

Lake Ontario Algae Cause & Solution Workshop Proceedings



**May 30, 2002
Rochester, New York**

Workshop Sponsors:

**Monroe County Department of Health
New York Sea Grant
NY Great Lakes Research Consortium
The Water Education Collaborative**

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Funding by:

NY Great Lakes Protection Fund Small Grants Program

Moderators:

**Dr. Frank Sciremammano, Rochester Institute of Technology
Helen Domske, New York Sea Grant**

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**Margy Peet, Monroe County Department of Health
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October 2002

TABLE OF CONTENTS

Introduction - Workshop Objectives	1
Background	2
Presentation Overviews	4
Conference Presentations	
Overview of the Basic Biology of Algae Growth Dr. Joseph Makarewicz, SUNY Brockport	6
Phosphorus and Other Nutrients in Lake Ontario Murray Charlton, Environment Canada/National Water Research Institute	23
Nuisance Algae Blooms Contributing Factors Chuck O'Neill, Sr. Extension Associate, NY Sea Grant	31
Preliminary Findings of Hyperspectral Imaging Project Dr. Anthony Vodacek, Rochester Institute of Technology	41
History of Lake Ontario Nuisance Algae Blooms Chuck O'Neill, Sr. Extension Associate, NY Sea Grant	48
Algae Management at Ontario Beach Park Charles Knauf, Monroe County Department of Health	50
USACE and URS Efforts to Analyze Options to Intervene at Ontario Beach Park Pier Michael Smith, Laura Ortiz, U.S. Army Corps of Engineers, and Dan Rothman, URS Grenier, Inc.	63
Conference Agenda	72
Work Group Breakouts	73
Summary of Evaluations	77
Presenter's Biographical Information	81
Attendees List	85

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Introduction – Workshop Objectives

On May 30, 2002, New York Sea Grant collaborated with Monroe County Department of Health and the Water Education Collaborative to sponsor a day-long workshop on the algae problem in Lake Ontario. The workshop, funded by the New York Great Lakes Research Consortium, examined the factors contributing to algae growth, problems associated with the algae blooms and potential solutions to this problem.

Residents in coastal areas along Lake Ontario have been dealing with nuisance algal blooms and the resulting mess and smell as the algae dies-off and ends up on beaches or along rocky shoreline areas.

This workshop provided a first time opportunity for those who study the problem, manage the areas impacted by the algae blooms and coastal residents who must cope with the algae on their property to gather together to share information and learn from each other. The workshop had strong support from many local and county governmental agencies, environmental organizations and university faculty members who comprised the 95 participants from both sides of the border who attended.

The organizers brought together experts from the U.S. and Canada to address issues related to these problems. Subjects covered at the workshop included basic biology of algae growth, recent research and trends, Lake Ontario algae bloom history, overview of past efforts to manage algae, and new ideas being evaluated for algae management. The workshop included solicitation of ideas for solutions and future research needs.

The program began with an overview of the basic biology of algae growth that was presented by Dr. Joseph Makarewicz of SUNY Brockport. Dr. Makarewicz also addressed Dreissenid mussels and their impact on water clarity, which increases light penetration and encourages algae growth. Murray Charlton, a research scientist from Environment Canada, focused on nutrients such as phosphorus and nitrogen and their role in algae growth.

Chuck O'Neill, a Senior Extension Associate from NY Sea Grant, provided information on physical factors impacting algal growth and identified different types of algae that can be found in these algal blooms, including *Cladophora*, *Ulothrix* and *Spirogyra*. *Cladophora* is a filamentous algae that grows in deeper water at warmer temperatures and is most commonly a problem during the summer months. O'Neill also provided an excellent historical overview of algal blooms that have impacted Lake Ontario for decades.

Other speakers included Dr. Tony Vodacek, of the Rochester Institute of Technology, who spoke about his findings on a study of the lake bottom using hyperspectral imaging. Speakers from Monroe County and the U.S. Army Corps of Engineers rounded out the presentations. Details of these presentations can be found in this publication. The group then broke up into small discussion groups that met to brainstorm potential solutions to the algae problem. Although no concrete solutions were offered, the groups indicated a need for additional research on the subject along with possible demonstration projects and educational/outreach activities.

Background

The accumulation of algae and its subsequent decomposition along the Lake Ontario shoreline contributes to bathing beach closures and causes strong odors along residential and recreational areas of the shoreline. The increasing problem impedes access to lakeshore recreational areas, impacts coastal homeowners, and has spurred citizens to organize and demand government actions to address the problem. Several factors have been identified as contributing to the problem of increased algae growth and accumulation, but the relative importance of each of those factors has not been agreed to or communicated to local governments or citizens.

The problem of rotting algae along the Lake Ontario shoreline has been a concern to residents and local governments in Monroe and other Lake Ontario shoreline Counties for many years. The rotting algae has contributed to temporary closures of Ontario Beach in Monroe County, and has resulted in ever increasing numbers of complaints from residents living along the entire Lake Ontario shoreline within Monroe County. The problem of rotting algae contributes to three use impairments identified in the Rochester Embayment Remedial Action Plan (beach closings, degradation of aesthetics, and eutrophication).

At Ontario Beach, the only public beach in close proximity to the City of Rochester, frequent temporary closures during the summer operating season are often due to *Spirogyra* and *Cladophora*, which wash up onto the beach and collect in the near-shore areas. The decaying algae provide both a substrate for growth and a nutrient source for bacteria that pose a risk to the well-being of bathers and necessitate beach closing. The odors caused by the decomposing organic matter also impact recreational and associated commercial operations in and near Monroe County's Ontario Beach Park.

While residents all along the shoreline have raised concerns about algae, a group of Lakeshore residents in the Town of Greece (4-miles to the west of Ontario Beach) have organized and become proactive in their efforts to contact public officials at all levels of government to demand actions to address the problem. The complaints focus around the fact that the raw sewage-like odors from the large quantities of rotting algae are so putrid that residents are forced to stay indoors with windows shut. When algae accumulations occur, it is impossible for lakeshore residents to use their shoreline for any recreational purposes. It is the perception of many landowners that their property values are being impacted and many complaints have included concerns about health impacts. Some residents question the fact that it is algae, rather than raw sewage washing onto their shore. Many residents do not understand or accept the fact that the algae is natural because it has, in their view, increased so dramatically in quantity and foulness. There is a need to identify the causes of the algae, the potential for solutions, and a methodology to effectively communicate the information to lakeshore residents and users.

An informal telephone survey done by the Monroe County Department of Health in 2000 indicated that algae growth and accumulation issues were of concern in all New York lakeshore Counties and that the algae accumulation issue, that appears to be increasing, is a lake-wide problem.

The identification of locations where the algae is growing is currently under investigation by the Rochester Institute of Technology through the use of hyperspectral imaging. Funds provided by Monroe County and by the New York Great Lakes Protection Fund Small Grants Program are supporting that effort. The results of that work are expected to explain only where the algae is growing. It is not expected to provide an explanation of which algae growth factors have the greatest impact on the phenomenon of ever increasing accumulations of algae or what, if anything, can be done to effectively manage the growth and accumulation of algae.

In addition to the hyperspectral imaging project, the U. S. Army Corps of Engineers is sponsoring a habitat restoration feasibility study in the Ontario Beach area. The feasibility study goal is to identify the best method of improving the environmental quality of the Ontario Beach study area—including reducing the accumulation of algae west of the Federal West Pier that extends into the Lake from the Genesee River. To date, several remedial alternatives have been identified and compared with respect to their cost and effectiveness. As part of that effort, the Corps has conducted some field demonstration projects of possible alternatives during the summers of 2001 and 2002.

Efforts are under way in the public engineering and public works community to design public projects to divert algae away from the public bathing beach at Ontario Beach Park in Monroe County. There is a need to bring all available information on the issue of Lake Ontario algae growth and management together to seek a common understanding of the dynamics of the natural ecosystem and the potential for successful intervention into the natural system causing the algae growth and accumulation. The conference organizers believe that the workshop held on May 30, 2002, has played a role in dealing with the algae problems in Lake Ontario.

General Workshop Outcomes

Three main outcomes resulted from this workshop: communication among interested individuals, identification of future research needs, and education. The most apparent outcome is the promotion of communications on many levels i.e., between academic researchers, Canadian federal and local officials, lakeshore residents, and the towns and counties located along the southern lakeshore. One interesting point that was made during the workshop was that *Cladophora* found on the south shore has changed consistency from a matted mass to a pea soup-like substance and this has not been the case on the Canadian shorelines, where algae has remained in matted clumps.

By gathering together those attempting to address the algae problem, those studying the contributing factors and affected residents, future research needs were more readily identified. The educational opportunity provided by the workshop is invaluable. It not only helped people better understand the current problem but the exchange of information allowed everyone to focus on the scale of the problem, as well as what types of algae problems are occurring in different areas. Participants also were able to learn about current research and what type of research is needed to address this problematic environmental situation.

Presentation Overviews

The workshop allowed for speakers to share their theories on the factors affecting algae growth. This is the first time that experts have collectively shared this information on known and potential causes and it is a crucial step in addressing the Lake Ontario algae growth and accumulation problem. The following is a synopsis of each speaker's main ideas:

Dr. Joseph Makarewicz, SUNY Brockport

Dr. Makarewicz focused on nutrients such as phosphorus and nitrogen and their role in promoting algae growth. He explained that, while phosphorus has been considered to be the nutrient most affecting algae growth, a current theory needing further research is that zebra mussels may have upset the usual relationship of phosphorus and nitrogen so that nitrogen may be playing a more important role. He stated that zebra mussels in Lake Erie led to an increase in the amount of nitrate in the western basin, which was also found to affect ammonia and phosphorus levels. He also noted that wind-driven upwellings bring nutrient-laden water up from the bottom of the Lake.

Murray Charlton, Environment Canada

Mr. Charlton also focused on the role of phosphorus and nitrogen in promoting algae growth. He stated that while \$20 billion dollars has been spent to reduce phosphorus inputs to the lake from wastewater treatment plants, no efforts have been made to remove nitrogen. The result is that nitrate and nitrite trends are increasing. He also pointed to fertilizer usage data for the Great Lakes basin that shows that Monroe, Orleans, and Wayne Counties are among the counties with the highest rates of fertilizer usage. He explained the concept of a 'thermal bar' - a warm ring of water existing around the perimeter of the lake that sets the stage for algae growth. Mr. Charlton stated that Canada has begun to conduct genetic finger printing of algae and this could lead to a better

understanding of the origin of algae that washes up on shore. He also shared that the Canadian Center for Inland Waters is researching whether *Cladophora* will grow with nutrient levels found in offshore waters.

Charles O'Neill, New York Sea Grant

Mr. O'Neill gave an historical perspective on algae blooms dating back to the 1930s. He described the different types of algae (*Cladophora*, *Ulothrix*, and *Spirogyra*) that wash up along the lakeshore and in what conditions or times of the year they grow best. He stated that it appears that meteorological conditions may be linked to algae blooms. In years when algae blooms have been the worst, it has been a warmer than average summer, warmer earlier in the season, sunnier, with lower turbidity. In years when the algae growth has been minimal, the temperatures have been cooler than average in the summer, warmer later in the year, cloudier, with higher turbidity. Mr. O'Neill also addressed the change in algae consistency experienced by the south shore from a matted substance to a soupy substance. He stated that the factors contributing to this may include one or more of the following: zebra mussel shells shredding the algae, the increase in lake water temperature enhancing the rotting of algae, and algae growing in deeper portions of the lake having more time to rot before washing inshore. He also noted that the circulation in the lake is generally counter-clockwise.

Dr. Anthony Vodacek, Rochester Institute of Technology

Dr. Vodacek presented his initial findings on a study of the lake bottom using hyperspectral imaging. The study involved flying over Lake Ontario and capturing images of the lake bottom. He explained that based on initial information there appears to be a relationship between algae growth and the hard-bottomed areas of the lake. This study is expected to be complete in 2002.

Other speakers focused on algae management solutions, both past and present.

Charles Knauf, Monroe County Department of Health

Mr. Knauf shared the different management techniques that have been tried in Monroe County to date and explained that in reaction to the change in the consistency of the algae, the techniques have been modified. He stated that when the algae was in long matted clumps, it could be raked up and hauled away. In 1996, the County purchased equipment to harvest the algae from the water, but this attempt was foiled because the algae was no longer matted but soupy. Recently, the management practices at Ontario Beach have concentrated on moving material parallel to shore and letting the waves move the algae instead of attempting to use heavy machinery, which grinds algae into the sand causing a potential bacteria problem.

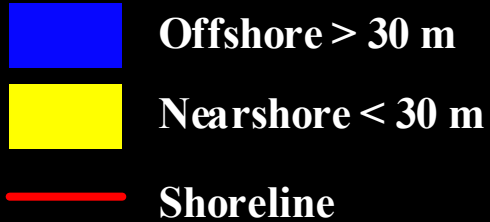
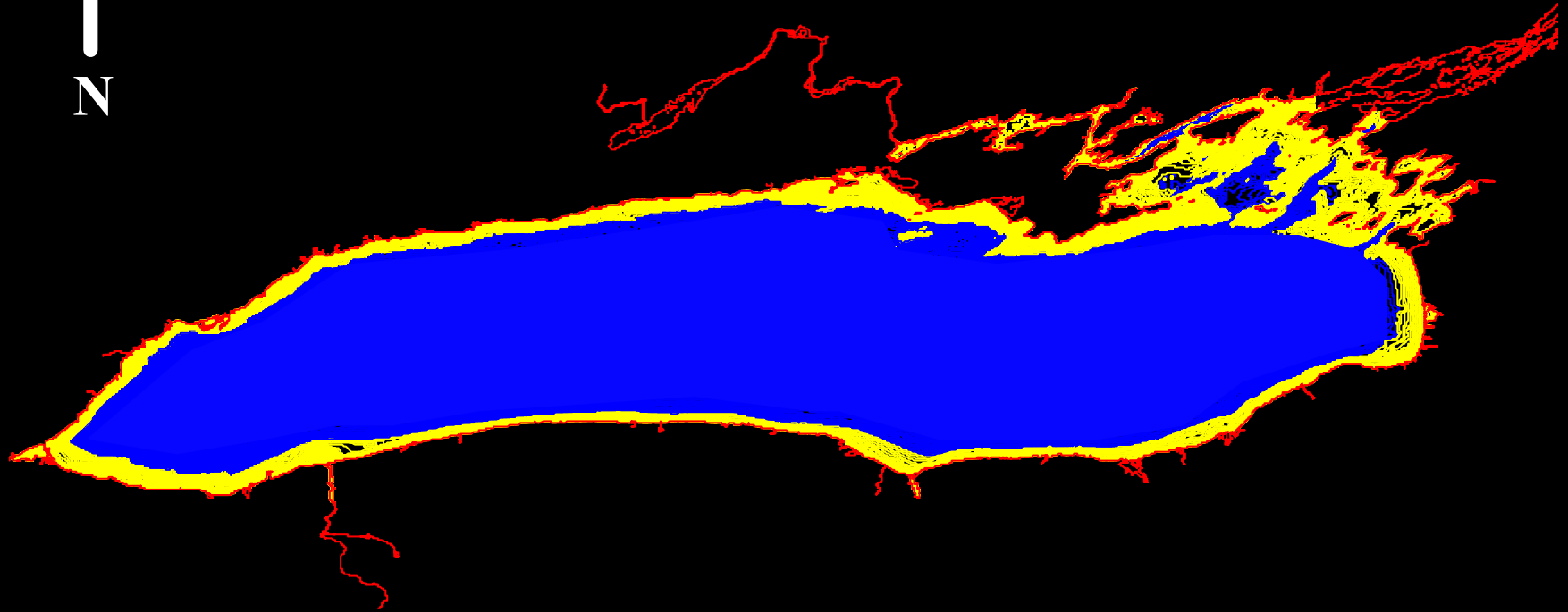
Dan Rothman, URS Grenier, Inc. (Consultant for the USACOE)

Mr. Rothman described the efforts to design a procedure to collect and remove the algae gathering along the western side of the Ontario Beach Pier. One option that is currently being explored is pumping the algae into the Genesee River outlet. He explained the operational questions that still need to be addressed such as efficient methods to 'herd' the algae and the impact to the river.

Overview of the Basic Biology of Algae Growth

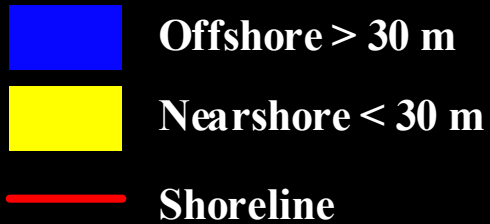
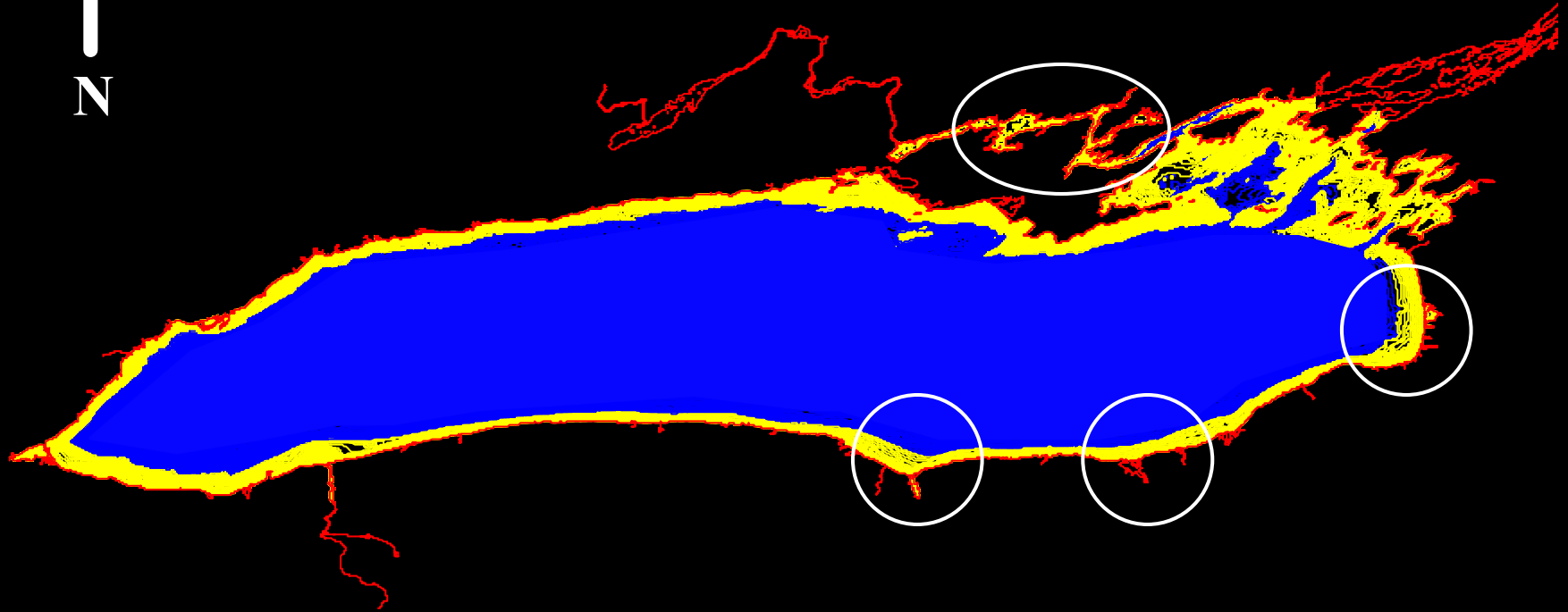
Dr. Joseph Makarewicz
SUNY Brockport

Lake Ontario Nearshore, Offshore, And Embayment Habitats



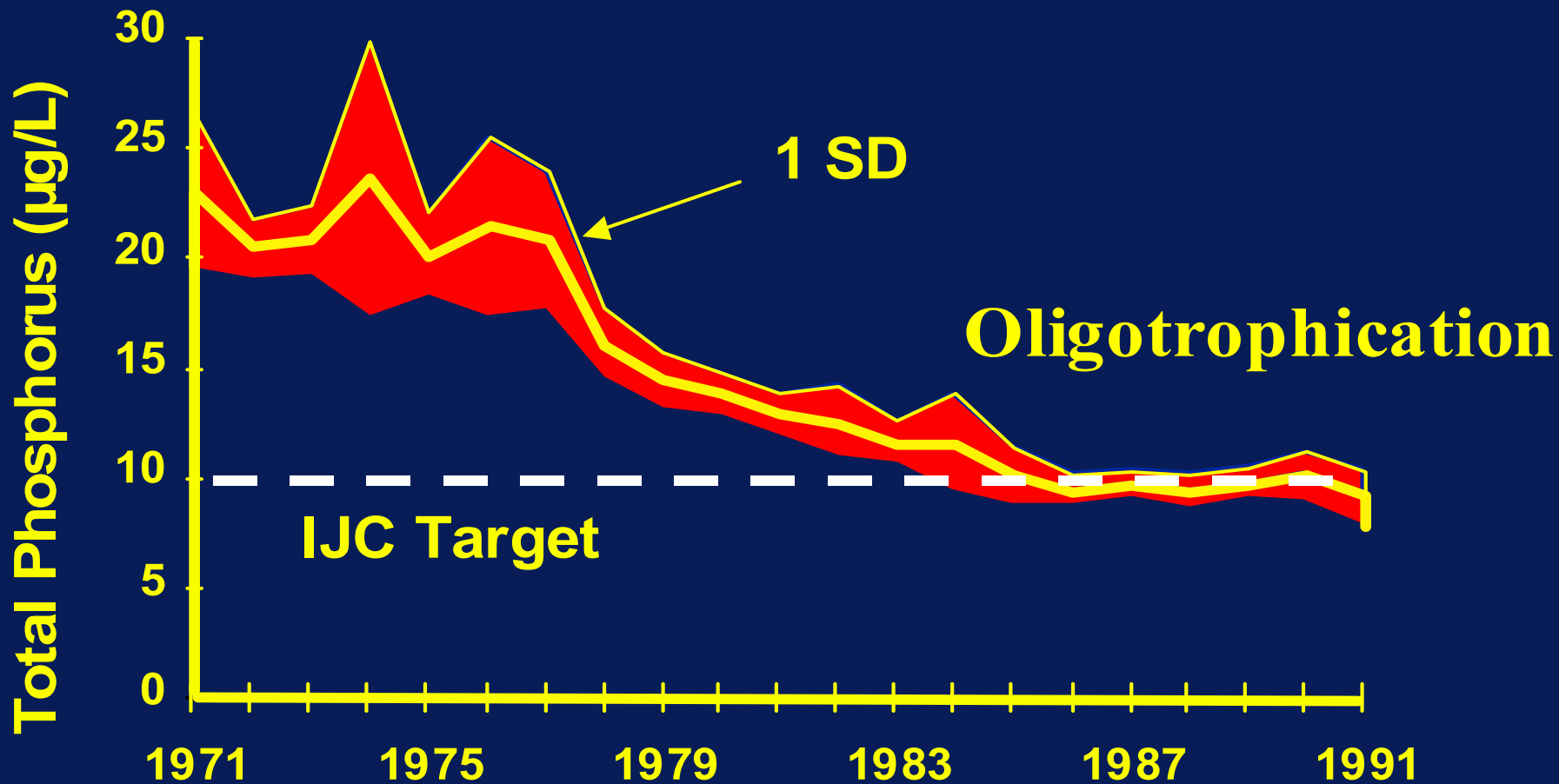
Nearshore surface area 19%

Lake Ontario Nearshore, Offshore, And Embayment Habitats

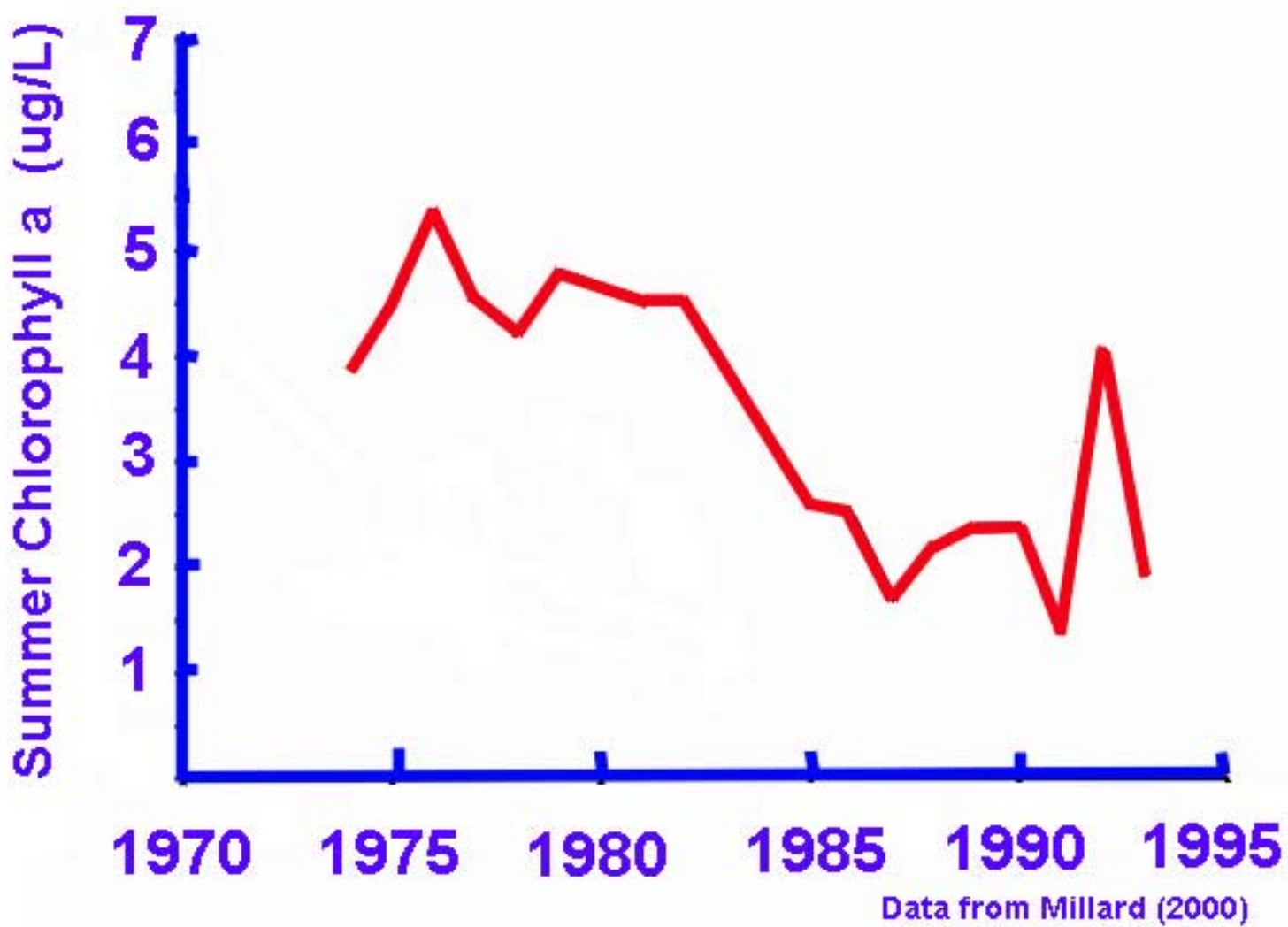


Bay of Quinte surface area 1.2%
Total embayment surface area 2.1%

Total Phosphorus Loading Offshore Lake Ontario



* Source: CCIW



Kendahl, NY: Summer, 2001



Cause?

