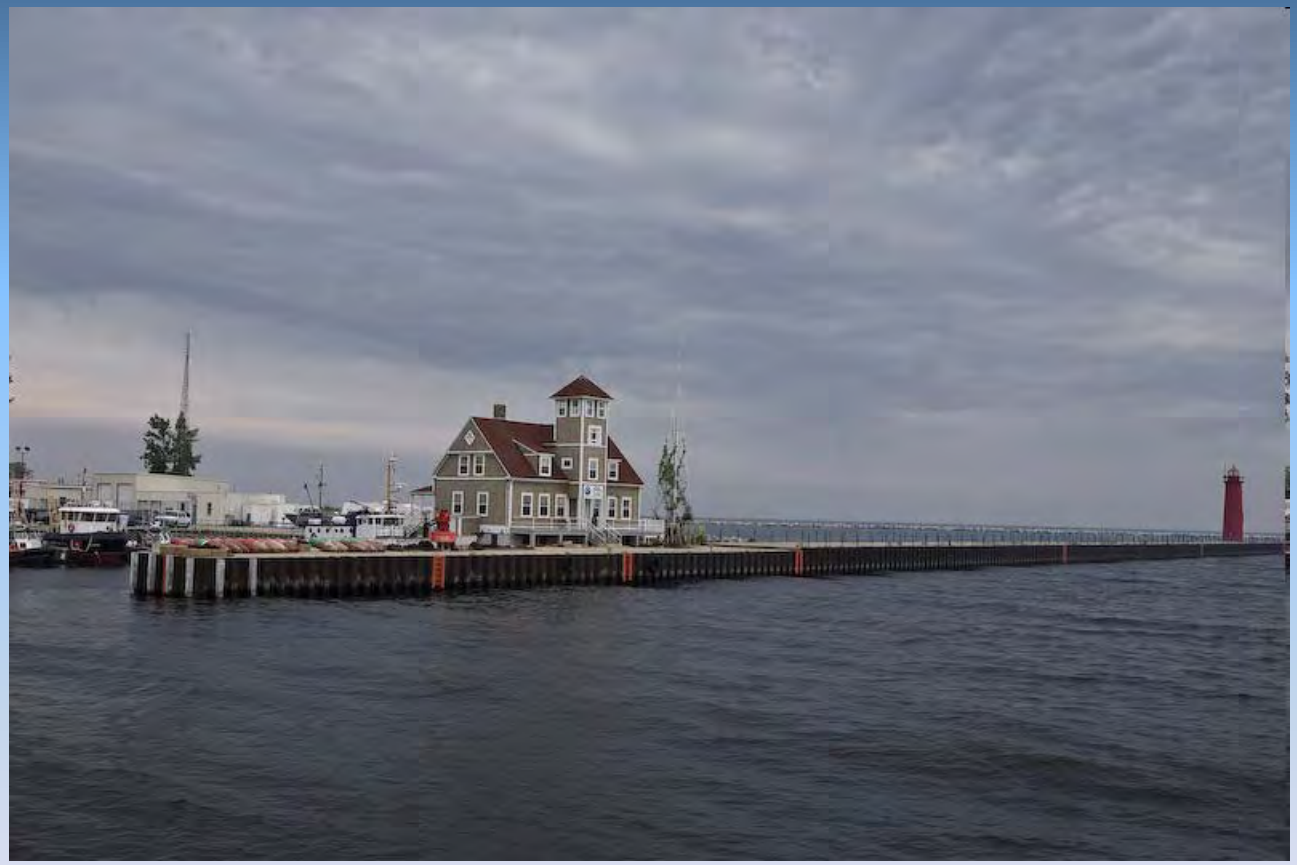
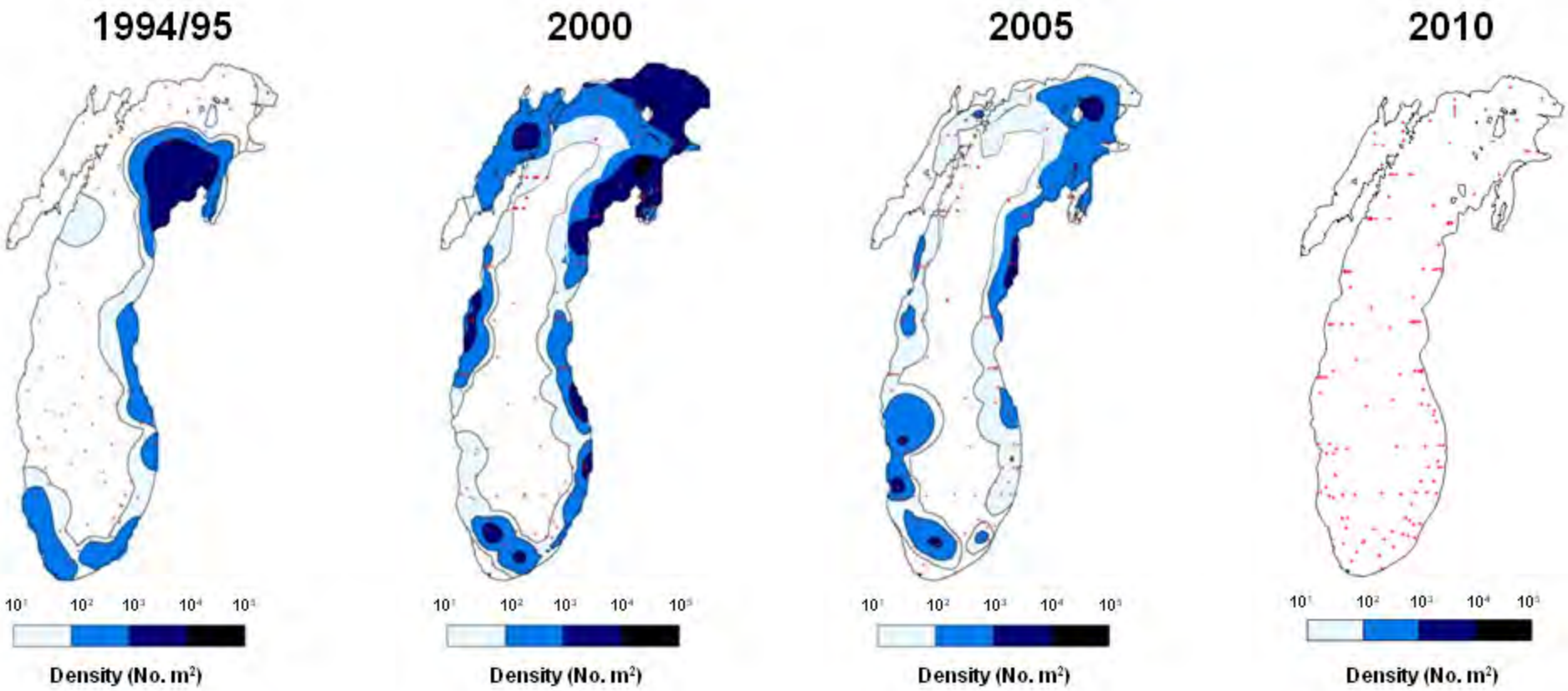
Trends in Lake Michigan's Food-web



