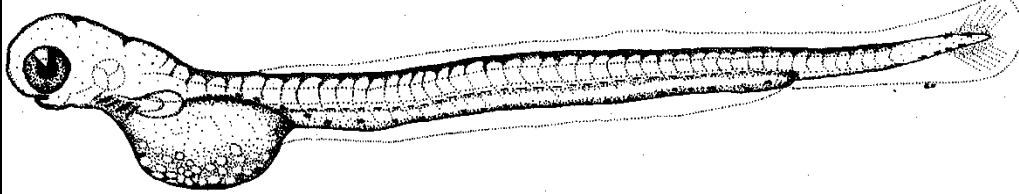


Huron Southern Basin







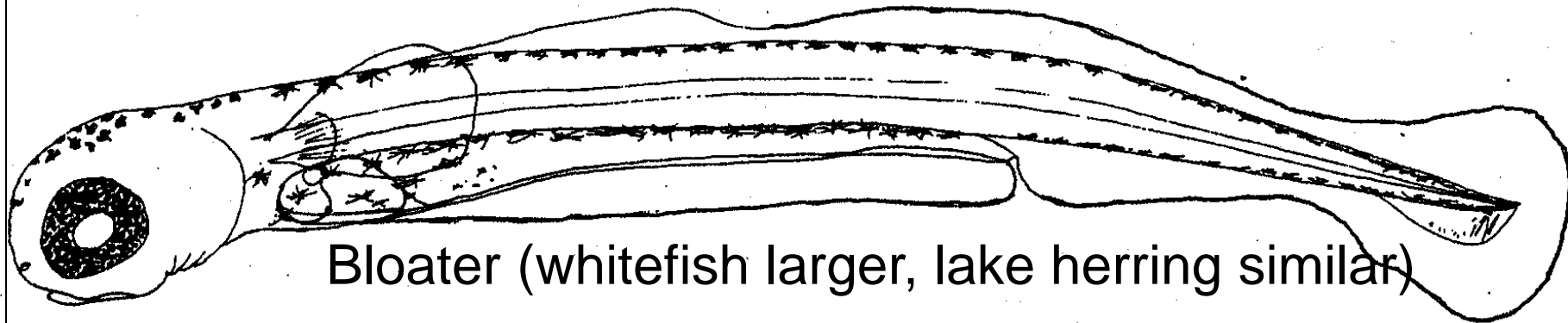
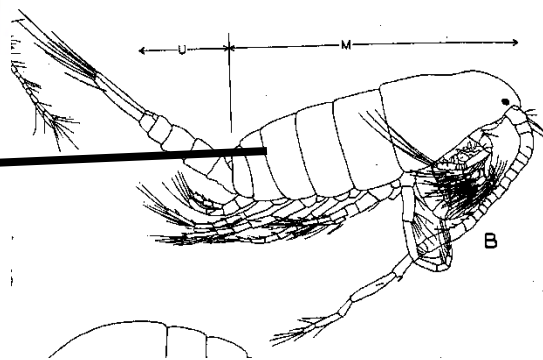
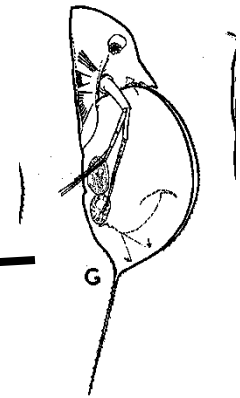
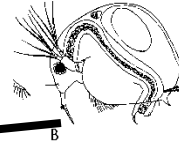
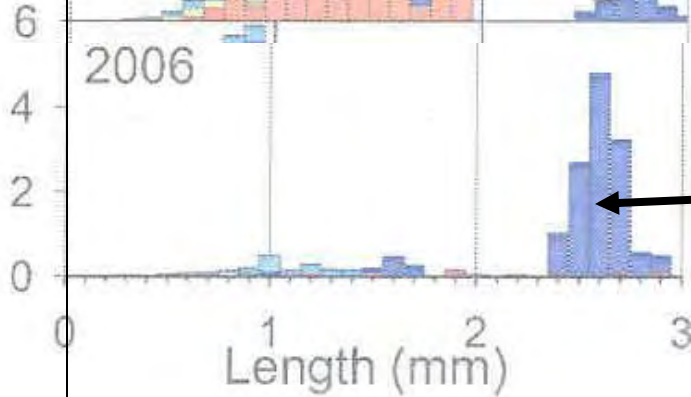


## Northern Michigan

1998



2006



Bloater (whitefish larger, lake herring similar)

# AMPHIPOD DIPOREIA

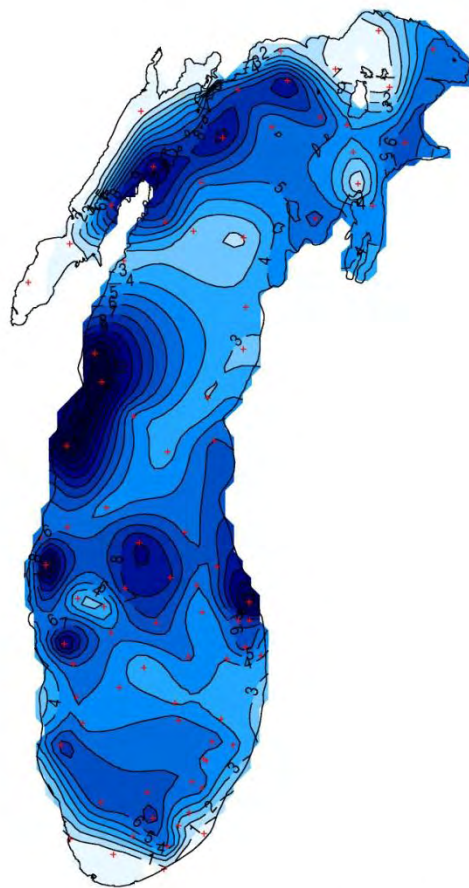


*Diporeia hoyi*

# *Diporeia* spp.

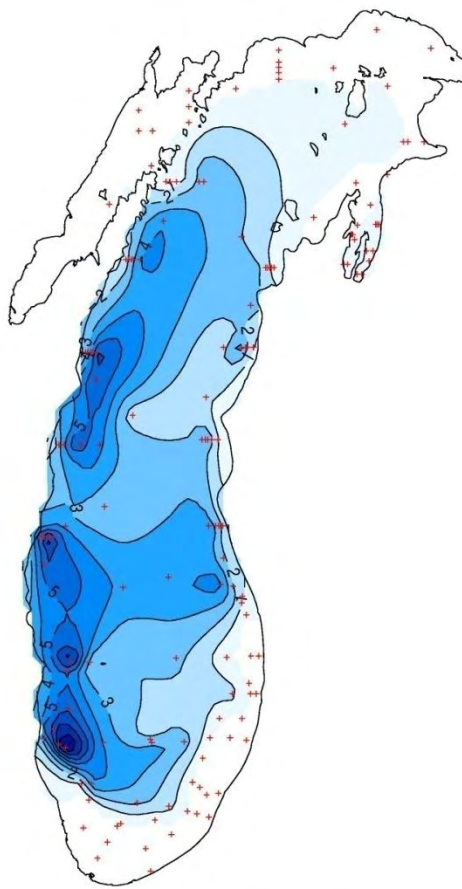
94% Decline in 10 Years

1994/95



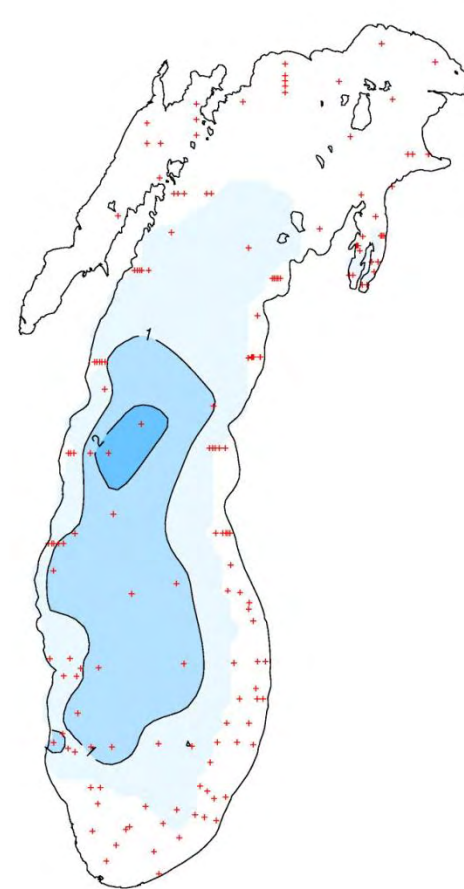
Density (per  $\text{m}^2 \times 10^3$ )

2000



Density (per  $\text{m}^2 \times 10^3$ )

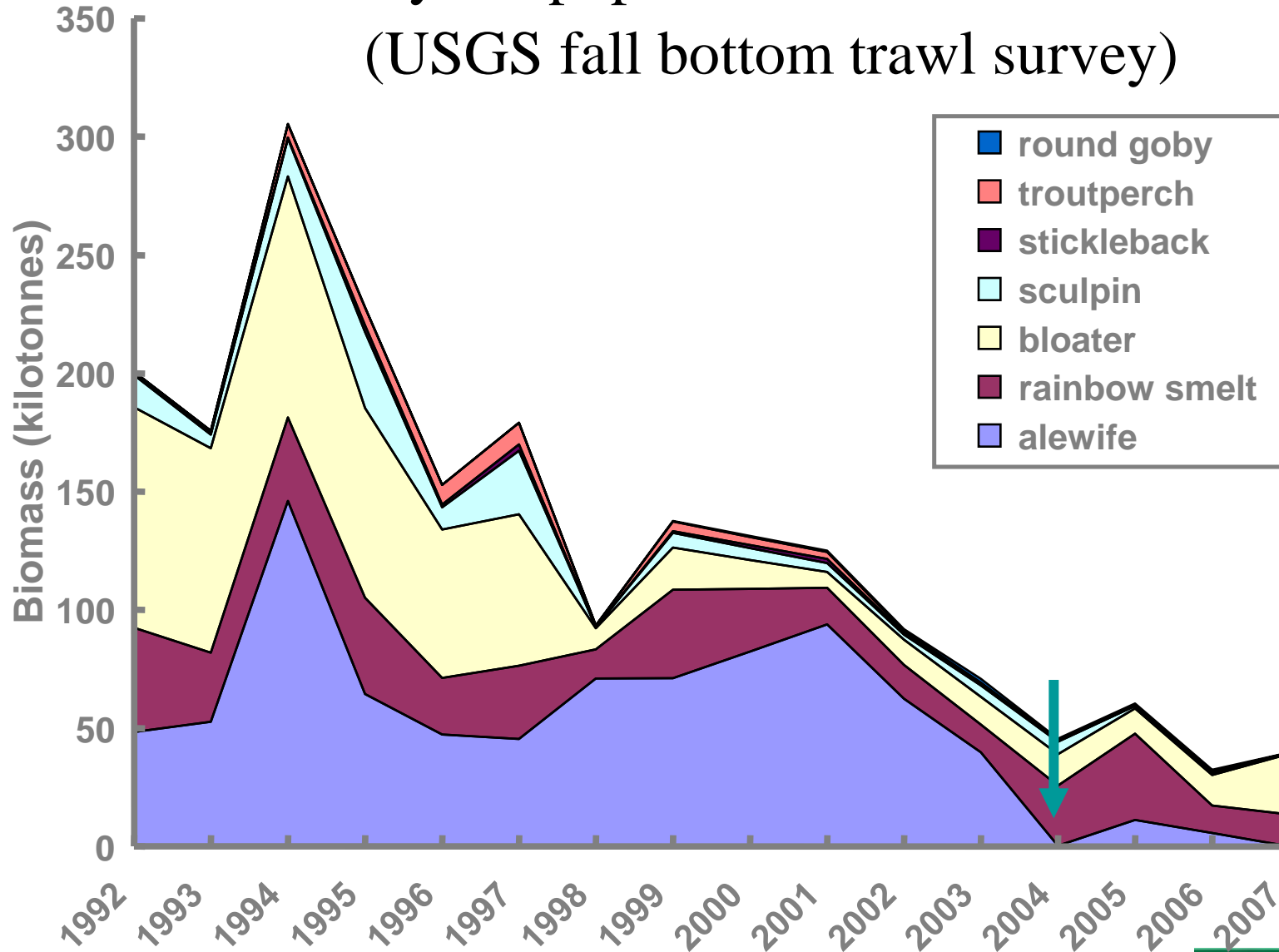
2005



Density (per  $\text{m}^2 \times 10^3$ )