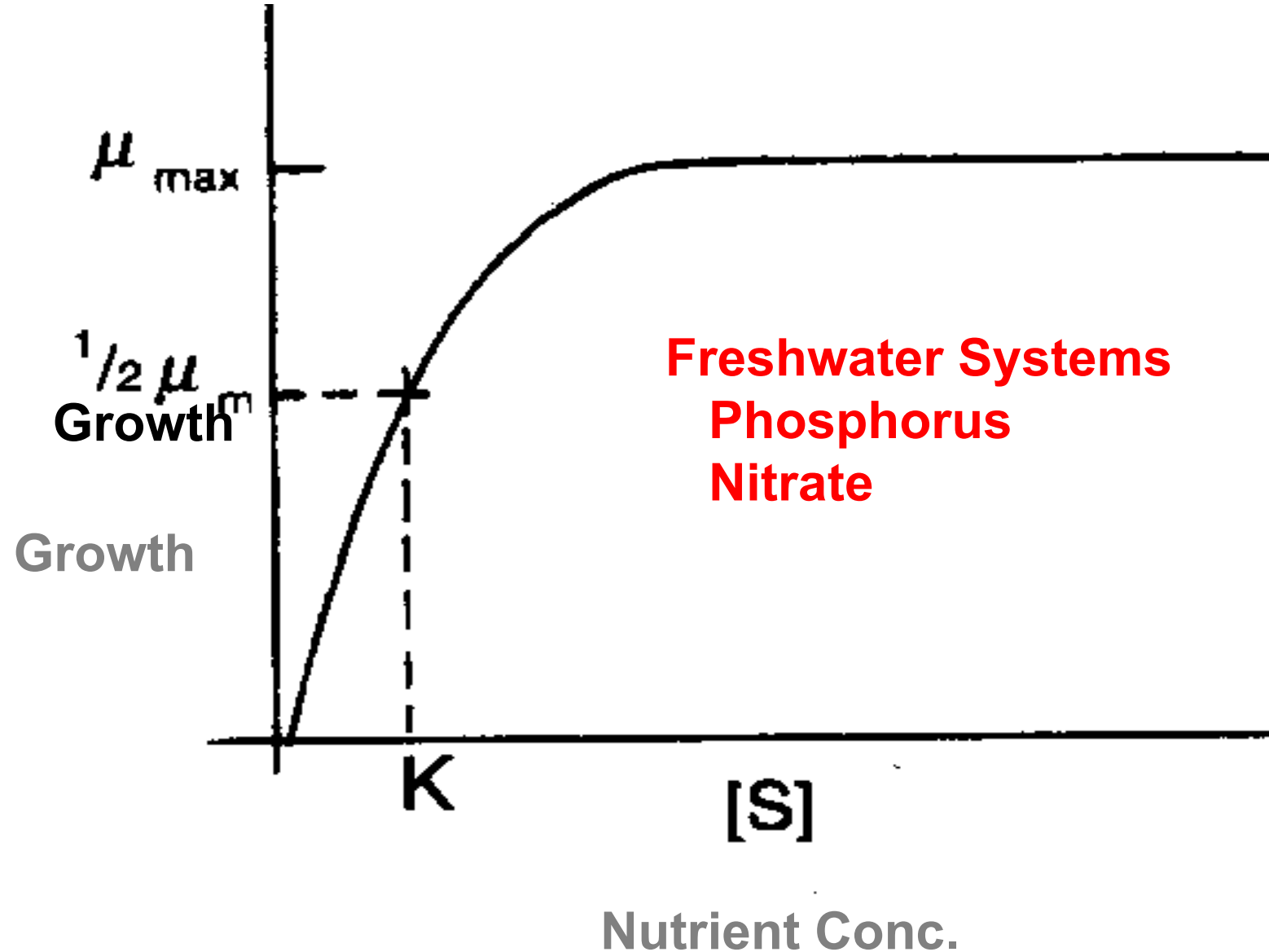
Background on Nuisance Algae

- *Ulothrix*, *Srirogyra*, and *Cladophora*
- *Cladophora* was the most dominant alga during the summer of 2001
- *Cladophora* is a light dependant, blue-green algae
- Grows on lake bottom
- Highest peak of production in late August
- Other species earlier in the year

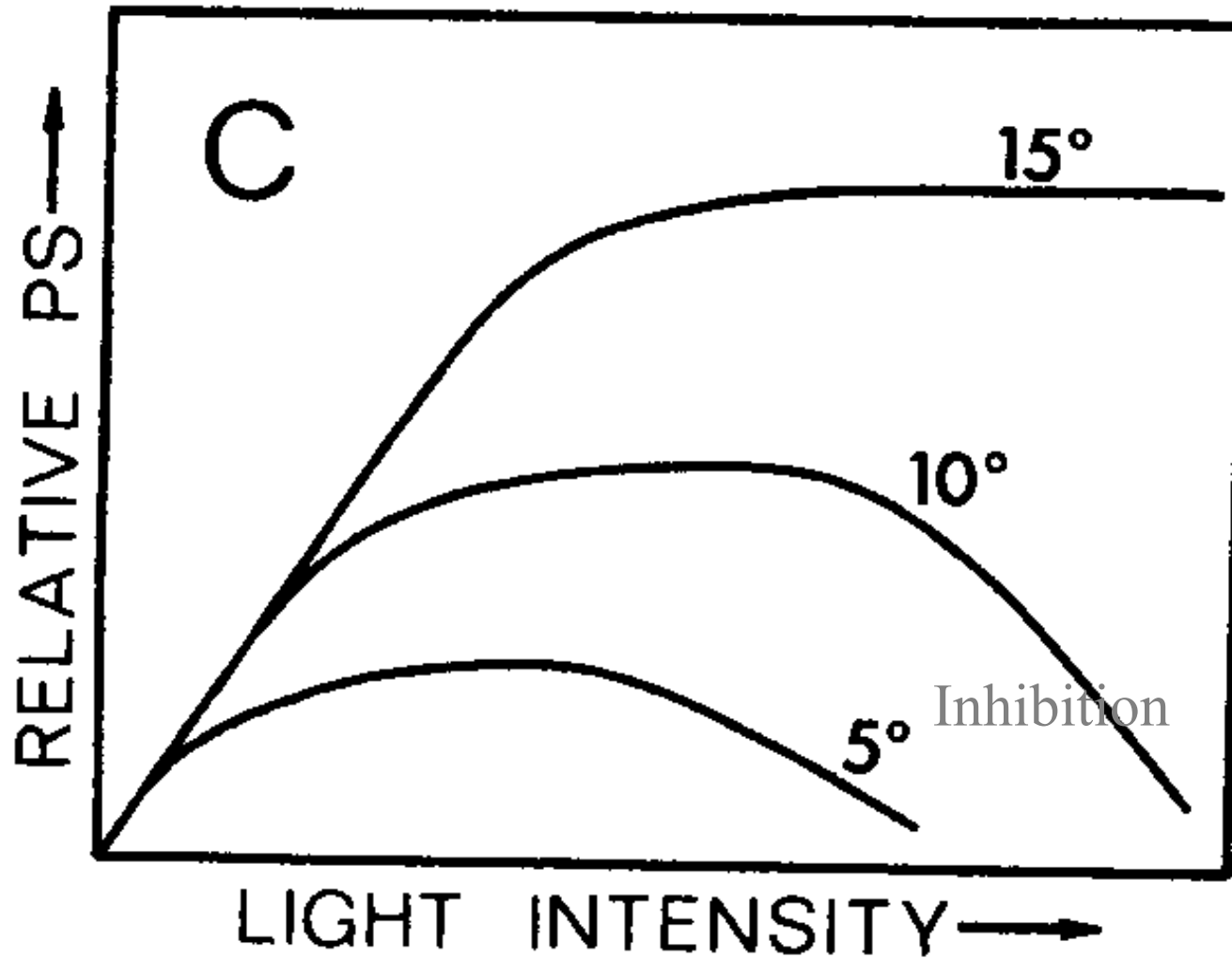
Nuisance algae observed during the summer of 2001



Plankton Growth in Response to External Nutrient Concentration



Effect of Temperature and Light on Photosynthesis (PS)



Organic Matter and Organic Growth

Organic compounds can function as nonessential accessory substances that may stimulate algal growth.

Vitamins – many algae require vitamins

Vitamin B-12

Thiamine

Biotin

Flotation Mechanisms

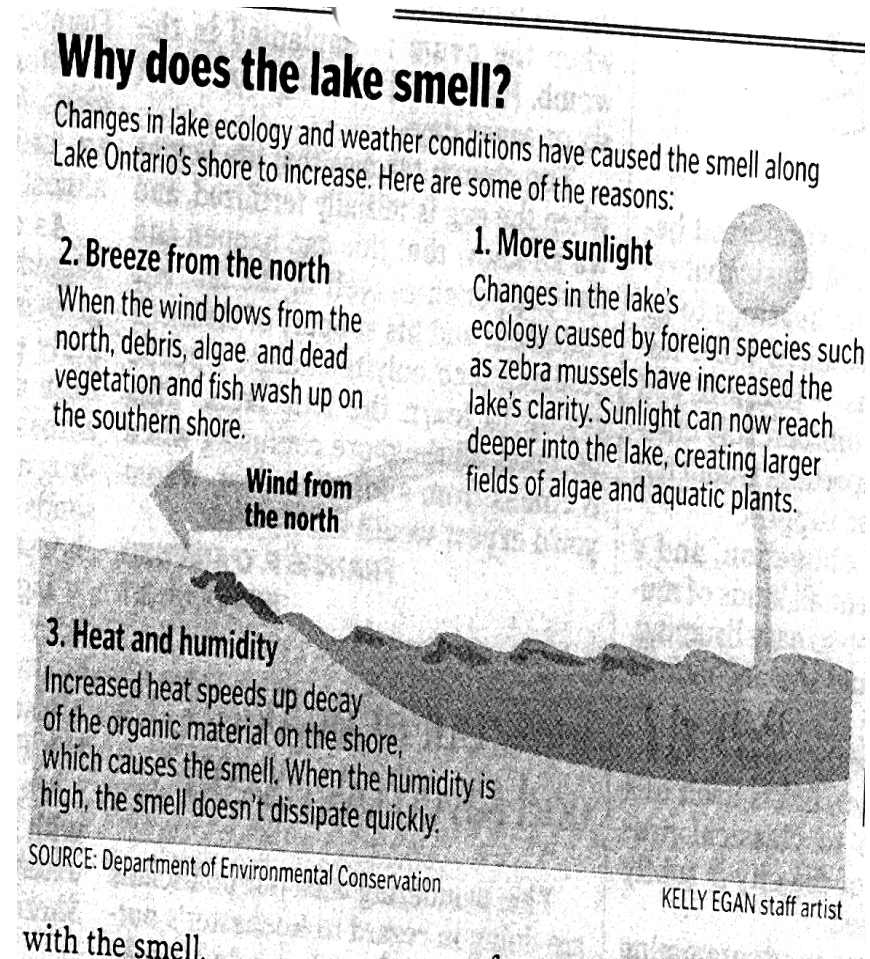
Cyanobacteria -

Cyanobacteria, through gas vacuoles, are able to regulate buoyancy and undergo limited vertical migration to poise themselves within physical and chemical gradients favorable to growth – usually toward the bottom of the euphotic zone

In extreme cases, blooms of cyanobacteria become so dense that “scums” of thick crusted accumulations of Cyanobacteria cover the water in wind-protected Areas.

How the Algae Reaches the Shoreline

- Wave action detaches the alga
- Large mats form on the water surface
- Currents transport the alga to the shore line



Nearshore vs Embayments: Water Clarity

Year 2000 May – October Average	Nearshore	Embayment
Chl a (ug/L)	1.40	5.87
Secchi Depth (m)	6.26	3.30

Nearshore vs Embayments: Temperature and Nutrients

Year 2000

May – October Average

Nearshore

Embayment

Temperature (C)

15.97

17.97

TP (ug/L)

13.02

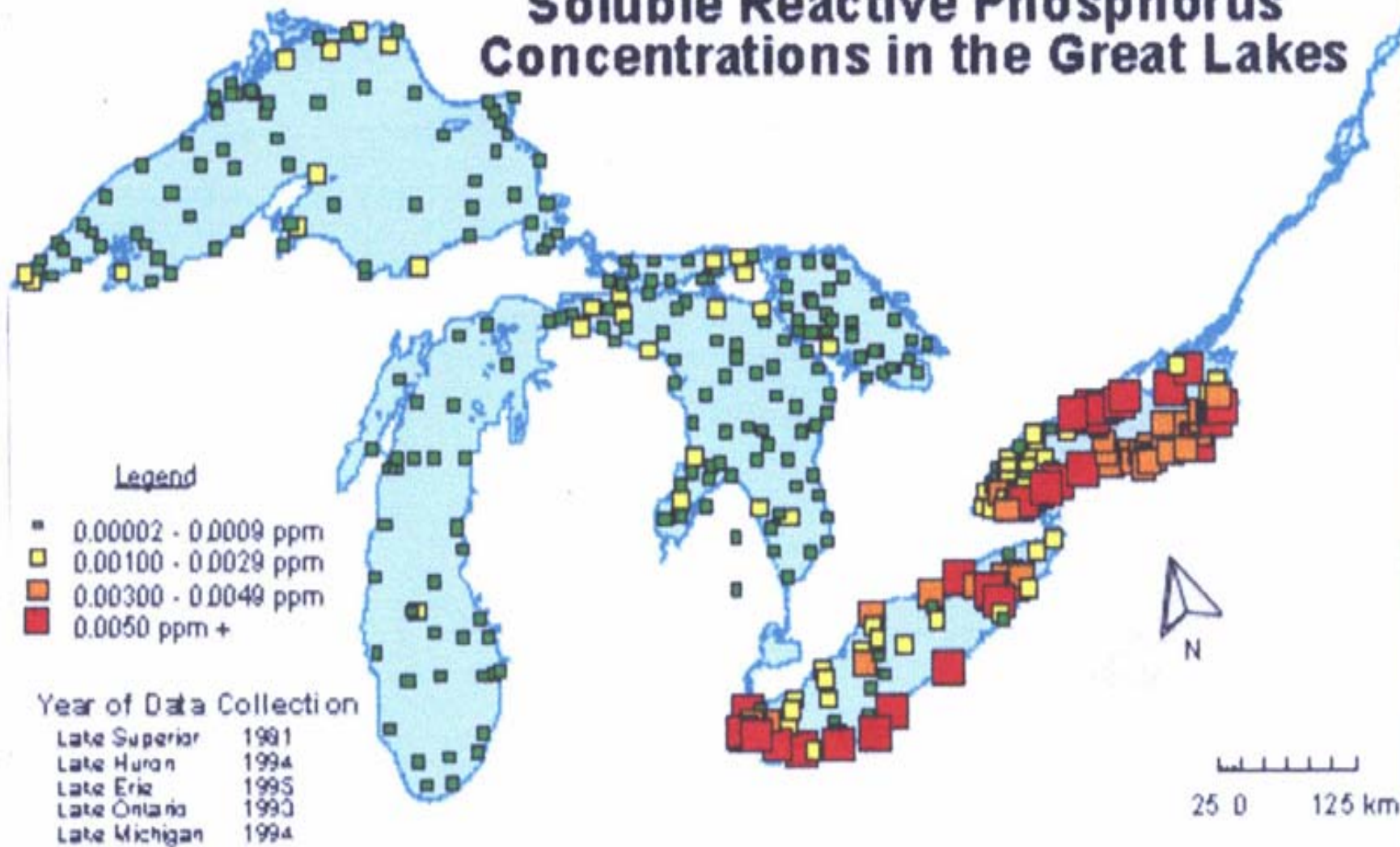
23.30

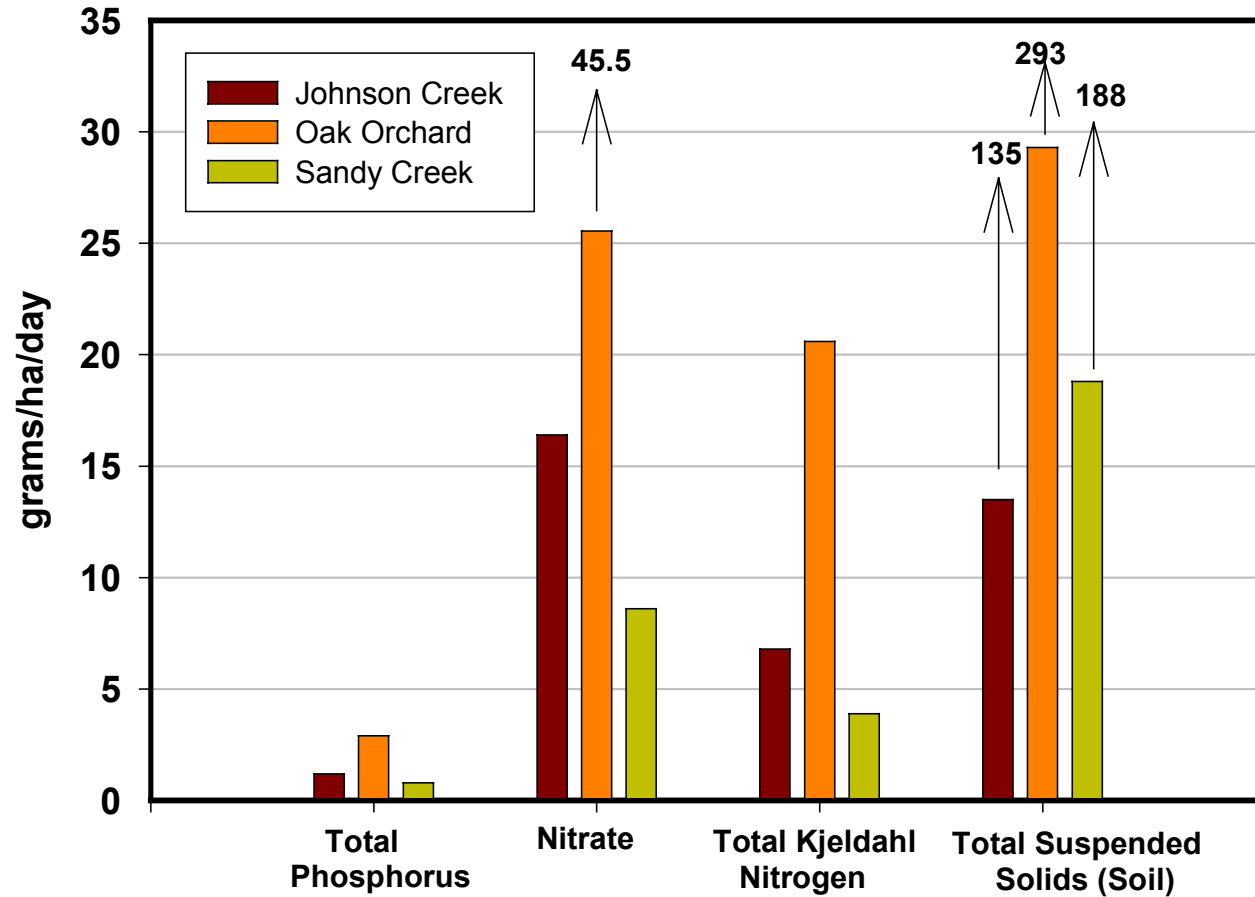
SRP (ug/L)

2.79

3.53

Soluble Reactive Phosphorus Concentrations in the Great Lakes





Soil and Nutrient Loss from Orleans County Watersheds

Are there new sources of Phosphorus?



Ice Ban[®]

Anti-Icing / Deicing Products



Chemical deicing agents used?

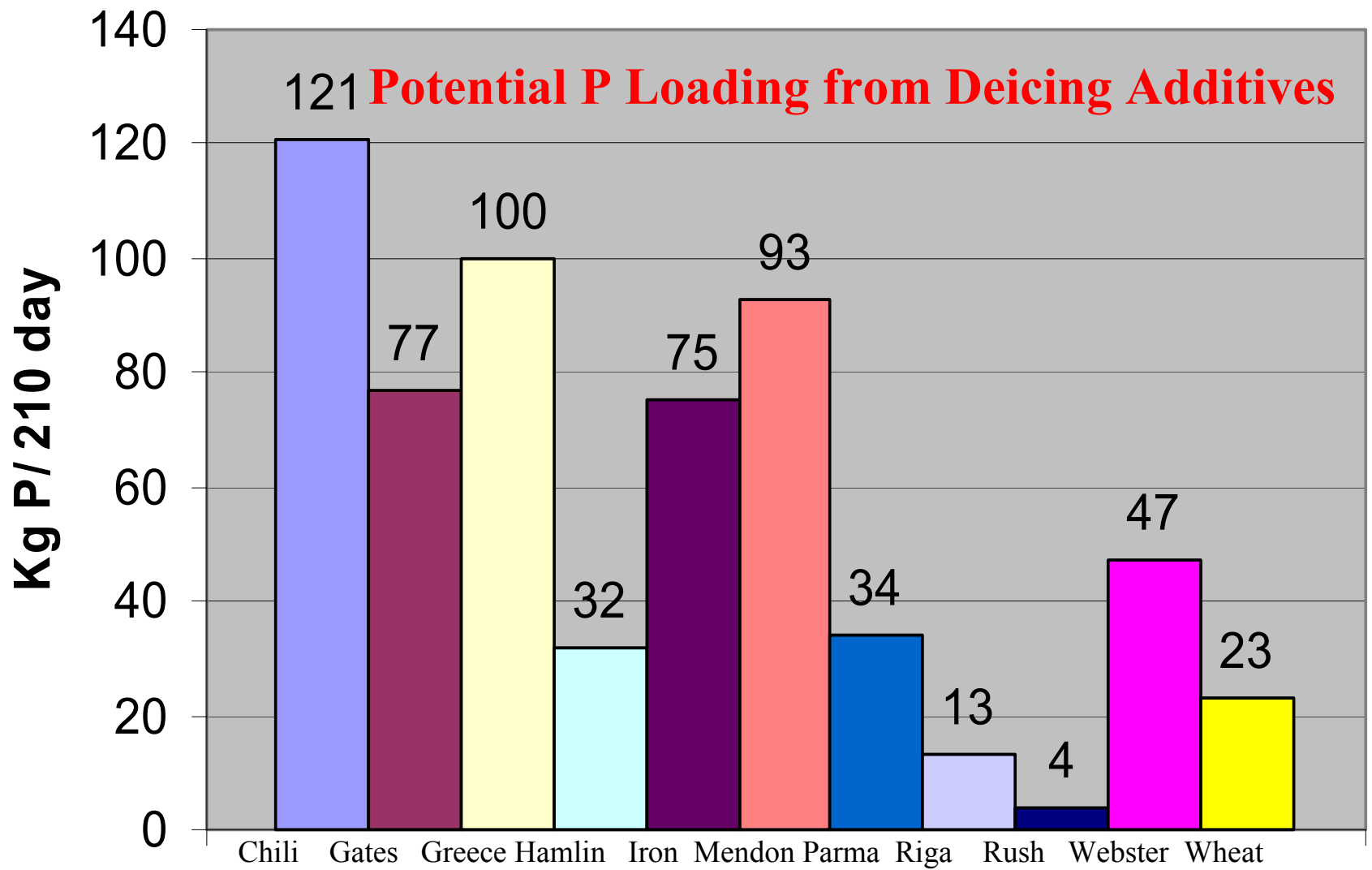
- Less corrosive than salt
- Increase surface adhesion
- Prevent clumping in stored salt piles
- They are cost effective

NATURAL SOLUTIONS CORPORATION



What are these deicing agents and what are they made up of?

Product	Description	Total chloride (mg/L)	Total Phosphorus (mg/L)
Magic-zero	MgCl ₂ and Spanish and/or Venezuelan cane sugar byproduct 50:50	18,6000	596
Ice B' Gone	Spanish cane sugar byproduct	28,4000	323
Caliber M2000	Manufactured corn product and MgCl ₂ 20:80	29,3000	249



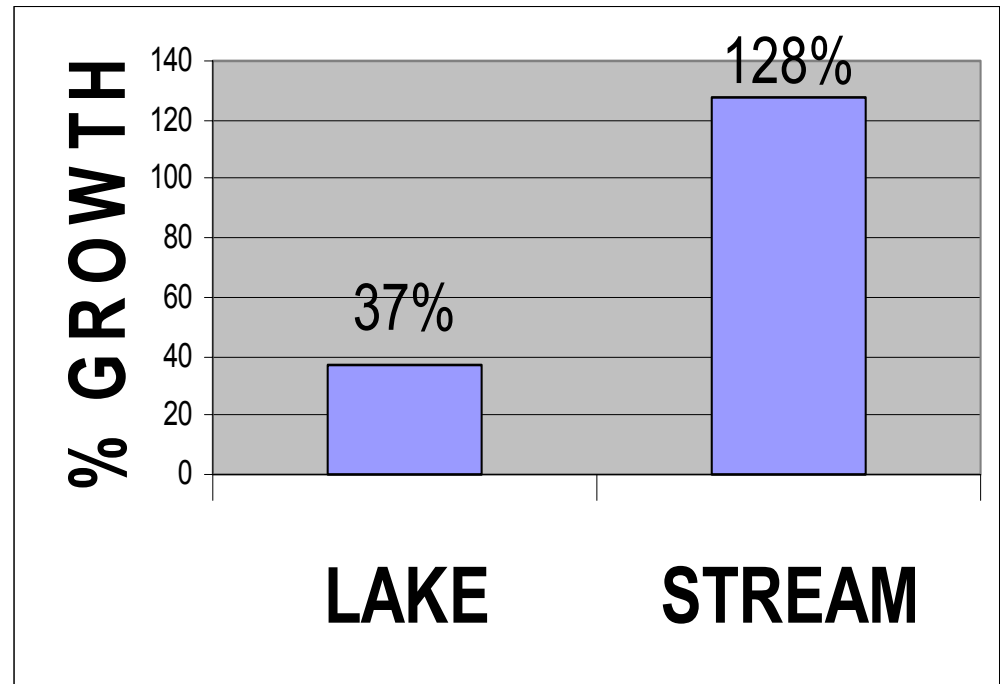




Wilkins Creek Data:

	SITE	% GROWTH
L A K E	Chamber 1	58.45
	Chamber 2	30.41
	Chamber 3	31.14
	Chamber 4	29.38
	AVG. =	37
S T R E A M	Chamber 5	104.50
	Chamber 6	84.89
	Chamber 7	149.91
	Chamber 8	172.68
	AVG. =	128

% GROWTH of METAPHYTON



* t test ($\alpha = .05$) Showed Statistical Difference.
($P < .001$)

A photograph of a single, closed Quagga mussel shell. The shell is elongated and spindle-shaped, with a light tan or yellowish-brown color and a smooth, slightly glossy surface. It is positioned vertically on the left side of the image.