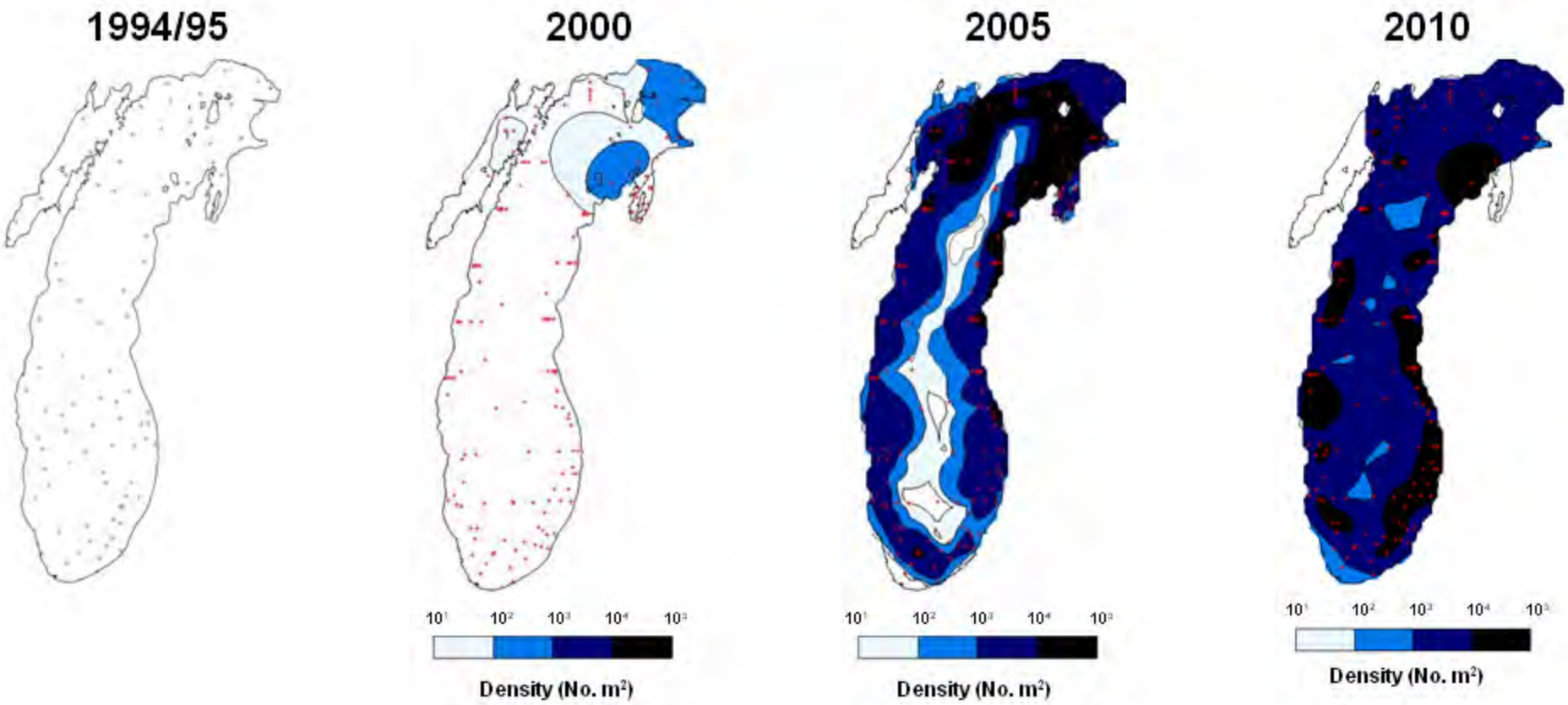
Steven Pothoven

Zebra Mussel

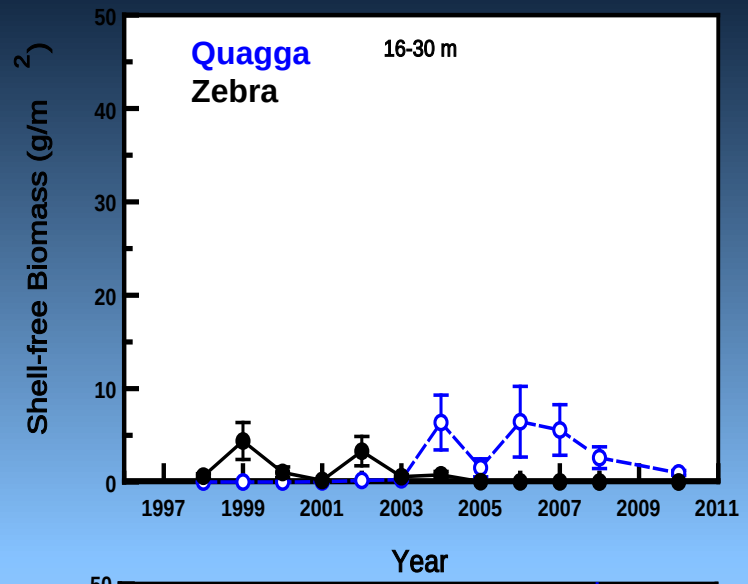


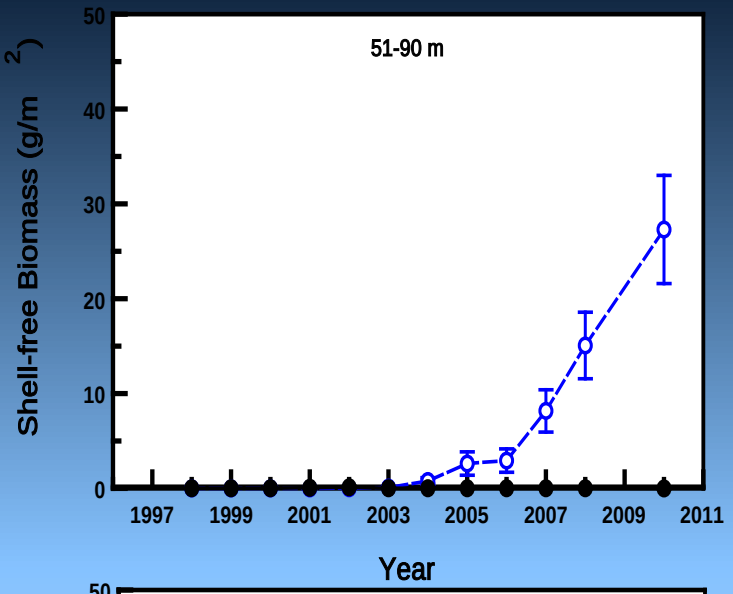
Data from T. Nalepa

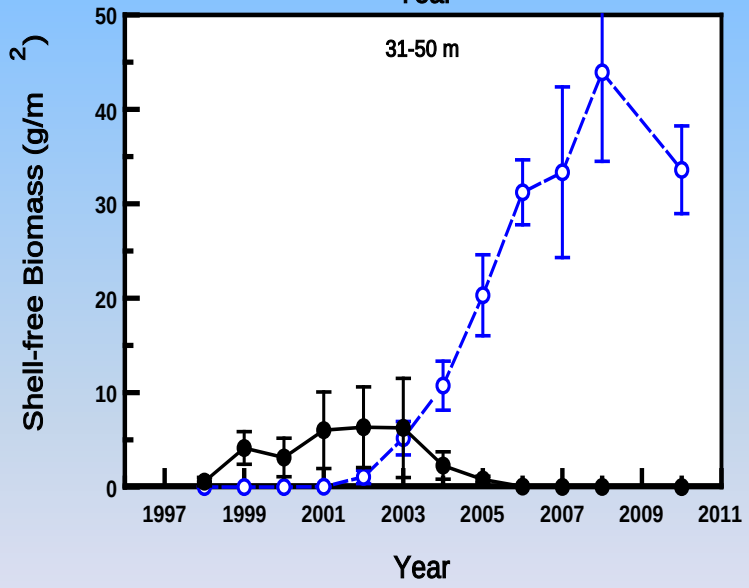
Quagga Mussel

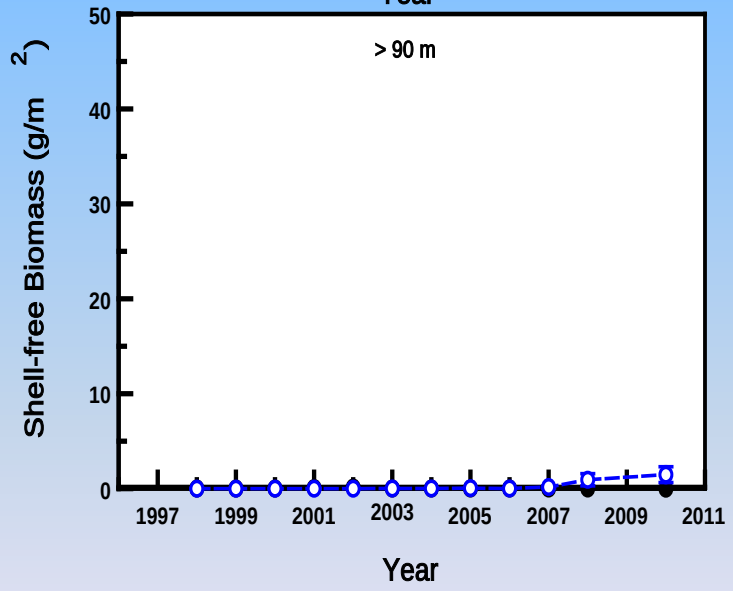


Data from T. Nalepa



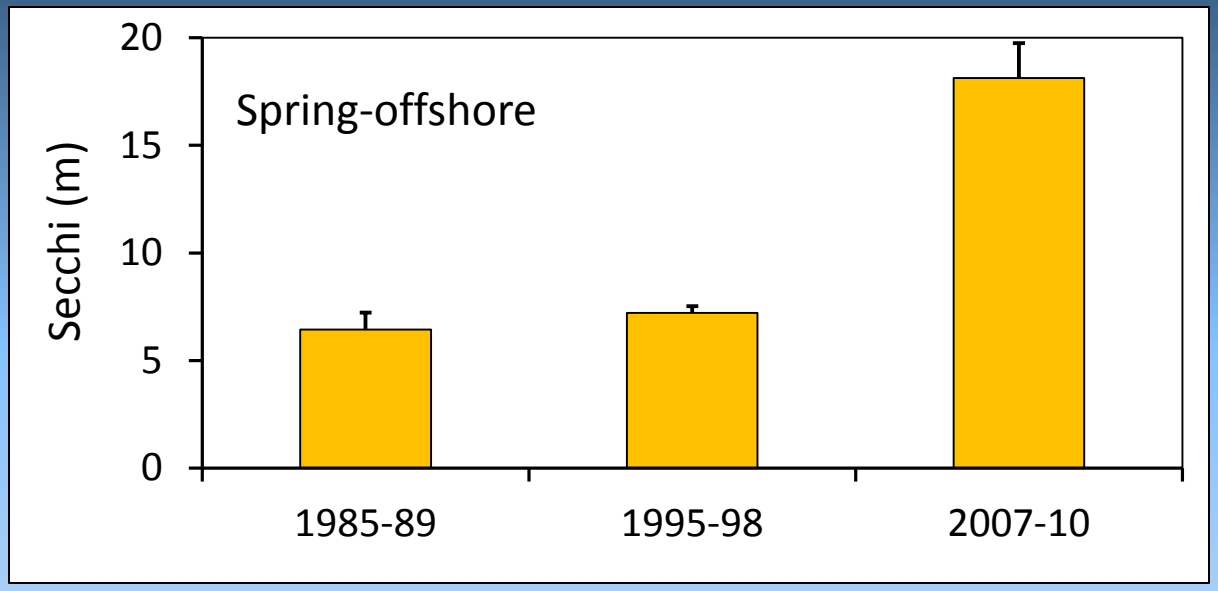






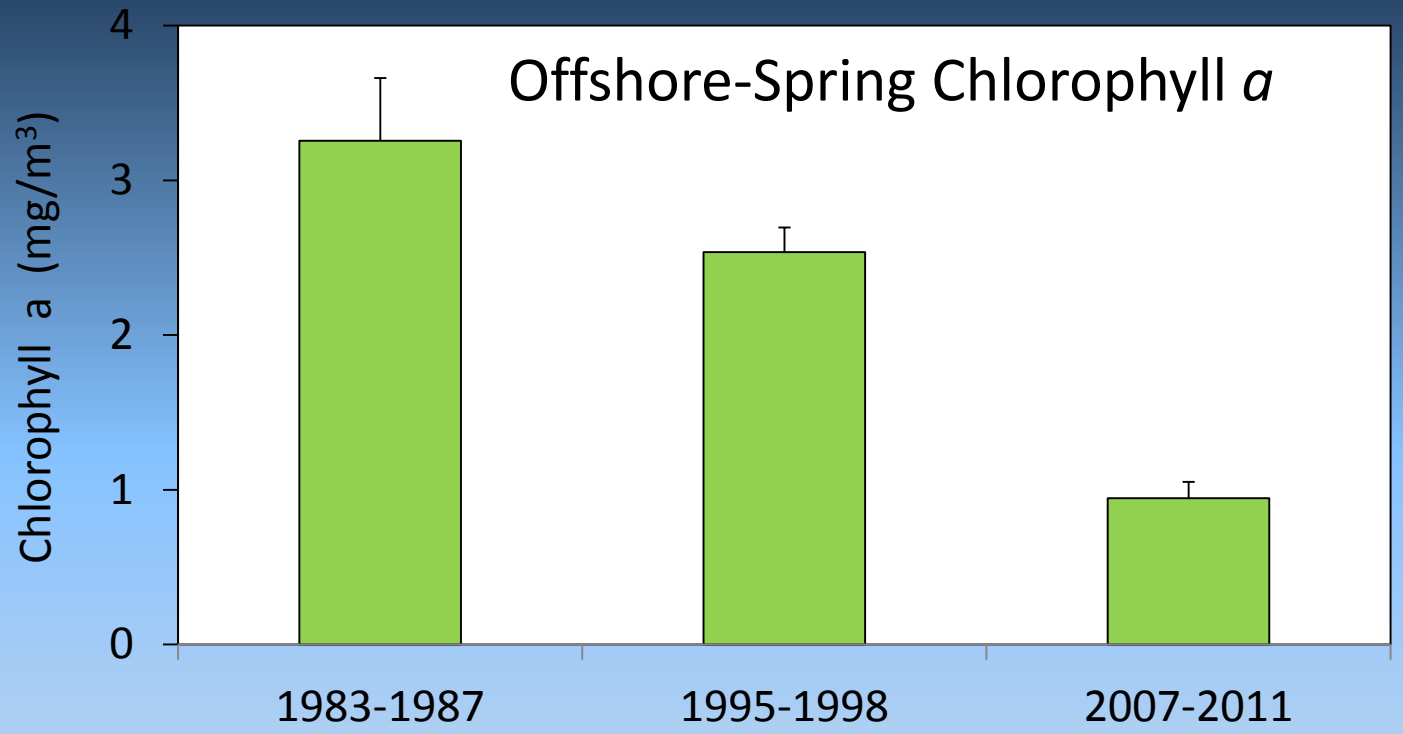
Quagga biomass stabilizing/decreasing in nearshore; continues to increase offshore

Data from T. Nalepa (UM)

