Western Lake Michigan Nearshore Survey of Water Chemistry and *Cladophora* Distribution, 2004-2007

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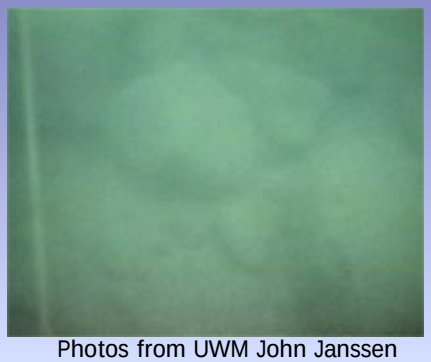
DNR Integrated Science Services

WHAT IS THE STINKING SLIMY MESS ON MY BEACH AND WHY IS IT HERE?



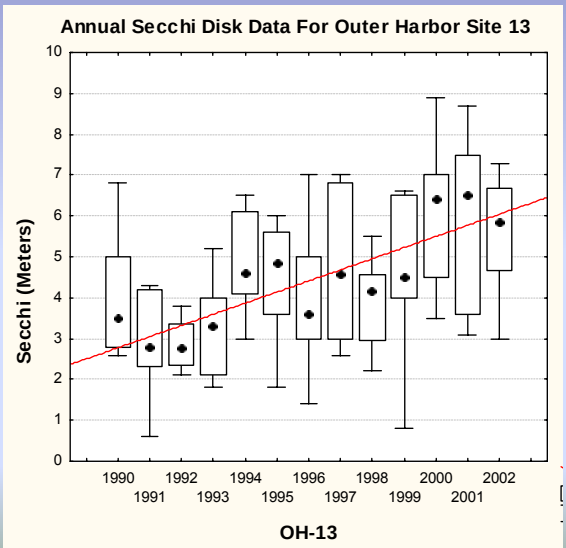
1986

Photos from UWM John Janssen

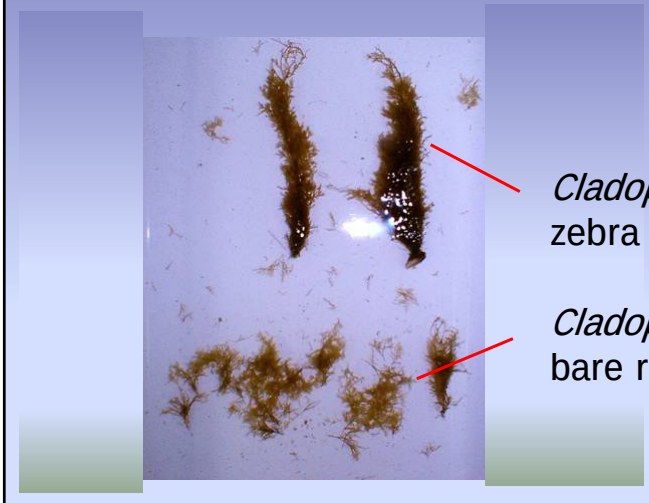
2001

Dreissenid mussels

IMPROVED WATER CLARITY



Data provided by MMSD



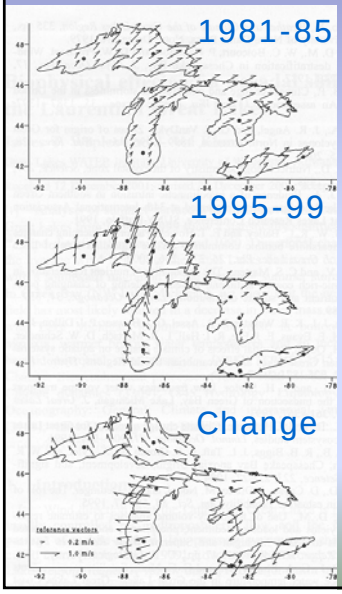
Cladophora growing on zebra mussels

Cladophora growing on bare rock

Filaments tend to have higher P concentration at their base
ZM may be acting to improve P supply to *Cladophora*