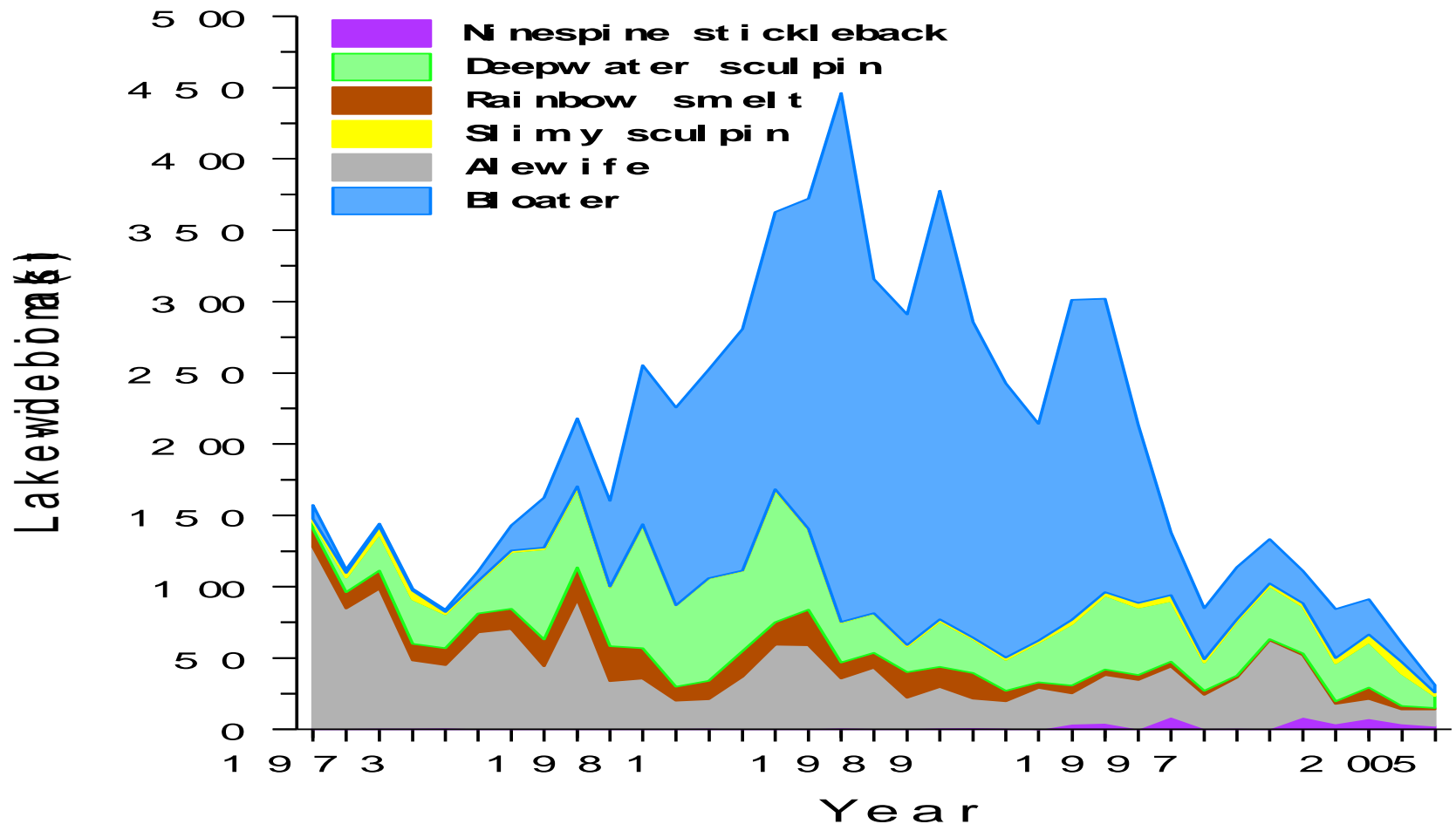


# Preyfish populations in Lake Huron (USGS fall bottom trawl survey)



Data courtesy Ed Roseman, USGS GLSC

# LAKE MICHIGAN FORAGE FISH CATCHES (USGS, MADENJIAN)

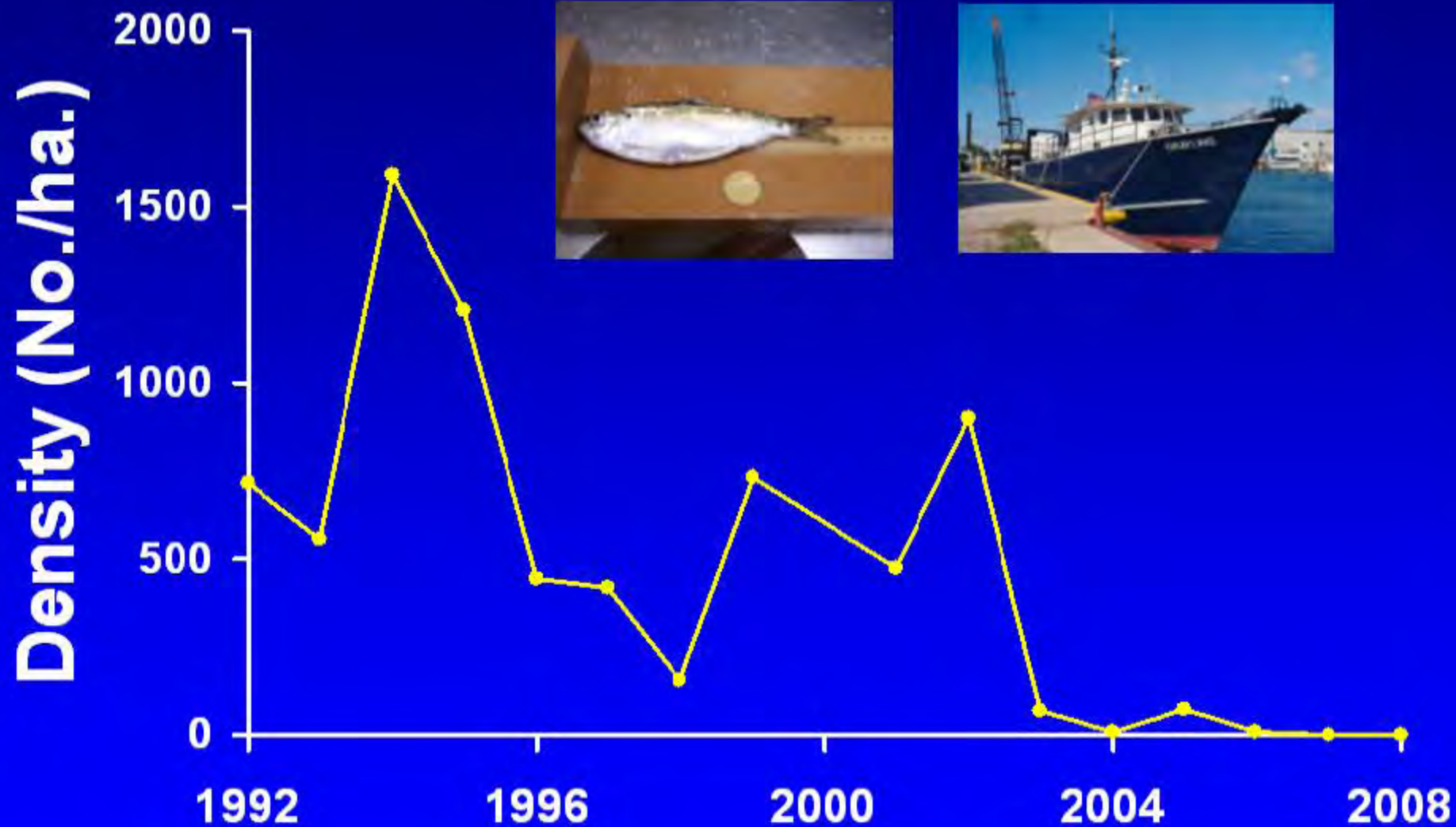


# SALMON FISHERY: LK HURON

- ALEWIFE, MAIN PREY OF SALMON, VERY SCARCE
- CHINOOK, COHO SALMON FISHERY PROBABLY EXTINCT IN LAKE HURON
- \*\*\*\*\*
- BUT THERE HAS BEEN A RESURGENCE IN ES, WL, LT, AND LH