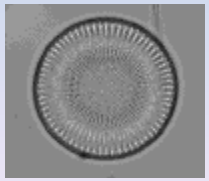


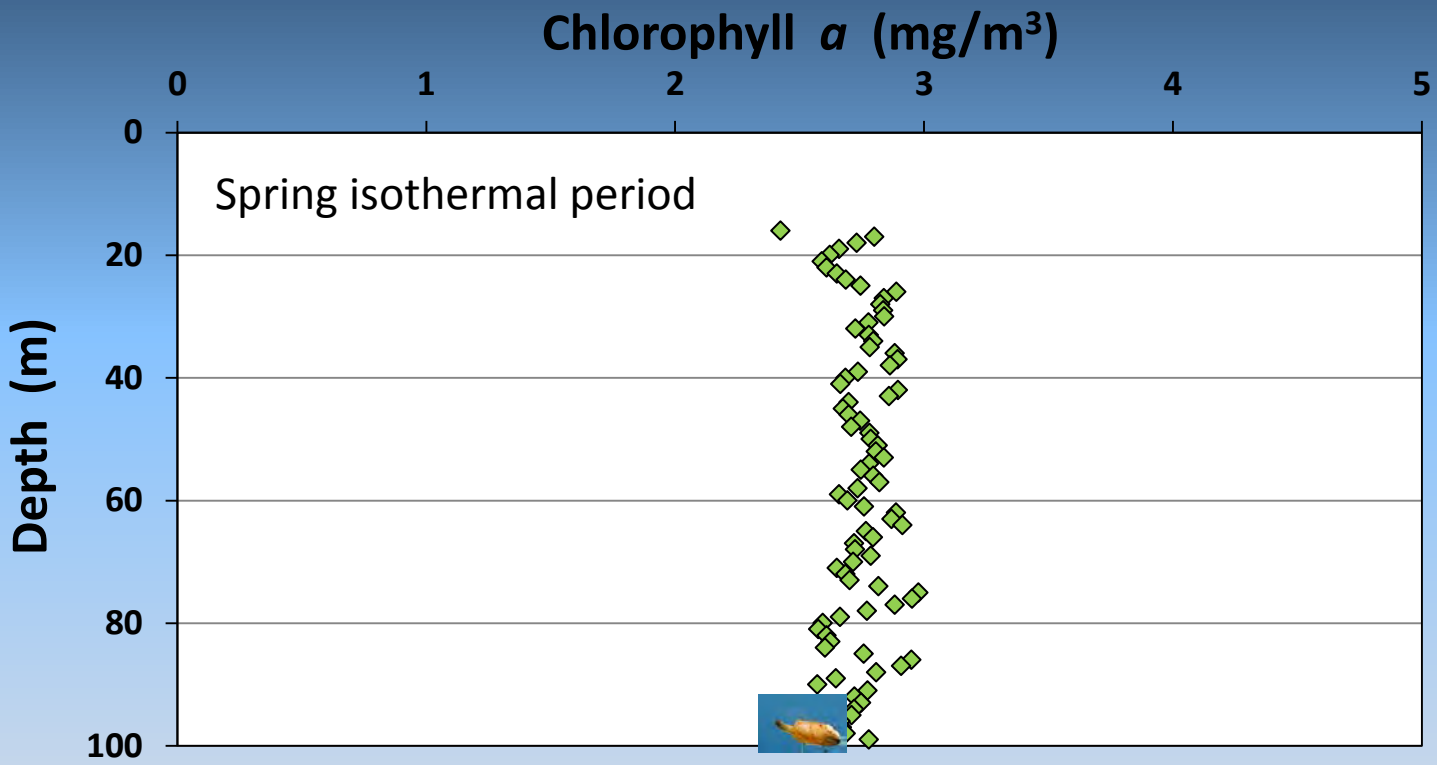
Increased water clarity—

secchi depth up to <u>32 m</u> in northern Lake Michigan

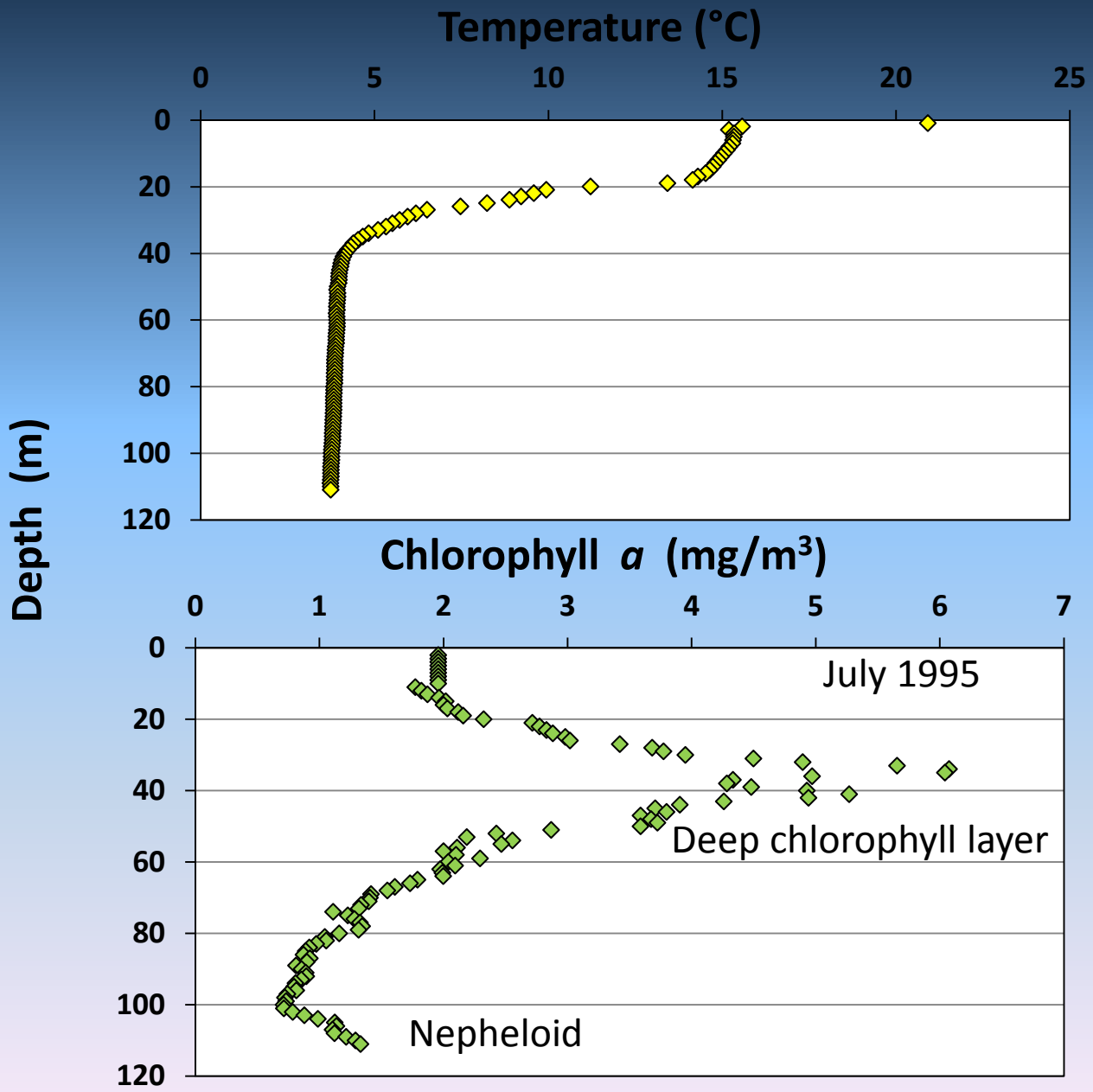


The loss of the spring phytoplankton bloom—especially diatoms

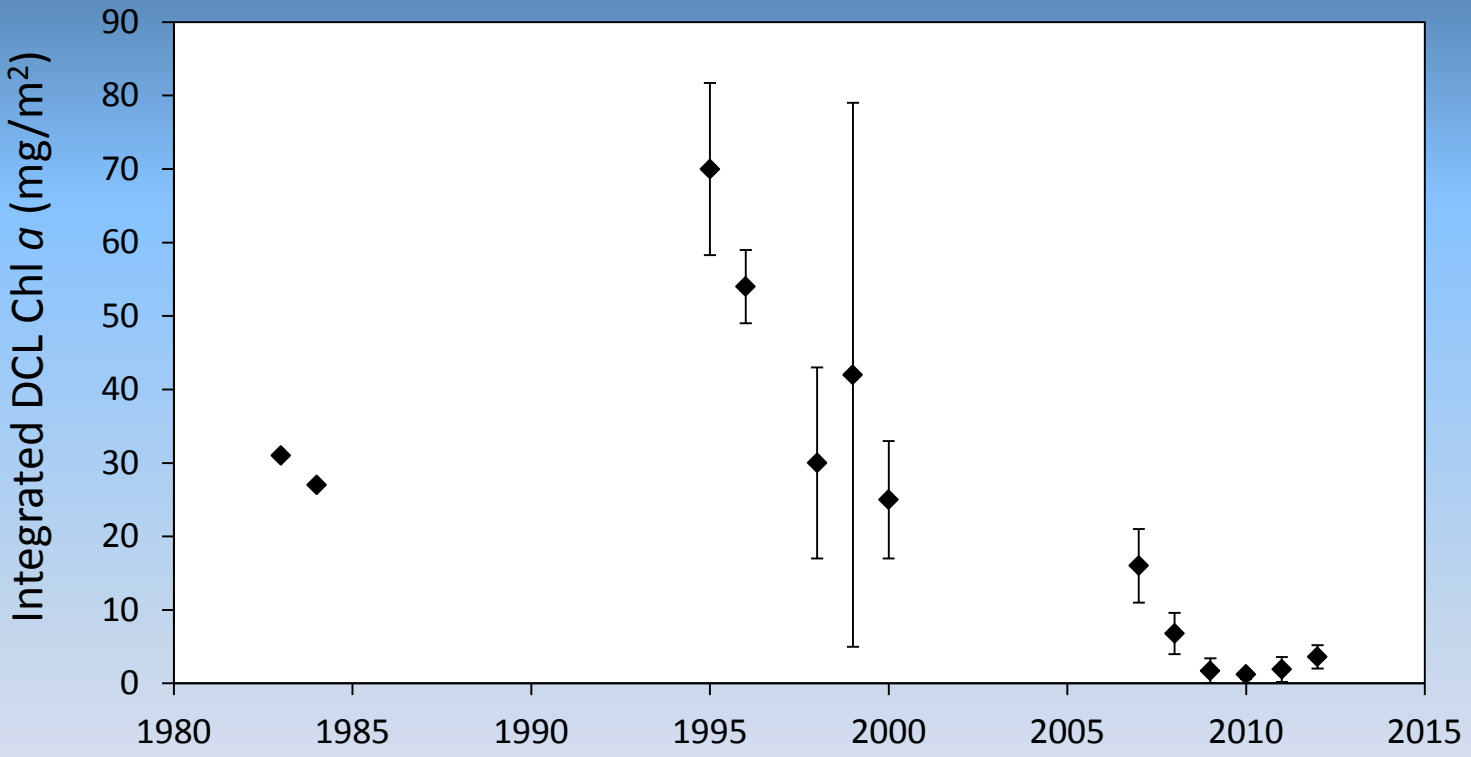




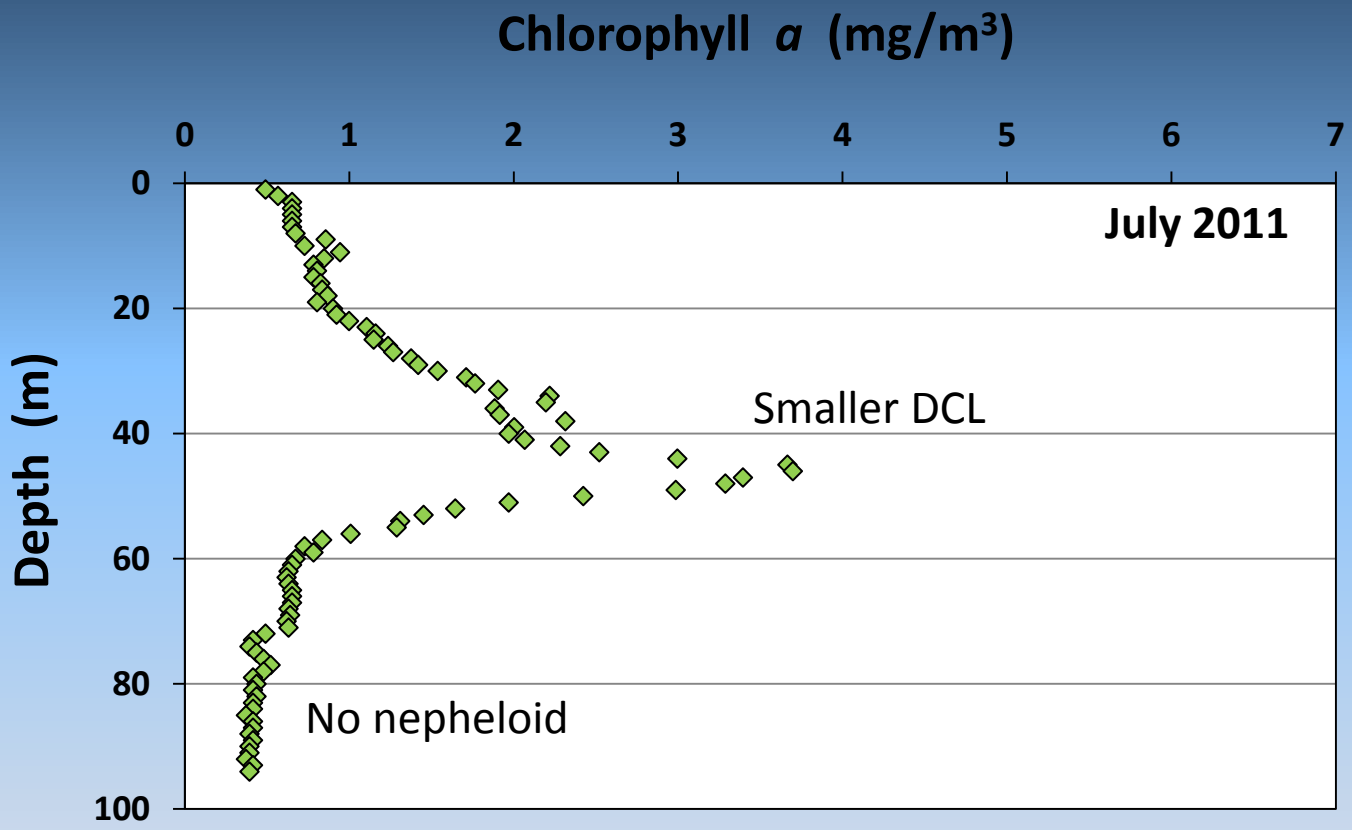
In the spring, mussels in the offshore are "connected" to the entire water column


Temperature (°C)
0
5
10
15
20
25
Depth (m)
0
20
40
60
80
100
120
Chlorophyll a (mg/m³)
0
1
2
3
4
5
6
7
July 1995
Deep chlorophyll layer
Nepheloid