Photo and Data: Harvey Bootsma, UWM Great Lakes Water Institute

SHIFT IN WIND DIRECTION

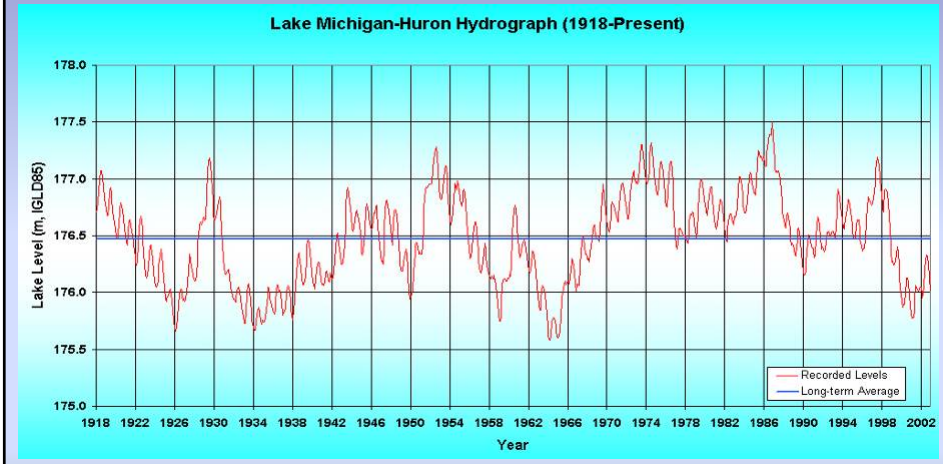


Average August wind field over the Great Lakes basin

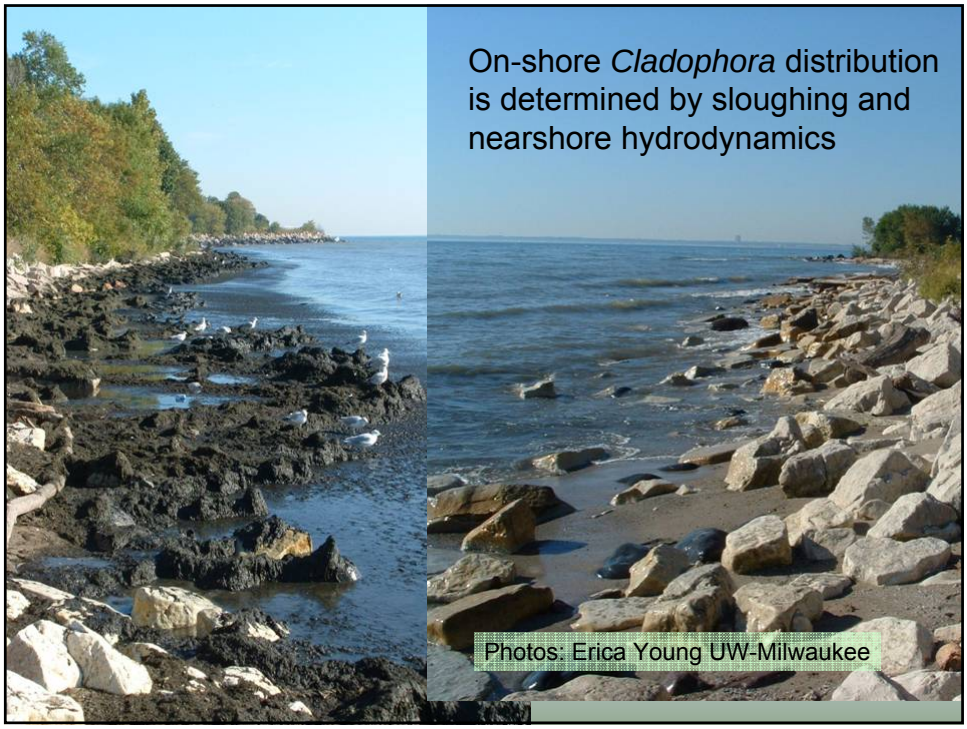
- Summer surface wind fields over GL show significant shift in wind direction from late 1980s until today
- Shift reflects a southward migration of the dominant summer storm track – a symptom of climate variability

Source: J Waples and V Klump, 2002, Geophysical Research Letters, *29(8)*

Long Term Water Level Changes



Collected and archived by NOAA's National Ocean Service.


On-shore *Cladophora* distribution is determined by sloughing and nearshore hydrodynamics
Photos: Erica Young UW-Milwaukee

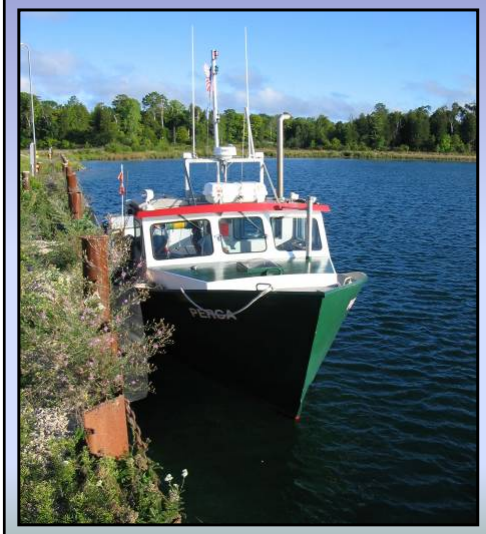
WDNR Survey

Funding support by:

WISCONSIN DEPT. OF NATURAL RESOURCES

WISCONSIN COASTAL MANAGEMENT PROGRAM

Fish Management

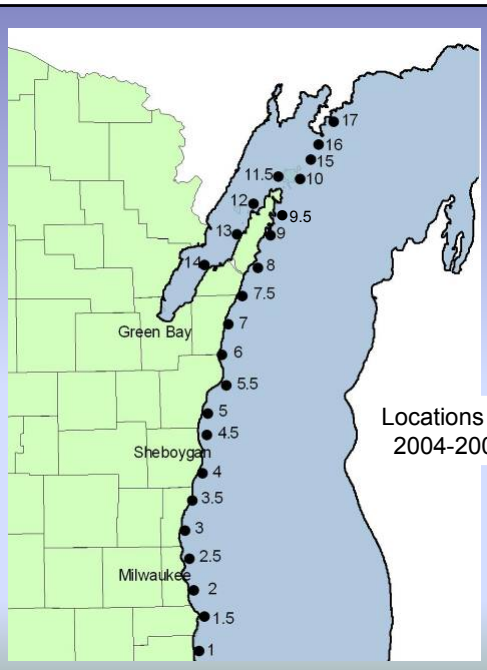


Objectives

- What is the density and distribution of *Cladophora* along Wisconsin's Lake Michigan coastline?
- What are nearshore nutrient concentrations?

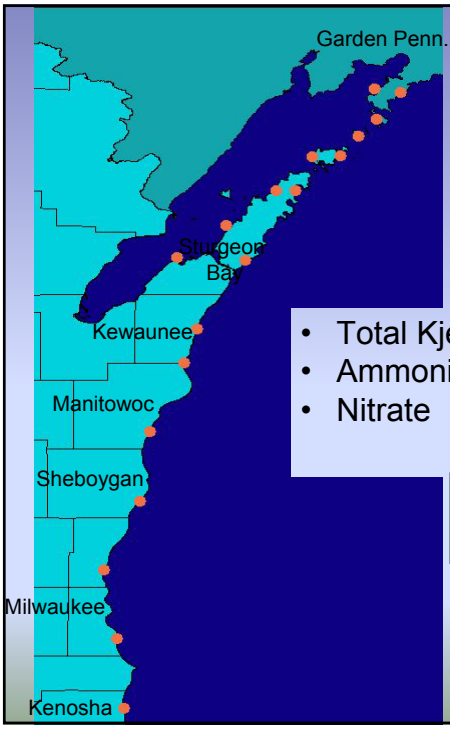
STUDY DESIGN

- **2004** – What is coastal distribution of *Cladophora* and nutrients spatially and temporally.
- **2005** – Expand spatial coverage; determine in what form does *Cladophora* overwinter and are spring nutrient levels different from summer.
- **2006** – How do *Cladophora* coverage and nutrient levels differ between early and late summer.
- **2007** – How do *Cladophora* coverage and nutrient levels differ before and after the peak biomass period of late July.