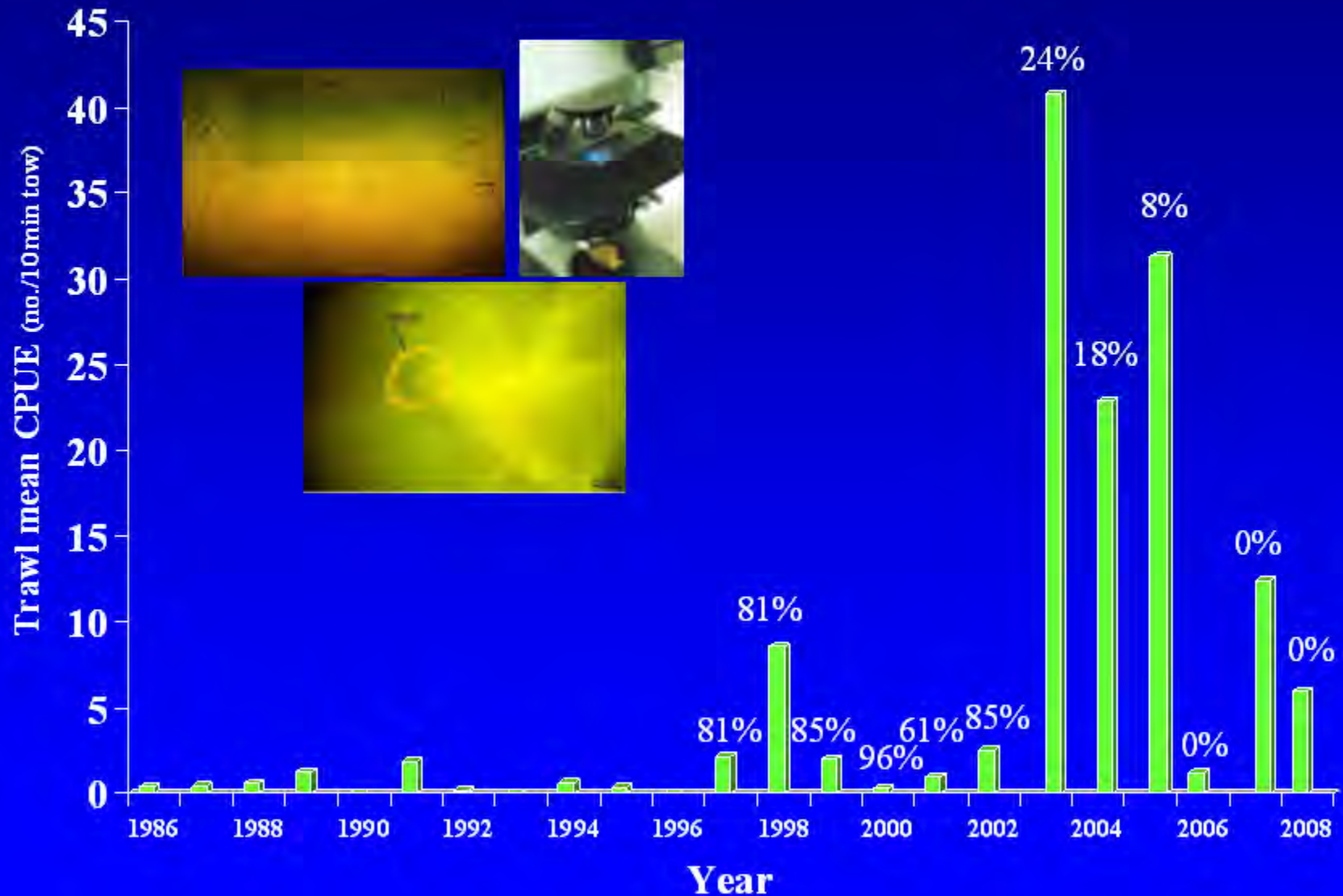


# Adult Alewife



# Age-0 Walleye Trawl CPUE Saginaw Bay

And percent hatchery contribution









A COMPARISON OF THE ST.  
CLAIR RIVER FISH  
COMMUNITY  
1993 VS. 2011

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# METHODS

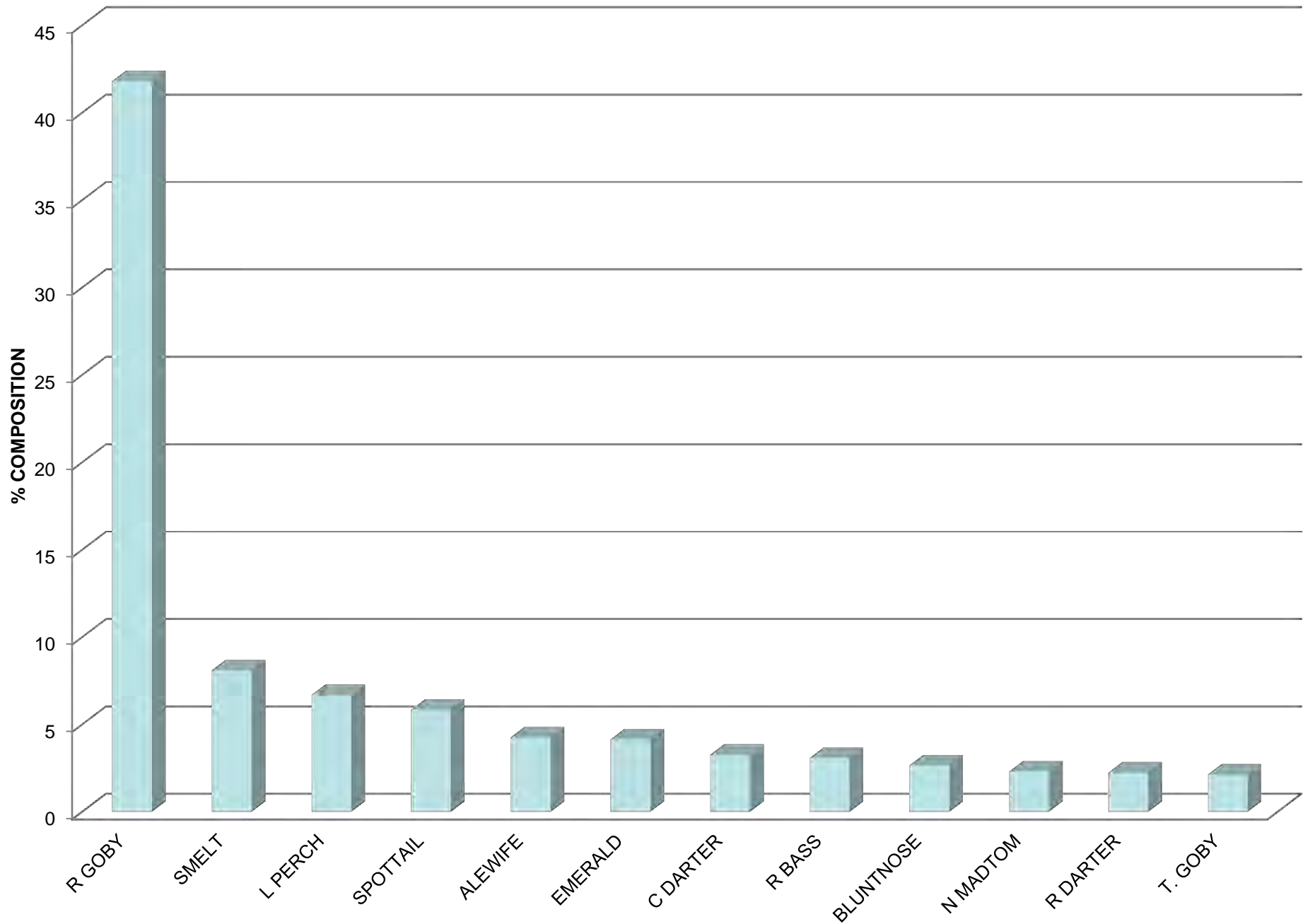
- SEINING IN NEARSHORE
- TRAWLING AT 3, 5, 7, 9, AND 11 M
- DAY AND NIGHT
- APRIL-DECEMBER 1993
- SPRING, SUMMER, AND FALL 2011

# OBJECTIVES

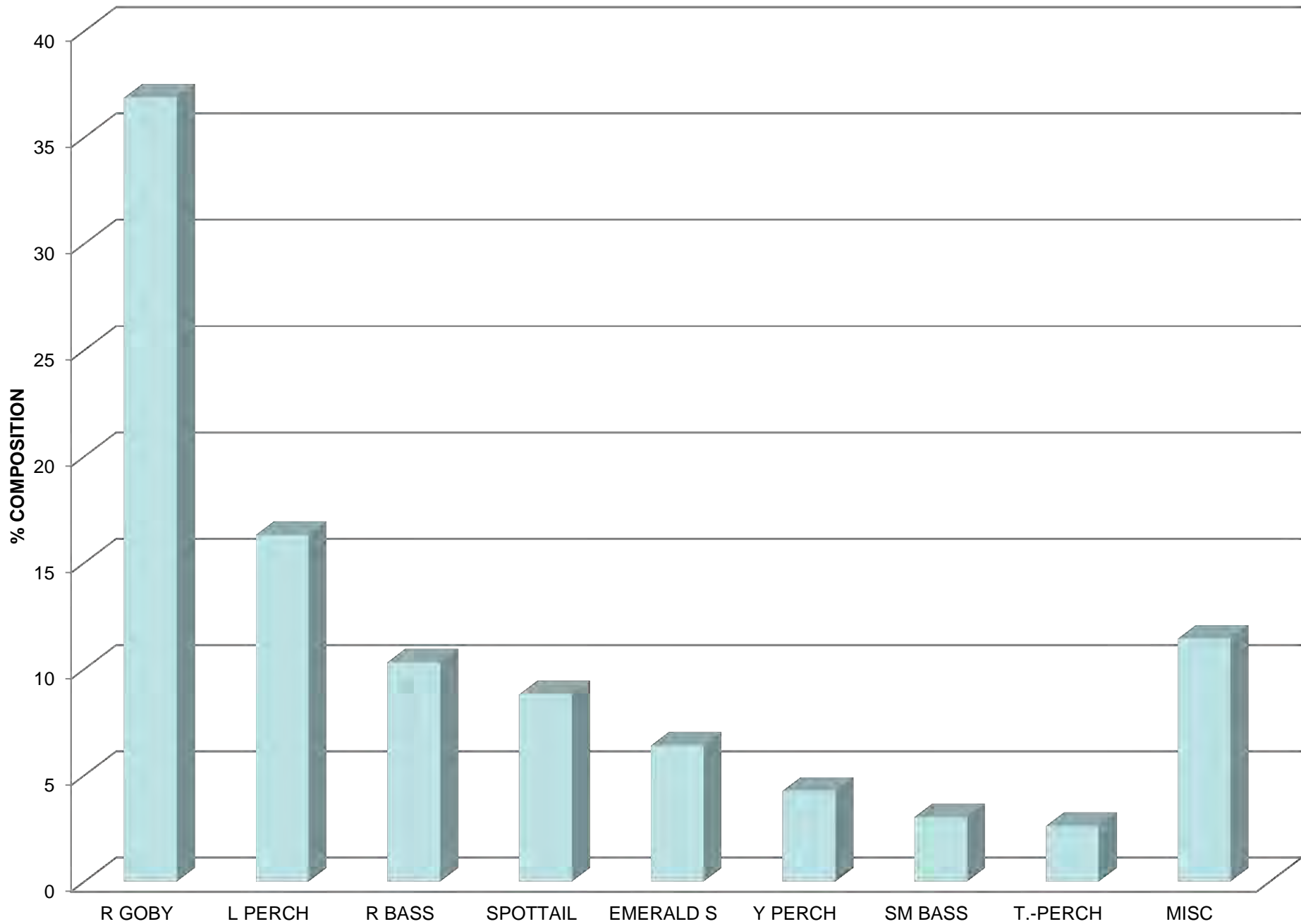
- DETERMINE IF INTRODUCTION OF THE ROUND AND TUBENOSE GOBIES HAD DETRIMENTAL EFFECTS ON BENTHIC SPECIES
- EMPHASIS ON SCULPIN, DARTERS, MADTOMS, LOGPERCH
- ROUND GOBIES FIRST FOUND IN 1990 IN ST CLAIR RIVER