Mean early summer DCL (Area > 2 mg/m^3)
Offshore -110 m



Summer chlorophyll profile

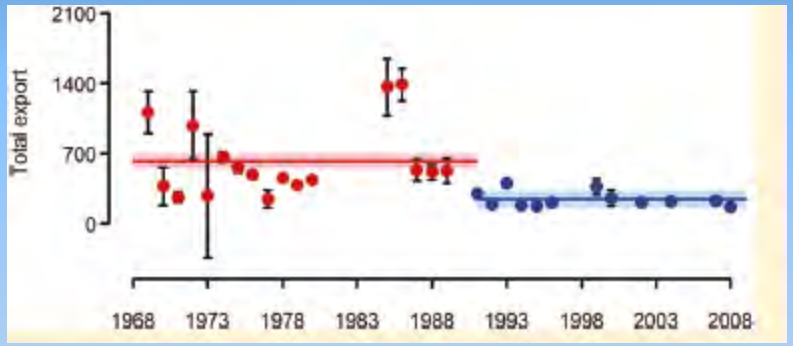


Less spring bloom material settling

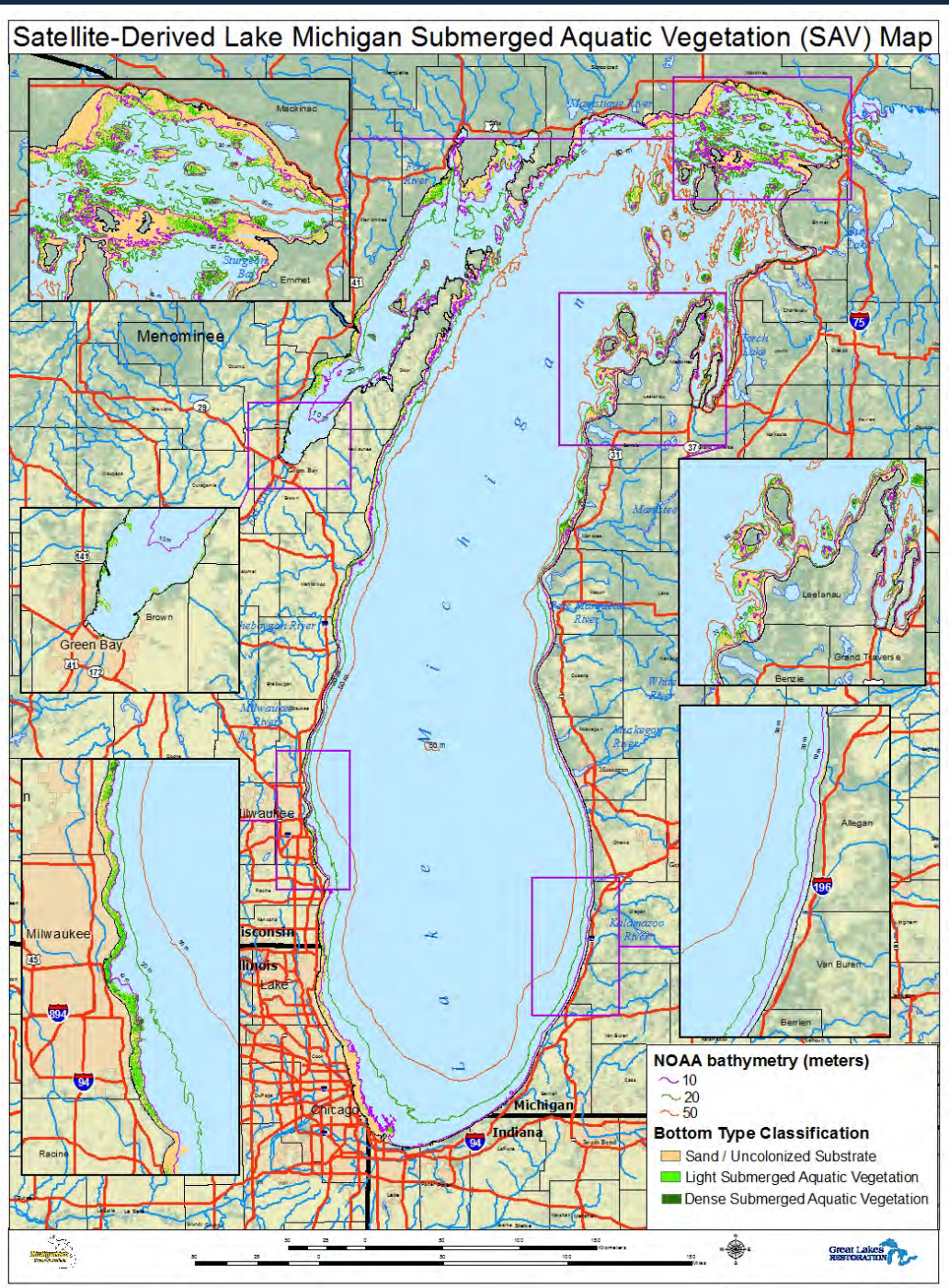
Nearshore-Offshore transport disrupted by nearshore mussels

Typical Zebra Mussel Shallow Water Impact in 1990s- Saginaw Bay, Lake Huron

SAGINAW BAY



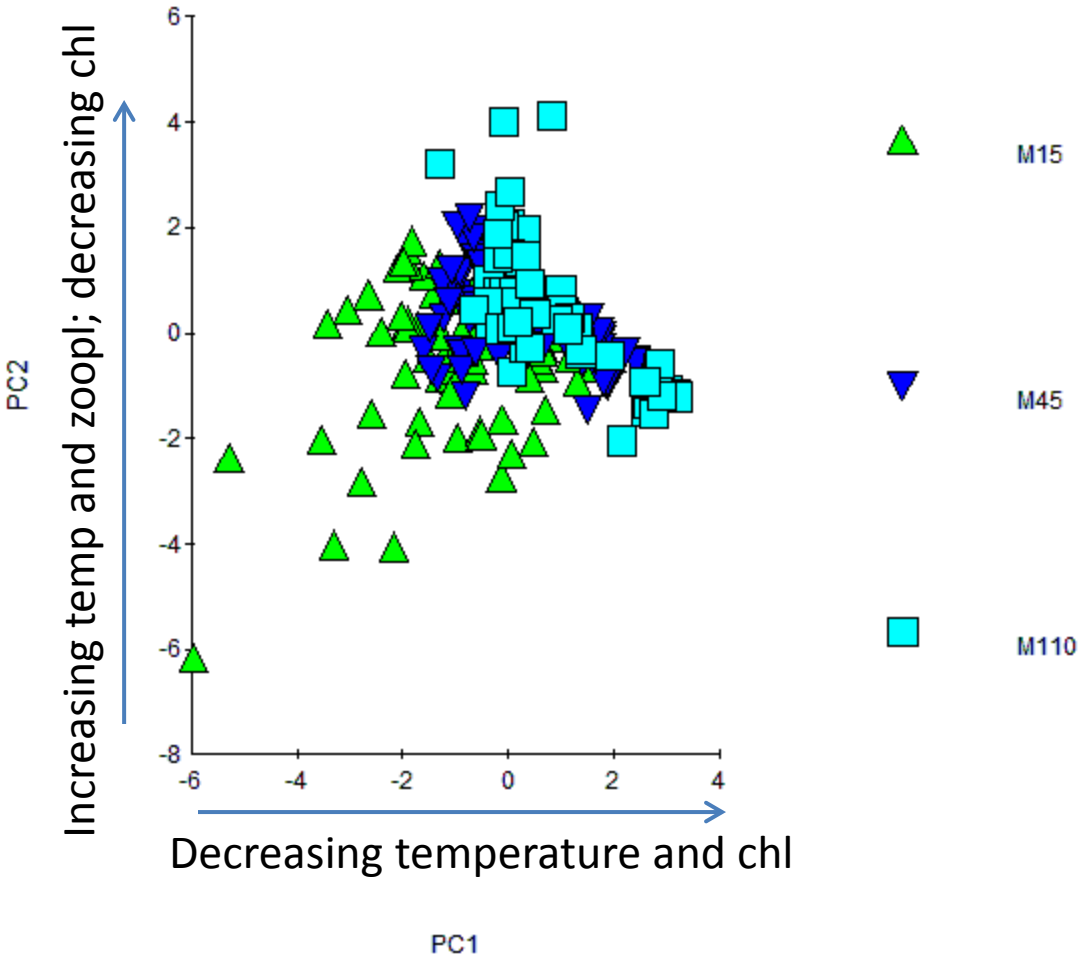
RETENTION OF NUTRIENTS NEARSHORE-
→ more algae (Cha et al. 2011)