Locations used during 2004-2007 sampling

Station no.	Location
1	Kenosha
1.5	Racine
2	Milwaukee S
2.5	Shorewood
3	Cedarburg
3.5	Port Washington
4	Oostburg
4.5	Whistling Straits
5	Centerville
5.5	Manitowoc
6	Two Creeks
7	Rostock
7.5	Kewaunee
8	Lily Bay
9	Bailey's Bay
9.5	Rowleys Bay
10	Wash. Is. E
11.5	Wash. I. W.
12	Sister Bay
13	Horseshoe Bay
14	Henderson Point
15	St. Martin Is.
16	Summer Is.
17	Kregg Bay



Sampling

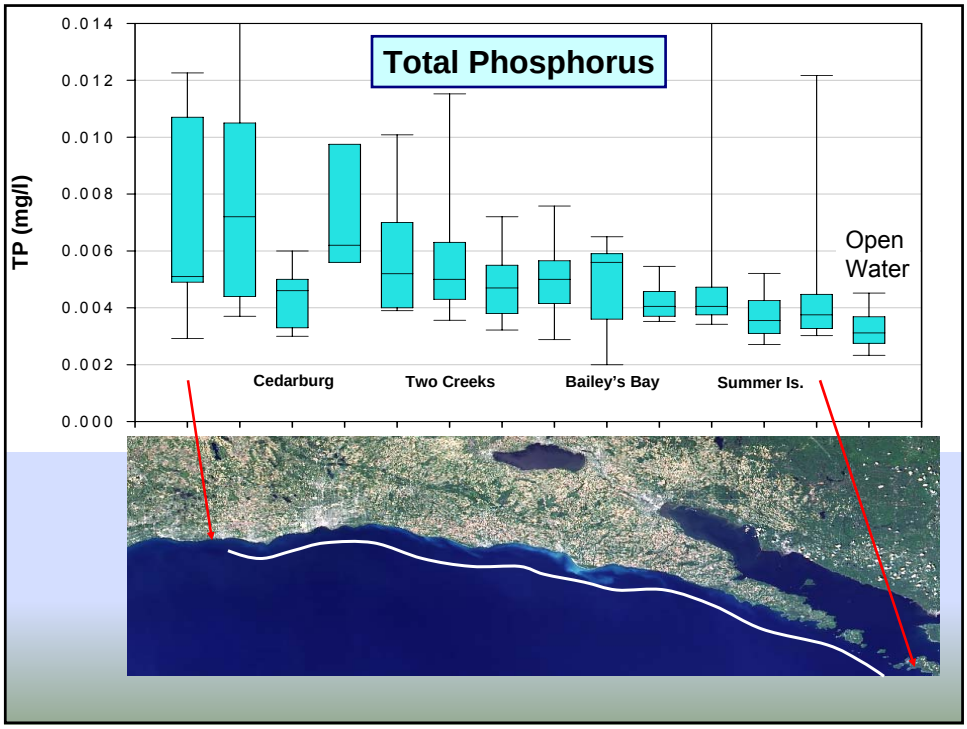
- 17 sites
- 2 times per year
- 2 m and 10 m
- Profiles