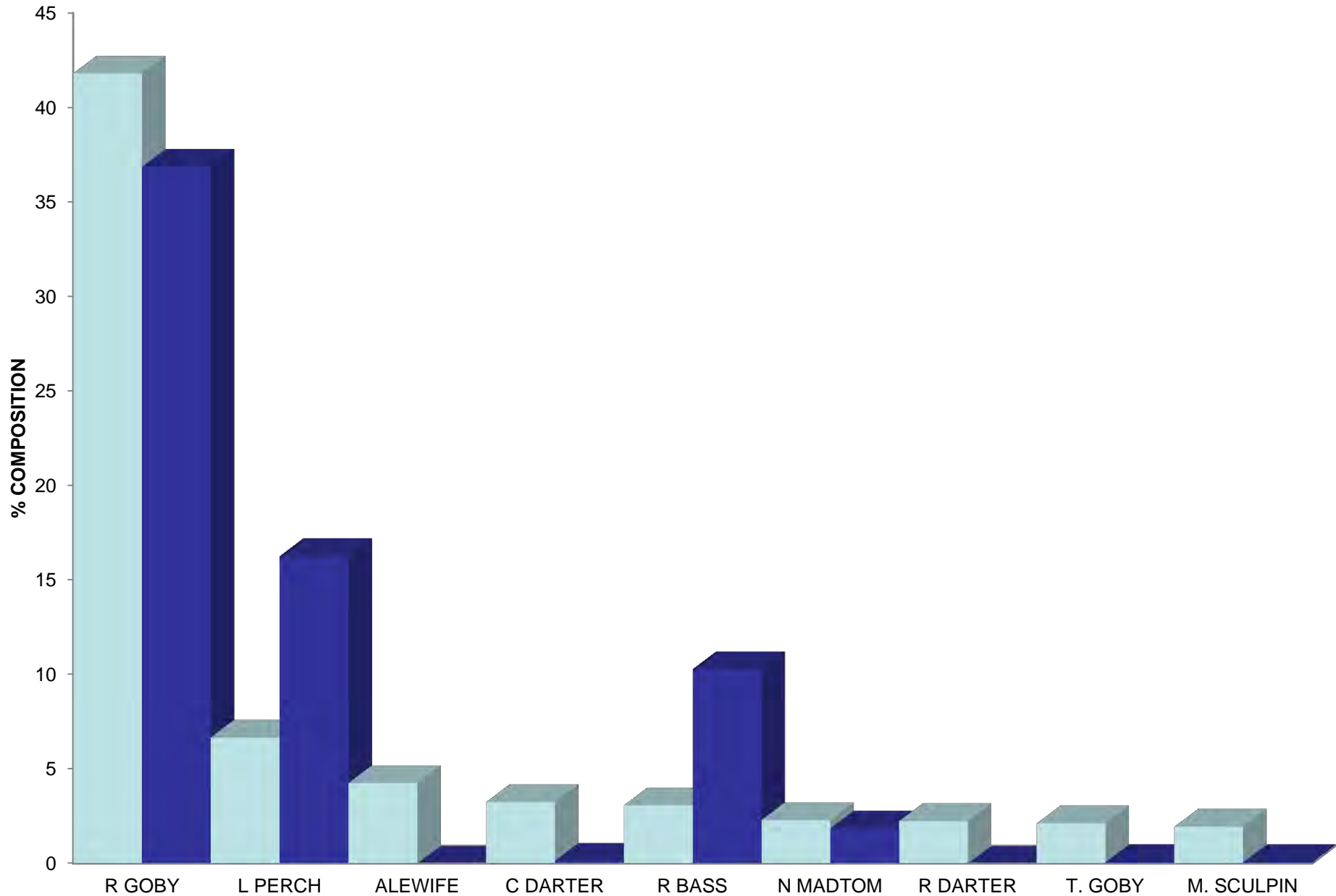
# ST. CLAIR RIVER FISH COMMUNITY - 1993-94



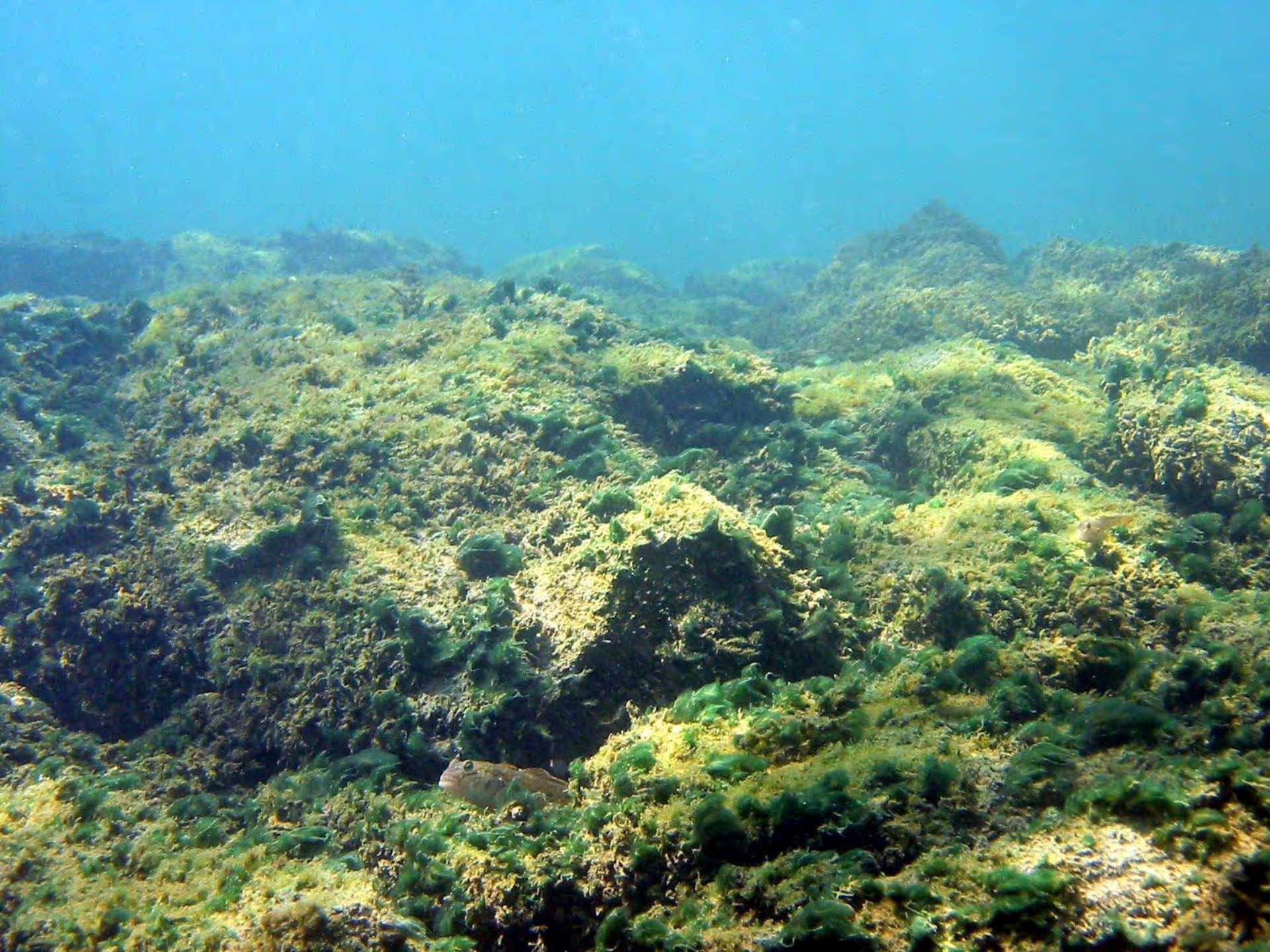
# ST. CLAIR RIVER FISH COMMUNITY, 2011



# ST. CLAIR RIVER FISH COMMUNITY: 1993 (N=11,253) VS. 2011 (N=1,454)











- From 1993 to 2011, round goby composed a similar proportion of catch: about 40%

# FISH SPECIES THAT DID NOT CHANGE

- -- ROUND GOBY
- --NORTHERN MADTOM, AN  
ENDANGERED SPECIES

# FISH SPECIES THAT INCREASED

- LOGPERCH – DOUBLED IN CATCH
- ROCKBASS – TRIPLD IN CATCH

# SPECIES THAT DECLINED IN CATCH

- -ALEWIFE: WENT FROM 5% TO NEAR 0
- -CHANNEL DARTER (AN ENDANGERED SPECIES): 4% TO NEAR 0
- -RAINBOW DARTER (NATIVE SPECIES): 3% TO NEAR 0
- MOTTLED SCULPIN (NATIVE SPECIES): 3% TO NEAR 0
- TUBENOSE GOBY: 3% TO NEAR 0