Quagga

A photograph of a single, closed Zebra mussel shell. The shell is elongated and spindle-shaped, with a dark brown to black color and a highly textured, ribbed surface. It is positioned vertically on the right side of the image.

Zebra

Zebra Mussels

Early maturity

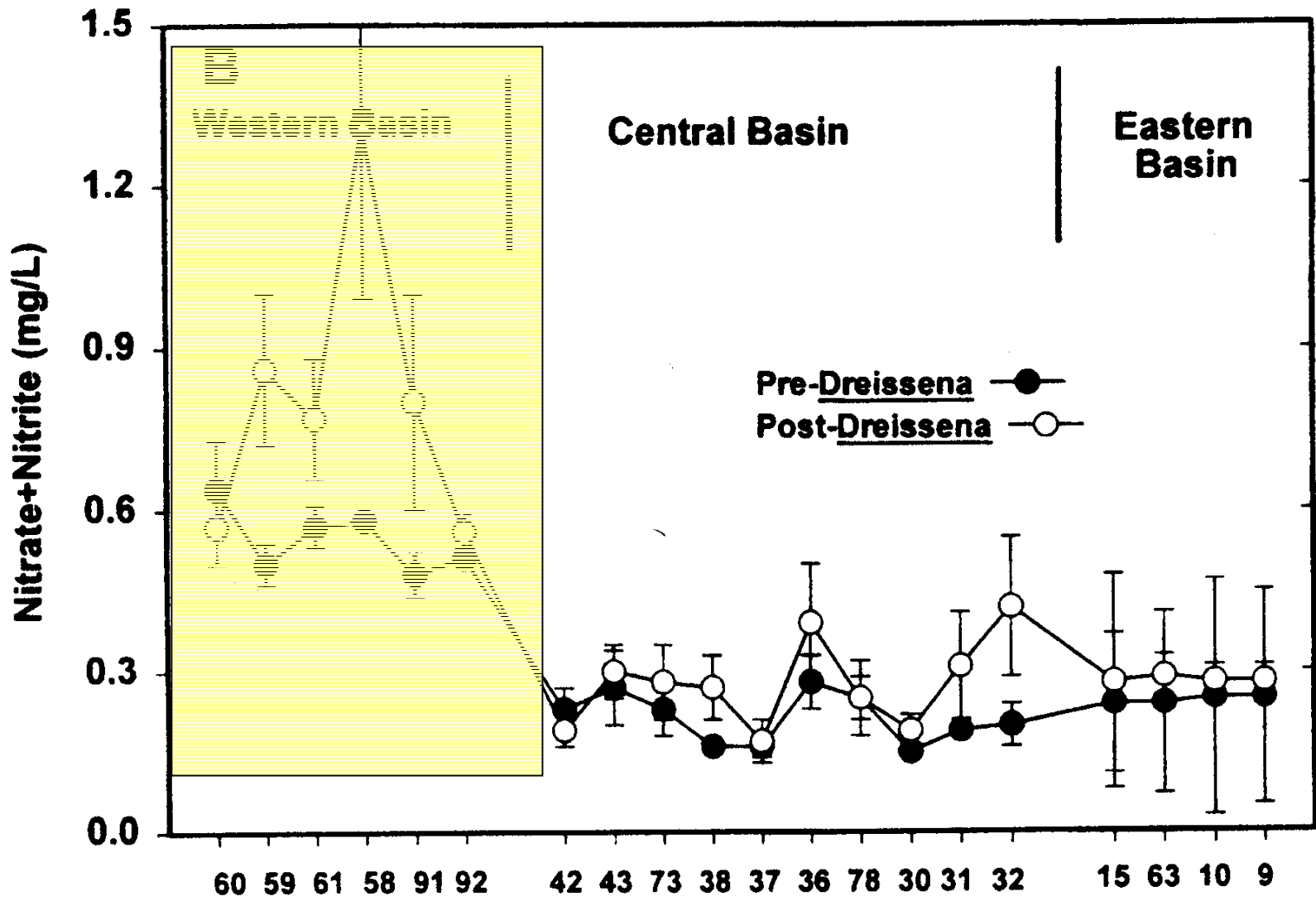
High growth rates

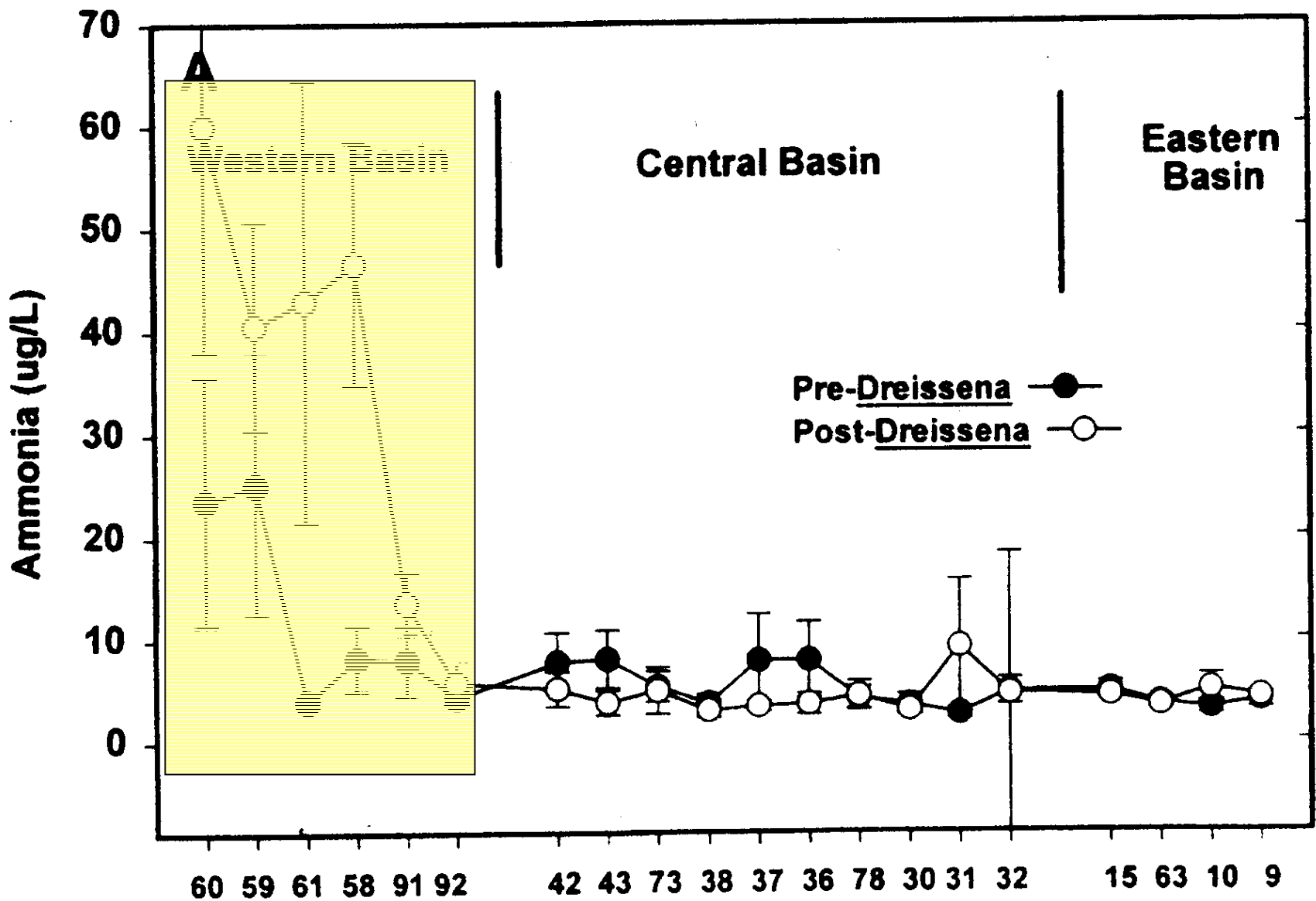
High fecundity

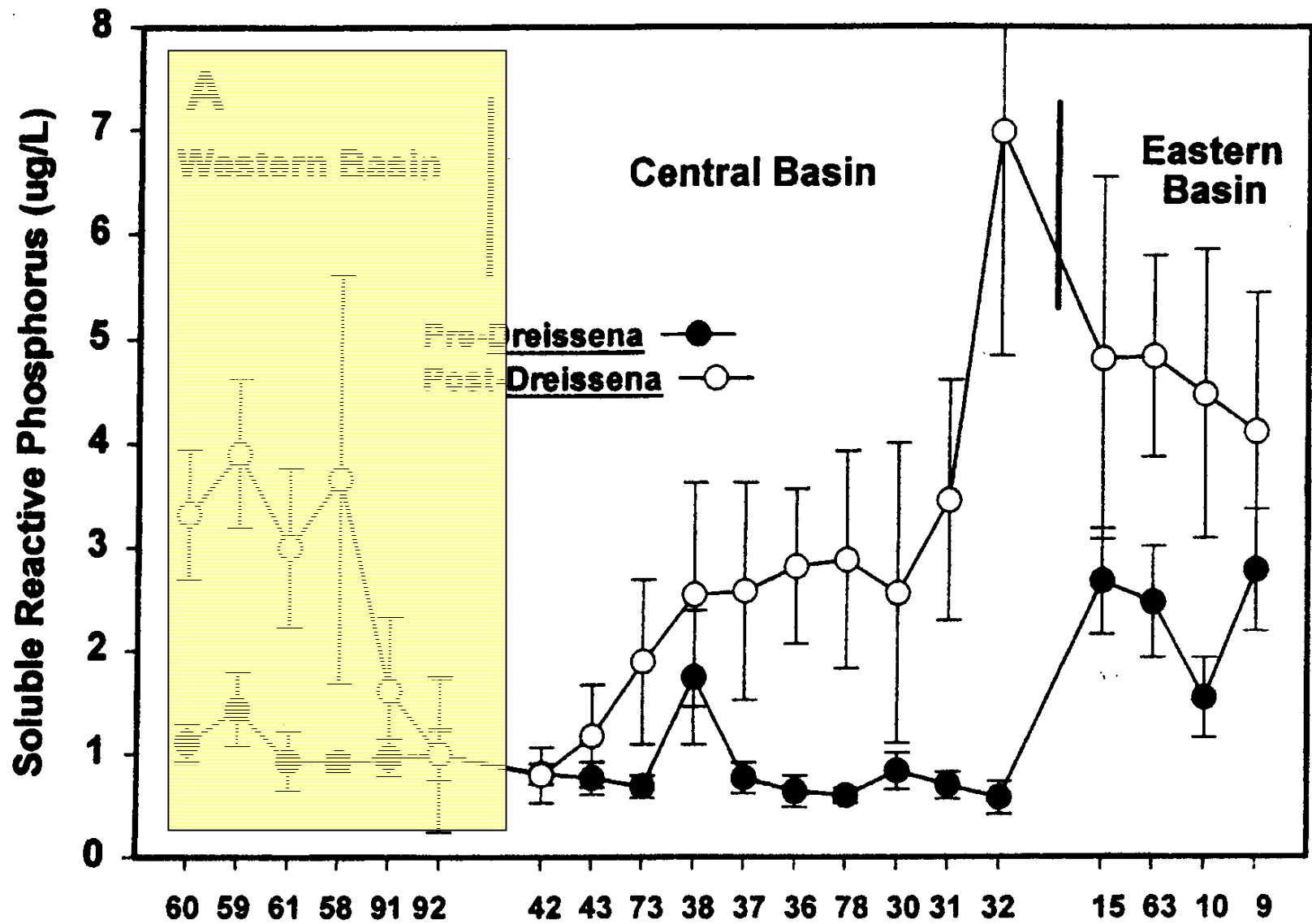
Flexible diet

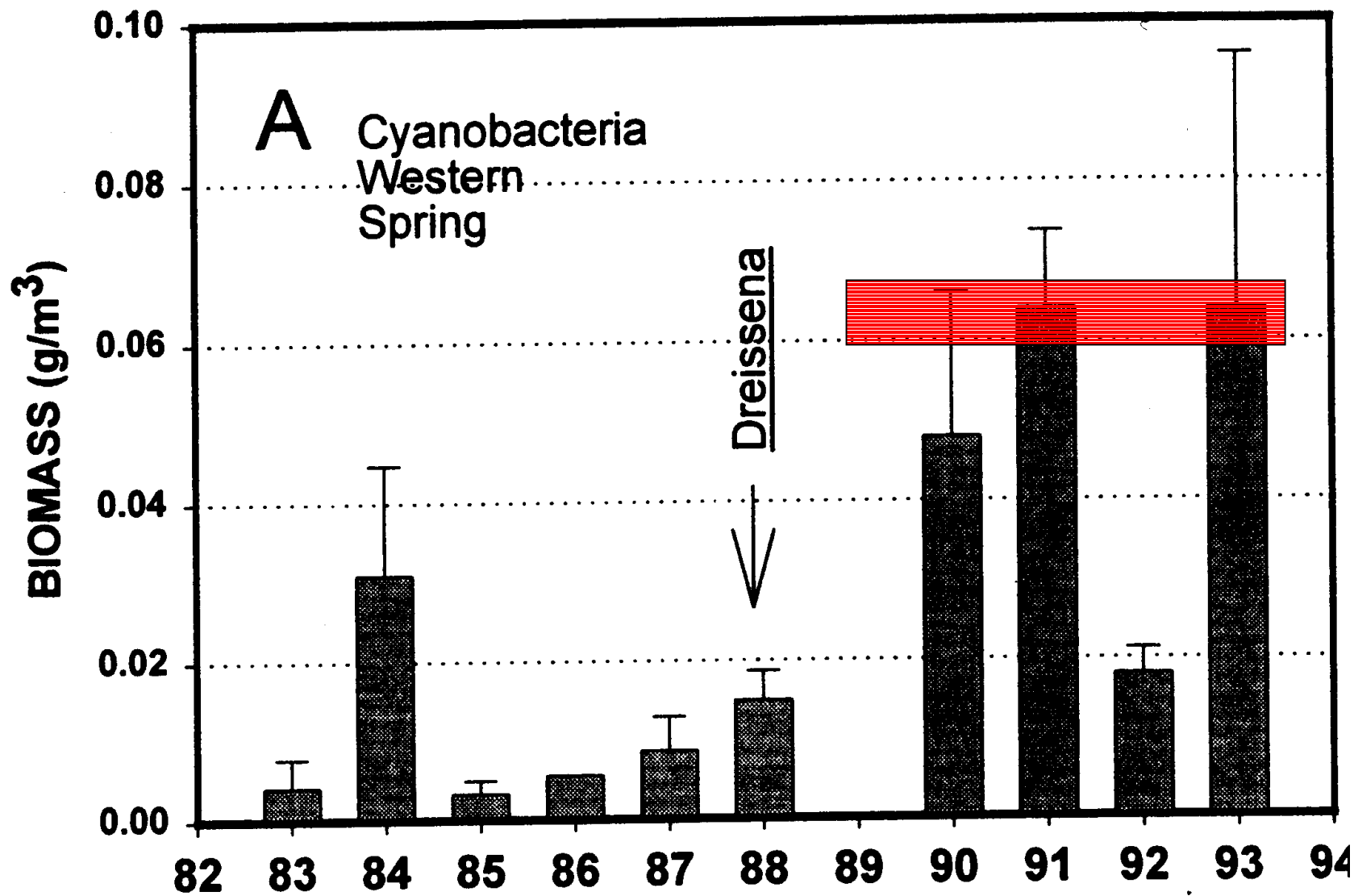
Zebra mussels are capable of filtering particles down to the size of 5 μm

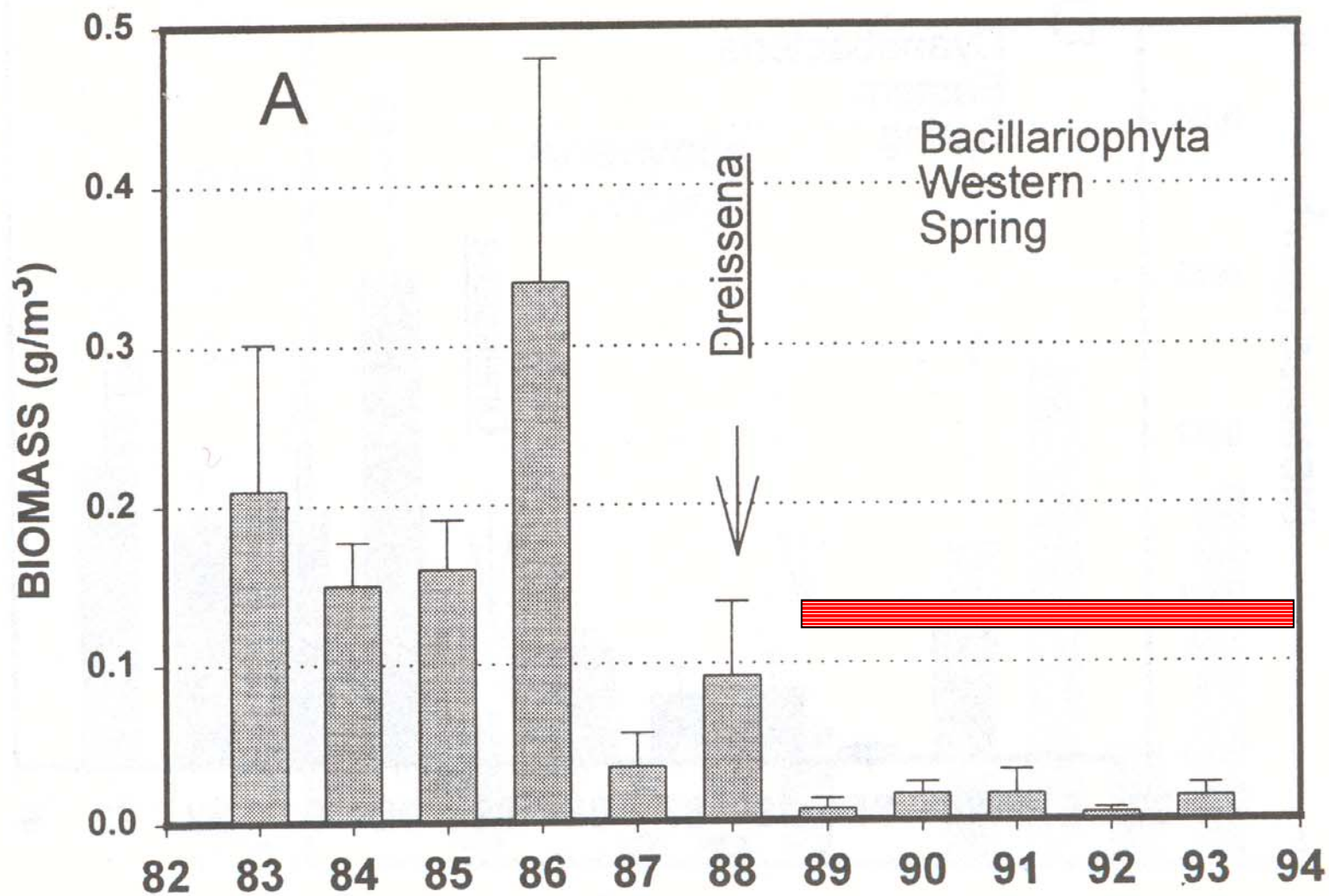
Ability to settle on just about any substrate











Redfield ratio

**Phytoplankton growing at maximum growth possess a characteristic ratio of major ions
16N : 1P**

The supply of phosphorus may exceed the the supply of nitrogen in eutrophic waters

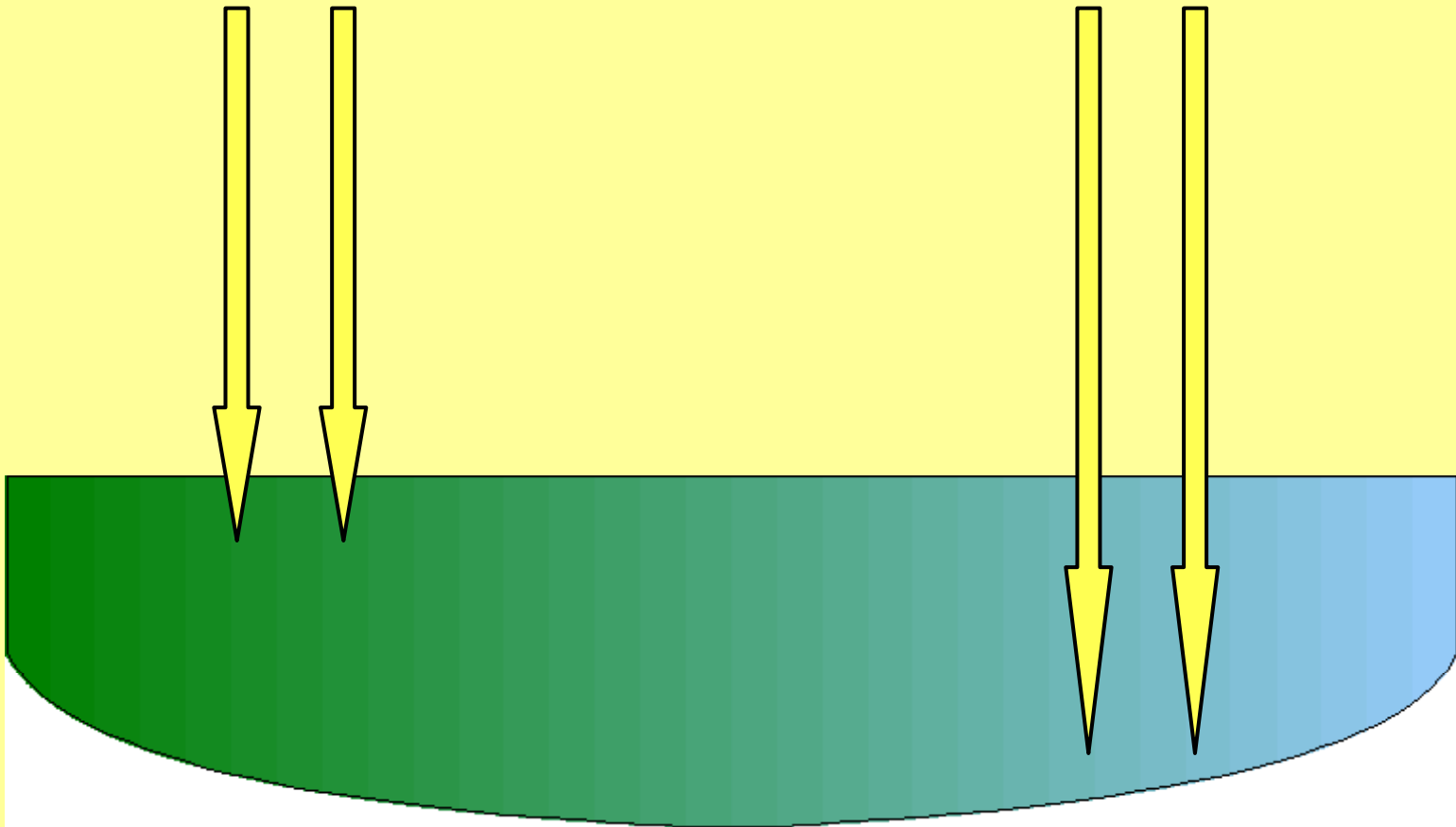
Under these circumstances, nitrogen fixing Cyanobacteria are favored.