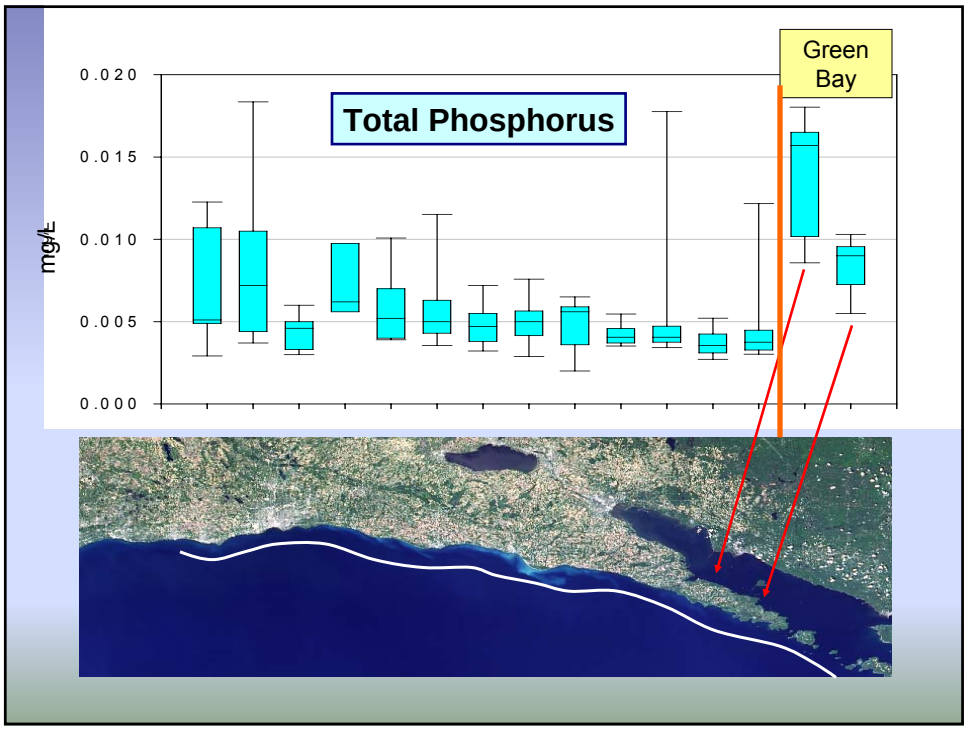
Nutrients

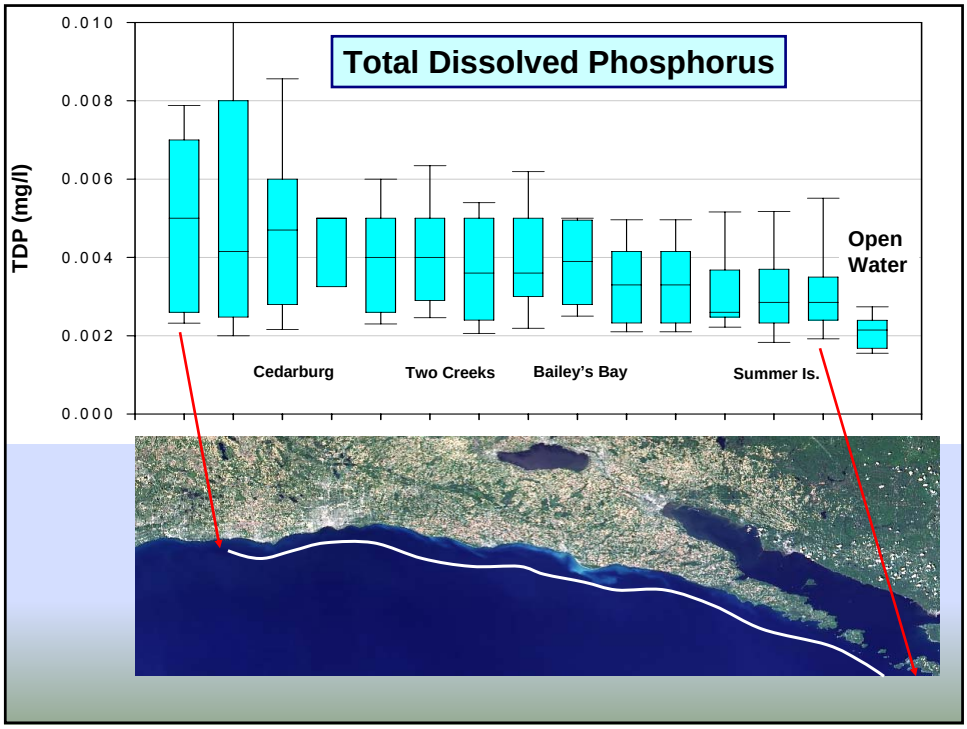
- Total Kjeldahl N
- Ammonia
- Nitrate
- Total suspended solids
- Total P
- Total dissolved P
- Dissolved reactive P

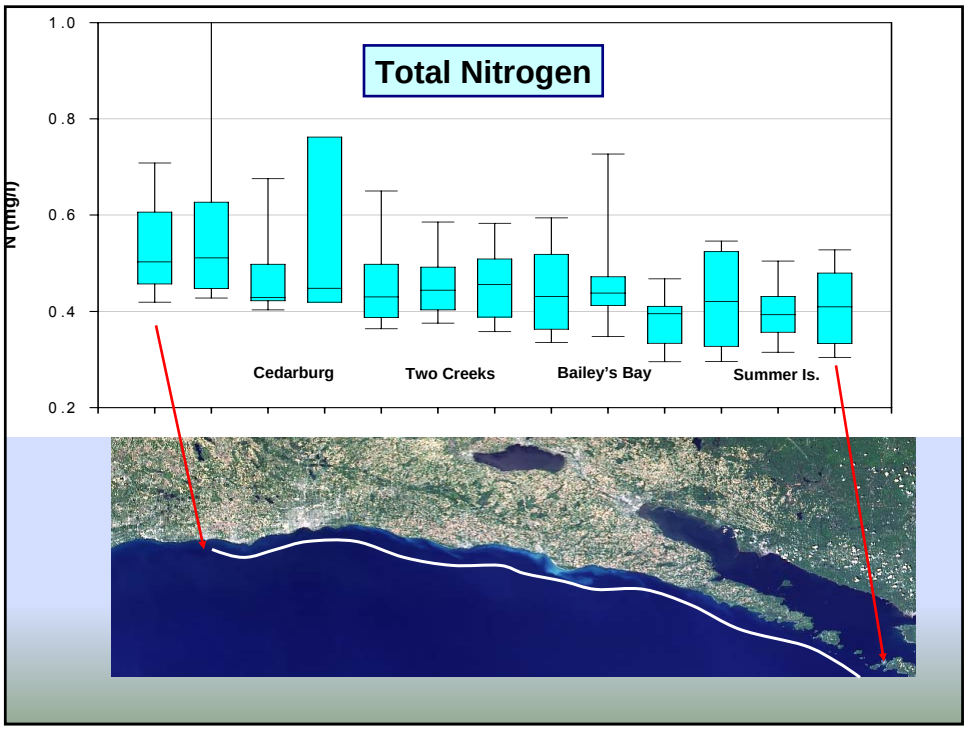
Cladophora Distribution and Characteristics