# PCBs IN NEW INVASIVE SPECIES FOOD CHAIN

- AOC
- INVASIVE SPECIES FOOD WEB
- BIOACCUMULATION IN SPORT FISH  
RESULTS

# New Food Web

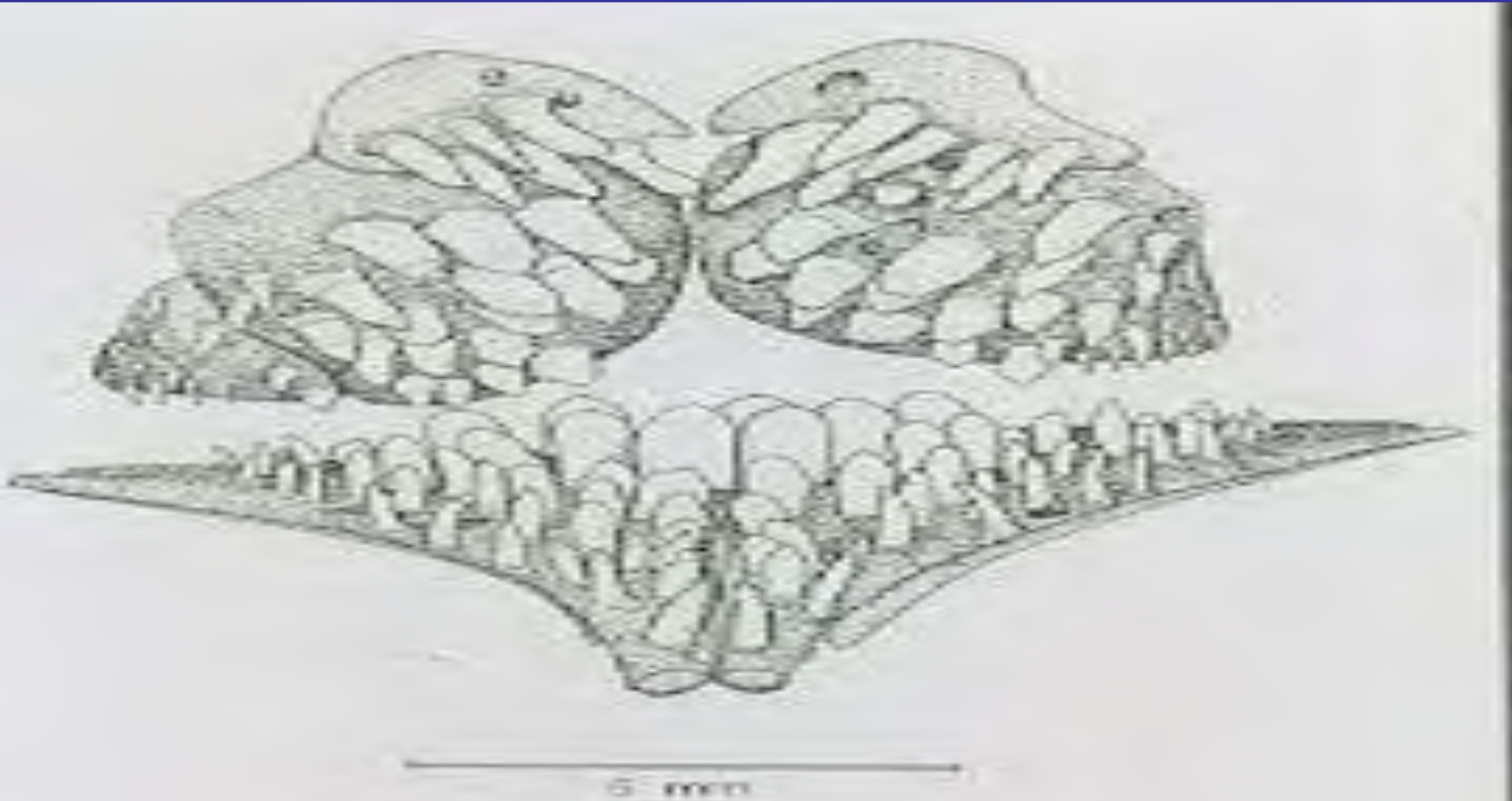




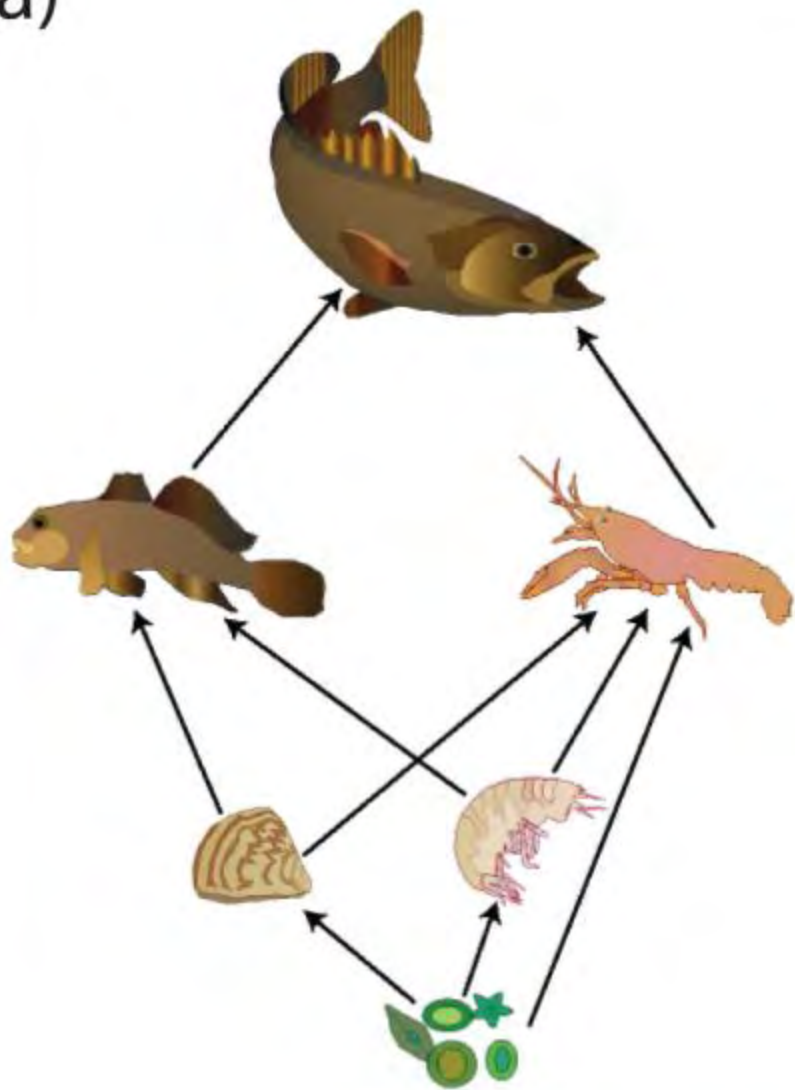




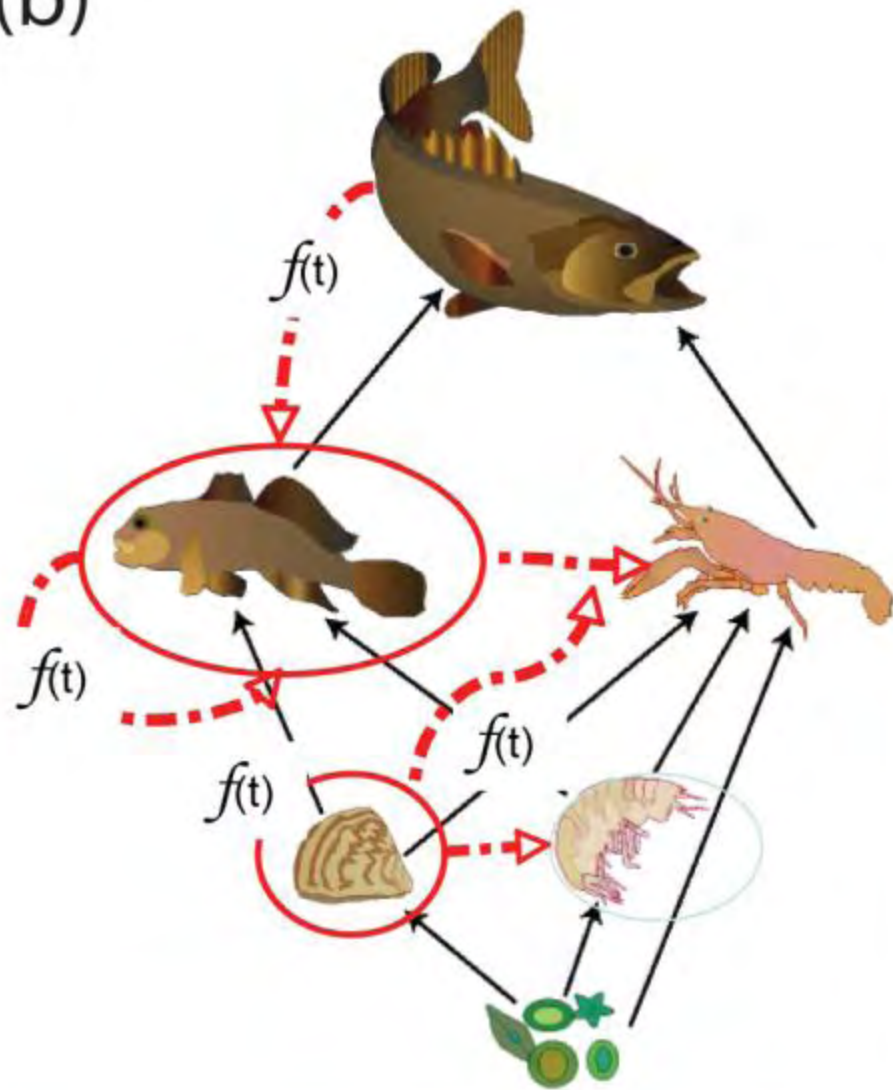
# ROUND GOBY MOLARIFORM TEETH



(a)



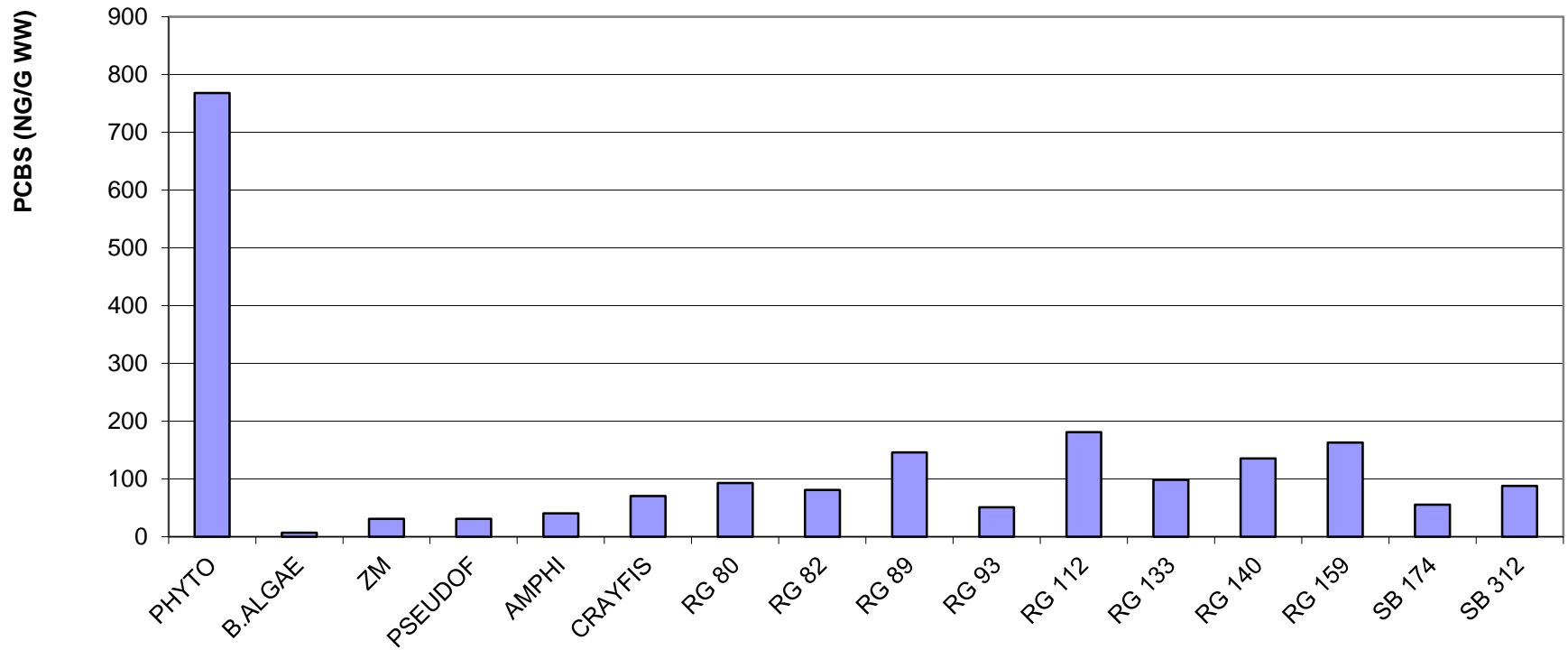
(b)