Some feel, zebra mussels are affecting this Ratio (long term vs short term cycling)

**Pre-nutrient control
and zebra mussel**



**Post-nutrient control
and zebra mussel**



Impact of Zebra Mussels and the Upwelling Phenomenon

Zebra mussels are filter feeders

- Water clarity is increasing
- More available light near the bottom
- **Upwelling is the rising of cold, nutrient-rich water into the upper levels of a lake**
- **This periodic increase of nutrients may aid in increased alga growth**
- **Sloughing off when nutrients are reduced.**

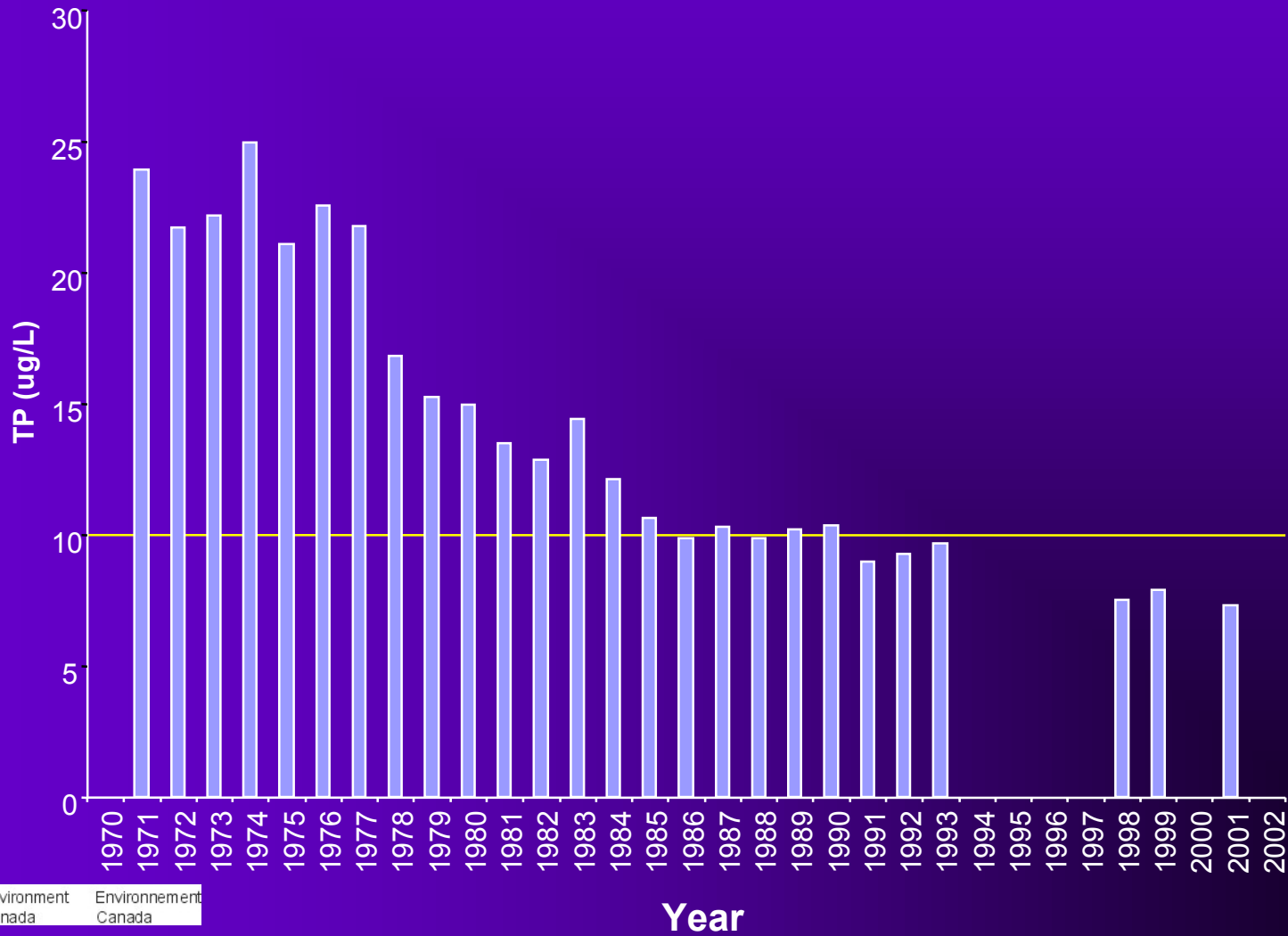
Consequences of Zebra Mussel Invasion

- **Biofouling**
- **Filter feeding**
 - a. **Decline in phytoplankton**
 - b. **Increase in filamentous/colonial algae**
Can not eat them? Size limitation?
 - c. **Increased water clarity**
 - d. **Shift from pelagic to benthic food web**
- 3. **Nutrient dynamics**
 - a. **Accumulation of bio-deposits- Stimulates weeds and some invertebrates**
 - b. **Increase in nitrate, ammonia, SRP**
 - c. **Effects N:P ratio, favors blue-green algae**

Phosphorus and Other Nutrients in Lake Ontario

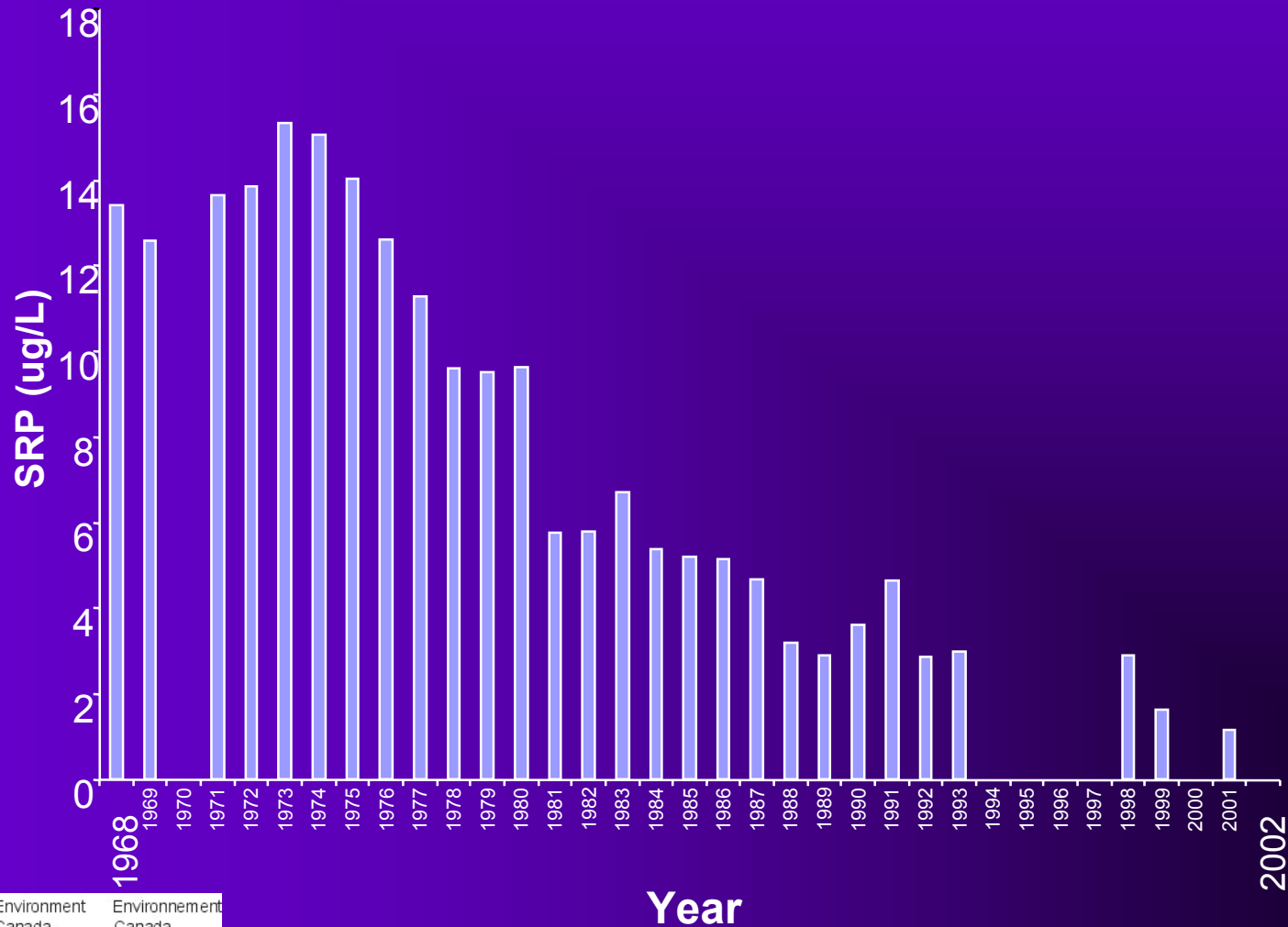
**Murray Charlton
Environment Canada
National Water Research Institute
Burlington, Ontario**

Lake Ontario TP Trends (open lake, spring, surface sampling)



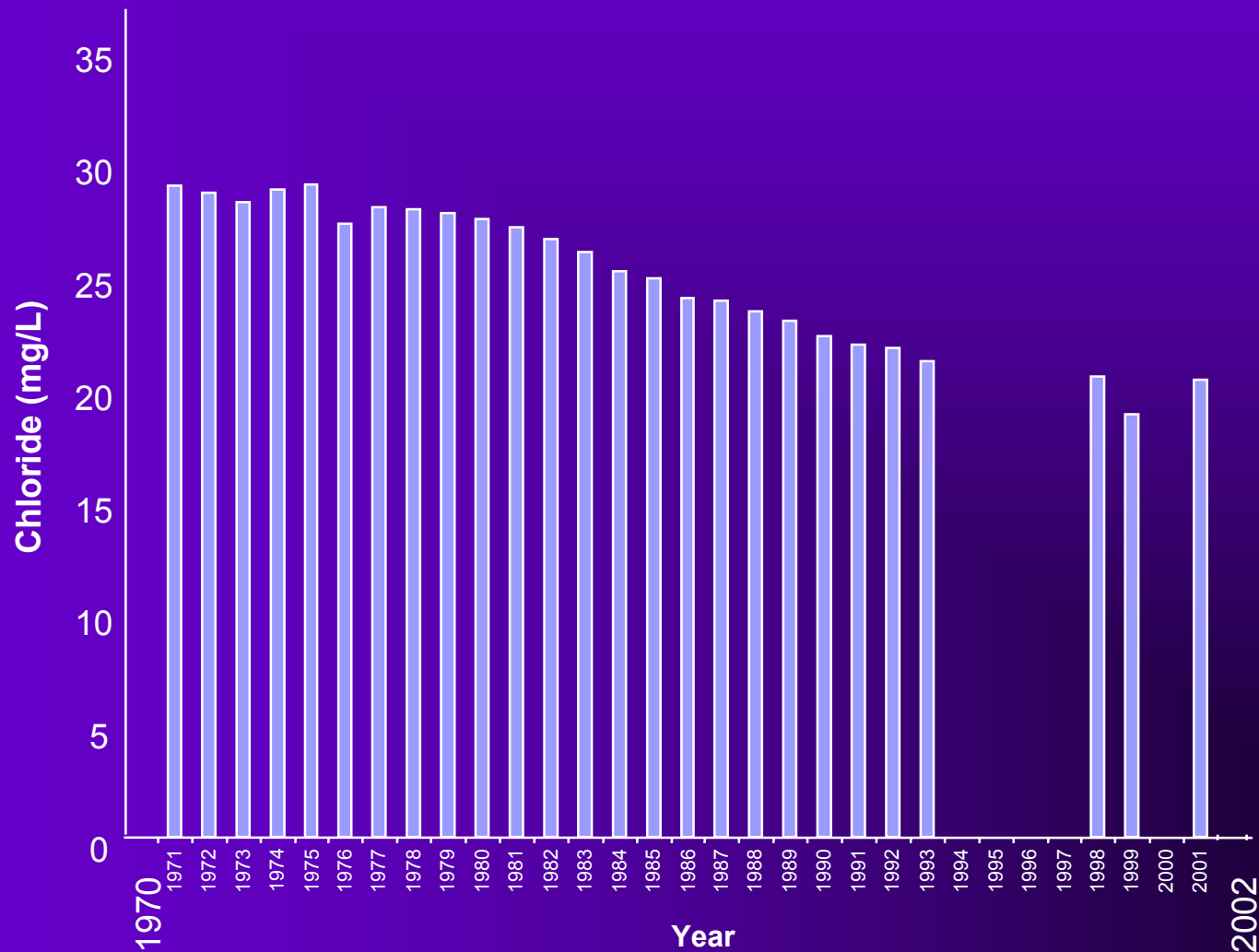
Lake Ontario SRP Trends

(open lake, spring, surface sampling)



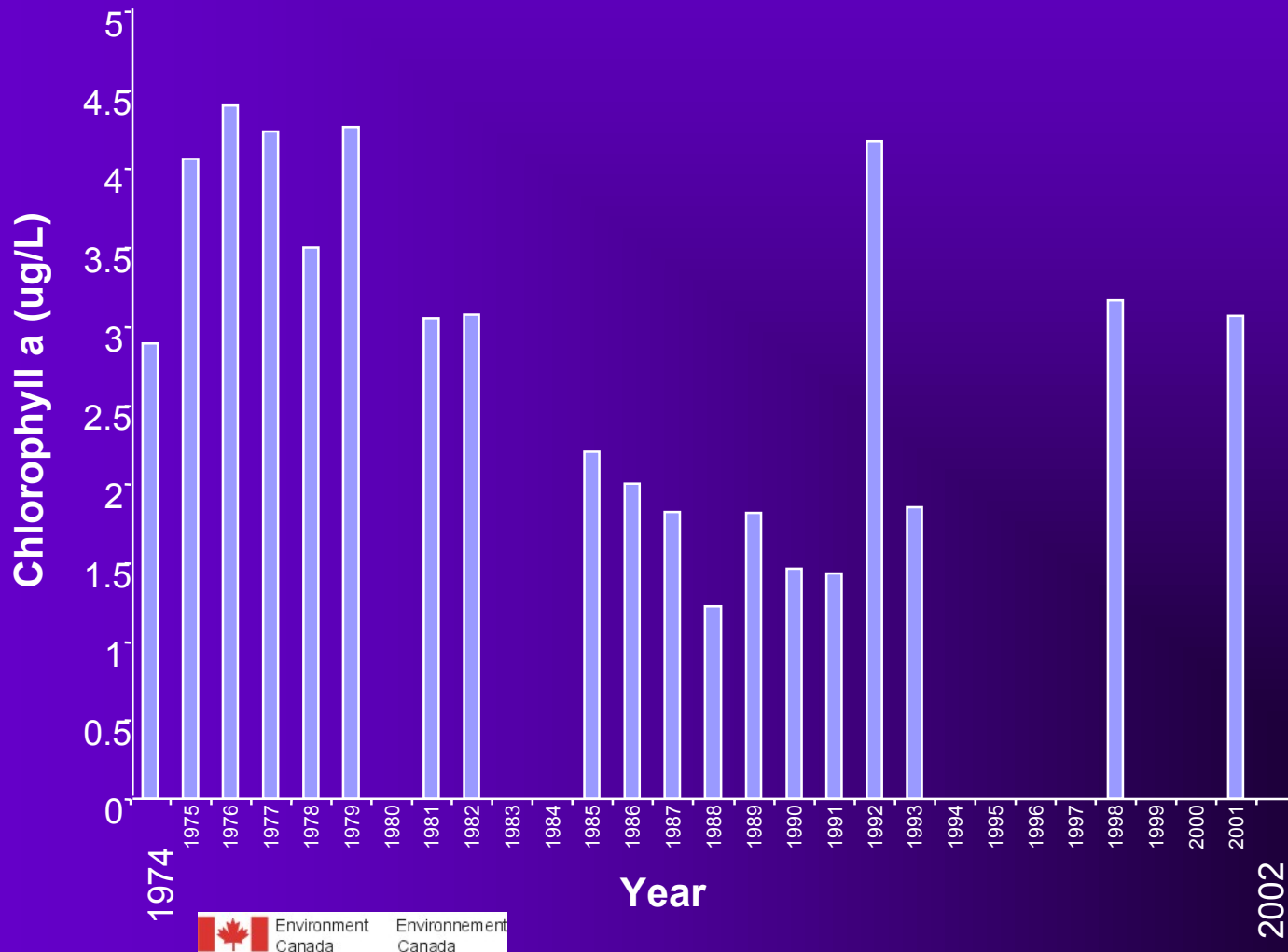
Lake Ontario Chloride Trends

(open lake, spring, surface sampling)



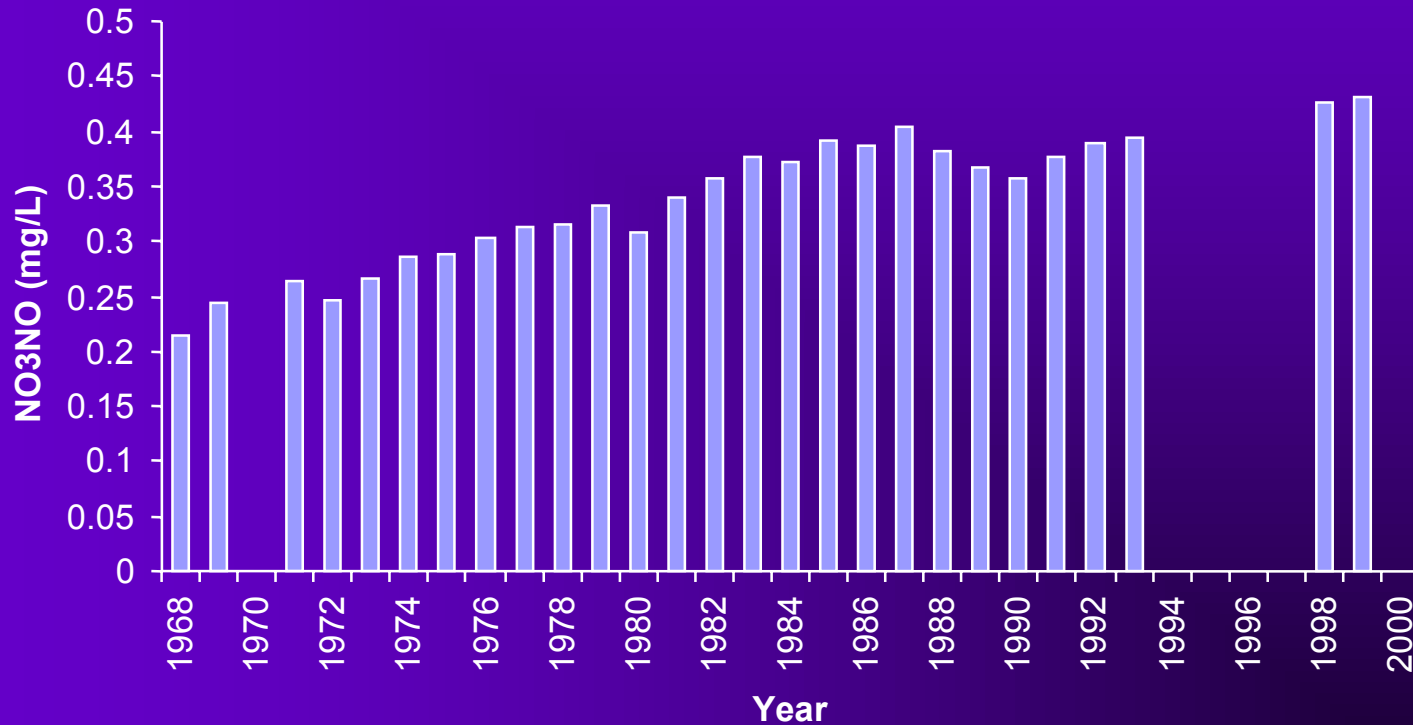
Lake Ontario Chlorophyll a Trends

(open lake, summer, Integrated 0-20m sampling)



Lake Ontario NO₃NO₂ Trends

(open lake, spring, surface sampling)

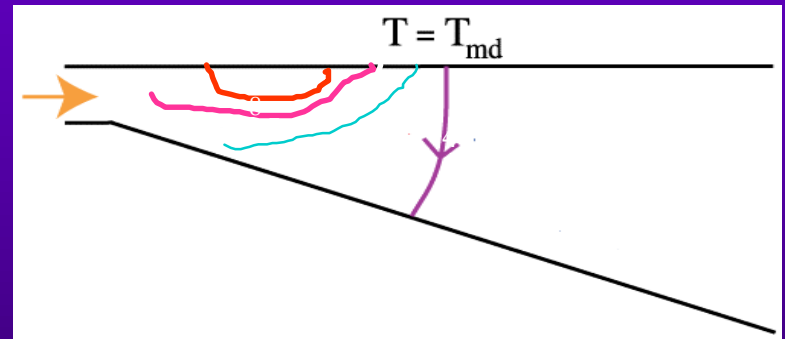


Observations on Canadian *Cladophora*

- Problem was severe in 60s and 70s.
- Problem decreased with lake phosphorus.
- Growth is more luxuriant around cities.
- Water clarity has increased - this allows growth to greater depths.

Thermal Bar

In spring, water warming takes place due to heat flux from the atmosphere.

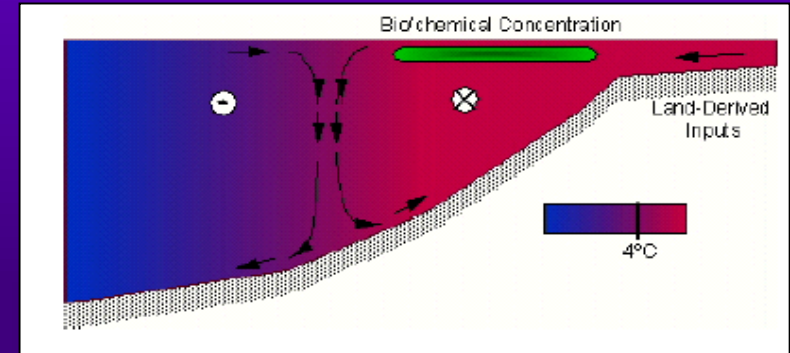


Water in shallow zones is heated faster compared to deep water.

Waters on the shallower zone of 4°C isotherm becomes stably stratified, and waters on the deeper side of 4°C are unstably stratified.

In the vicinity of 4°C isotherm (THERMAL BAR) double cell circulation develops with converging flow in the surface and downwelling at 4°C isotherm zone.

Divergence in the bottom layers and weak upwelling of isotherms in the shallow zone.



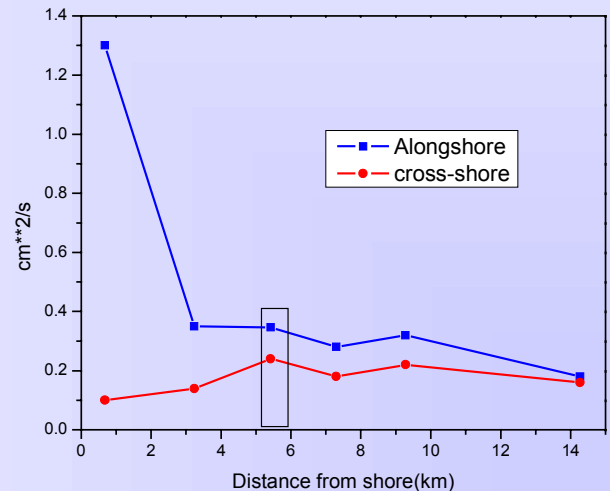
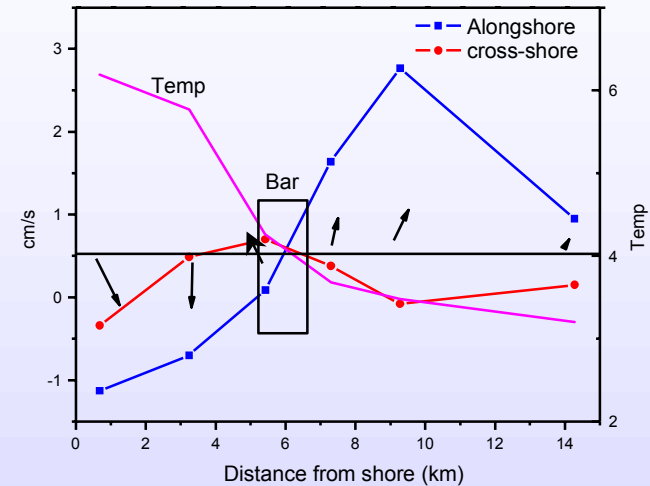
Characteristics of Flow inside and outside Thermal Bar along the North Shore

In the top plate thermal bar is located 5-6 km from the shore.

The currents are strongly in westward (shoreparallel) in the coastal side of the bar. In the offshore zone the currents flowed in the opposite direction.

In the coastal side the alongshore turbulent exchanges are stronger, with relatively very weak cross-shore horizontal exchanges.

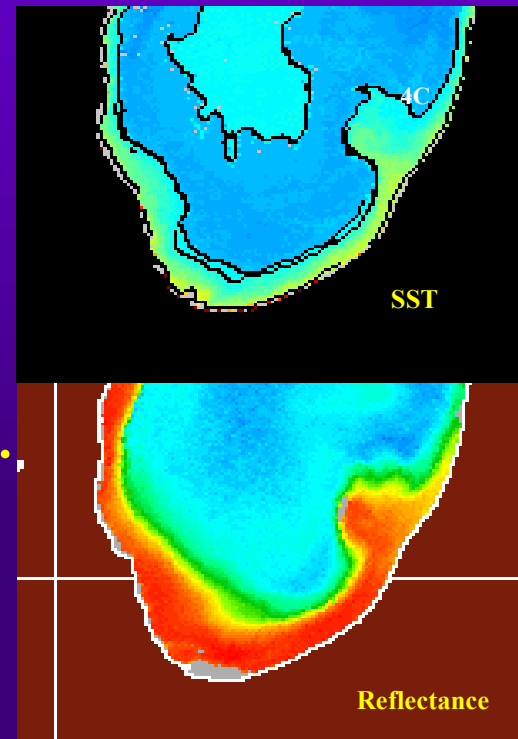
Note: Weak cross-shore flow and turbulent exchanges can lead to trapping of coastal waters inside the bar region.