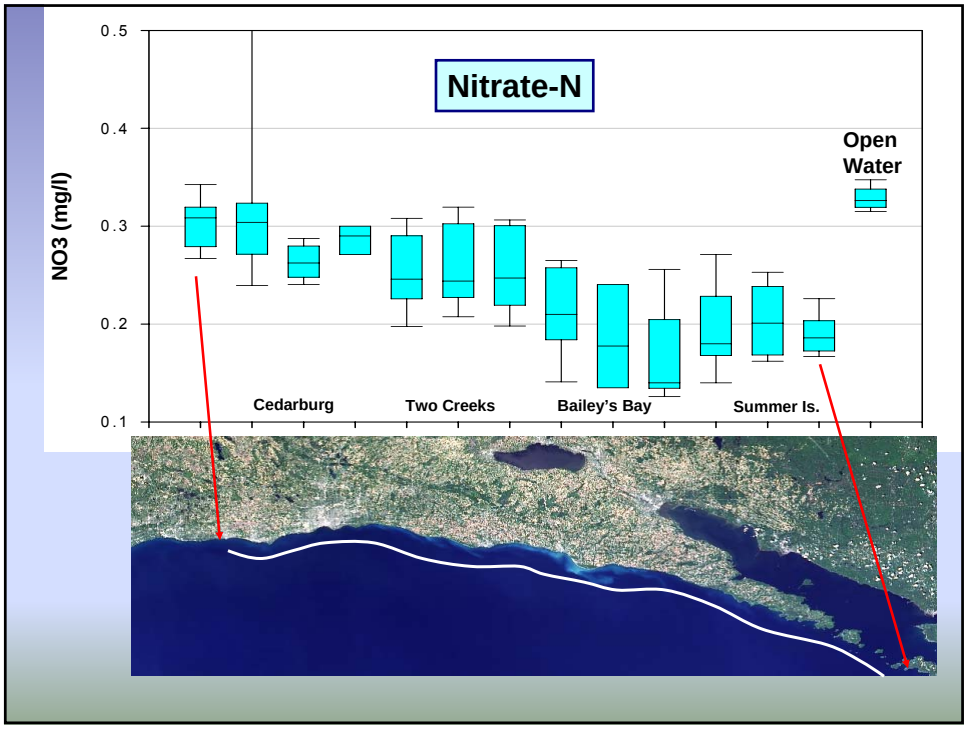
- 10 m
- Substrate
- Density
- Dreissenid mussels


Total Phosphorus
TP (mg/l)
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
Cedarburg
Two Creeks
Bailey's Bay
Summer Is.
Open Water


Total Phosphorus
Green Bay
mg/L
0.020
0.015
0.010
0.005
0.000


Total Dissolved Phosphorus
TDP (mg/l)
0.010
0.008
0.006
0.004
0.002
0.000
Cedarburg
Two Creeks
Bailey's Bay
Summer Is.
Open Water


Total Nitrogen
1.0
0.8
0.6
0.4
0.2
Cedarburg
Two Creeks
Bailey's Bay
Summer Is.