# PCBs IN NEW BENTHIC, SHORTENED FOOD WEB

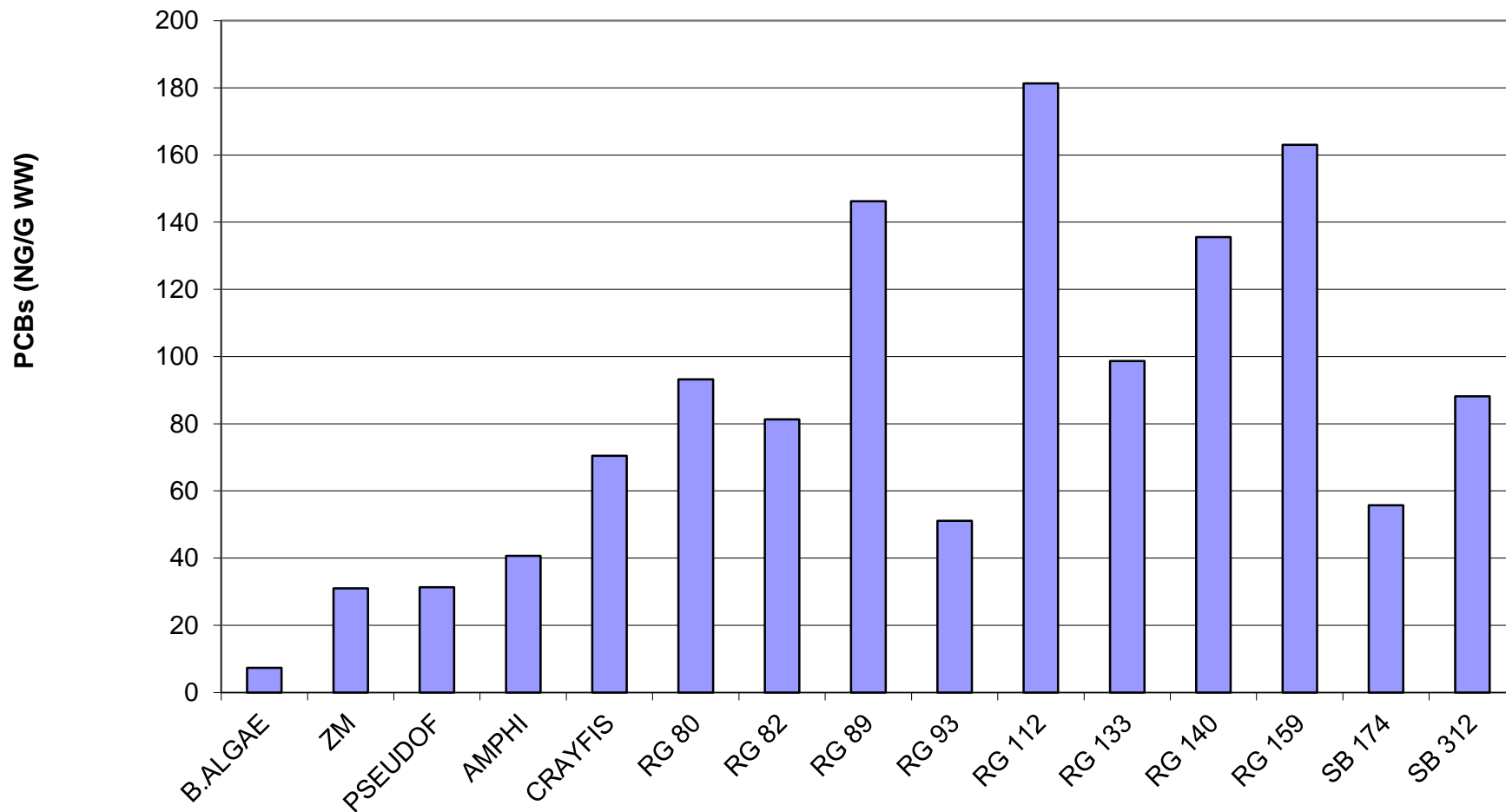
- -ST. CLAIR RIVER FOOD WEB
- -CALUMET RIVER FOOD WEB
- -RAISIN RIVER FOOD WEB
- -COMPARISON WITH SAGINAW RIVER  
AND ST. LOUIS RIVER, DULUTH, MINN
- ? POSSIBLE USE AS A DELISTER OF  
AOCs

## ST CLAIR RIVER PCBs IN THE FOOD WEB, 1999

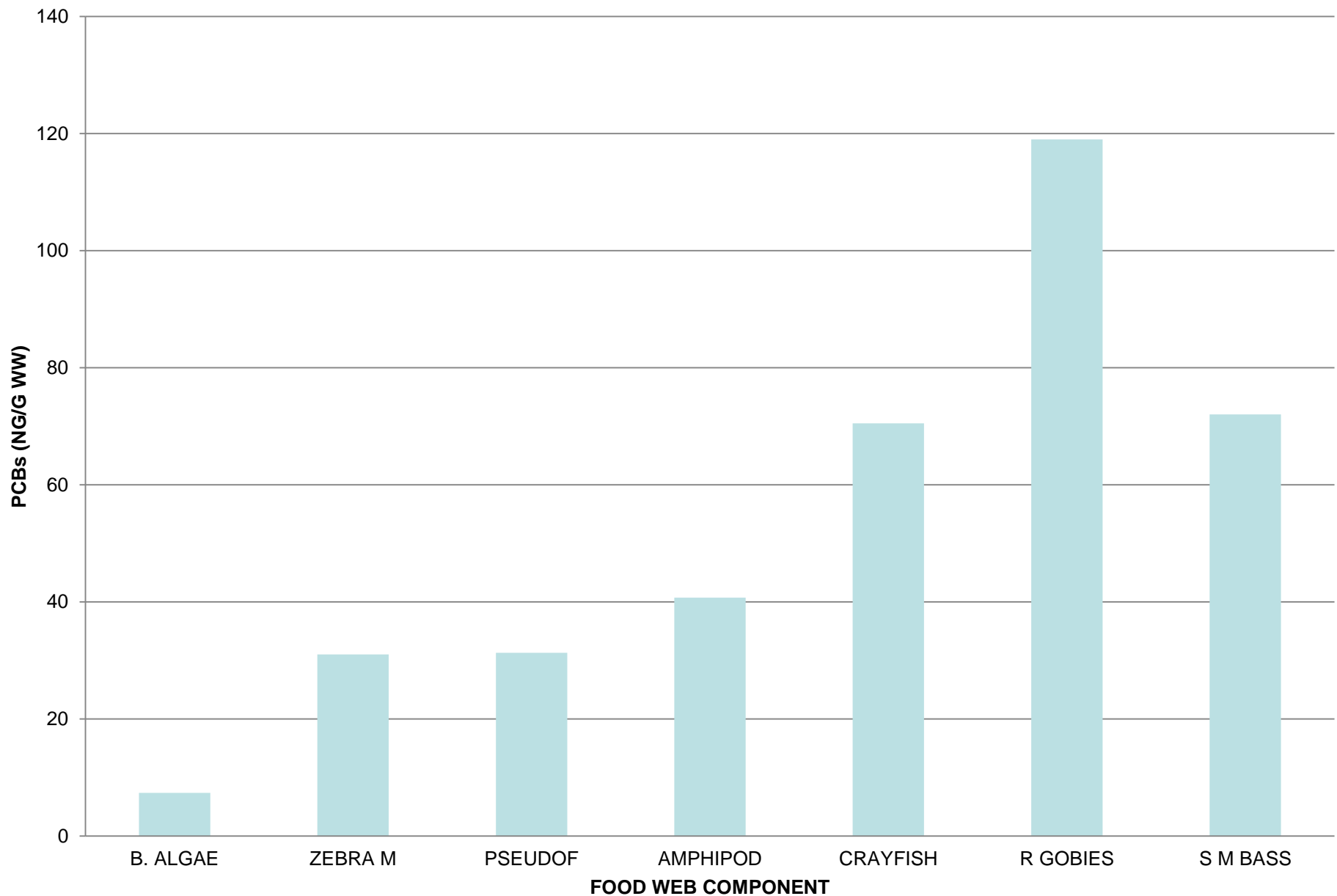




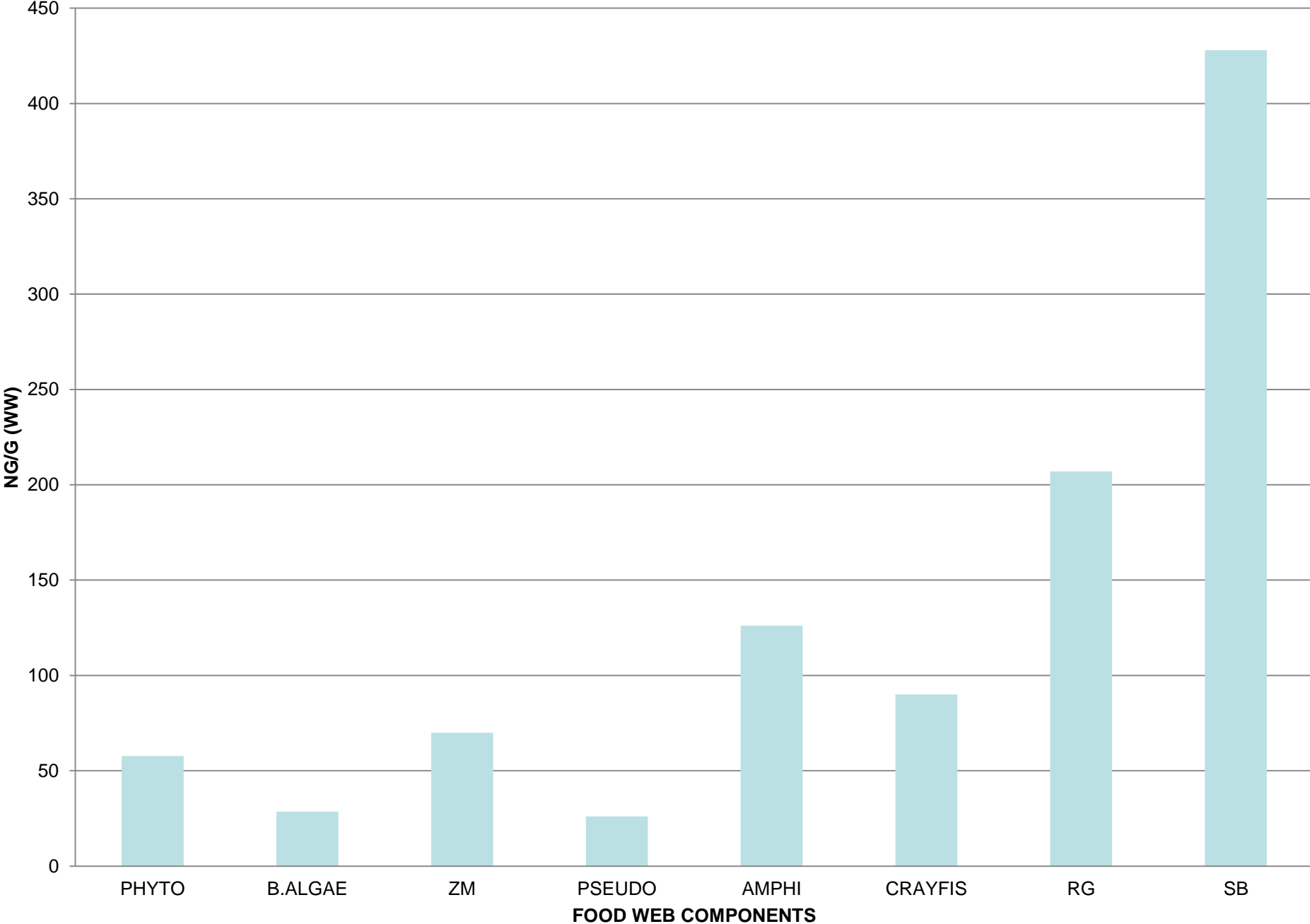
# ST CLAIR RIVER PCBS IN THE FOOD WEB, 1999