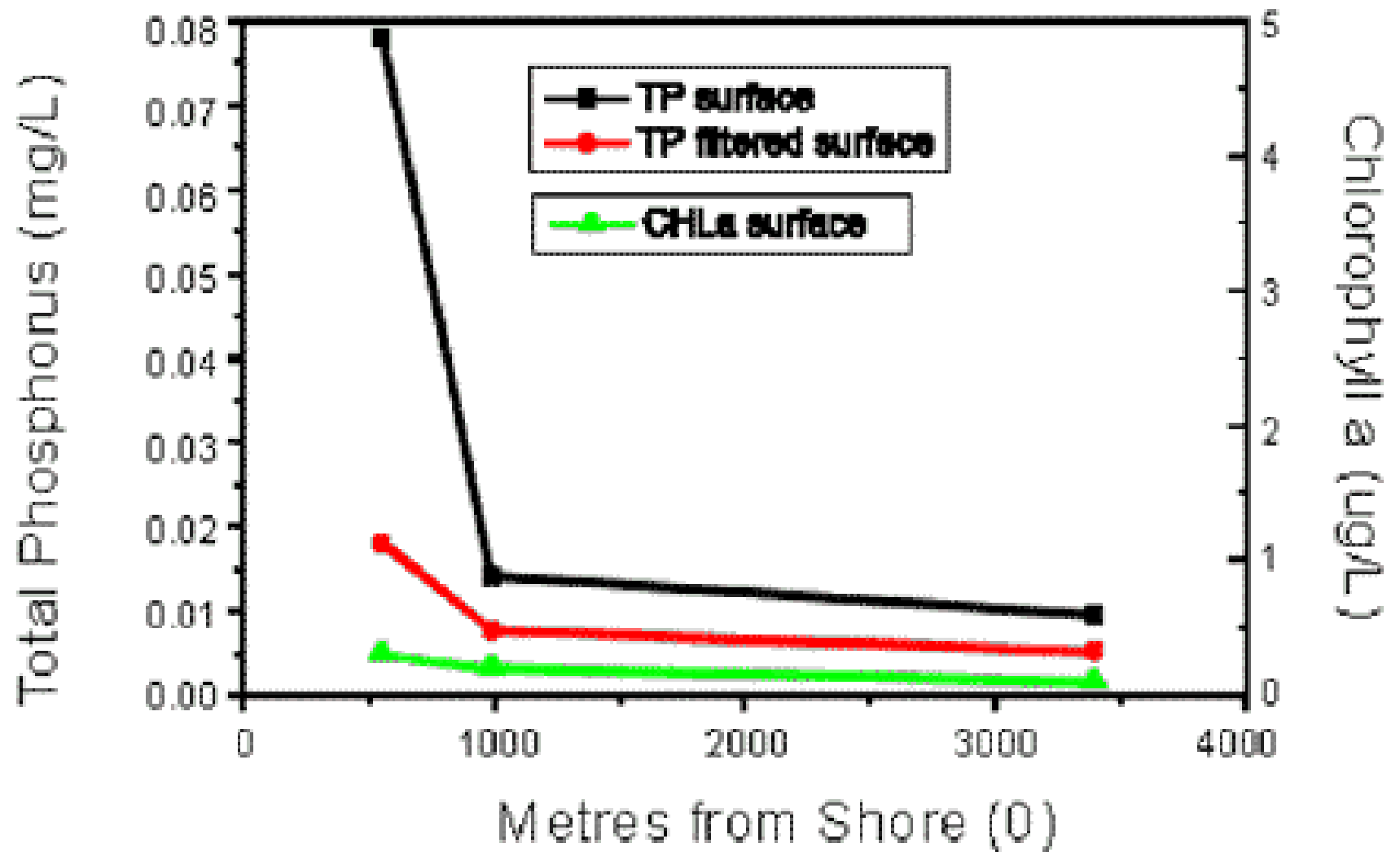
Suspended Sediments and Thermal Bar in Michigan

This example shows the suspended sediment concentrations due to a storm and thermal bar position during that period.

It clearly shows that thermal bar restricts the material transport to the offshore region.

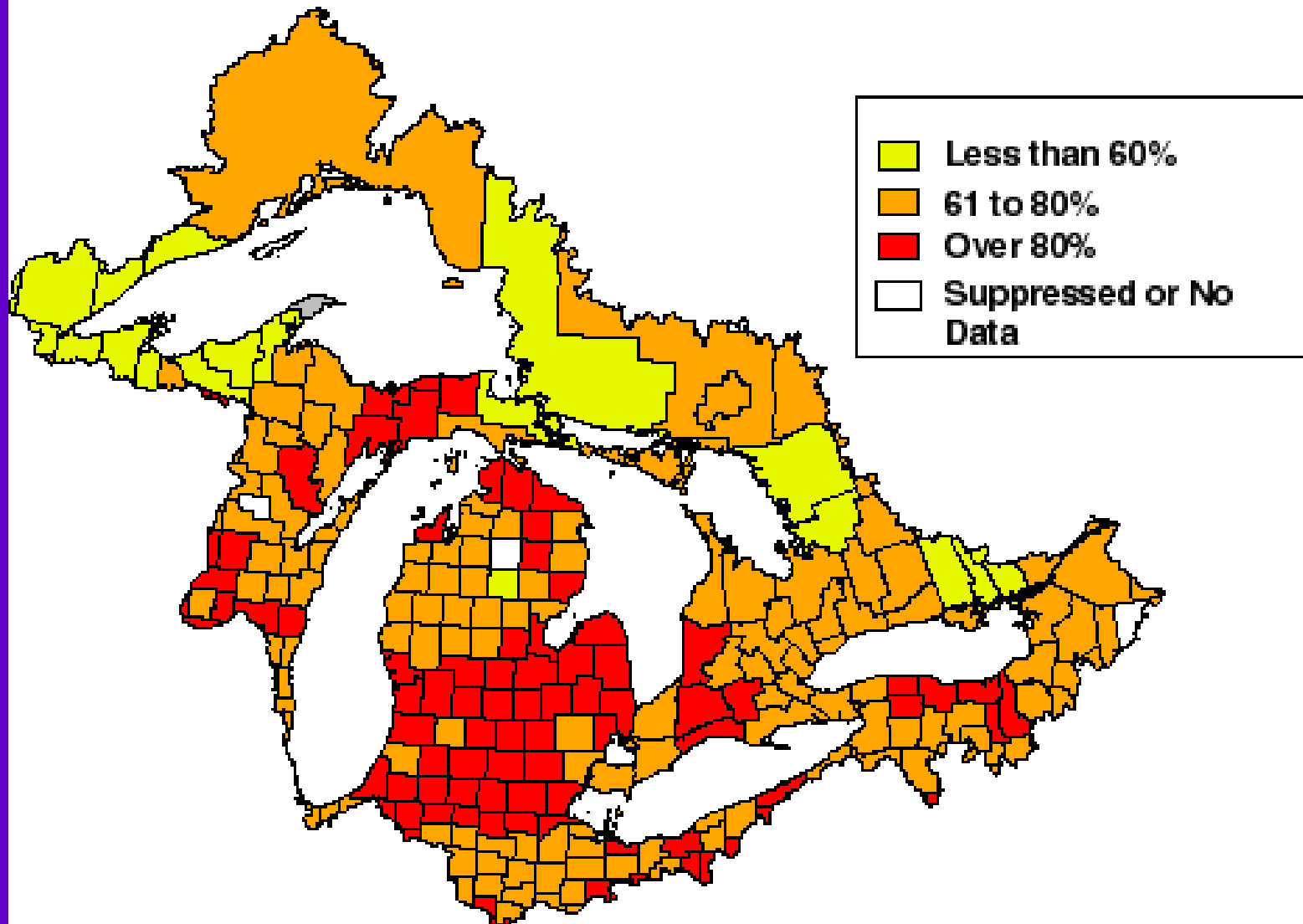


L. Ontario Humber Bay September 1991



Fertilizer Use in the Great Lakes Basin

1991/92 Area Receiving as a Proportional of Total Cropland



Canadian Observations

- *Cladophora* complaints have increased in the last two years.
- Noticeable biomass was present a few years ago.
- Research is underway on nearshore nutrients, offshore growth, thermal bar.
- The only known control is nutrients.
 - sewage, runoff, Ag/house fertilizer, rivers

Questions?

- Can *Cladophora* grow at offshore P concentrations?
- What is the effect of zebra mussels?
- Would further phosphorus controls control *Cladophora*?
- Is there any handle on the problem besides nutrient controls?

Nuisance Algae Blooms Contributing Factors

What's It All About?

Algae

Chuck O'Neill

Sr. Extension Associate

NY Sea Grant

Lake Ontario Algae Workshop

Greece Town Hall

30 May 2002

Nuisance Algae Blooms

- **Growth begins in spring**
 - ↑ **Water temperature**
 - ↑ **Level of available nutrients**
 - ↑ **Length of daylight**
- **Continues until water temperature reaches summer highs**
- **High water temperature + high nutrient levels = large floating mats dislodged by wave action**
- **Onshore winds drive mats onshore where they rot**

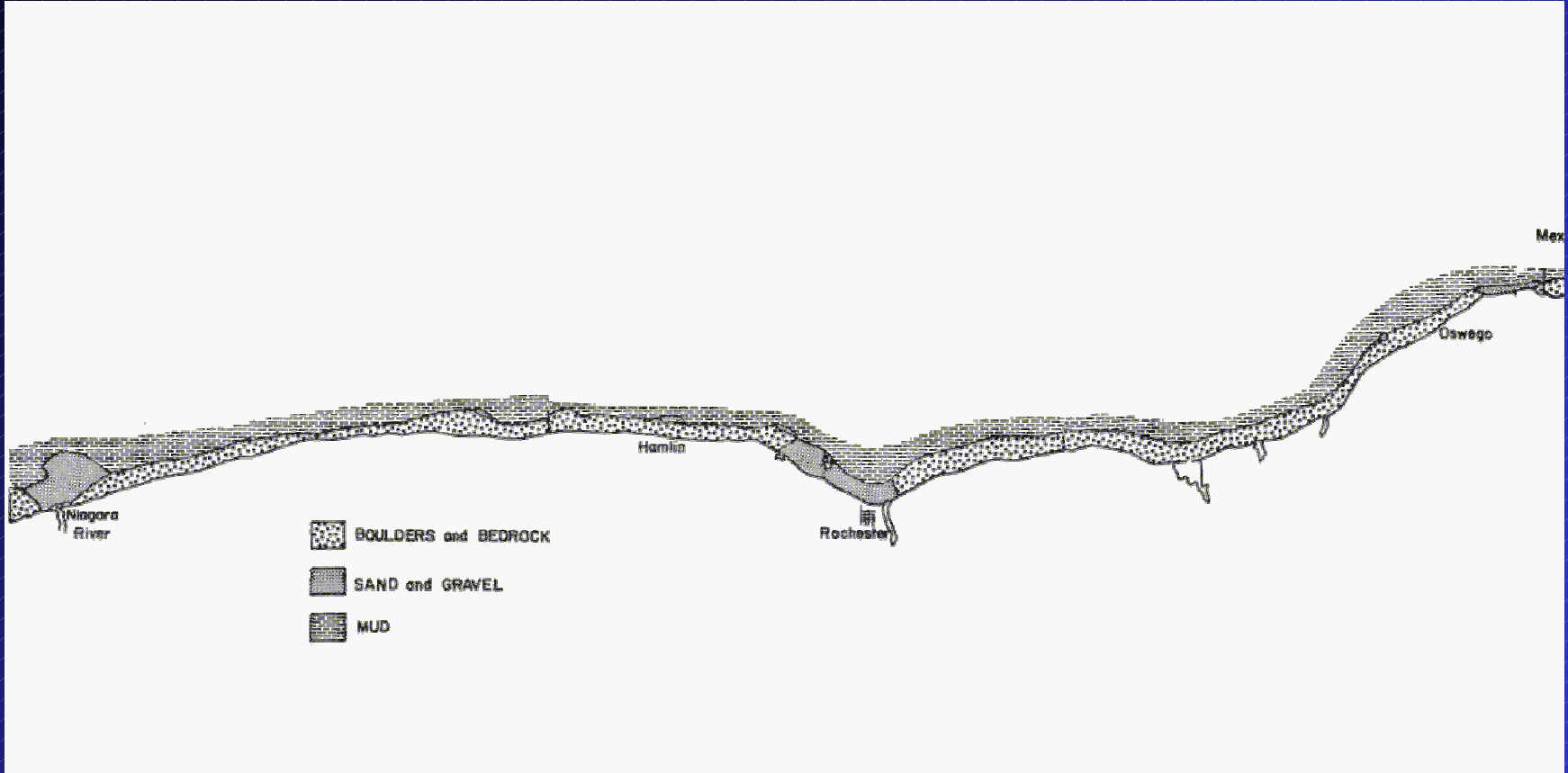


Nuisance Algae Blooms



- **1930s: enormous algal blooms frequently observed lakewide**
- **Decreased somewhat as lake became more turbid**
- **1970s: Sewage treatment = improved water quality = increased algal proliferation**
 - **≈ 33% of shoreline from Toronto to Kingston**
 - **≈ 66% of shoreline Niagara to Rochester**
 - **≈ 79% of shoreline east of Rochester**
 - **Large masses of decaying algae created problems along nearly all of shoreline**

Lake Bottom Substrates

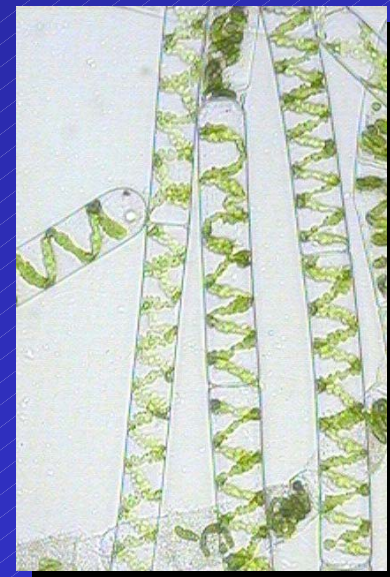
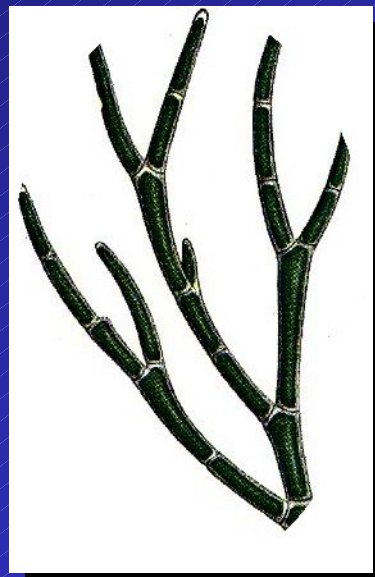


Nuisance Algae Blooms

The Players:

(Most important attached filamentous periphyton in Great Lakes rocky littoral zone)

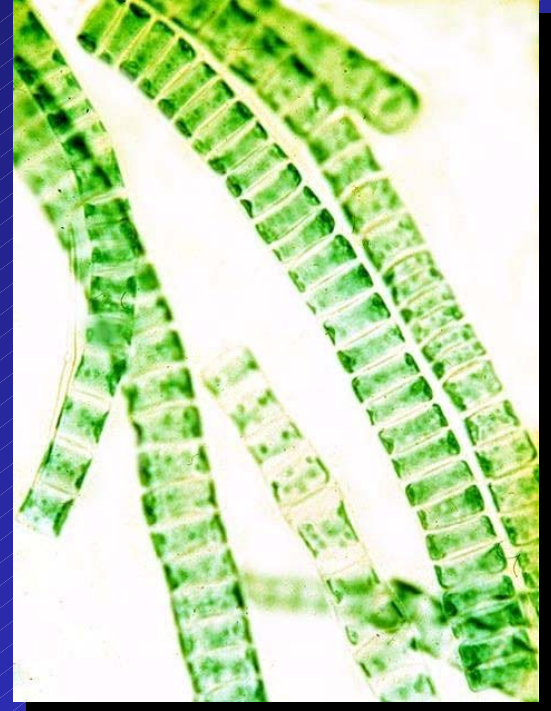
- *Ulothrix zonata*
- *Cladophora glomerata*
- *Spirogyra*



Ulothrix zonata

Ulothrix:

- Unbranched green alga
- Produces long filamentous strands
- Usually occupies shallow[er] water
- Cells typically as broad as long
- Grows attached to hard surfaces



Ulothrix zonata

Bottom Type Preferences:

- Usually occupies the splash zone
- Wave-swept rocks at air-water interface

Temperature range:

- Generally a cold water plant
- Growth peaks $\approx 10^{\circ}\text{C}$ (50°F)

Nutrients:

- 3 – 5 $\mu\text{g/L}$

Impact of Water Clarity:

- Unknown
- Assumed that increased clarity = increased growth



Cladophora glomerata

Cladophora:

- Branched green alga
- Produces long (up to 3 ft.) filamentous strands
- Usually occupies deep[er] water
- Grows attached to hard surfaces
- Two crops/yr. – 1st floats free mid-July, 2nd mid- to late-Fall



Cladophora glomerata

Bottom Type Preferences:

- Usually occupies rocks in deeper water below splash zone
- Generally 1.5 – 2 m pre-zebra mussel
- Down to 5+ m post-zebra mussel***
- Overlap with *Ulothrix*



Cladophora glomerata

Temperature range:

- Growth starts $\approx 10^{\circ}\text{C}$ (50°F) – overtakes *Ulothrix*
- Peaks at $\approx 20^{\circ}\text{C}$ (68°F)
- Stops at $> 22^{\circ}\text{C}$ (72°F)
- Decreasing temperatures in mid- to late-September result in replacement by *Ulothrix*



Cladophora glomerata

Nutrients:

- **> 2.0 $\mu\text{g/L}$ SRP adequate for growth**
- **5 $\mu\text{g/L}$ SRP for maximum growth rate**
- **58% reduction 1972 - 1983**
- **Pre-phosphate ban: little response to minor P concentration variations**
- **Post-phosphate ban: greater response to P concentration variations**
- **Intermittent loads/small sources stimulate local growth**
- **Local inputs = greater local abundance**
- **Possible scavenging nutrients from zebra mussel feces & pseudofeces**
- **Highest concentrations off mouths of Niagara River & Genesee River - nutrient enrichment?**



Cladophora glomerata

Impact of Water Clarity:

- Pre-phosphorous ban growth appeared more substrate dependent than light or nutrient dependent (IFYGL – 1972-73)
- Post-phosphorous ban anecdotal information indicates light penetration increases spatial range potential***



Spirogyra

Spirogyra:

- Unbranched, filamentous green alga
- Found in almost every pond or ditch
- Free-floating throughout water column
- Forms a thick scum on surface

Temperature range:

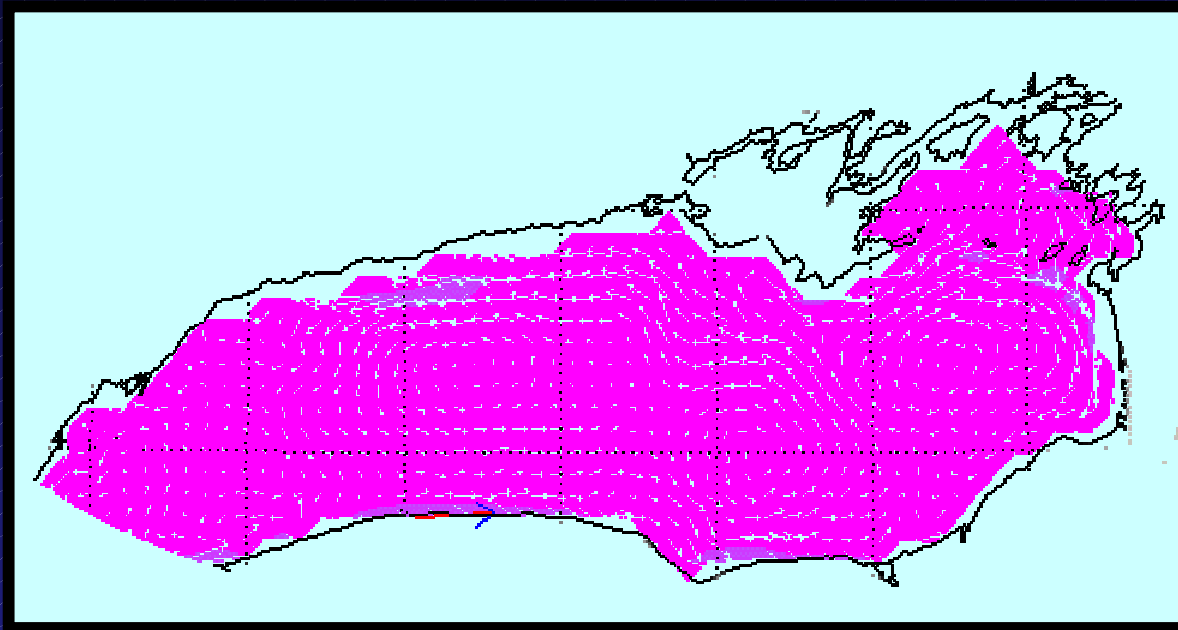
- Generally a cold – cool water plant
- Reproduces $\approx 1^{\circ}\text{C}$ (34°F) - 15°C (59°F)

Impact of Water Clarity:

- Assumed that increased clarity = increased amount of water column available for growth = increased total biomass

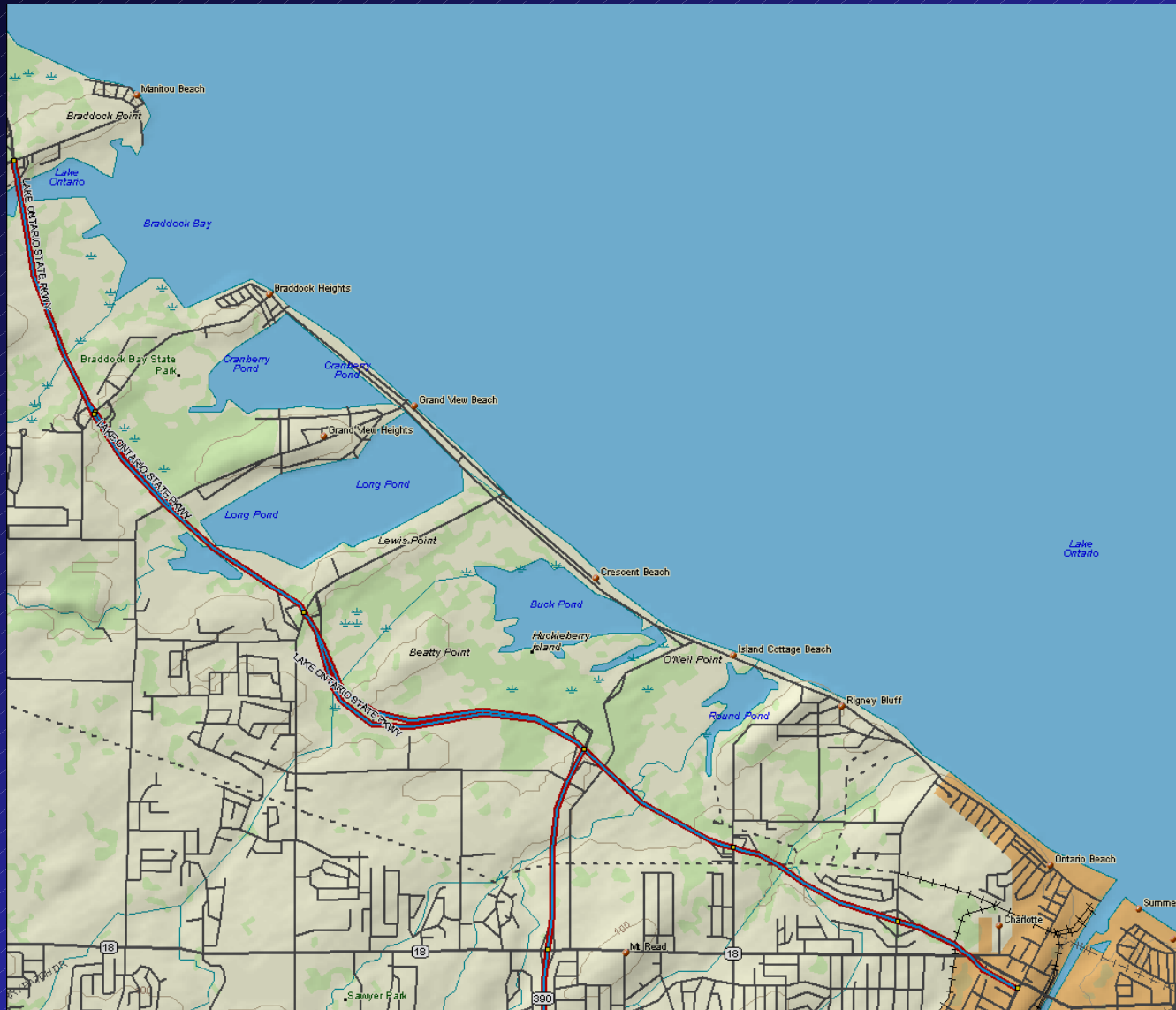


Lakewide Circulation Patterns



- **General open-water circulation is counterclockwise**
- **Tends to bring algae from west and north onto central basin shore**

Shoreline Catchments



Shoreline Catchments



Shoreline Catchments



Cladophora / Zebra Mussel Interactions

Growth Limitations

- Light penetration
- Availability of hard substrate

Mussel Filtering Impacts

- Increased water clarity and depth of light penetration
- Potential to expand vertical distribution of benthic algae



OH Sea Grant Study - Western Lake Erie

- Spatial and vertical distribution during peak *Cladophora* biomass period
 - 1980s (pre-zebra mussel)
 - 1992 (post-zebra mussel)

Cladophora / Zebra Mussel Interactions

Preliminary Results

- Increased water clarity has *not* resulted in increased vertical distribution
 - Competition for hard substrate
 - Little attachment to zebra mussels



Spatial Distribution

- *Cladophora* dominates from splash zone down to ≈ 1.5 m
- 1.5 to 2.0 m - - - active competition
- 2.0 m and deeper - - bedrock & cobble bottom dominated by zebra mussels (regardless of adequate light penetration)

Algal Bed Patterns in the Rochester Embayment and Along the Western Shoreline of Lake Ontario

Dr. Anthony Vodacek

Nina Raqueno

Center for Imaging Science

Digital Imaging and Remote Sensing Laboratory



MISI June 25, 2001, vicinity of Payne Beach

Project History

Project basis

- IFYGL study in 1973
- Water depth and bottom type mapping from remotely sensed images

Funding sources

- County Health Department, \$7,000
- Great Lakes Protection Fund, \$7,000
- Finger Lakes-Lake Ontario Watershed Protection Alliance, \$4,450

Budgeted costs

- Three MSI overflights, Wayne County to the Niagara River
- Staff time
- Summer undergraduate student

Approach

Benthic algae, review of IFYGL study

Remote Sensing data

- Modular Imaging Spectrometer Instrument (MISI), 2001 and 2002
- Landsat, various dates, primarily springtime
- Advanced Visible-Infrared Imaging Spectrometer (AVIRIS), May 20, 1999

Image processing for water depth mapping and detection and identification of bottom type

- ENVI software at the Center for Imaging Science
- IDL program for quantitative analysis

Ground truth observations and samples

Ground Truth Sampling

Digital Imaging and Remote Sensing Laboratory

- Braddock's Bay west to Wautoma Shoal
- GPS location
- Site description
- Ponar
- Depth
- Secchi Depth

County Health Department

- Long Pond east to Russell Station
- GPS location
- Site description
- Ponar
- Depth
- Secchi Depth