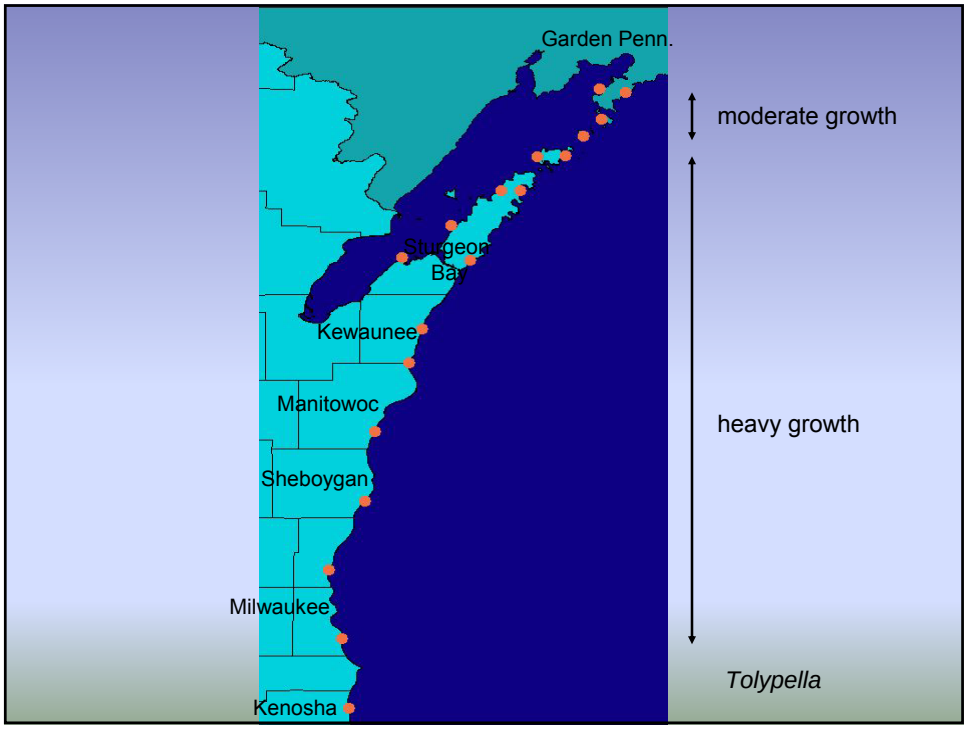


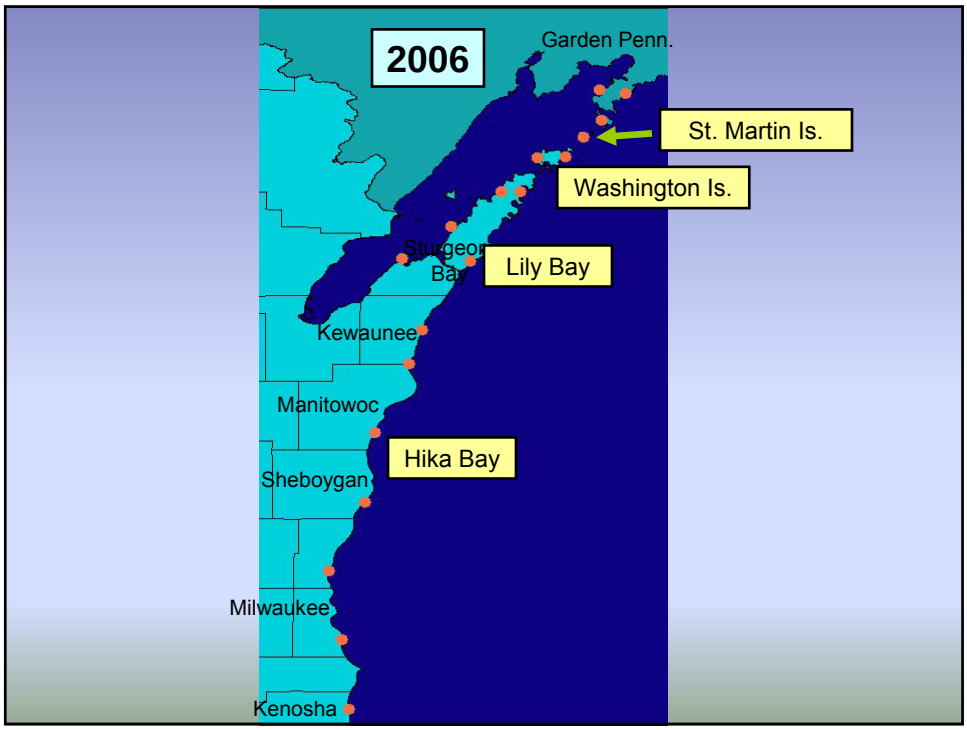
South Milwaukee July 2006

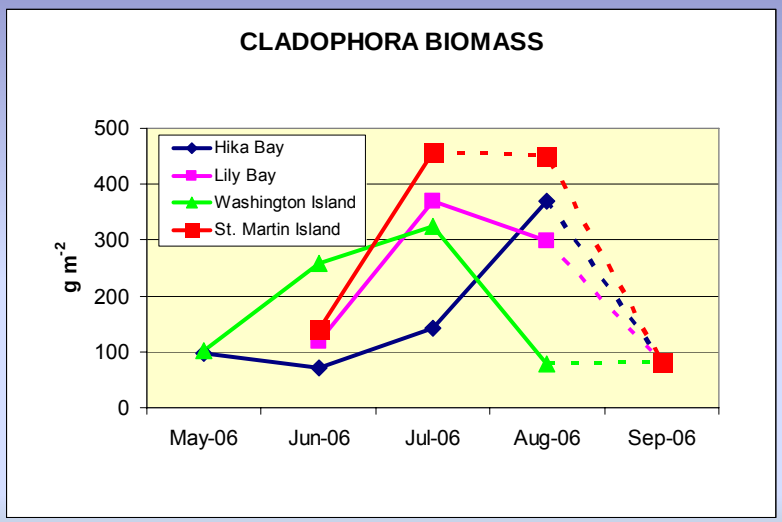
CLADOPHORA

CLADOPHORA **COVERAGE**

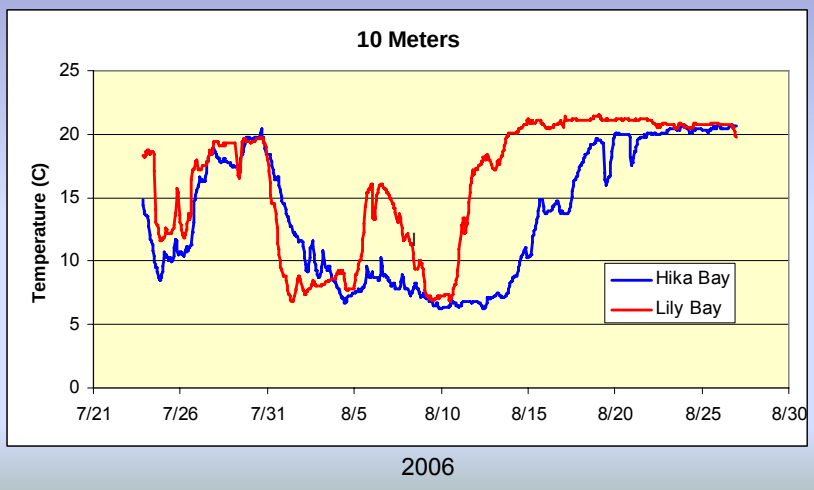
- **Coverage dependent upon substrate**
  - *Best is rock*--coverage generally 80-100%
  - *Second best* **is a mixture of cobble and sand**--coverage generally 50%
  - *Sand* is the least desirable--coverage generally less than 10%

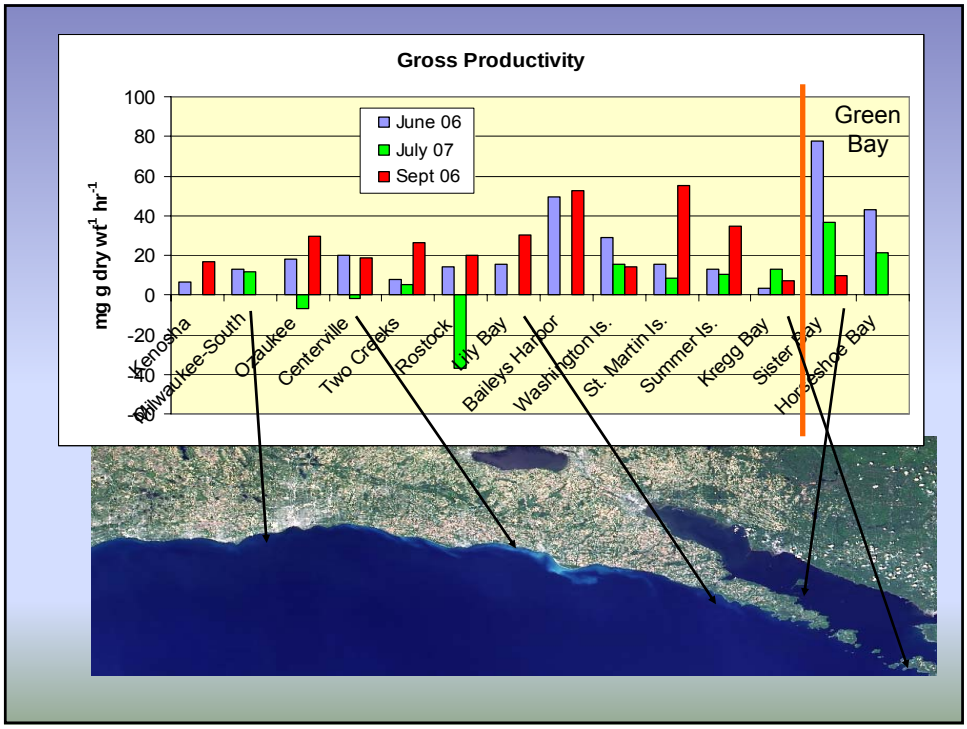

Garden Penn.
moderate growth
Sturgeon Bay
Kewaunee
Manitowoc
heavy growth
Sheboygan
Milwaukee
Kenosha
Tolypella