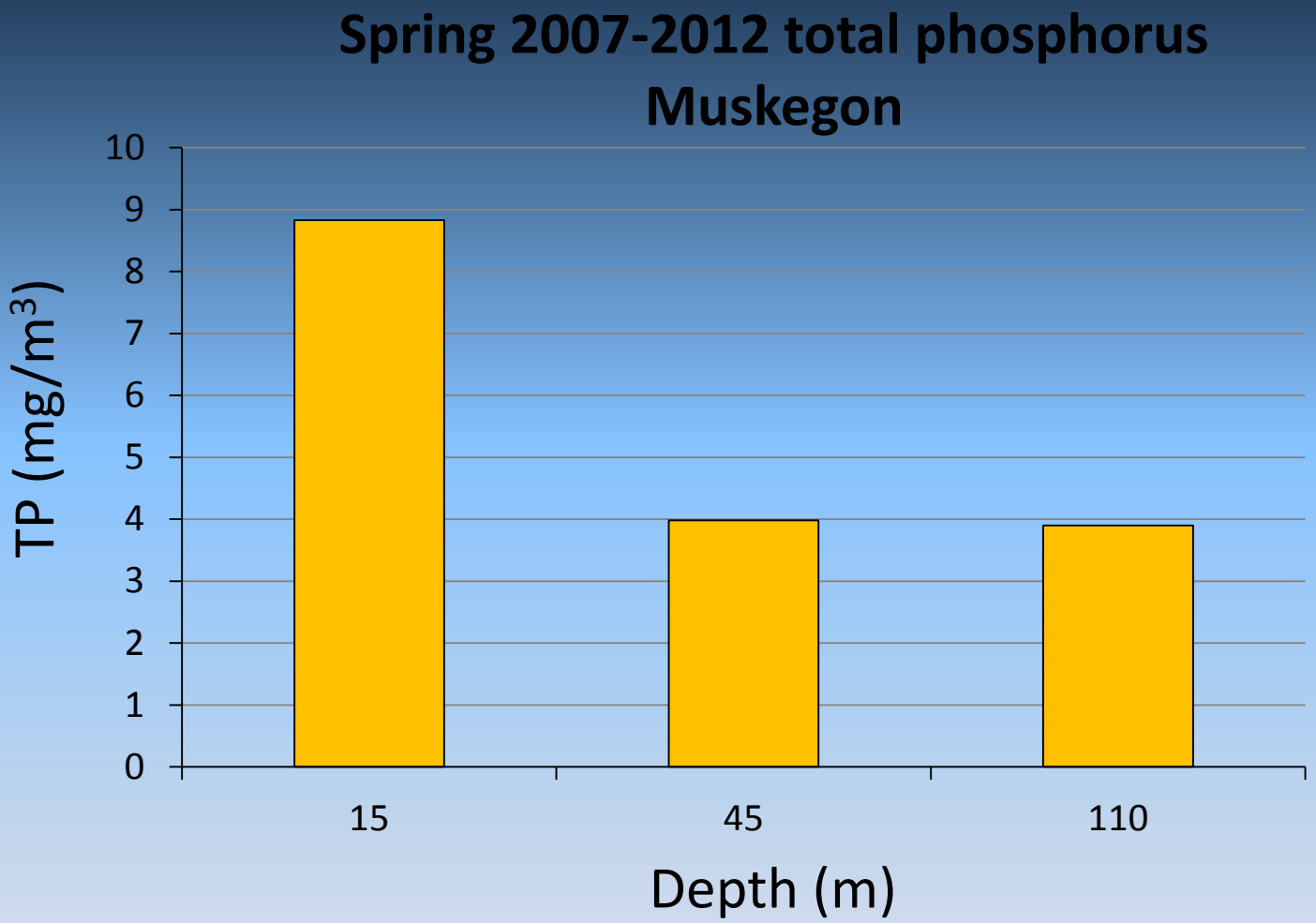


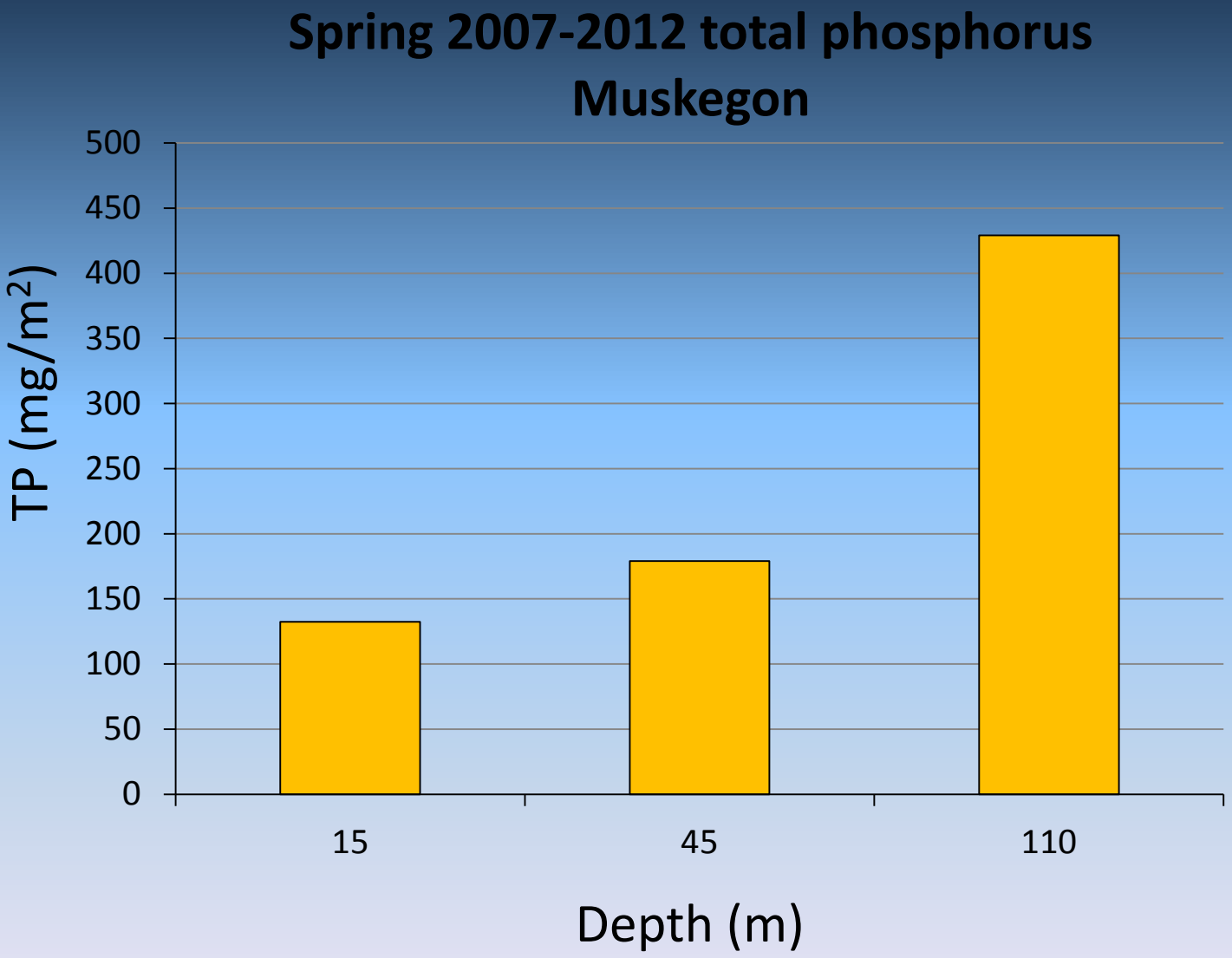
28% of mapped nearshore habitat in Lake Michigan is occupied by *Cladophora* or other SAV

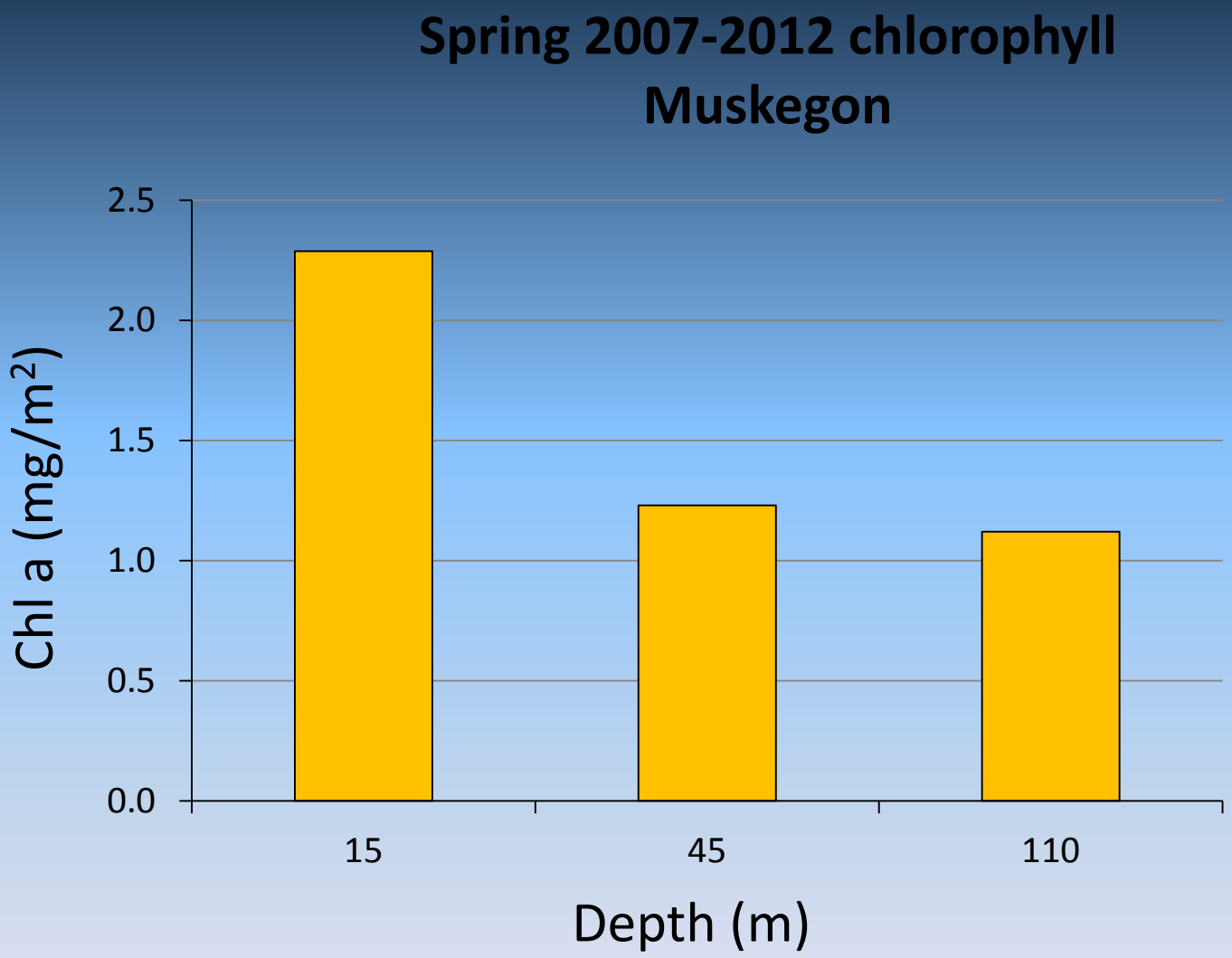
From Shuchman et al. 2013

Nearshore and Offshore are different environments
(temperature, chl, zooplankton)

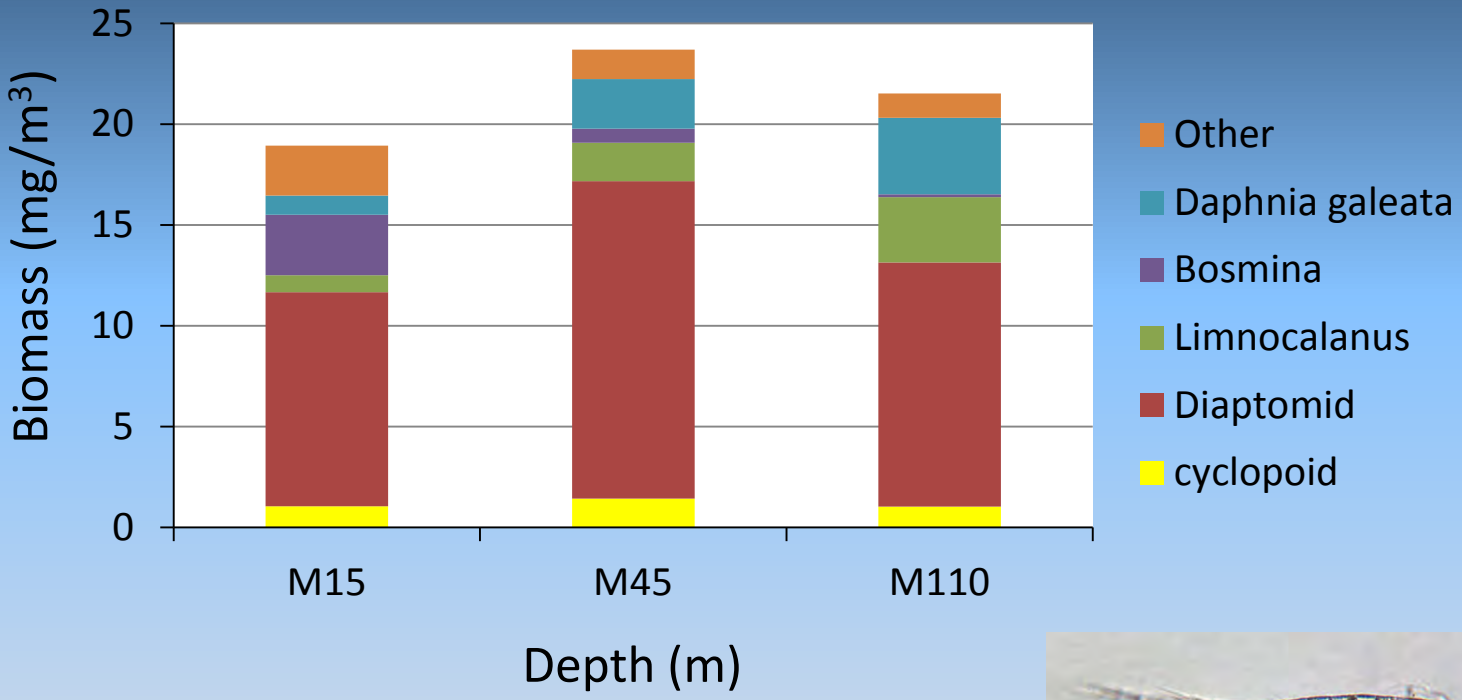



Spring 2007-2012 total phosphorus
Muskegon
TP (mg/m3)
10
9
8
7
6
5
4
3
2
1
0
15
45
110
Depth (m)


Spring 2007-2012 total phosphorus
Muskegon
TP (mg/m²)
500
450
400
350
300
250
200
150
100
50
0
15
45
110
Depth (m)