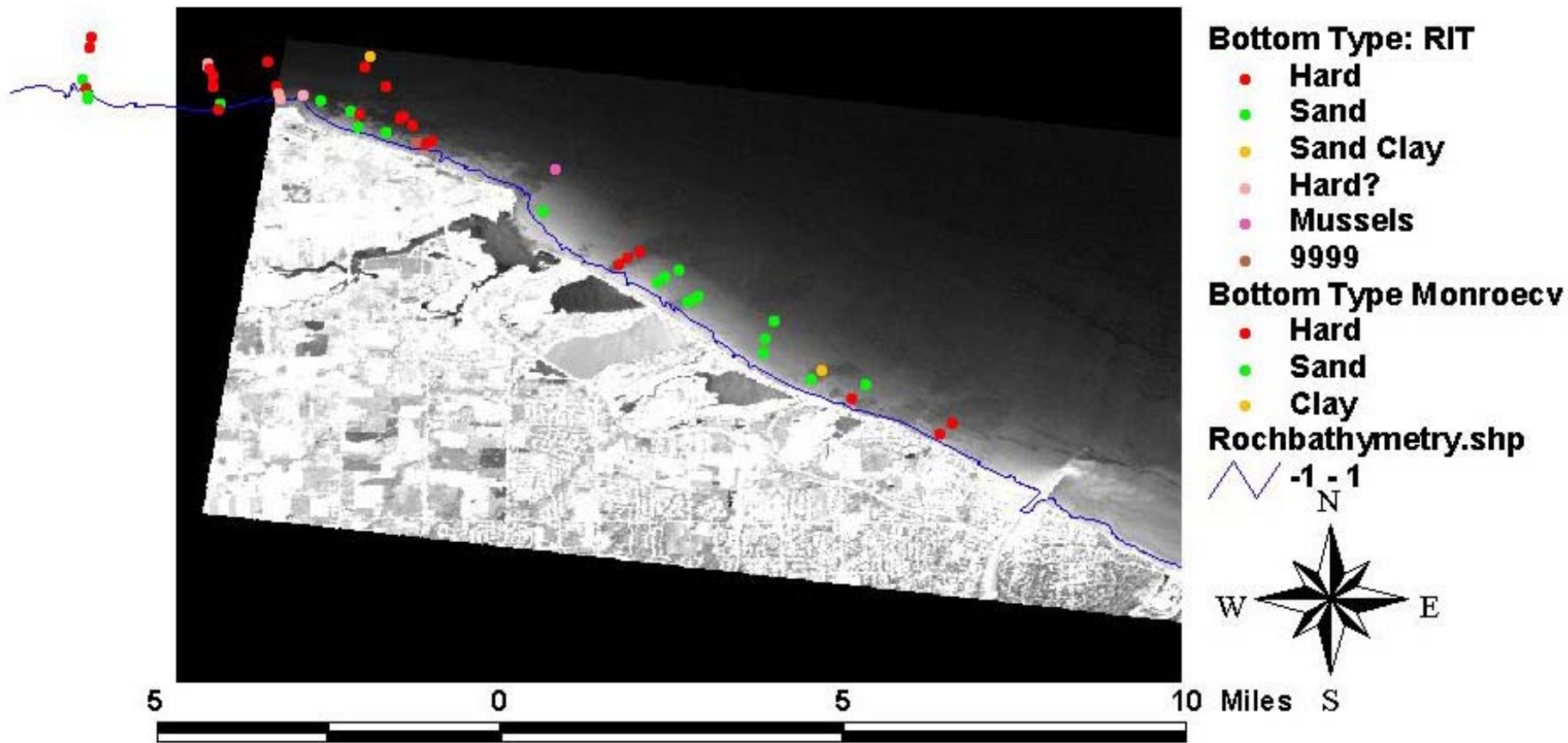
Citizen Input

- *Timing of overflights*

Ground Truth Locations

June 26, 2001,

Rochester Embayment west of the Genesee River mouth



AVIRIS image, May 20, 1999

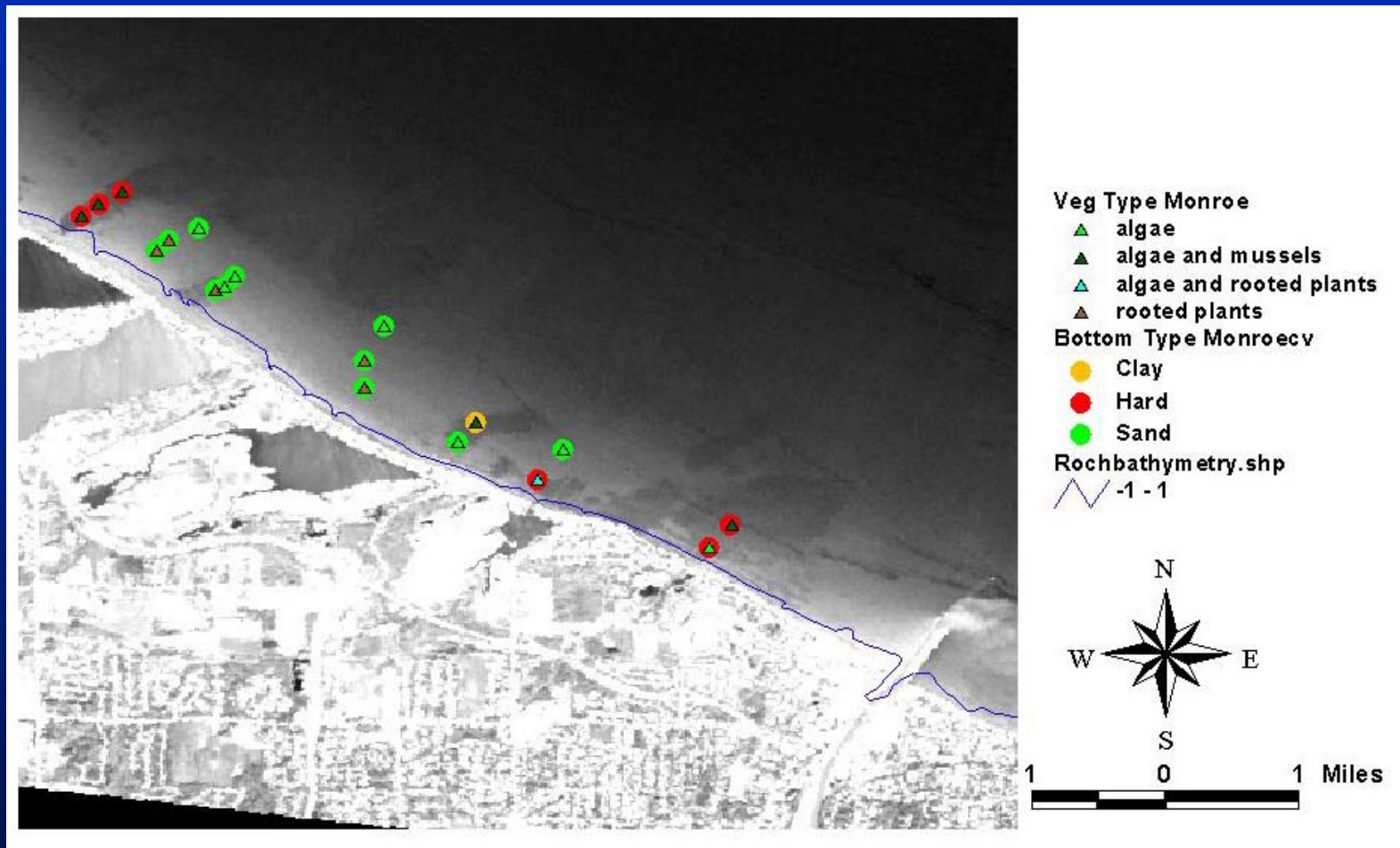
Initial Results

Ability to differentiate hard bottom (e.g. cobble) from sand or silt bottom

- *Benthic algal attachment requires a hard bottom*

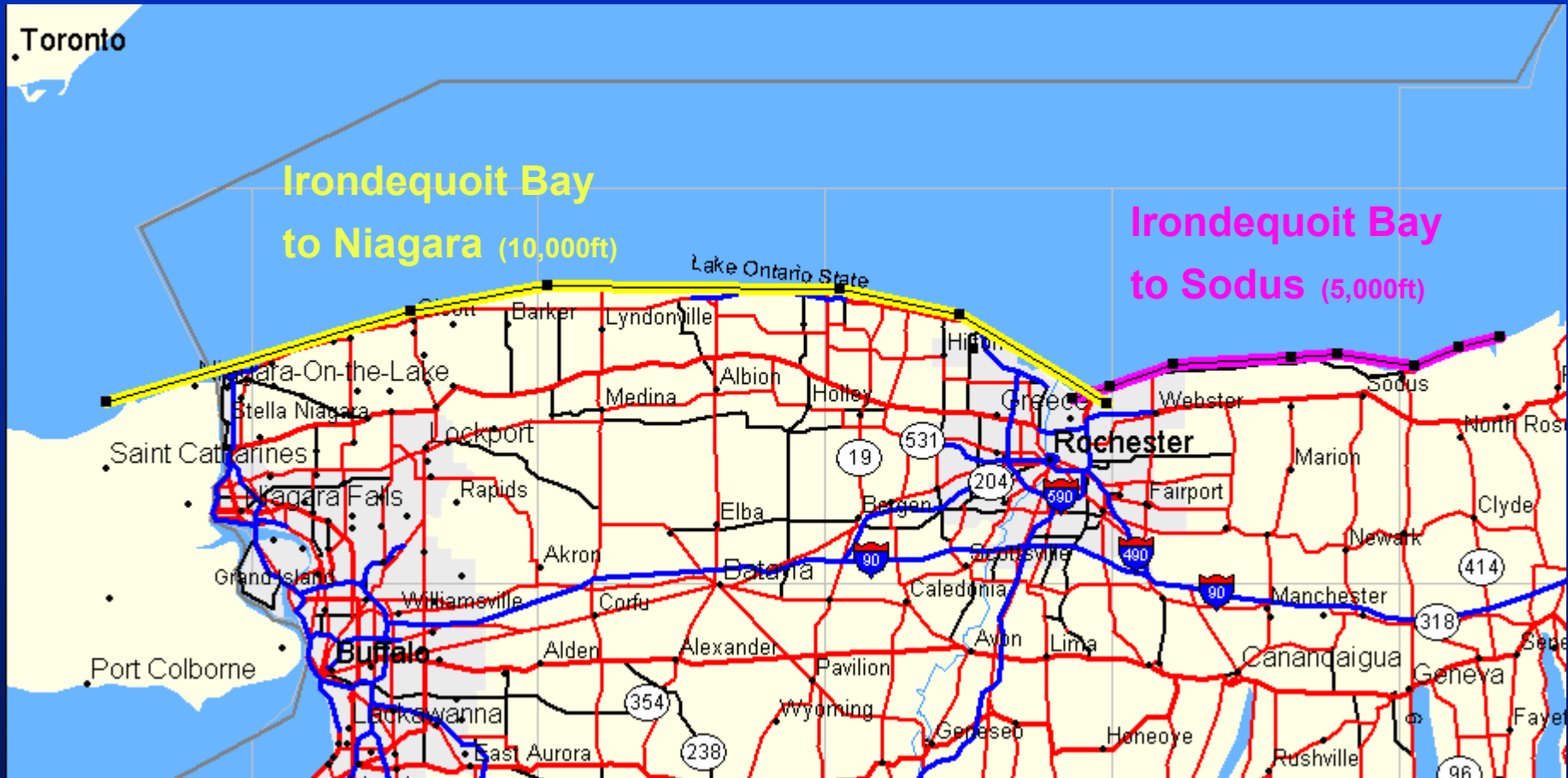
A large area of hard bottom exists just to the west and north of Ontario Beach

- *Could this single location be the source of the algal problem at the beach?*

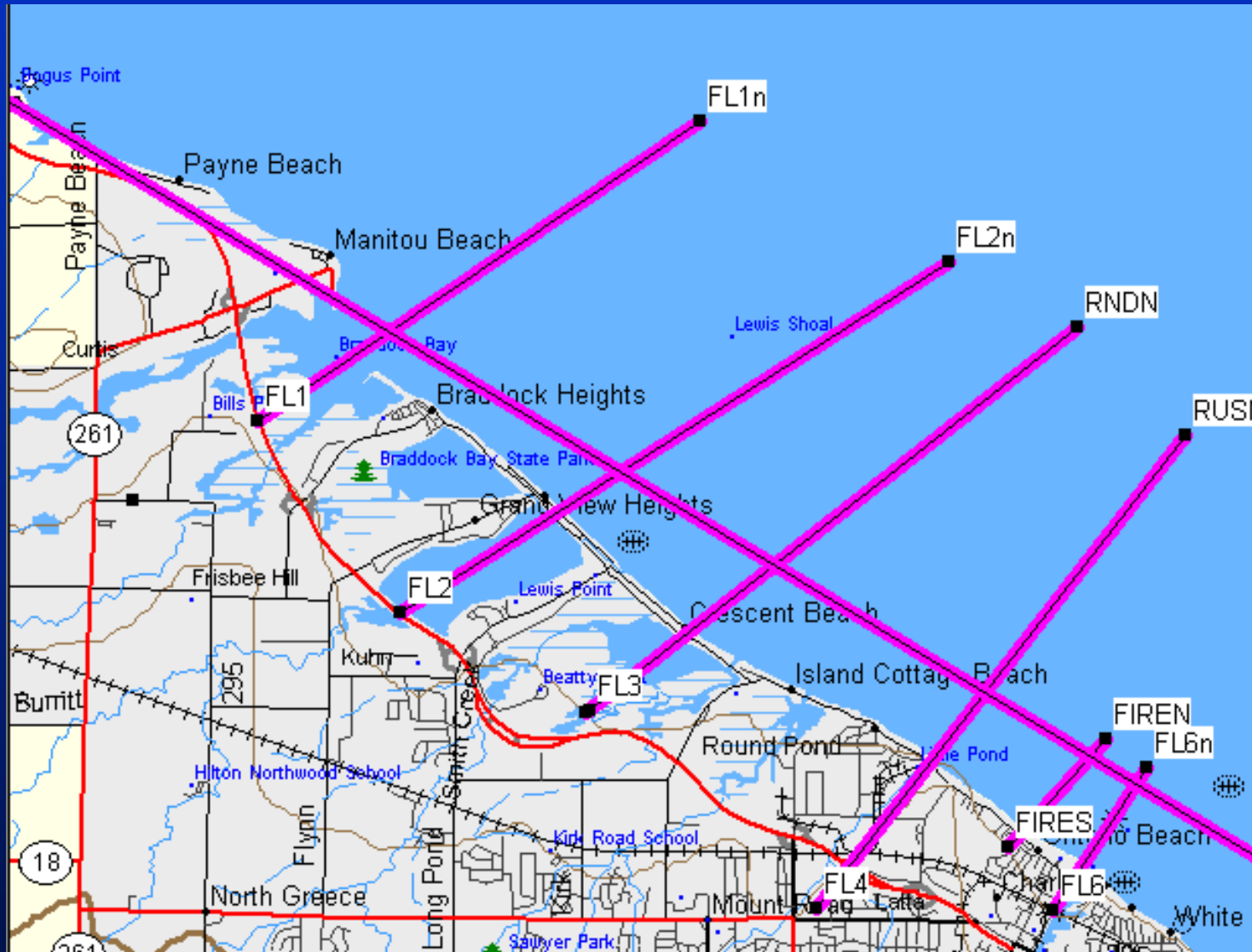


AVIRIS, May 20, 1999

MISI Flight Lines June 25, 2001

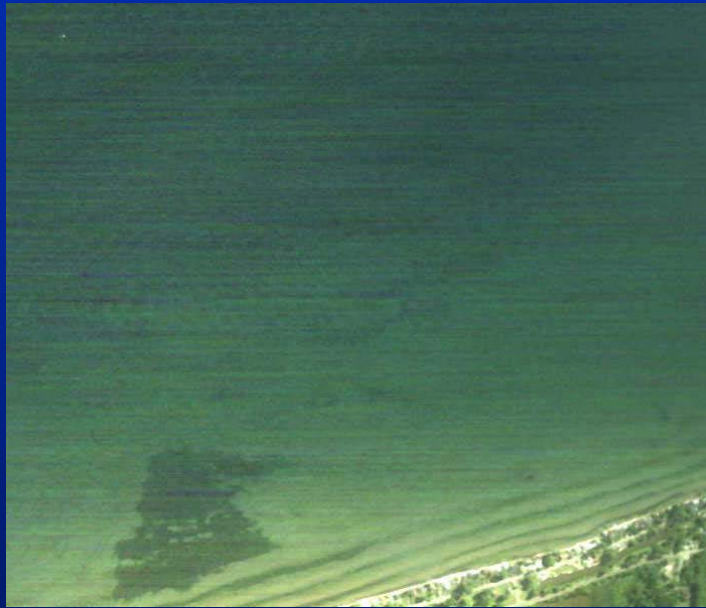


MISI Flight Lines in the Embayment June 25, 2001

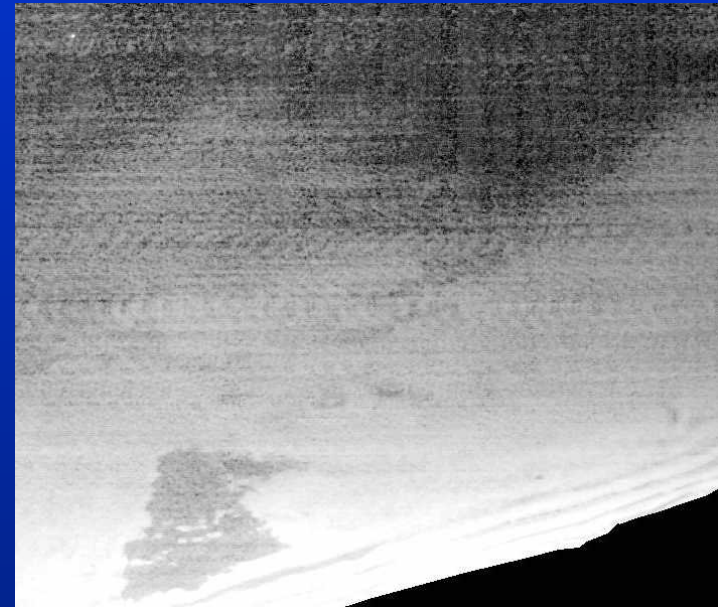


Preliminary Image Processing Results on MISI Data

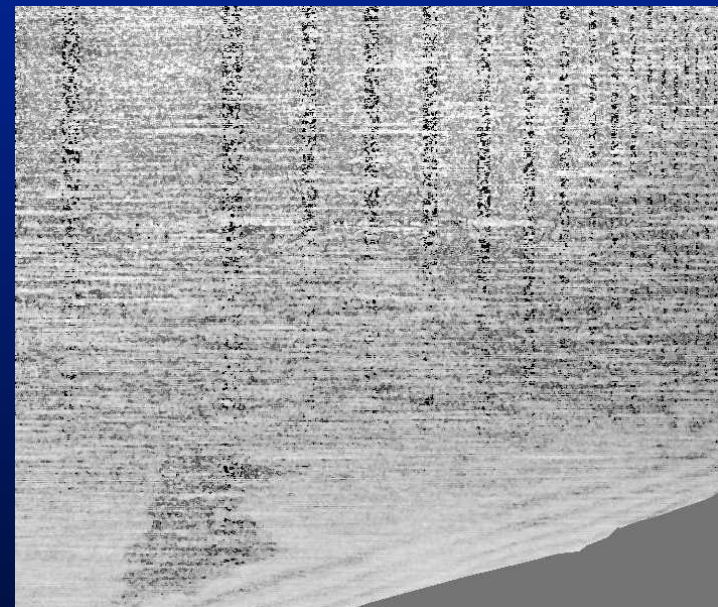
*MISI June 25, 2001
vicinity of Grandview Beach*



true color

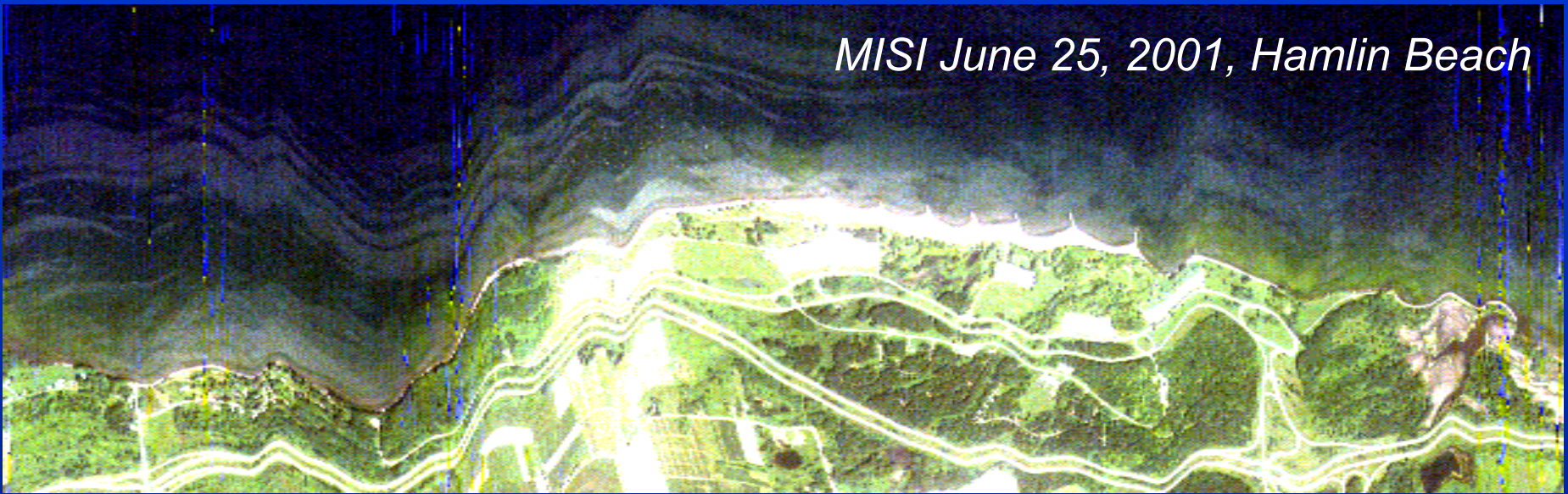


depth

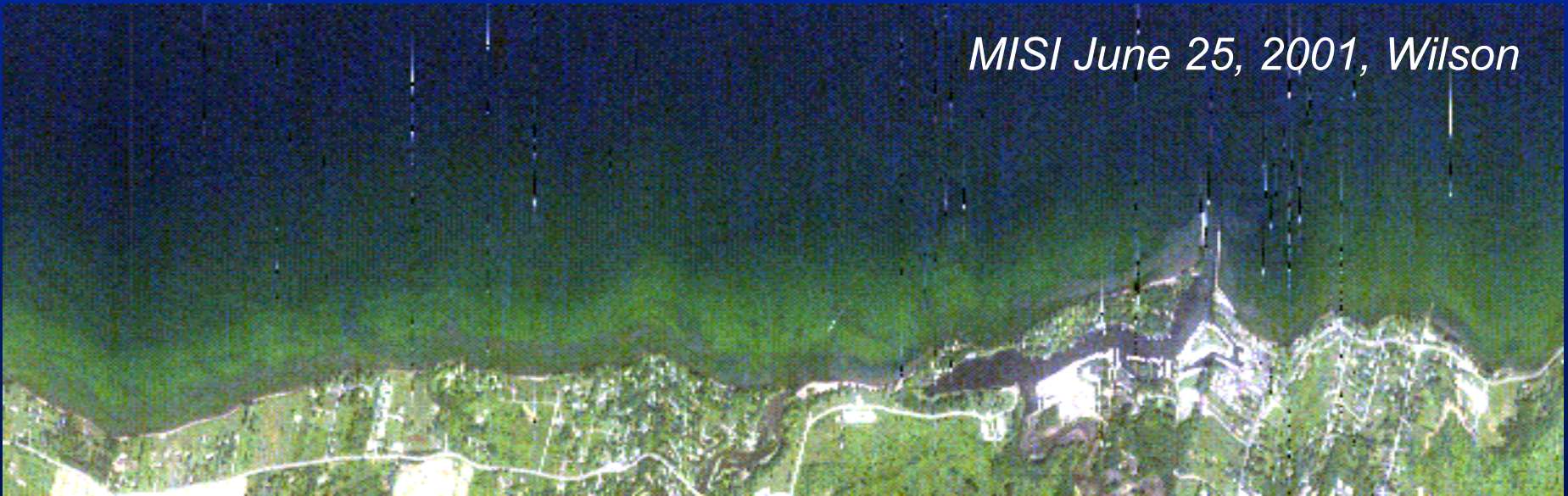


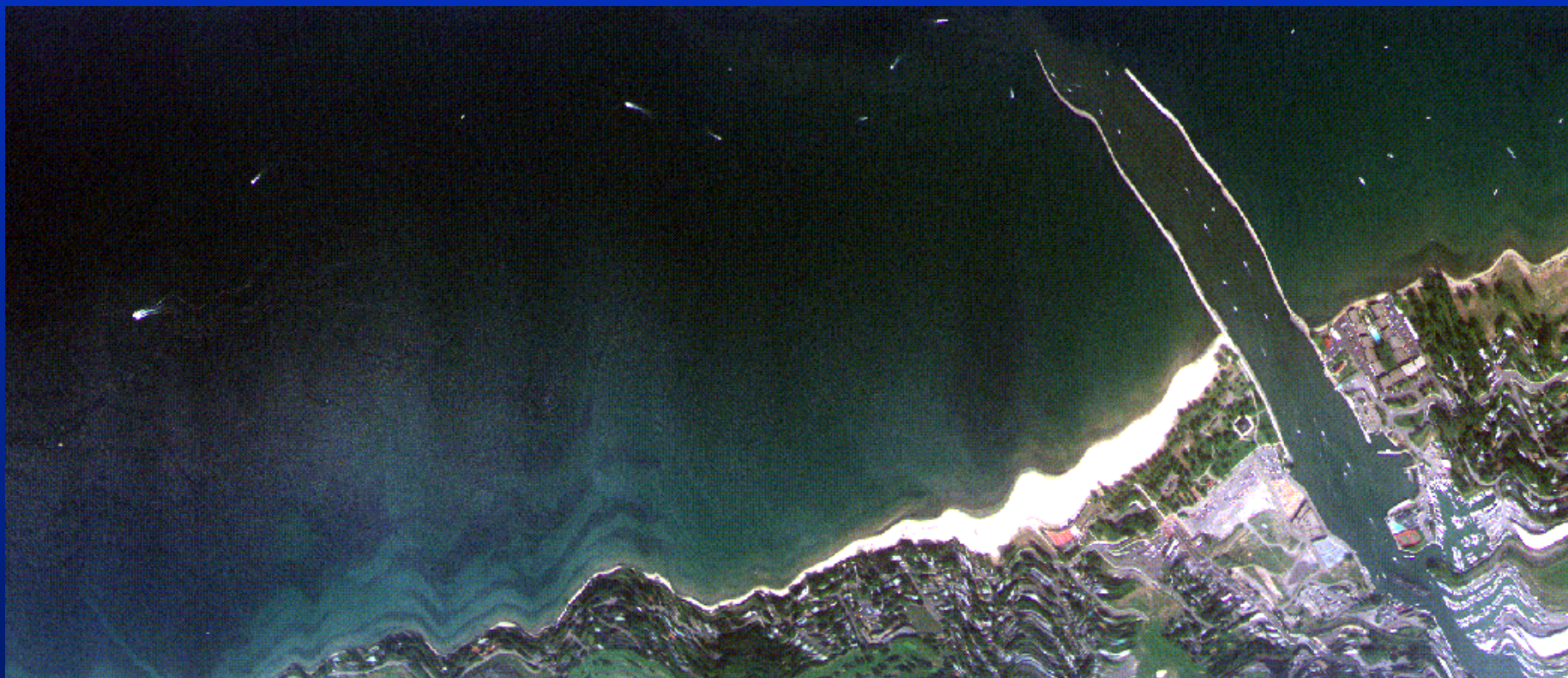
*bottom
type*

MISI June 25, 2001, Hamlin Beach



MISI June 25, 2001, Wilson





MISR September 9, 2001, Ontario Beach

Further Project Work

2 overflights planned and associated ground truthing

- 1 MISI overflight in early to mid season
- 1 MISI overflight at minimum growth (very early spring or fall)
- Biomass estimate

Image Processing

- MISI image quality should be very improved in 2002
- Transfer IDL program to ENVI
- To what depth can we distinguish bottom types?
- Algal covered hard bottom versus algal free hard bottom
- Image comparison to IFYGL results >> what has changed in 28 years?