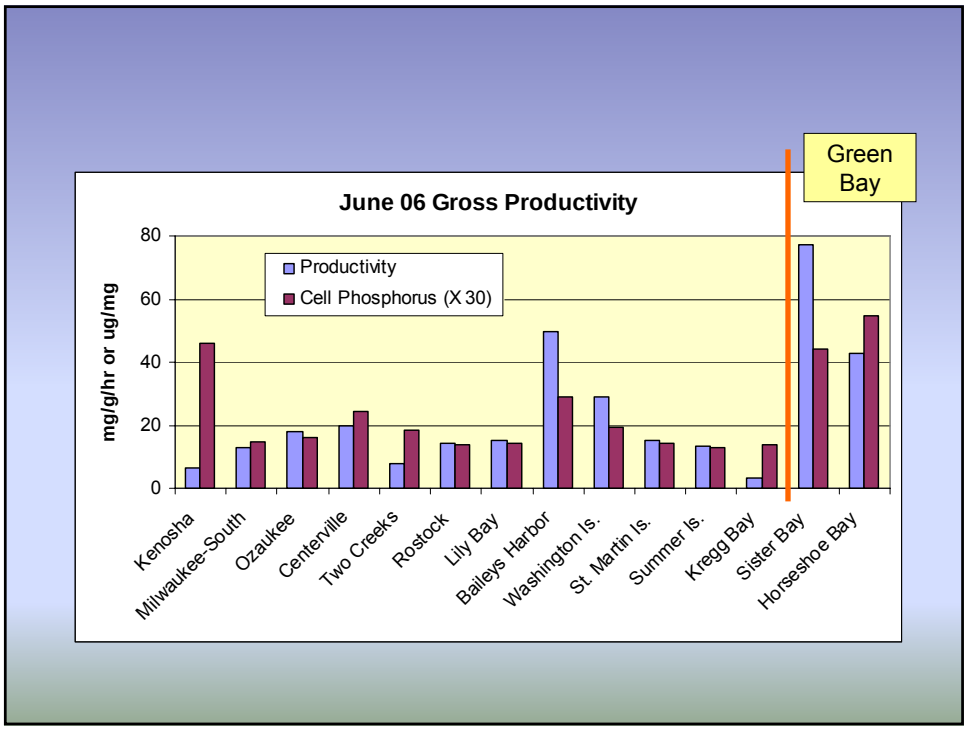

2006
Garden Penn.
St. Martin Is.
Washington Is.
Sturgeon Bay
Lily Bay
Kewaunee
Manitowoc
Hika Bay
Sheboygan
Milwaukee
Kenosha