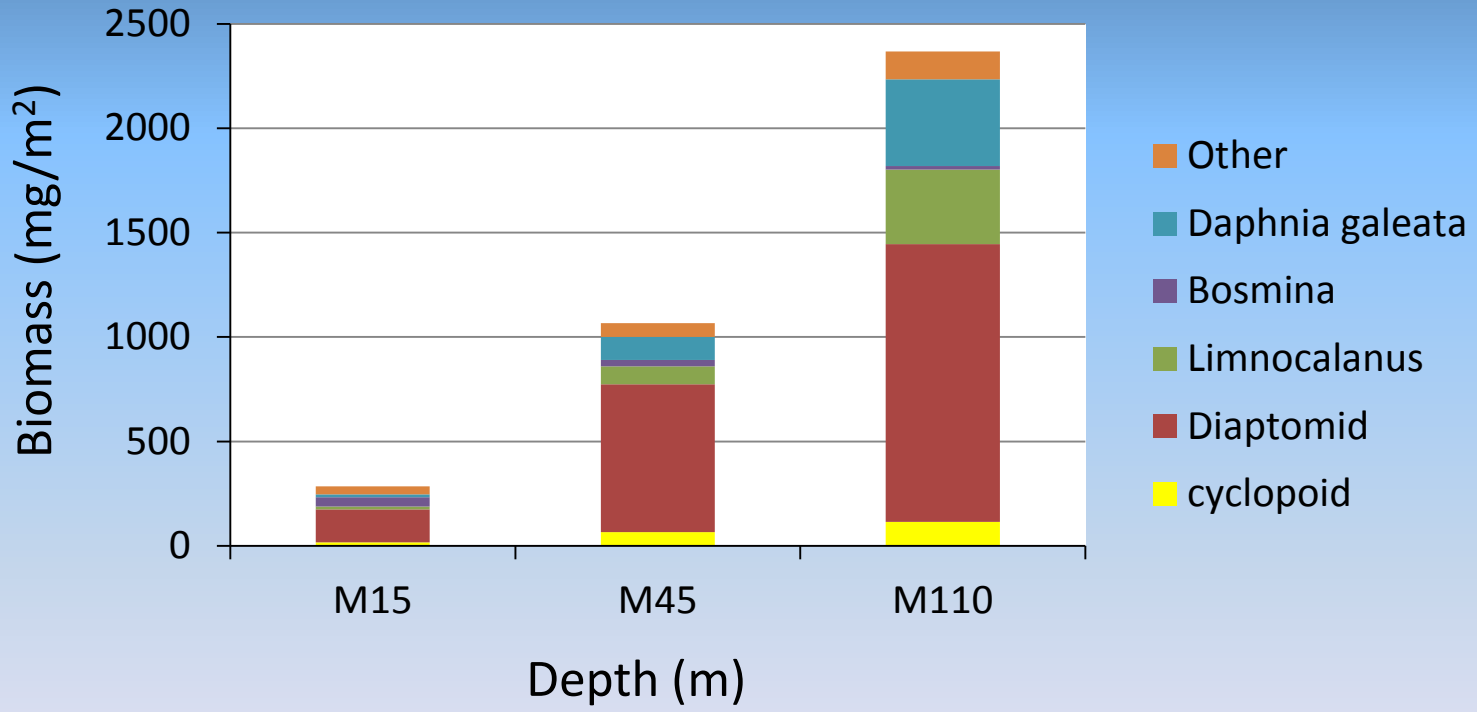

Spring 2007-2012 chlorophyll
Muskegon
2.5
2.0
1.5
1.0
0.5
0.0
Chl a (mg/m2)
15
45
110
Depth (m)

Mean annual zooplankton abundance 2007-2012 Muskegon



Reflective of an oligotrophic community

Mean annual zooplankton abundance 2007-2012
Muskegon



Zooplankton community differences nearshore-offshore

CLADOCERANS (fleas)