Contact Information

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Rochester Institute of Technology
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History of Lake Ontario Nuisance Algae Blooms

Chuck O'Neill
Sr. Extension Associate
NY Sea Grant

Lake Ontario Algae Workshop
Greece Town Hall
30 May 2002

Algae Bloom Timeline

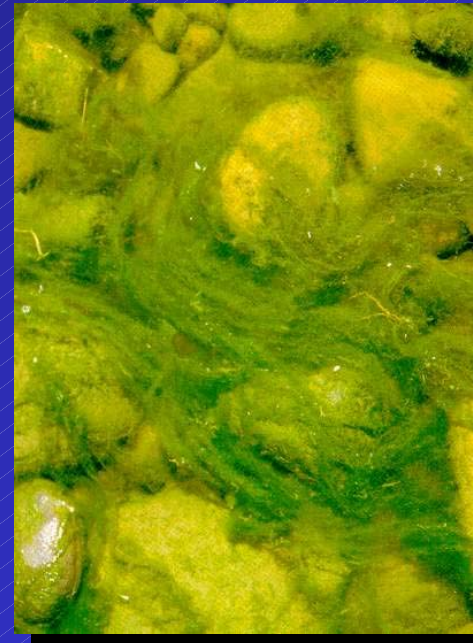
1930s

1958

Late-60s
- 70s

1982-83

2001



Nuisance Algae Blooms

Bloom-Year Commonalities

- Warmer than average summer
- Warm earlier
- Sunnier
- Lower turbidity



Bust-Year Commonalities

- Cooler than average summer
- Warm later
- Cloudier
- Higher turbidity





Subject - Past efforts to manage algae growth and accumulation at Ontario Beach Park.

Manage Growth - All efforts have been directed at Lake Ontario Nutrient reduction - There have been no efforts that were targeted to a specific area of the Lake
Manage accumulation - Major portion of this talk.

Algae, especially *Cladophora*, were identified as the largest contributor of fecal coliform in the 1976 Ontario Beach water quality evaluation that led to development of the criteria and reopening of the beach after its closure by NYSDOH in 1967. Historically, *Cladophora* washed up at Ontario Beach between July and September in mats or clumps composed of 2 to 3 foot strands of the material. - First 15 years



Cladophora mat – Fresh material, very green.



After a few days in the sun. This black material also takes on a profound odor as a result of decomposition.



Piles and tire marks – Tires on tractors and loaders grind the material down into the sand, where it incubates better. The warm, dark, moist environment ideal for bacterial production during decomposition. High waves can then resuspend some of this buried material.

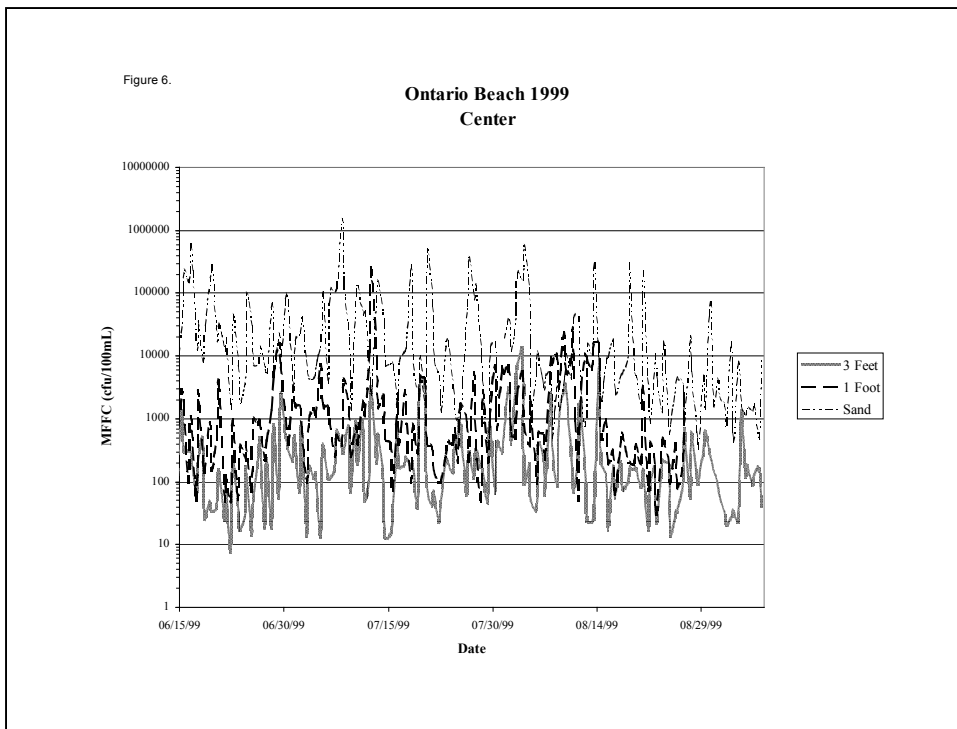


Chart of data for 3 foot samples, 1 foot samples, and sand illustrating higher coliform densities close to shore and in the interstitial water.



Front end loader used to push the algae to shore, where it is then piled up for later removal after some dewatering.



More manual labor. This was effective with smaller quantities of material, and when it came in 2-3 foot strands and mats.



Another potential bacteria source using the newly raked beach. As many as 1000 gulls use Ontario Beach for a roosting area before flying inland to city and suburban parking lots to feed during the day. Kensico studies recently published indicate ring billed gull feces carry coliform densities in the billions per gram of material.



Puddles on the beach after rain - These sometimes act as breeder areas for algae and have had high coliform counts. On occasion, Sodium hypochlorite has been used to disinfect. Also, this is the only photo of “poor” conditions from 1985 until 1989.

Results of gravimetric analyses of samples collected from sand piles. The volatiles are the water contained in the algae in the piles. The volatile solids are the solid, structural parts of the algae (mainly cellulose). The data indicate that the piles consisted mostly of sand.

Date	Location	Wet Weight (g)	Dry weight (g)	Percent Volatiles	Percent Volatile Solids
7/17/97	New Pile at East end of Beach 10'x5'x3'	47.6182	38.2372	19.7	2.3
		44.2819	35.6217	19.6	2.6
7/21/97	Pile Far East end of Beach 66'x21'x9'	47.0246	42.3272	10.0	1.6
7/21/97	Pile at easternmost lifeguard chair 15'x8'x5'	52.4695	44.5094	15.2	2.0
7/22/97	Pile at Far east 28'x10'x9'	48.8525	42.4578	13.1	1.9
		48.9350	43.4784	11.2	1.5
7/23/97	Small pile of fresh material being staged in center area of beach for removal to large pile at far east	54.1499	46.5583	14.0	1.6
		51.0675	43.4713	14.9	1.7

Table of Samples collected during 1997 shows that at best approximately 20% of the material moved in the traditional perpendicular push was algae (percent volatile and volatile solids). The rest was sand.

Recent cleanup efforts have focused on using the heavy equipment in a little deeper water to push a wave that carries the material to the easterly portions of the beach where it is then moved to shore for dewatering and removal. This has been more successful in cleaning up unless the quantity arriving is overwhelming.



Nice whitecaps, but look what happens to them as they get close to shore.

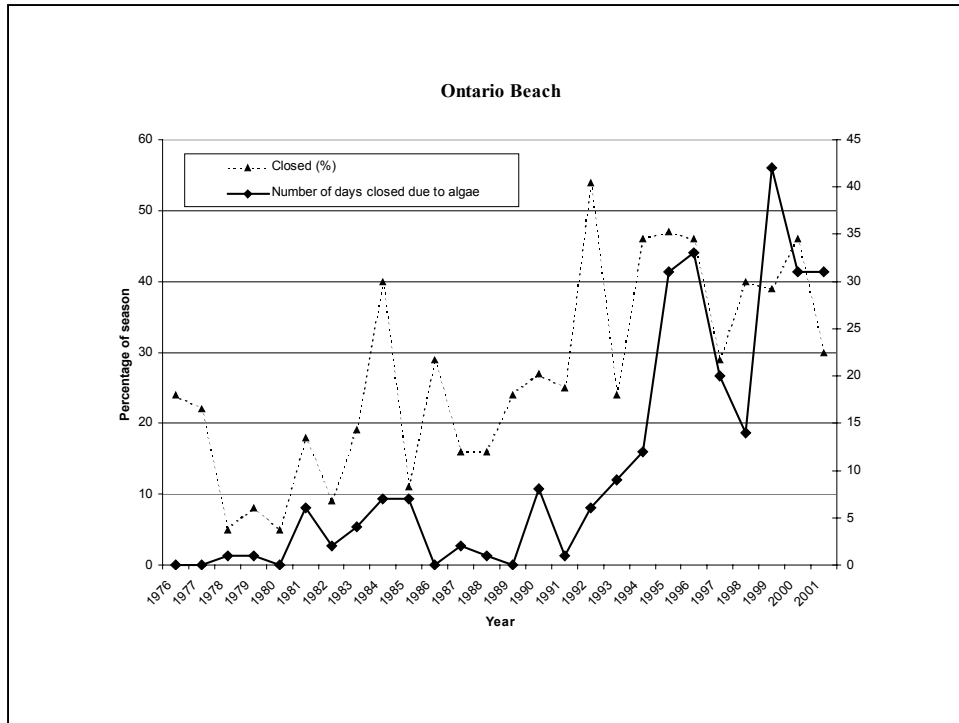


Chart of percent closures (dotted line/left Y-axis) and days when closure was caused by excessive algae (solid line/right Y-axis). Some earlier datasets did not specify reasons for partial closures, so only fully closed days are tabulated for earlier years.



Ruts again, but reasonably clean conditions.



Early 1990s, zebra mussels started showing up.
1991 - Small zebra mussels attached to lengthy strands.
1995 - Heavily encrusted strands - many smaller, chopped up pieces.



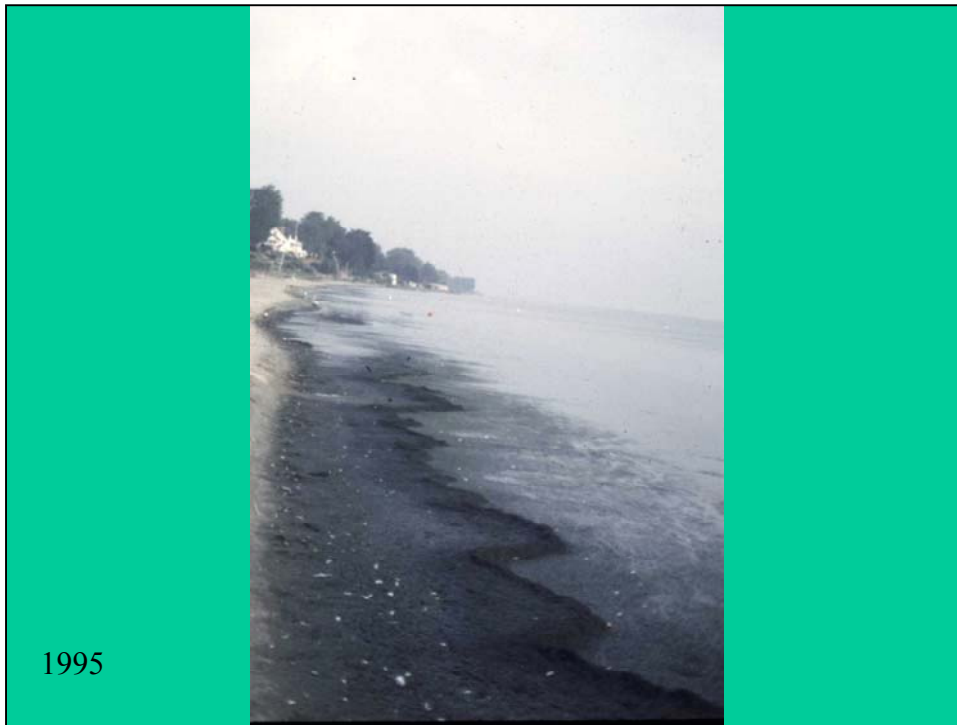
1992 - mixed into the sand, but still relatively low amounts of material.



Fairly crowded beach.



Rotting material. Starting to have a finer, soupier consistency.



1995 Very oily looking - notice the gull feathers.

1996 Earlier algae - Identified as *Spyrogyra*, Late June until mid July, then *Cladophora*.



In response to the much larger quantity of material in 1995, the county used NYS Aid to Localities funding to obtain a custom designed weed harvester from the Aquatic Boat Company. In 1996, the Harvester was tried, did not work due to shallow bottom slope and the much finer consistency of the material washing up, and was subsequently sold.



Mat of packed material, birds walking around on it. Similar conditions at other places along the lake, especially Grandview Beach in Greece and Webster Park.



Parks Department Rake - Fine teeth on a drum deposits material into a hopper, used mainly for the material on the sand and very shallow. Works pretty well, but its efficiency is limited by the hopper size.



Another loader, but working parallel to the water. Still mostly looks like sand.



Last summer - 7/5/2001 - Everything at once; gulls, piles, algae on the sand, algae in the water, etc. This would not be a remarkable photo, except that the parks department crews had been working on this accumulation for about 8 hours prior to this photo being taken at about 3 PM.



Another picture from the same day. The beach was closed or restricted for 19 days after the event on July 2nd. This photo was taken on July 5, but algae was the predominant reason for the closure on the majority of days within this period.

**USACE and URS Efforts to
Analyze Options to
Intervene at
Ontario Beach Park Pier**

Michael Smith

Laura Ortiz

U.S. Army Corps of Engineers

Dan Rothman

URS Grenier, Inc.

Summer 2002 Demonstration Program



Summer 2002 Demonstration Program *Authority*

- Section 1135 Habitat Restoration Feasibility Study
- Federal Sponsor: US Army Corps of Engineers - Buffalo District
- Congressional Representative: Louise M. Slaughter
- Non-Federal Sponsor: Monroe County Parks Department
- Prime Contractor: URS Corporation

Summer 2002 Demonstration Program *Objectives*

- General Goal - Reduce Algae Impacts at Ontario Beach
- Specific Goal: Field Test and Evaluate Alternative Methods for:
 - ◆ Algae Collection
 - ◆ Algae Handling
 - ◆ Algae Treatment/Disposal

Summer 2002 Demonstration Program

Relationship to August 2001 Demonstration

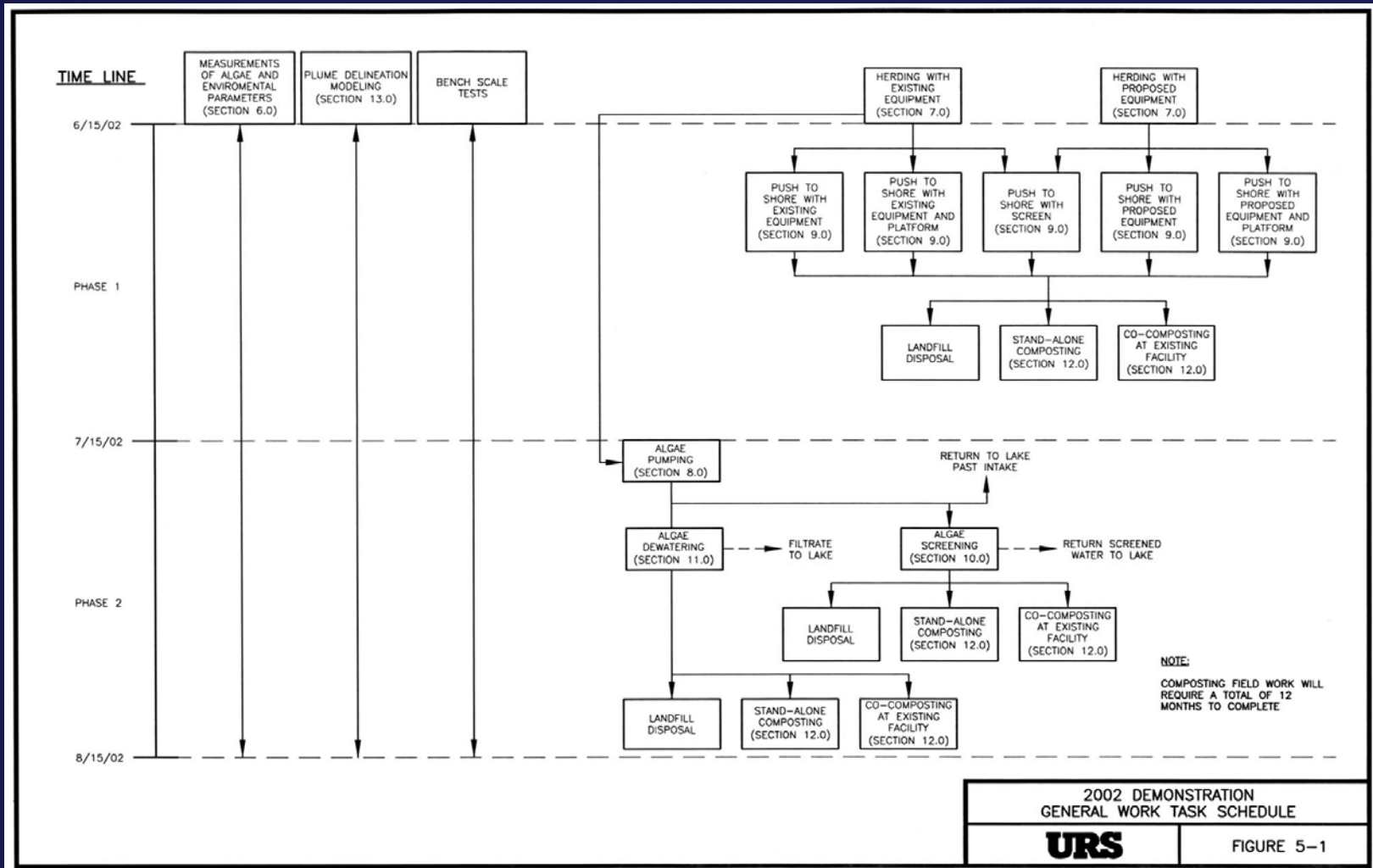
- Key Findings from 2001 Demonstration
 - ◆ Pumping in combination with algae herding is a feasible alternative
 - ◆ Sluice gate openings in the west pier is not a feasible alternative

Summer 2002 Demonstration Program

Relationship to August 2001 Demonstration

- Additional Questions to be Answered by 2002 Demonstration
 - ◆ What are physical and chemical characteristics of algae?
 - ◆ Can algae herding be performed more efficiently?
 - ◆ Are there operational issues with pumping algae?
 - ◆ Can land-based algae handling operations be improved by:
 - Onshore handling methods (platform/conveyor)?
 - Screening?
 - Mechanical dewatering?
 - Composting?
 - ◆ What would be the impacts of pumped algae on Genesee River/Lake Ontario/downstream property owners?

Summer 2002 Demonstration Program



Summer 2002 Demonstration Program

Algae & Environmental Measurements

- Ontario Beach Measurements
- Pumped Algae Measurements
- Compost Facility Measurements
- Genesee River & Lake Ontario Measurements

Summer 2002 Demonstration Program

Algae Herding Efficiency

- Goal to improve herding efficiency by:
 - ◆ Reducing time required
 - ◆ Increasing algae volume herded
 - ◆ Expanding effective herding area
- Compare existing equipment and operations with:
 - ◆ Larger equipment
 - ◆ Tandem operations
 - ◆ Use of accessory equipment
- Evaluation based on operational, analytical and visual results

Summer 2002 Demonstration Program

Algae Pumping

- Goal to evaluate “Pumpability” for:
 - ◆ Discharge to Genesee River/Lake Ontario, or
 - ◆ Discharge to shore for land treatment/disposal
- Pumping system location, equipment and operations
- Storage tank for algae measurements
- Evaluation based on flow measurements and observations

Summer 2002 Demonstration Program

Onshore Algae Handling

- Goal to evaluate alternative onshore handling operations
- Existing method
- Alternatives to be evaluated:
 - ◆ Modified “pushing” equipment
 - ◆ Concrete platform
 - ◆ Conveyor
 - ◆ Tandem operations
- Evaluation based on algae removal volumes, time requirements, incidental sand collection amounts

Summer 2002 Demonstration Program

Algae Screening & Dewatering

- Goal to reduce water content prior to land treatment/disposal
- Dual rotary screens
- Belt filter press
- Bench-scale testing
- System location, equipment and operations
- Evaluation based on:
 - ◆ Water removal efficiency (percent solids of treated algae)
 - ◆ Flow rate/flux through systems
 - ◆ Operational issues
 - ◆ Maintenance requirements

Summer 2002 Demonstration Program

Off-Site Algae Composting

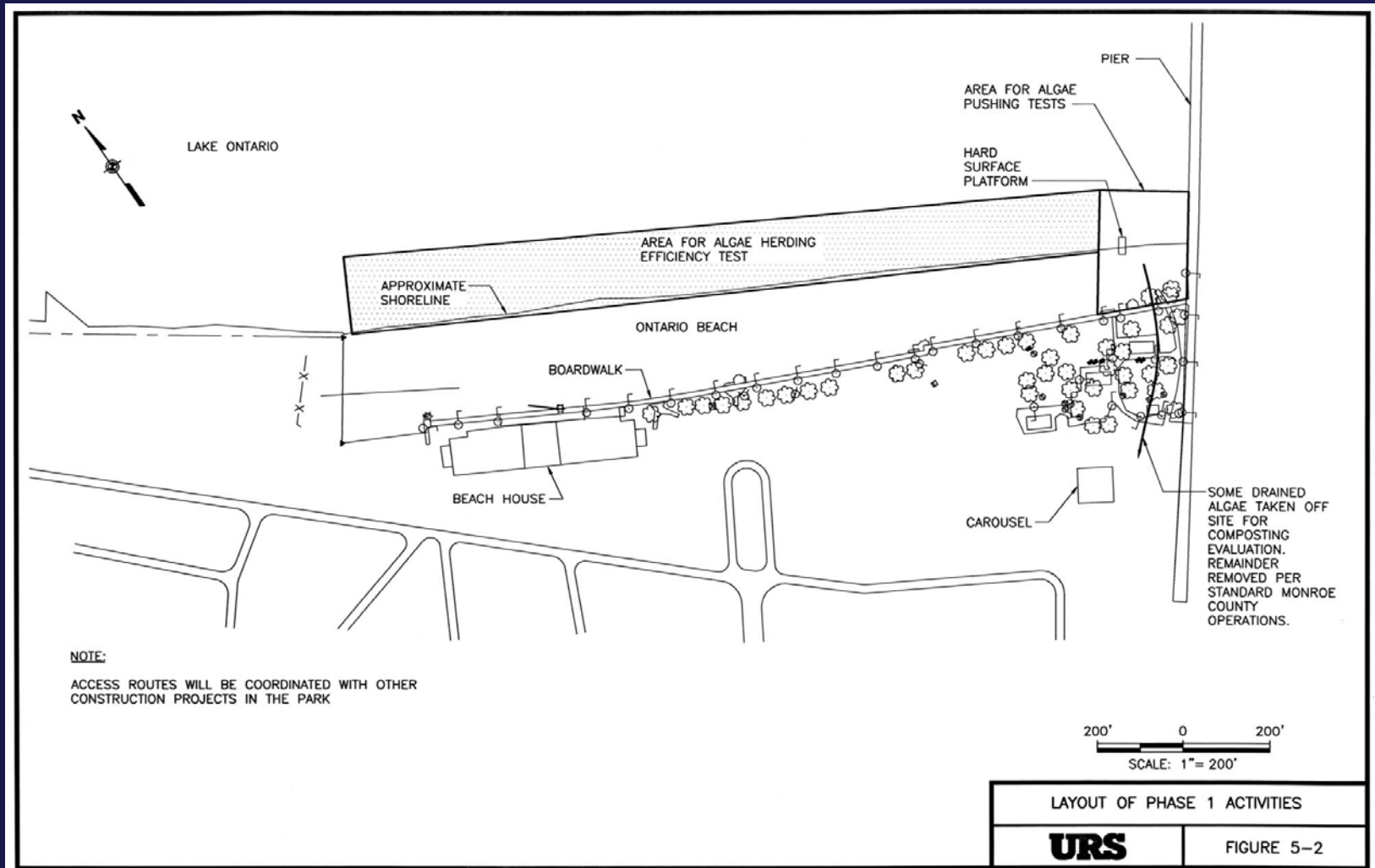
- Goal to evaluate feasibility of composting algae
- Stand-alone composting at GCOSTP
 - ◆ Drained algae (existing condition)
 - ◆ Screened algae
 - ◆ Dewatered algae
- Co-composting at GYWCF
- Evaluation by observations and analysis over 12-month period