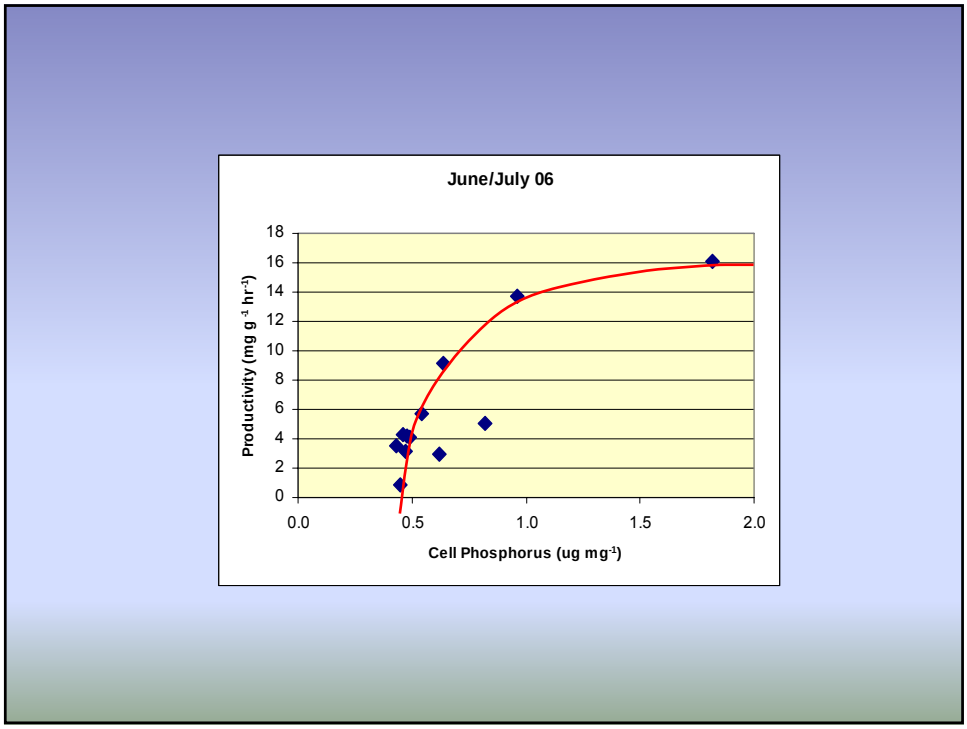


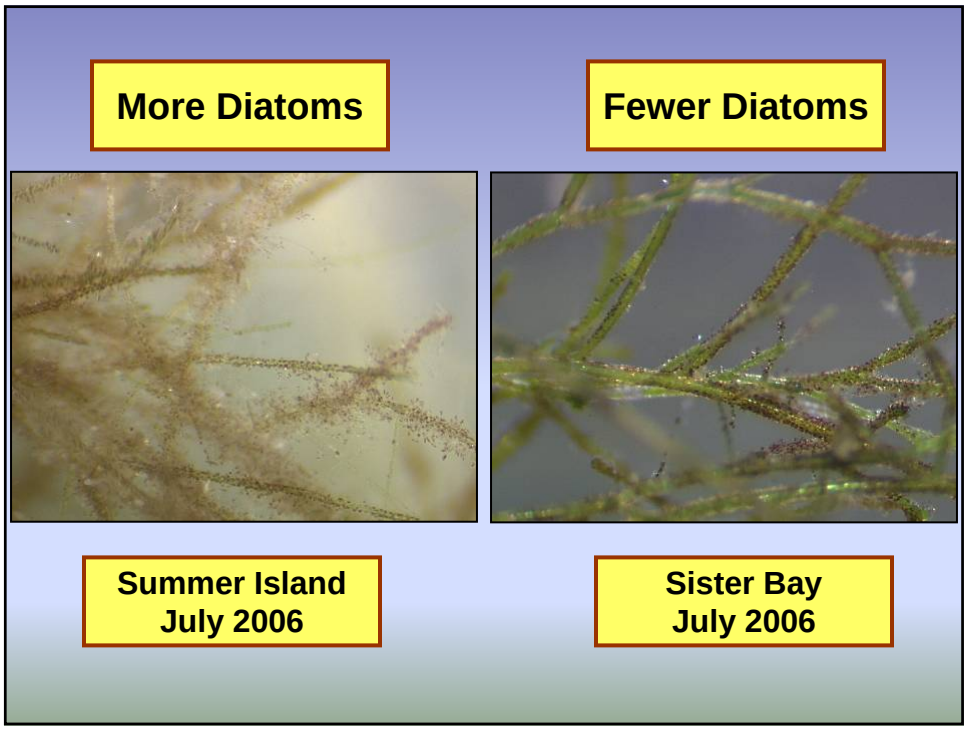
TEMPERATURE

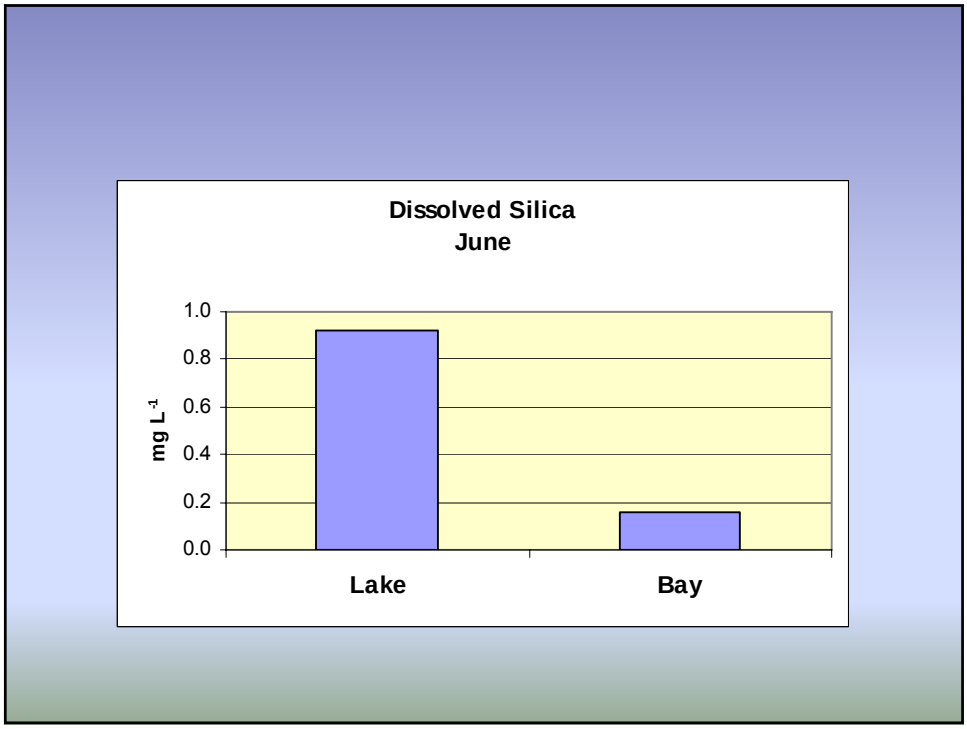



Gross Productivity
mg g dry wt-1 hr-1
100
80
60
40
20
0
-20
-40
-60
June 06
July 07
Sept 06
Green Bay
Kenosha
Milwaukee-South
Ozaukee
Centerville
Two Creeks
Rostock
Lily Bay
Baileys Harbor
Washington Is.
St. Martin Is.
Summer Is.
Kregg Bay
Sister Bay
Horseshoe Bay


June 06 Gross Productivity
mg/g/hr or ug/mg
80
60
40
20
0
Productivity
Cell Phosphorus (X 30)
Green Bay
Kenosha
Milwaukee-South
Ozaukee
Centerville
Two Creeks
Rostock
Lily Bay
Baileys Harbor
Washington Is.
St. Martin Is.
Summer Is.
Kregg Bay
Sister Bay
Horseshoe Bay


June/July 06
Productivity (mg g-1 hr-1)
18
16
14
12
10
8
6
4
2
0
0.0
0.5
1.0
1.5
2.0
Cell Phosphorus (ug mg-1)


More Diatoms
Fewer Diatoms
Summer Island
July 2006
Sister Bay
July 2006



CONCLUSIONS

- Phosphorus levels decline from south to north to Washington Island and then are similar in the northern portion of the lake.
- Total nitrogen levels are generally similar from south to north, or perhaps decline slightly.
- Nitrate levels decline from south to north, but levels are similar from Door Penn. and northern portion of the lake.
- The *Cladophora* productivity south/north trend doesn't seem to be related to nutrient trends.
- Unlike *Cladophora* in the eastern Great Lakes and Green Bay, the Lake Michigan population is associated with a diatom community.