# ST. CLAIR RIVER PCBs FOOD WEB, 1999



# CALUMET RIVER FOOD WEB PCBs, 1999





E Elm Ave

Detroit-Toledo

E 1st St

E 1st St

E Elm Ave

E Front St

13  
14

75

Detroit-Toledo Expy

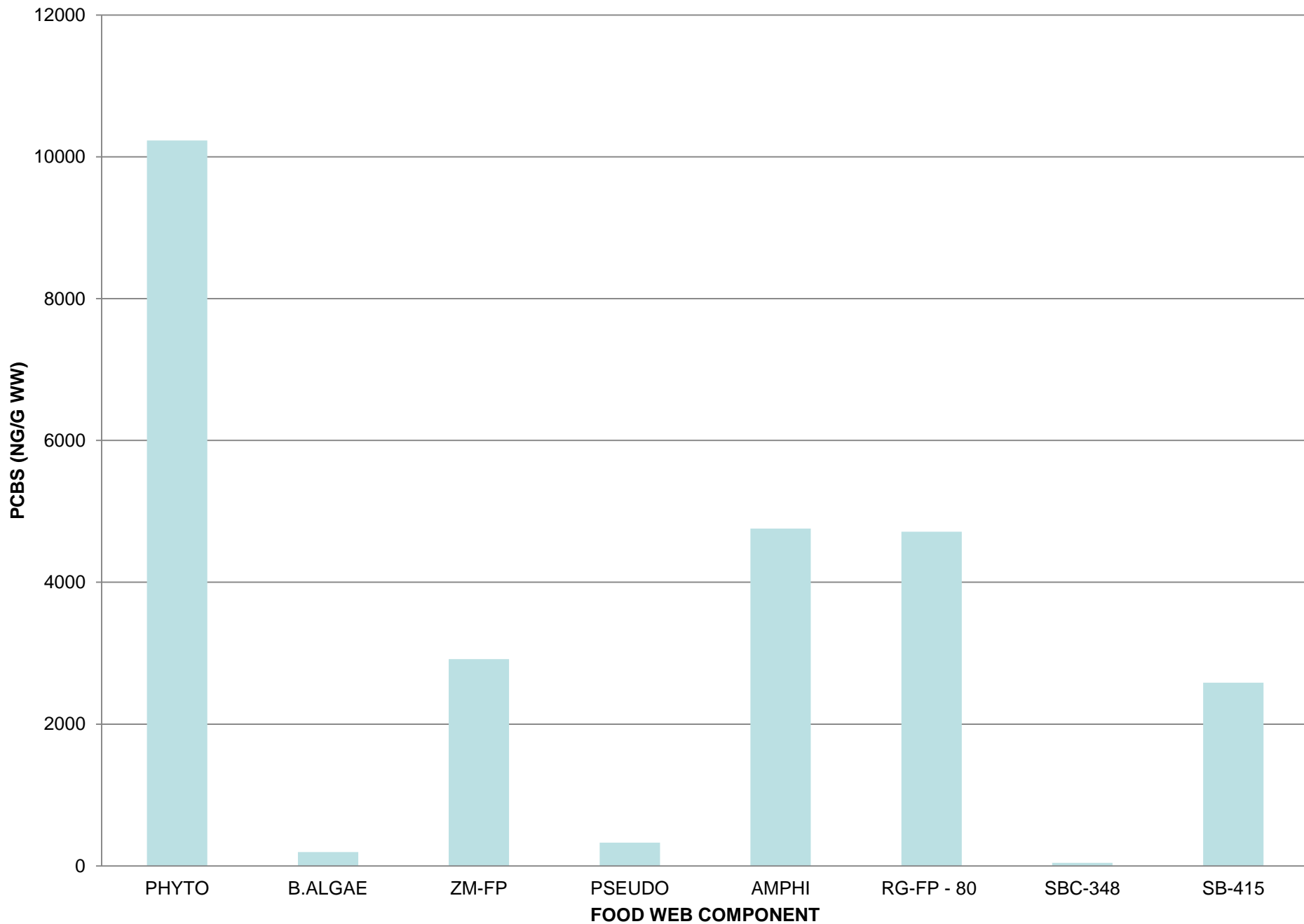
E Front St

75

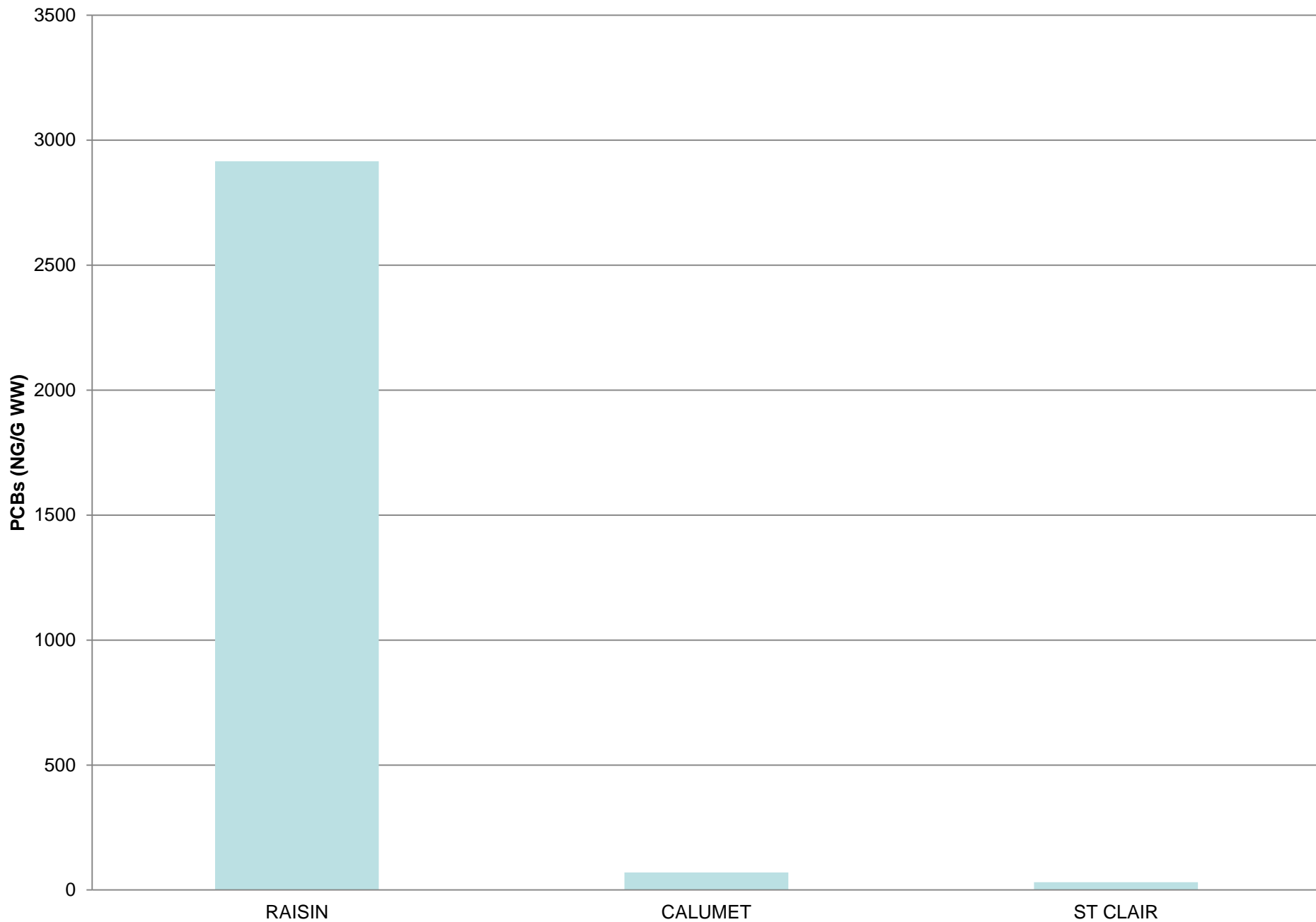
Woodland Cemetery



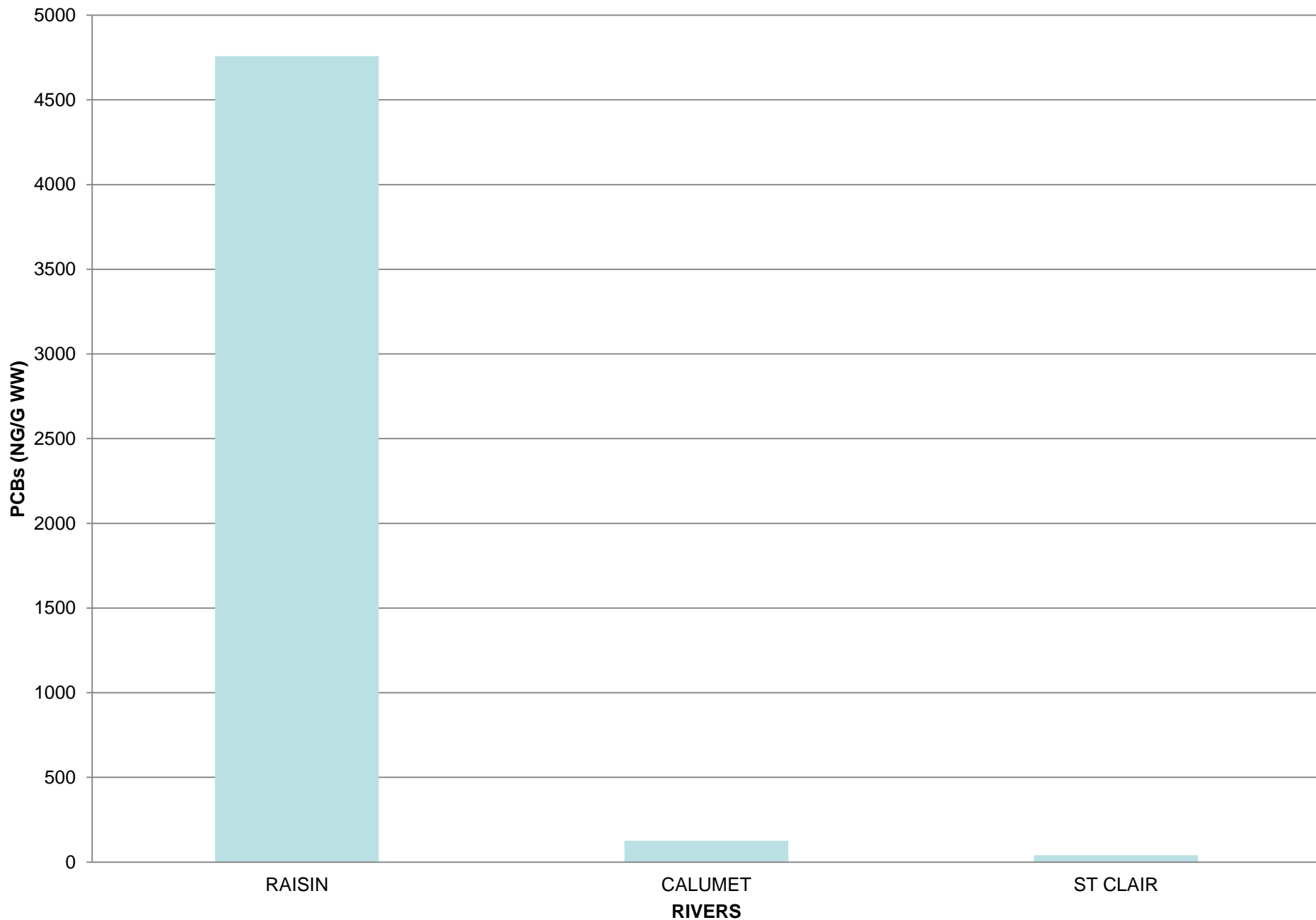
# RAISIN RIVER PCBs FOOD WEB, 1999



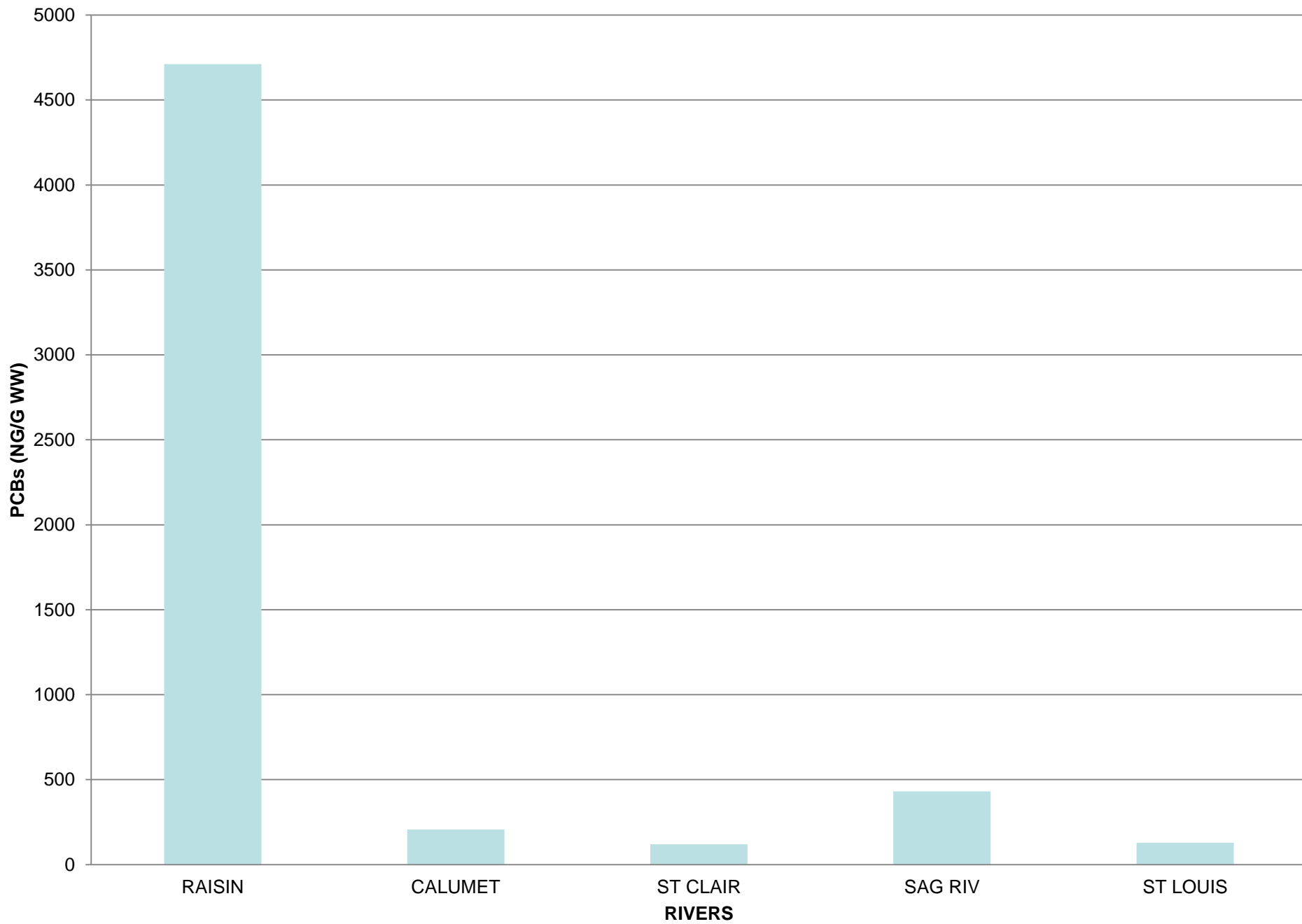
# PCBs IN ZEBRA MUSSELS FROM VARIOUS RIVERS, 1999



# PCBs IN AMPHIPODS FROM VARIOUS RIVERS, 1999

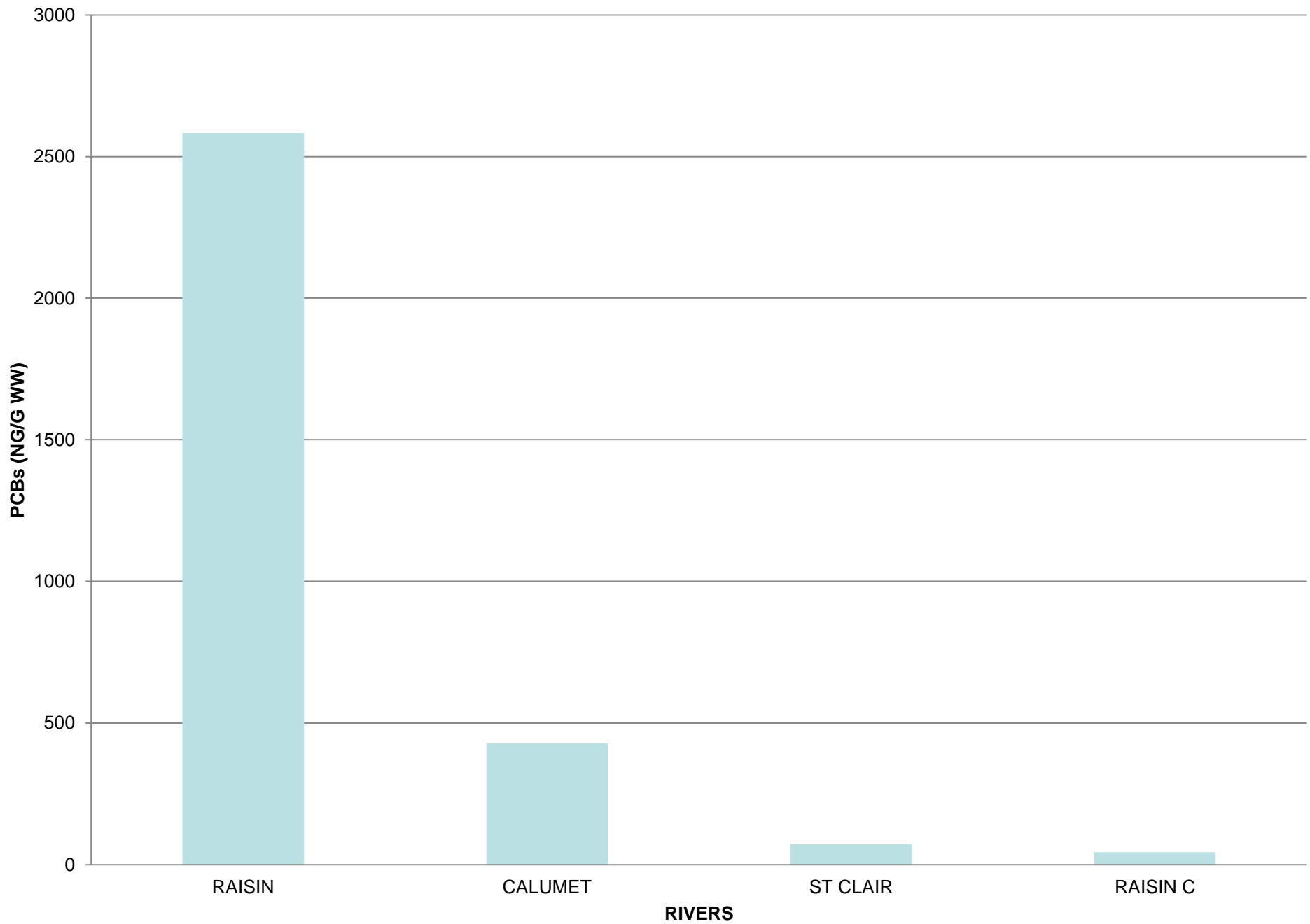


# PCBs IN ROUND GOBIES FROM VARIOUS RIVERS, 1999





# PCBs IN SMALLMOUTH BASS FROM VARIOUS RIVERS, 1999



# DELISTING CRITERIA

- CONSIDER USING PCBS IN THE RG-ZM-SMB FOOD WEB AS A DELISTING CRITERIA
- DATA FROM RAISIN SUGGEST THIS RIVER NEEDS MORE REHABILITATION, WHILE OTHERS ARE CONSIDERABLE LESS
- BETTER CONTROL SITES REQUIRED



# CONCLUSIONS

- LAKE HURON IS BECOMING MORE LIKE LAKE SUPERIOR
- NATIVE SPECIES REBOUNDED IN LAKE HURON- WL, ES, LT, LH
- ST CLAIR RIVER FISH POPULATIONS HAVE CHANGED:  
RG,NM:LP,RB:CD,RD,MS,AL,TN
- NEW INVASIVE SPECIES FOOD WEB CONDUCIVE TO PCB UPTAKE IN SMB





# QUESTIONS?