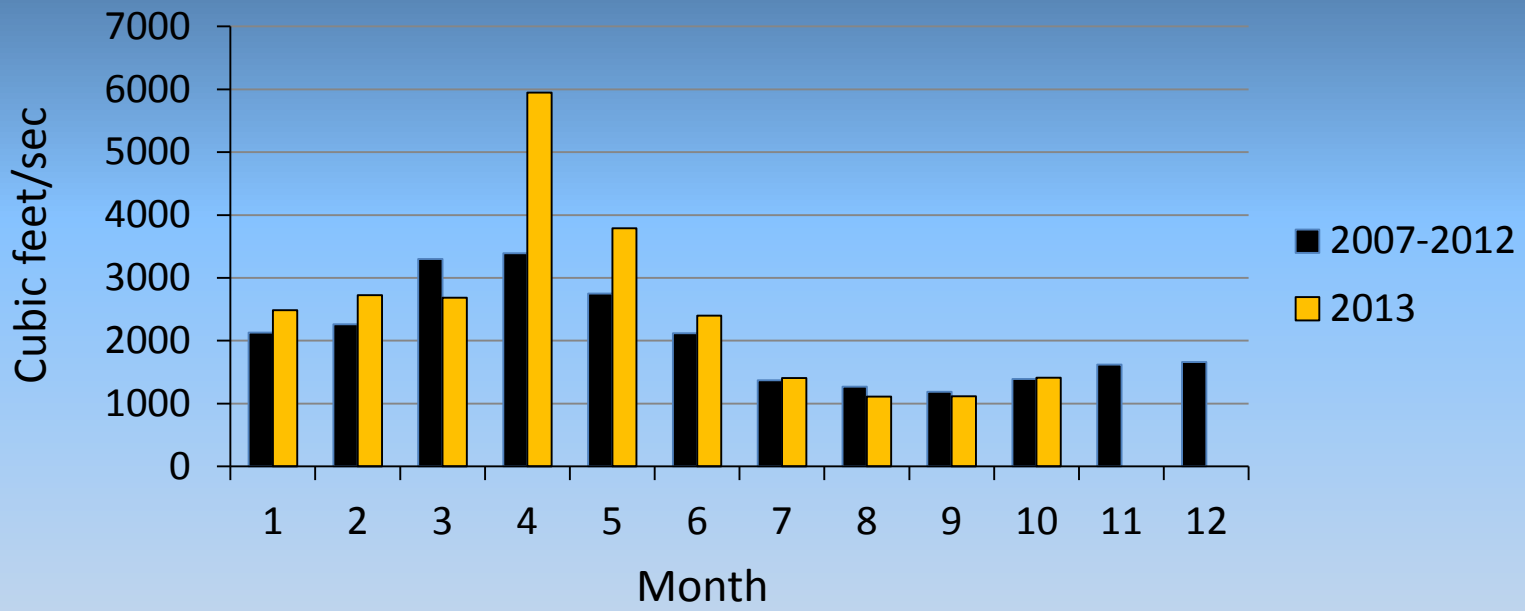
Bosmina –small bodied, nearshore

Daphnia –large bodied, offshore

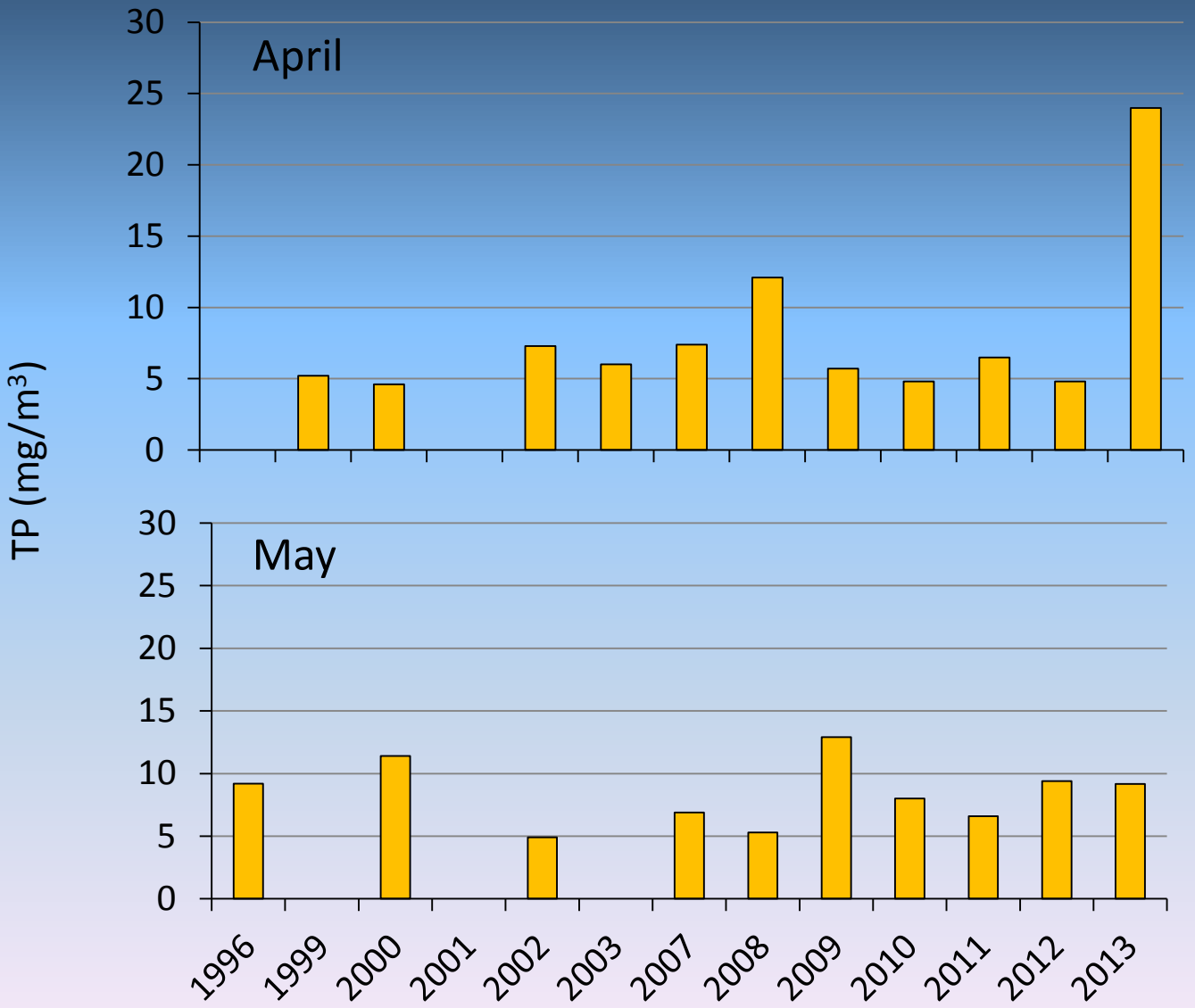
Cercopagis –small bodied, nearshore

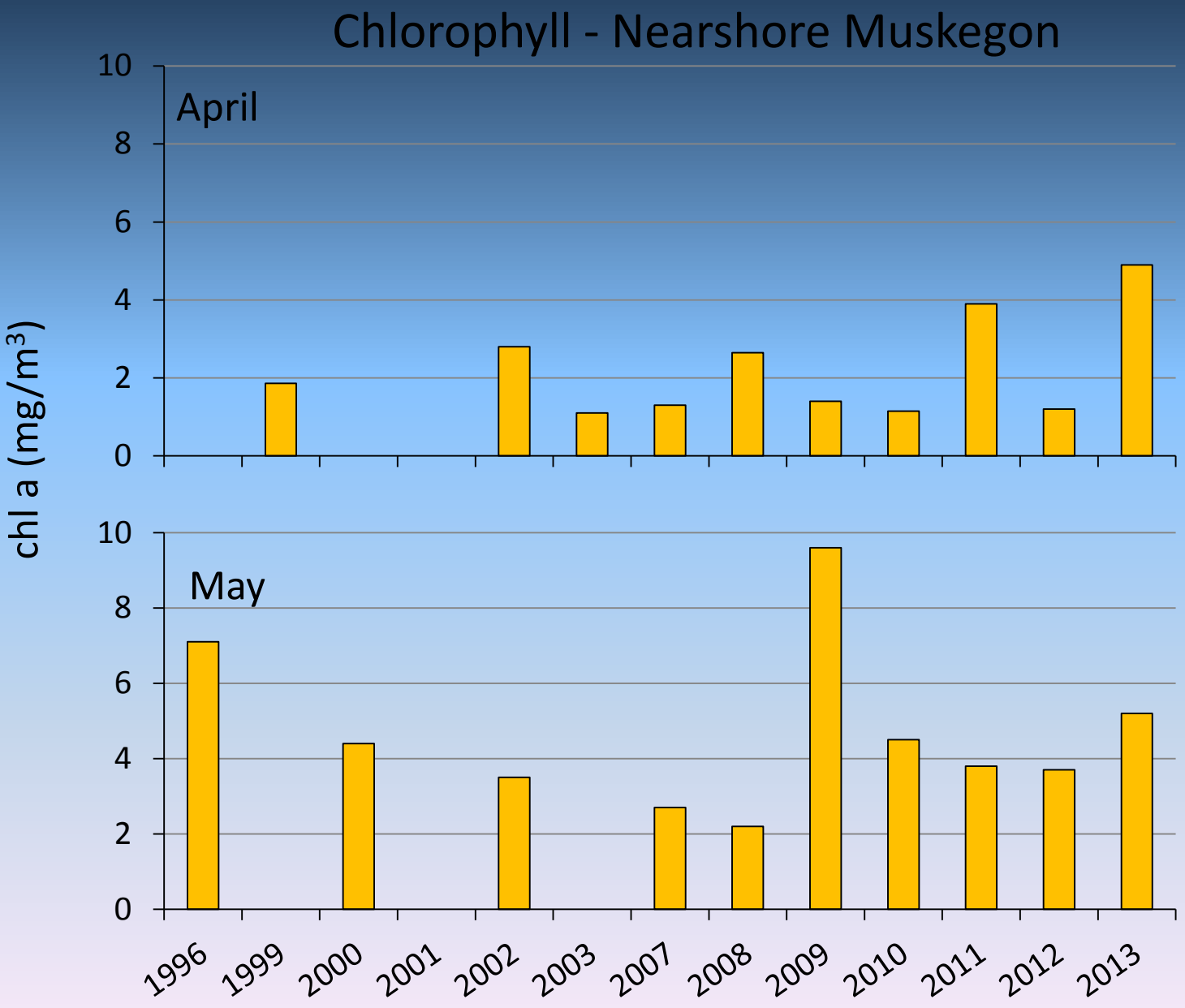
Bythotrephes –large bodied, offshore

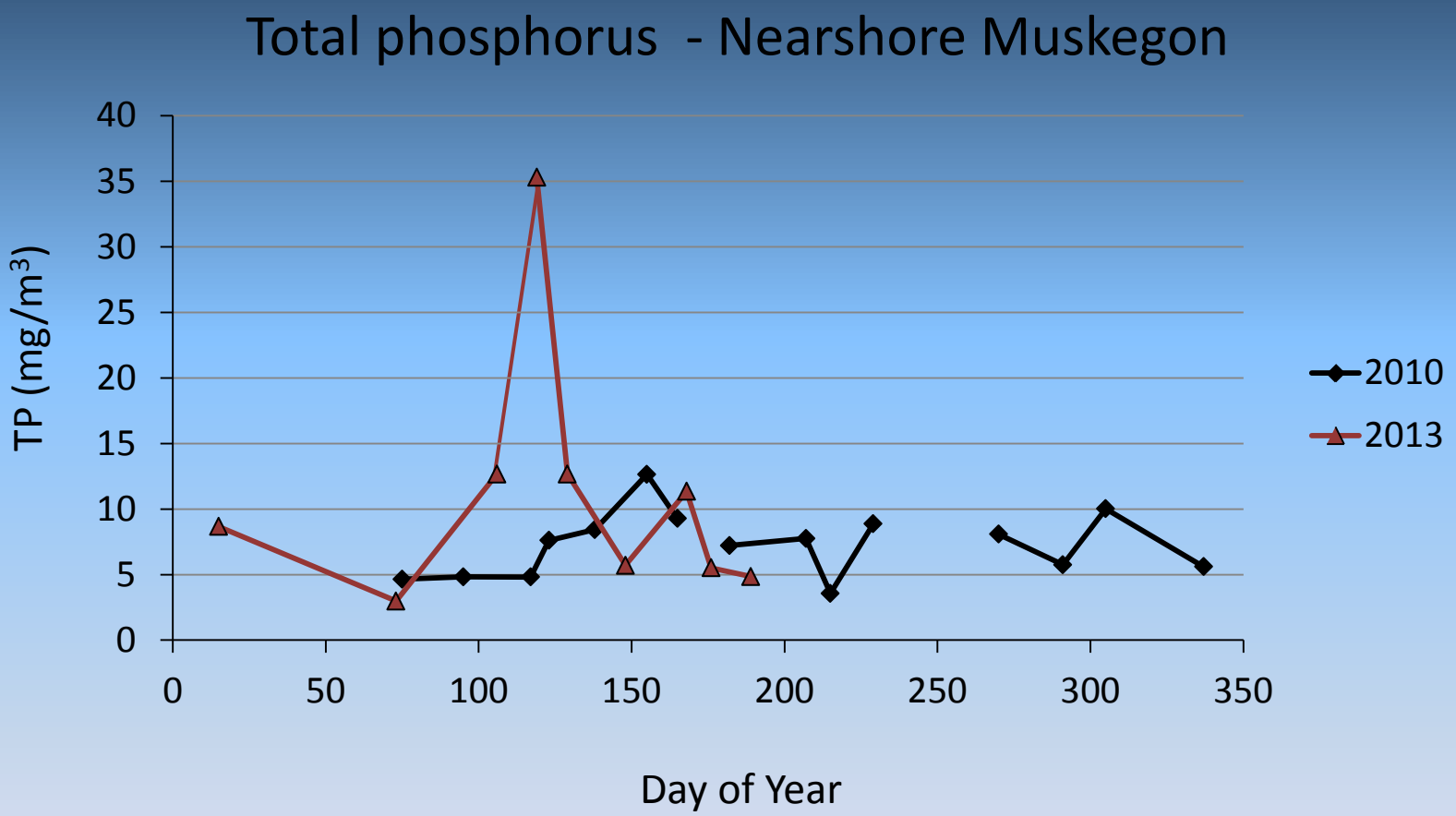
Muskegon River Discharge (below Croton; USGS data)

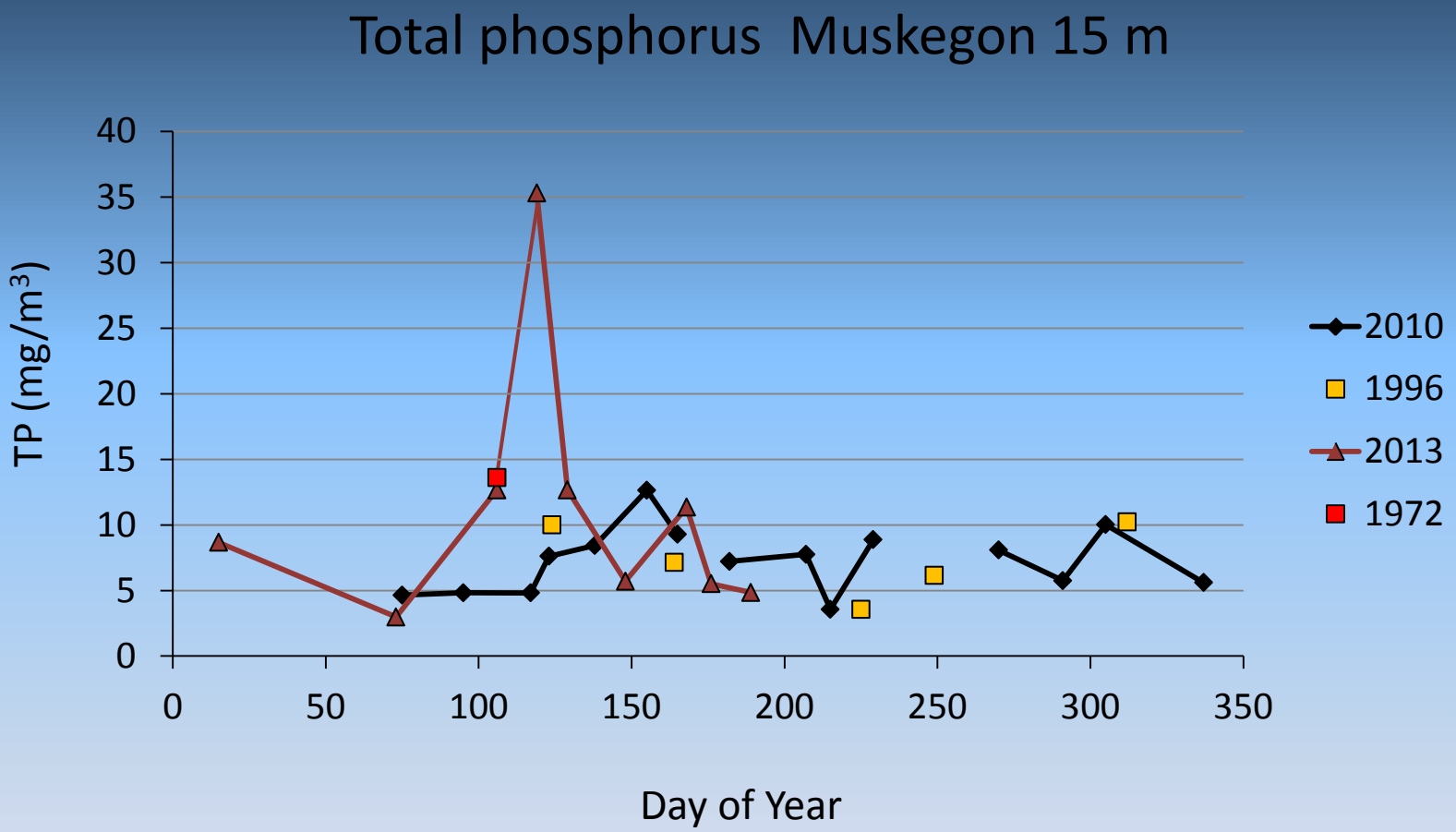


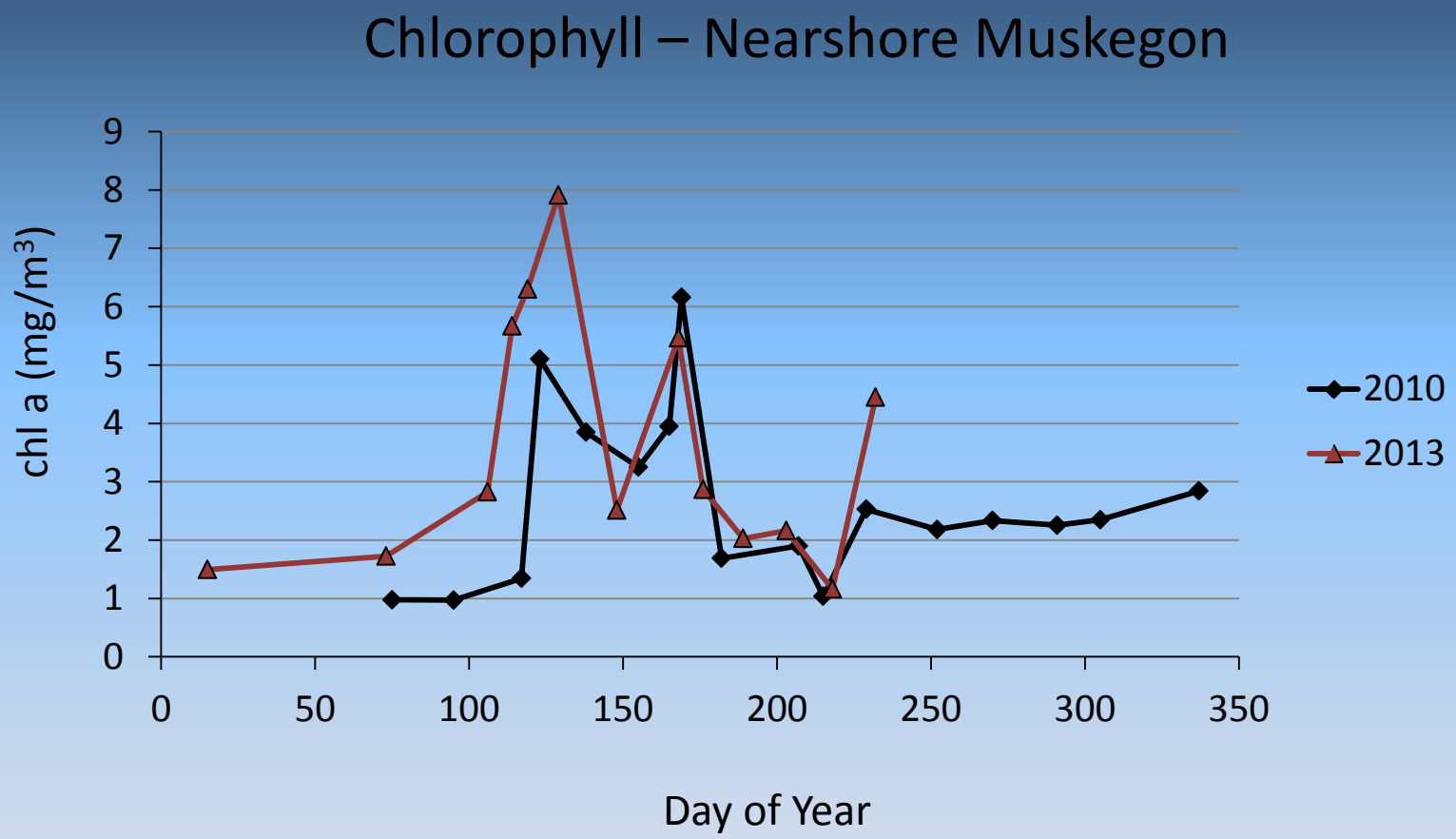
Total phosphorus - Nearshore Muskegon



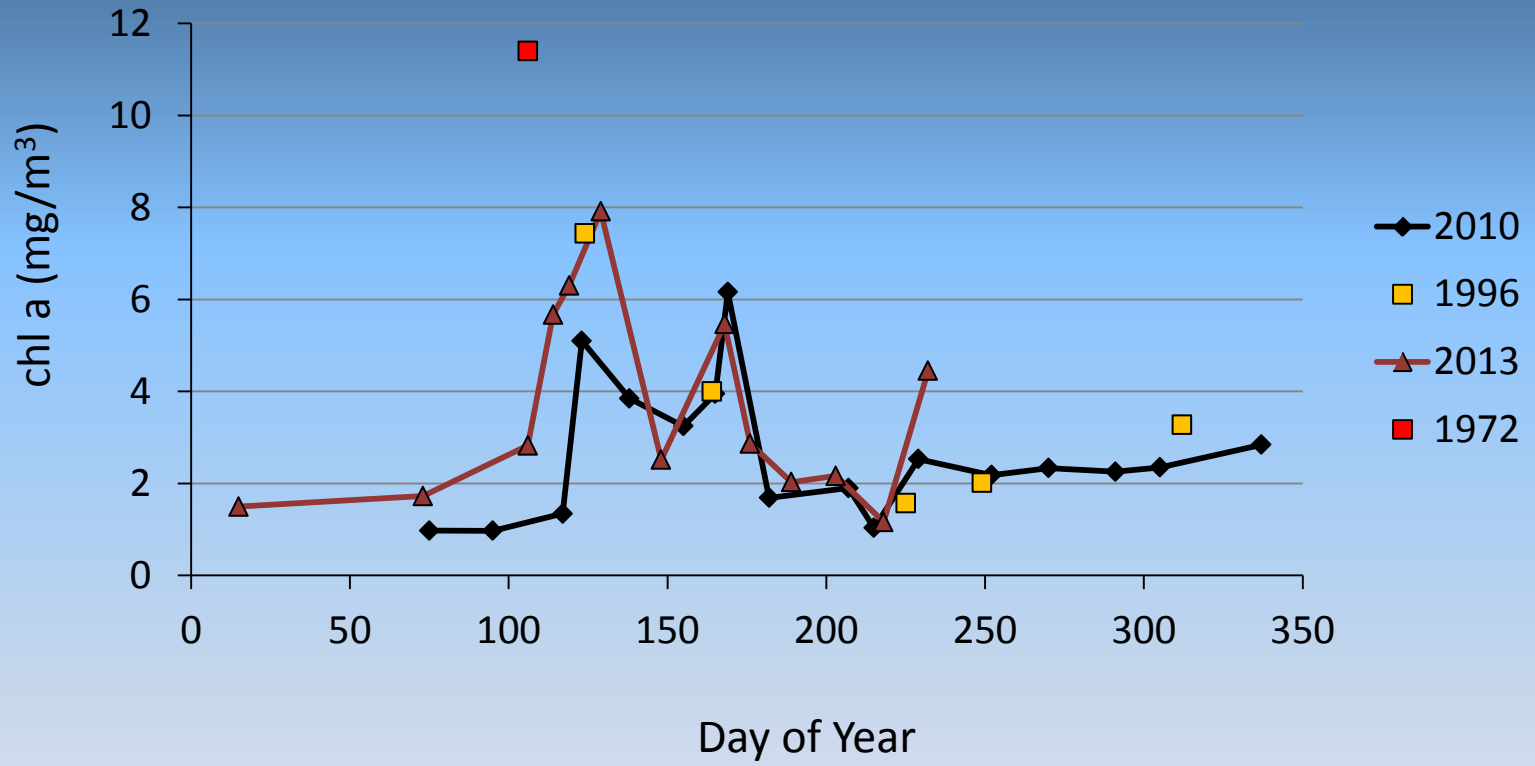

Chlorophyll - Nearshore Muskegon
April
May
chl a (mg/m3)
0
2
4
6
8
10
1996
1999
2000
2001
2002
2003
2007
2008
2009
2010
2011
2012
2013


Total phosphorus - Nearshore Muskegon
TP (mg/m³)
40
35
30
25
20
15
10
5
0
0
50
100
150
200
250
300
350
Day of Year
2010
2013

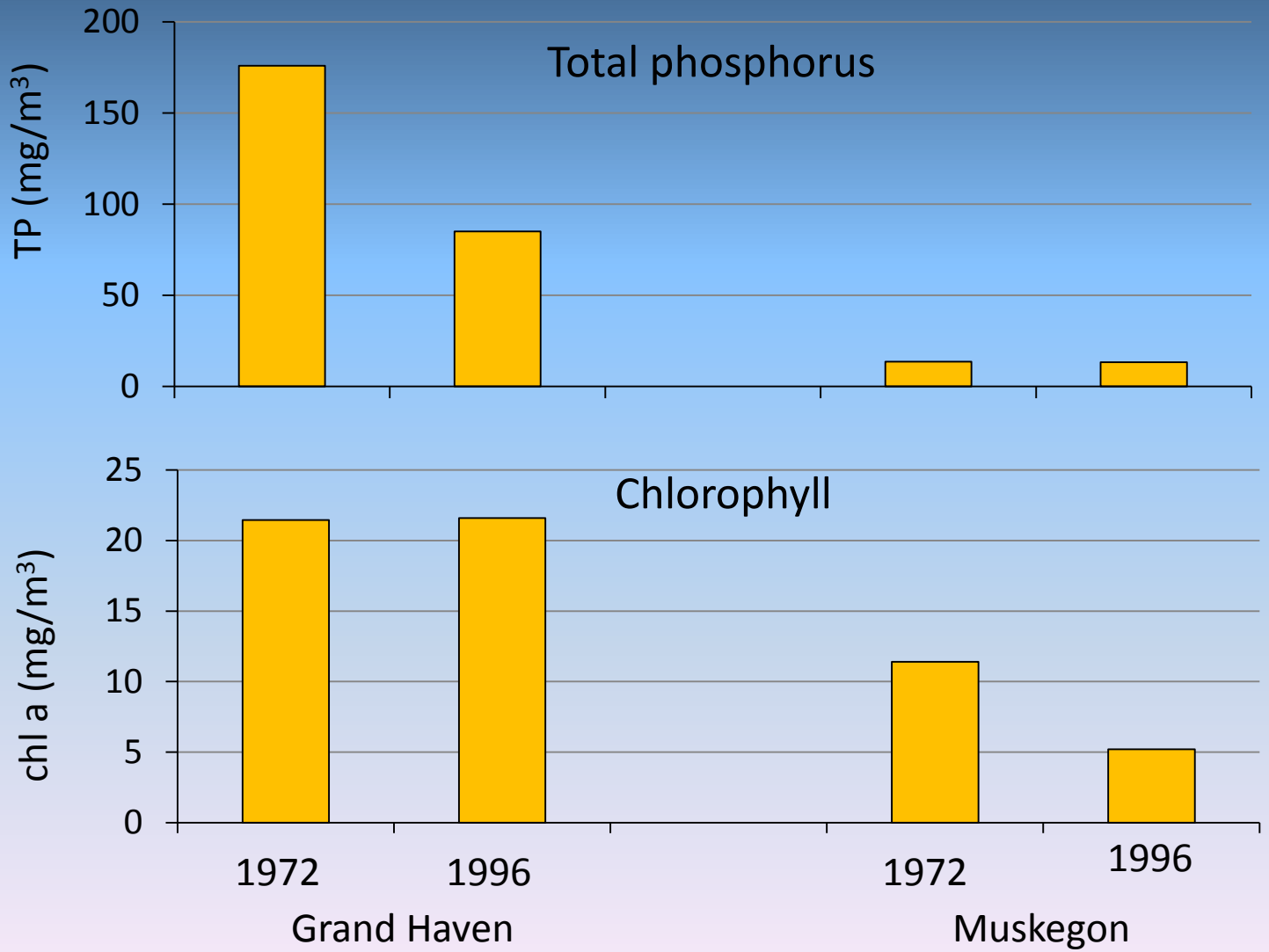

Total phosphorus Muskegon 15 m
TP (mg/m³)
40
35
30
25
20
15
10
5
0
0
50
100
150
200
250
300
350
Day of Year
2010
1996
2013
1972


Chlorophyll – Nearshore Muskegon
chl a (mg/m³)
9
8
7
6
5
4
3
2
1
0
0
50
100
150
200
250
300
350
Day of Year
2010
2013

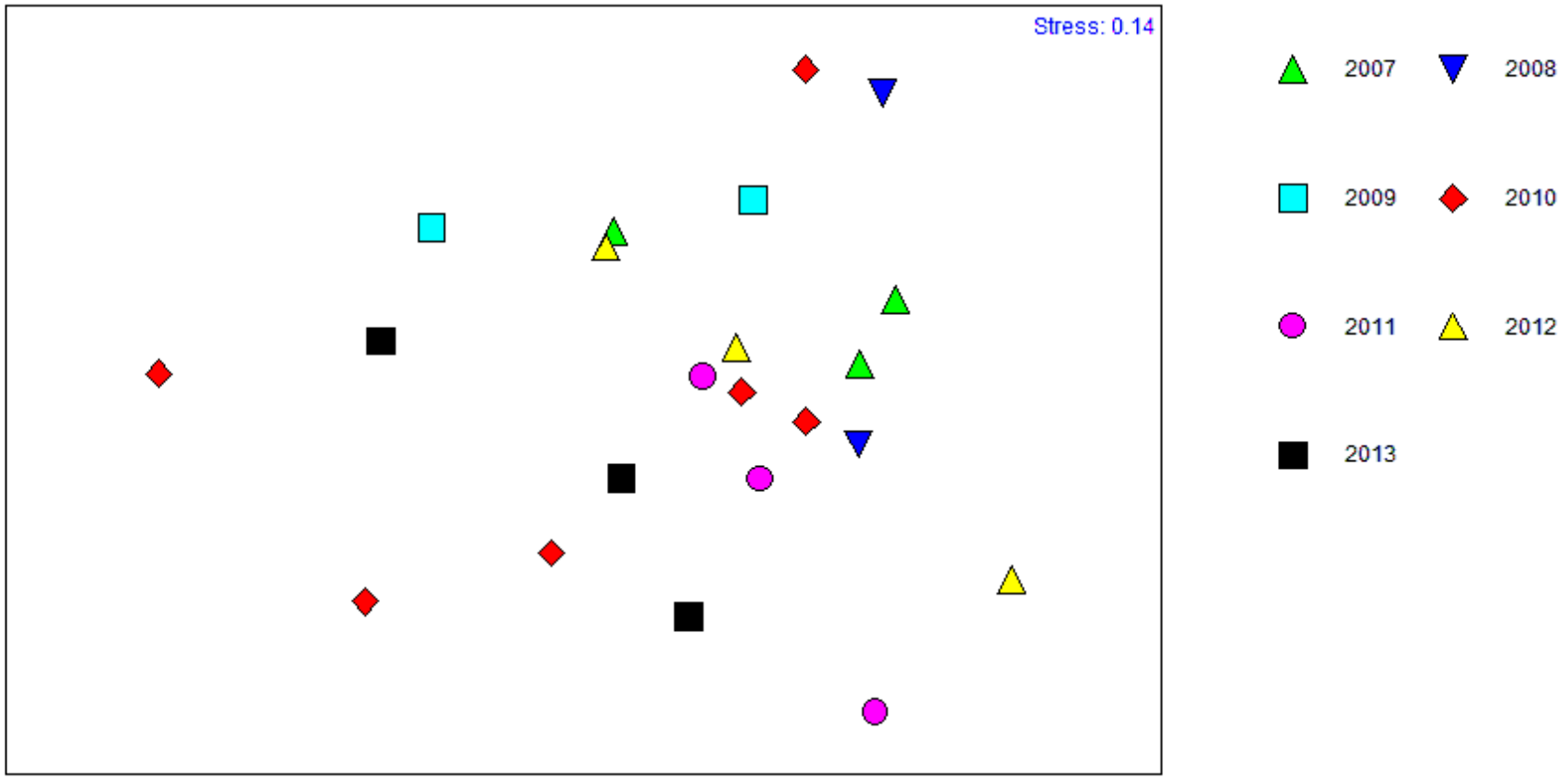
Chlorophyll – Nearshore Muskegon



Historical comparison - spring
Grand Haven- Muskegon river mouths



Spring zooplankton community assemblage analysis



More variable within a year than between years

A few things to consider….

The nearshore and offshore are different, but connected

Can P be reduced enough to eliminate nearshore water quality issues but still support the offshore pelagic food web?

Is removal of P by mussels temporary or permanent?