Summer 2002 Demonstration Program

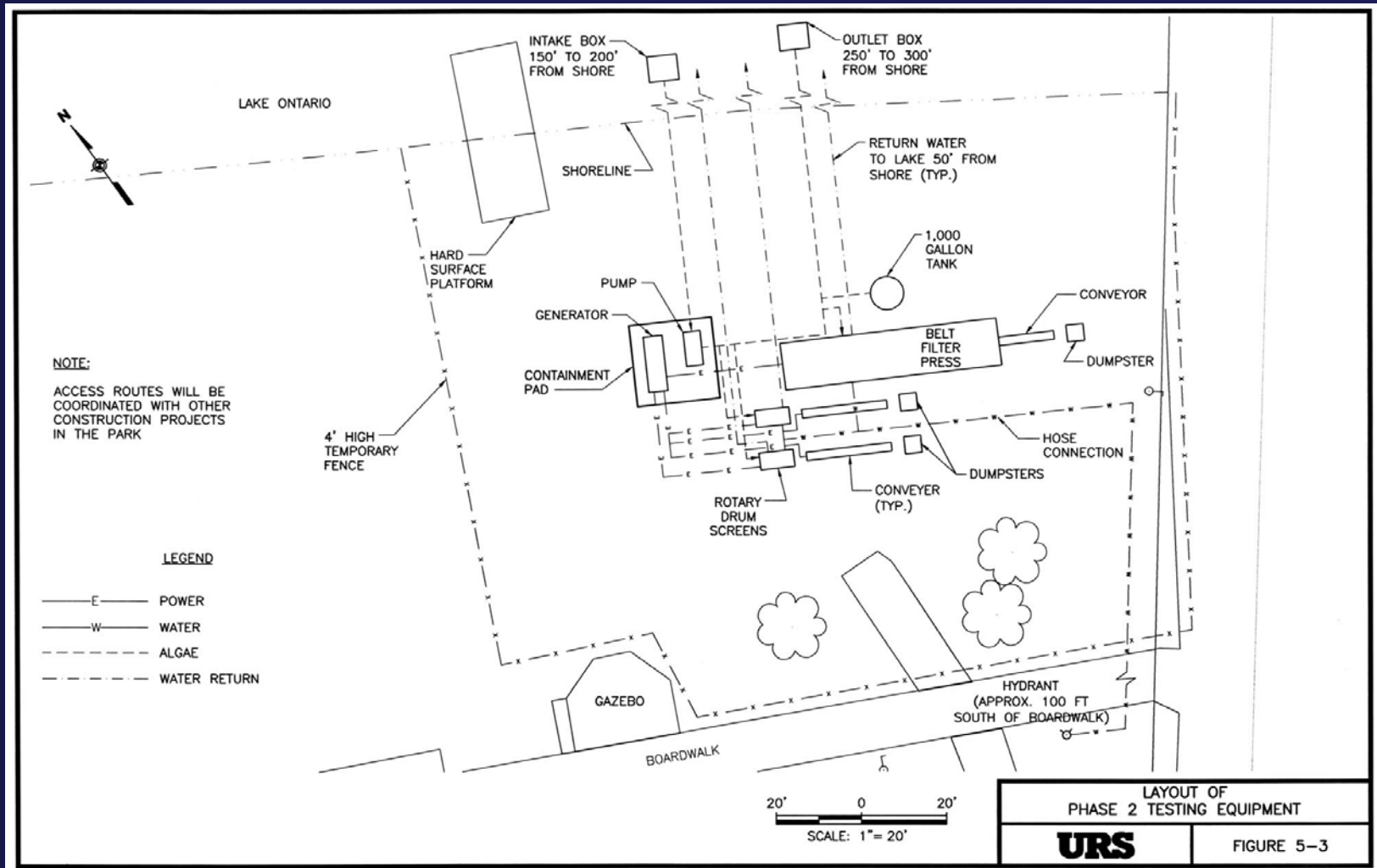
Plume Delineation Modeling

- Goal to evaluate impacts of pumped algae on Genesee River/Lake Ontario/Downstream shore landowners
- Hydrodynamic modeling (Offshore & Coastal Technologies, Inc.)
- Water quality modeling (Joseph F. Atkinson, PhD)
- Evaluation of plume movement and quality under various wind and river flow conditions

Summer 2022 Demonstration Program



Summer 2002 Demonstration Program



Summer 2002 Demonstration Program *Implementation Issues & Constraints*

- Capture various algae conditions
- Maintain existing Ontario Beach operations
- Coordinate with City of Rochester 2002 construction activities
- Minimize odors and aesthetic impacts
- Maintain continuous worker and public safety
- Provide public awareness
- Maintain site security
- Comply with applicable regulations

Summer 2002 Demonstration Program

Points of Contact

- US Army Corps of Engineers - Buffalo District
 - ◆ Michael Smith - (716) 879-4144
 - ◆ Laura Ortiz - (716) 879-4407
 - ◆ 1776 Niagara Street/Buffalo, New York 14207

Lake Ontario Algae Cause and Solution Workshop - May 30, 2002
Greece Town Hall

AGENDA

Algae Causes - Eastman Room

Moderator: Helen Domske, New York Sea Grant

1. Welcome: *Monroe County Executive Jack Doyle (8:30-8:40)*
2. Workshop Overview: *Margaret Peet, Monroe County Department of Health (8:30-8:45)*
3. Overview of the Basic Biology of Algae Growth - *Dr. Joseph Makarewicz, SUNY Brockport (8:45-9:05)*
4. Factors Contributing to Algae Growth and Recent Research or Trends (9:05-11:05)
 - A. Dreissenid Mussels and Water Clarity: *Dr. Joseph Makarewicz, SUNY Brockport*
 - B. Phosphorus and Other Nutrients in Lake Ontario: *Murray Charlton, MSc, Environment Canada*
 - C. Effects and Trends of Waves, Winds, Currents, Water Temperature, Lake-bottom Surface Type, and Natural and Man-made Traps in Algae Growth and Accumulations: *Charles O'Neill, New York Sea Grant*
 - D. Preliminary Findings of Hyperspectral Imaging Project: *Dr. Anthony Vodacek, Rochester Institute of Technology*
5. Break and Networking at Poster Session - **Atrium Area (11:05-11:25)**
6. Lake Ontario Algae Booms and Busts - A Historical Perspective on Lake Ontario Algae Blooms: *Charles O'Neill, New York Sea Grant - Eastman Room (11:25-11:45)*
7. Lunch and Poster Session/Photo Displays - **Community Room (11:45-1:00)**
8. Speaker Discussion and Response to Written Questions - Speakers will respond to written questions and summarize their thoughts about algae growth causes and/or future research needs - **Eastman Room (1:00-2:00)**

Algae Growth and Accumulation Solutions - Eastman Room

Moderator: Dr. Frank Sciremammano, RIT

9. Overview of session: *Dr. Frank Sciremammano, Rochester Institute of Technology (2:00-2:15)*
10. Overview of some past successful and unsuccessful efforts by Monroe County to manage algae growth and accumulation and sharing of information on why these projects were or were not successful: *Charles Knauf, Monroe County Department of Health (2:15-2:35)*
11. USACE and URS efforts to analyze options to intervene at Ontario Beach Park pier: *Michael Smith and/or Laura Ortiz, U.S. Army Corps of Engineers and Dan Rothman, URS Grenier, Inc. (2:35 to 3:00)*
12. Breakout Group Instructions and Short Coffee Break (3:00-3:15)
13. Breakout discussions to identify potential solutions or demonstration projects to manage algae growth – **Eastman Room and Community Rooms A & B (3:15 to 4:00)**
14. Final Break - Assemble results from breakout groups - **Atrium Area (4:00 to 4:15)**
15. Summary of potential solutions and demonstration projects to consider for future algae growth management, including a brief report from the leader of each breakout session - **Eastman Room (4:15 to 4:50)**
16. Next Steps: *Margaret Peet, Helen Domske (4:50 to 5:00)*

Sponsored by: Monroe County Department of Health, New York Sea Grant, New York Great Lakes Research Consortium, Water Education Collaborative

**Lake Ontario Algae Cause and Solution Workshop
May 30, 2002**

Blue Group—Eastman Room

Leader: M. Smith/D. Rothman

Recorder: Margy Peet

Growth Factor Research Need Ideas

- Find out what causes algae to change its consistency in Canada. It's still stringy—if there is potential for algae consistency to change for Canadians in future, they would be interested in why.
- Need to understand problem—is it upwellings or temperature? Also take advantage of existing data.
- Where is algae coming from and how is it moving around the Lake? Need to know.
- Timing between wind change and algae accumulation needs to be known.
- Add dye to growing algae and track it?
- Ground truthing by RIT did find *Cladophora* with living mussels (this may suggest further research needs to be done about whether or not *Cladophora* can grow on zebra mussels)
- Are sunspots an impactor/factor?
- Identify if our own activities are exacerbating the problem.
- Study why Erie and Ontario have more severe problem than upper Great Lakes. Is it nutrient levels?

Algae Management Ideas

- Pump material on to conveyor belt, compress it with roller, peel off as cake and fall into truck.
- Consider oil spill technology to clean up. May be impractical.
- Canada—genetic fingerprinting—use to target resources.
- Cover up hard substrate? Grow zebra mussels if it turns out that *Cladophora* really cannot grow on zebra mussels.
- Look at smaller upstream areas—cut down on two stormwater nutrients (by use of created wetlands, etc.).
- Move from pushing to pumping, centrifuge or grit removal.
- Find a predator? (Recognize potential danger of introducing predators because of impact on ecosystem. Danger of further imbalance to ecosystem.)
- Move the beach.
- Algae treatment plant.
- Dislodge algae at source before it starts serious growth.
- Move faster to address odors.
- Aerate to reduce odors.
- Ice the shoreline or super warm it.
- Use agent to slow algae growth.

New/Additional Information

- Pultneyville—algae plugs harbor for four days until settles.
- Ontario Beach gets mix of dead and alive algae perhaps suggesting multiple sources.
- Eastern Lake Ontario shoreline, problem seems to be lessening.

**Lake Ontario Algae Cause and Solution Workshop
May 30, 2002**

Yellow Group—Eastman Room

Leader: Charlie Knauf

Recorder: Gary Brown

- Human interactions (inputs, septic, agriculture) to ecosystem.
- Non-Point Source issue: demonstration study on inputs from sources (roads, ditches, gravel).
- Identify sources of phosphorus and focus on causes of algae.
- Biological control?
- Research on nutrients in regard to reoccurrence of *Cladophora*.
- Genetic fingerprinting to determine source.
- Monitoring streams for Phosphorus and Nitrogen.
- Quantitative analysis of percentage of phosphorus from source. Best management practices (lawn care). Leaves. Educate the public on BMP (buffer zones).
- Reduce non-point source phosphorus (buffer zones) demonstration project.
- Look at larger picture (weather patterns).
- Compare to other areas (localized versus regional)
- Sources other than streams (runoff) birds, ... etc. Algae blooms not associated with runoff events.
- Could be a natural phenomenon with not much room for human control (only 70 years of data).
- Prevention (chemical treatment while not harming wildlife). Demonstration project.
- Substrate treatment (remove substrate).
- More investigation on embayment (RIT)
- Substrate banks (i.e. wetland banks)
- CSO's, WWTP, Swirl separators
- Thermal bar (more research on nutrient capture at thermal bar)
- Caspian Sea (benchmark with control procedures)
- Cost of spot mechanical harvesting.
- Separation of algae and water—haul algae away.
- Upgrade WWTP's (i.e. beyond tertiary treatment) or (Ferrous sulfate, biocannister)
- Phosphorus source (outside or inside embayment)
- Lake current monitoring/relationship of obstructions, piers, etc.
- Move (agricultural roads) BMP's incorporation.
- Education (brochures, pamphlets)
- More information on exotic impacts.
- Quantitate obstruction size (breakwall, pier) versus algae quantity.
- Closer coordination with counties and closer ties with Canada.
- What kills algae? (limiting factor)
- Aqua shade.
- Algae screen/boom.

**Lake Ontario Algae Cause and Solution Workshop
May 30, 2002**

Green Group—Community Room A

Leader: Chuck O'Neill

Recorder: Carole Beal

A = Action. D = Demonstration. S = Study.

- Would it be possible to dislodge algae with boat and chain so wind can move it (early in the season)? (D)
- Study the impact of nitrogen. (S)
- Can a more “friendly” species of algae replace nuisance algae? (S)
- Possible to alter local fertilizers to reduce cause? Provide free soil tests. (*A)
- Look at species that eat algae. (A)
- Find other emergent vegetation to use up the phosphorus. (S)
- Any offshore rigging that can draw the algae from the shoreline, letting the water out (vacuum)? (D)
- Can something benign coat the substrate at critical times? (S)
- Research uses for algae and harvest it. (S)
- Barrier to prevent algae from coming in. (D)
- Use barley straw to stop growth. (D)
- Research the algae organisms. What is a natural level? What is the role of algae in ecology? (*S)
- Extend the WWTP out further into Lake. (A)
- How do *Ulothrix*, *Cladophora* and *Spyrogyra* fit into food chain and what consumes them? (S)
- In Florida, use fish to clean the canals. (S)
- Investigate cyclical nature of blooms. (S)
- Would thermal discharges contribute to problem? (S)
- What is different about Lakes Ontario and Erie? (Less problem on other three Great Lakes)
- Where are the phosphorus and nitrates coming from? (S)
- Need long-term education on causes. Look at non-point sources.
Example: grass clippings, leaves. (*A)

*High priority. (If we had \$100,000 which would we fund?)

**Lake Ontario Algae Cause and Solution Workshop
May 30, 2002**

Red Group—Community Room B

Leader: Murray Charlton

Recorder: Margit Brazda Poirier

- Address Non-point source pollution—proactive. e.g. Great Lawns/Great Lakes.
- Education of the public on sources of phosphorus, Great Lawns/Great Lakes, Community Water Watch monitoring.
- Education, prevention, response, diverting algae before it gets to beach.
- Entrap algae before it gets to beach (using netting)
- Question: Effect of septic systems on Lake Ontario algae? Yes impact, don't know where polluters are.
- More research and education on causes of algae—how residents impact lake.
- Adopt a beachfront to help clean up algae on private land.
- Need funding for ongoing research and current data.
- Need good science to back up actions.
- Mass balance study is needed to answer question, where is algae coming from?
- Is northwest quadrant treatment plant impacting nutrient load to Lake Ontario?
- Letter to Louise Slaughter re U.S. meeting the intergovernmental agreement with Canada and outcomes of today.
- Congressional Action needed
- Implement RAP actions and LaMP—need funding.
- Need greater program coordination between programs, e.g. Community Water Watch and septic inspections.
- Consider ban on fertilizer with phosphorus.
- Buffer zones between agricultural fields and streams—stream ordinances to reduce soil erosion.
- Enforcement of regulations, e.g. soil erosion from construction sites.
- More testing of creeks for phosphorus sources; also Niagara River.
- Research and education; regulations should have a scientific basis; need maps of problem to persuade the public and politicians
- DNA testing of algae to find its source then educate people on collective contribution.
- Focused action on treating symptoms—for short-term relief (along with research).
- Need funding specific for implementation and maintenance.
- Sediment transport model—more effort from major tributaries to look into nutrient loading.
- Thermal imaging along lake to determine septic.
- Return in one year to report on how we've done (i.e. another workshop).

**Lake Ontario Algae Cause and Solution Workshop
May 30, 2002
Summary of Evaluations**

Number of Evaluations: 43

1. Was the information that was shared and processed useful to you?

All of it was useful: 19

Between all of it was useful and somewhat useful: 19

Somewhat useful: 5

Between somewhat useful and not at all useful: 0

Not at all useful: 0

2. How well did the conference attain the objectives stated in the announcement?

Excellent: 20

Between excellent and good: 17

Good: 5

Between good and poor: 1

Poor: 0

Comments:

- Informative, but no solutions. Some ideas—more research needed.
- We need a solution.
- Take action to alter fertilizers.
- Got good information about biology and chemistry of problem.
- Causes were covered well. Solutions, other than more research needed, were not.
- I think the workshop was great, but the information gathered must be put to use in order to reach the objectives and make it worth while.
- Unfortunately, it brought up more questions than solutions, but it was very interesting.
- Lots of new information.
- Presentation of known facts was good. A good sharing atmosphere.
- Excellent speakers, ideas and presentations. Very thought provoking. Moderators were excellent.
- Covered possible causes and made audience think of possible future solutions.
- It was really great to see so many people on the same page. This really helps advance the agenda.

3. Was there appropriate opportunity for audience participation in the form of questions?

Excellent: 33

Between excellent and good: 10

Good: 0

Between good and poor: 0

Poor: 0

4. Were your questions answered to your satisfaction?

Yes: 36

No: 0

Comments:

- Some questions were answered
- Questions answered where information is known.

5. What remaining questions do you have?

- How do we prevent instead of solve the problem? Should have shared why Corps of Engineers chose herding system
- Where do we go from here?
- Who pays for all the research proposed?
- How much is being spent to address problem—public or private money?
- Lake levels control.
- In my algal studies of a tributary of the Genesee, I found a very large proportion of diatoms. What factors contribute to this?
- Rate of growth and life cycle of algae.
- Yes, how to handle the algae problem?
- Why can't algae be grown in the laboratory?
- I will be interested to hear what is done next and the results.
- How can we keep up to date on results of studies currently under way? (e.g. remote sensing and COE demonstration)
- How will ideas be shared?
- Will this group meet again (possibly in a year) to see how we are doing? Share our success?
- Will the USACOE pumping algae idea cause more turbidity at the beach and river?

6. Did you find the small discussion groups helpful?

- Good go-around, not unlimited brainstorming.
- Yes! (27)
- So-so!
- Not especially, but good way for everyone to have a chance to talk.
- More time would have been helpful.
- Enlightening—good idea. (2)
- Good exchange and input.
- Great opportunities for networking.
- Good dialog and interaction.
- Could have been longer.
- Very good.
- Gave everyone a chance to comment.
- More like sharing of ideas than a discussion. Would need more time.
- Seeing various perspectives was very helpful.
- Very good. Many new ideas brought forward.
- Interesting approach. Be nice to have more “structure” to it, i.e. have each group list and rank ideas etc. Hard to get a “take home” message from the groups.
- I thought all four groups did an excellent job at coming up with ideas, and very healthy discussions.

- Yes, everyone participated.

7. What were the most useful agenda items?

- Speakers with knowledge.
- The cause.
- Dr. Joe Makarewicz and Charles O’Neill.
- Small discussion groups.
- All helped present various aspects of the issue.
- Joe Makarewicz is always very informative. The background understanding was most helpful. (2)
- Control of non-point source pollution.
- Talking to others with the same problem.
- Factors contributing to algae growth. (2)
- Morning presentations.
- Can’t decide.
- Good choice of speakers.
- Algae history in Great Lakes.
- Information about algae and its growth. Small brainstorming groups.
- All. (2)
- What to do if measures should be taken at all.
- Similar problems on Canadian and United States side. Clean up solutions and costs.
- Overview of how algae forms/history. Small group solution ideas—some trial demonstration projects.
- “Algae 101,” Charles Knauf, Charles O’Neill (both).
- It’s hard to say. I think each speaker brought a certain perspective to the workshop. I appreciated each of them for what they brought to the discussion.
- History of algae in Lake Ontario and factors contributing to algal growth—presenters were excellent!

8. What could have been done better?

- For better hearing, have speaker repeat the question before he answers it.
- Establish a follow-up study group.
- Raise presentation screen so bottom can be seen.
- Very well done; proceeding should include two important themes: (1) this is a lakewide problem versus local; (2) this is a costly and potentially human health problem versus “just a nuisance.”
- Perhaps direct people to eat lunch together in interest groups. Give us a list of participants with some contact information.
- Couldn’t see projector well.
- Visuals (slides were not visible by some of the audience).
- More quantitative data to support degree of nitrogen/phosphorus non-point migration load to lake from different sources!
- More time in small groups. Maybe more than one session.
- Can’t think of anything.

- All speakers were good. However, there was quite a bit of repetition during the morning talks.
- An awful lot of information was crammed into one day.
- Room needed to be darker.
- Have a list of participants' addresses, contact etc.
- Maybe start it at 9:00 a.m. for travelers.
- Find an answer.
- One always should question outcomes based on those represented. It is not surprising that a forum largely composed of academia would focus on the need for more research. If the audience were largely private citizens or town employees, what your suggestions and ideas would look like would probably be markedly different.
- Putting an engineer after lunch is dangerous.
- Need a better viewing area for slides, otherwise a great facility.
- I thought this was extremely well done. (Nice site too—better than Burgundy Basin Inn.)
- Great Job! Well run. Interesting speakers.
- Overall, a very good workshop and complementary level of expertise from both speakers and audience participants.
- Please make certain to distribute proceedings to the individual attendees.
- You should pat yourself on the back for a job well done. Keep asking and keep us moving. Thank you for considering Greece as your locale to have this workshop. Keep up the great work you are doing.

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hmd4@cornell.edu (Helen Domske)

Presenter's Biographical Information

John D. ("Jack") Doyle, Monroe County Executive

Mr. Doyle, a lifelong Rochester resident who has dedicated his career to public service in Monroe County, has been the Monroe County Executive since 1995. Prior to becoming County Executive, Doyle was a New York State Supreme Court Justice in the 7th Judicial District. Before becoming a Supreme Court Justice, Doyle served as Monroe County Attorney during the Morin Administration. In his first job out of law school, Doyle was a staff attorney in the City of Rochester's Urban Renewal Department and was subsequently named Corporation Counsel for the City of Rochester.

Margaret Peet, Monroe County Department of Health

Contact information: mpeet@monroecounty.gov (585) 274-8442

Margaret Peet currently serves as a manager of the Bureau of Environmental Quality at the Monroe County Department of Health in Rochester, New York. Margaret's last 22 years of experience has focused on Monroe County and Great Lakes water quality planning efforts. Margaret co-leads the recently formed Bureau of Environmental Quality in its efforts to protect and improve the natural environment of Monroe County by conducting research, advising government, implementing solutions, and educating the community. She provides staff support for the Monroe County Stormwater Coalition, serves on the New York Great Lakes Basin Advisory Council, Monroe County Water Quality Coordinating Committee, and coordinates with other levels of government to implement environmental programming.

Margaret holds a bachelor's degree in Urban and Environmental Studies from Grand Valley University in Michigan, and a Masters Degree in Public Administration from SUNY Brockport.

Dr. Joseph Makarewicz, SUNY Brockport

Contact information: jmakarew@brockport.edu

Joseph Makarewicz (Ph.D., Cornell University) is a Distinguished Professor of Biological Sciences, the Director of the Environmental Science Program at the State University of New York at Brockport and a former Senior Fulbright Research Fellow to Germany. With over 100 publications and \$ 4 million in funding from Sea Grant, EPA, NSF, USDA, etc., his research has focused on four areas: fate and transport of nutrients and herbicides in watersheds, phytoplankton and zooplankton ecology, the ecology of exotic species and pesticide movement in food webs.

Murray Charlton, MSc, Environment Canada /National Water Research Institute

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Murray Charlton received his MSc degree in Zoology from the University of Toronto in 1971. He worked on the ecology of Char Lake in the Northwest Territories for the International Biological Programme with University of Toronto until joining Environment Canada in 1973. Since then he has conducted research on Lake Erie, Lake St. Clair, Lake Superior, the St. Lawrence River, and Lake Ontario. The research has concentrated on eutrophication problems especially algae and dissolved oxygen with later research branching out to include “Areas of Concern”, taste and odour, aquaculture, and shoreline algae. He leads a research group of physicists, chemists, and biologists working on the Great Lakes.

Charles O’Neill, New York Sea Grant

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Charles R. O'Neill, Jr. [Chuck] is a Cornell University Senior Extension Associate and New York Sea Grant Coastal Resource Specialist. He serves as Director of the National Aquatic Nuisance Species Clearinghouse, a special aquatic nuisance species and invasive species outreach project of NOAA and New York Sea Grant. He is responsible for the development and implementation of extension education programs, publications, and applied research projects in aquatic nuisance, nonindigenous, and invasive species introduction, spread, impact, control, and policy, coastal resource management, coastal processes and erosion control, coastal public policy, and surface water resource conservation. Chuck has authored numerous zebra mussel publications and is the publisher of *Aquatic Invaders*, the Clearinghouse’s quarterly research and policy based aquatic nuisance, nonindigenous, and invasive species digest. Chuck serves on the Communications, Education and Outreach Committee of the Aquatic Nuisance Species Task Force and is the co-chair of the Communications, Education and Outreach Committee of the newly formed Northeast Panel on Aquatic Nuisance Species.

Before joining New York Sea Grant in 1980, Mr. O'Neill worked as an Environmental Procedures Analyst for the County of Monroe, New York, where he developed the County's Environmental Quality Review Local Law and administrative procedures, and as an environmental analyst for the New York State Department of Environmental Conservation.

Dr. Anthony Vodacek, Rochester Institute of Technology

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Anthony Vodacek graduated with a B.S. in Chemistry from the University of Wisconsin-Madison in 1981. He received an M.S. in 1985 and a Ph.D. in 1990 in Environmental Engineering from Cornell University, studying the use of laser-based remote sensing of water quality. He then held postdoctoral positions at the Commission of the European Communities Joint Research Center in Ispra, Italy and the NASA Goddard Space Flight Center. He then worked in the Department of Chemistry and Biochemistry at the University of Maryland as a researcher until joining the faculty in the Center for Imaging Science at RIT in 1998. He is a member of the American Society of Limnology and Oceanography, the American Geophysical Union, the International Association for Great Lakes Research, and the Alliance for Marine Remote Sensing and is the RIT Campus Representative to the Great Lakes Research Consortium. He has research interests in developing remote sensing as a tool to study a variety of aquatic and terrestrial environmental problems.

Dr. Frank Sciremammano, Rochester Institute of Technology

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Frank Sciremammano, Jr. obtained a BS (1971), MS (1972) and PhD (1977), all in Mechanical Engineering from the University of Rochester. He served on the faculties of Stockton State College in Pomona, NJ and Oregon State University in Corvallis, OR, and was a Senior Associate and Research Director for Coastal Plains Environmental Consultants in Atlantic City, NJ. Dr. Sciremammano returned to Rochester in 1981 to join the College of Engineering at the Rochester Institute of Technology, where he is now a full Professor of Mechanical Engineering. He is a licensed Professional Engineer in the states of New York and New Jersey.

Dr. Sciremammano is currently a member of the International St. Lawrence River Board of Control and the International Lake Ontario –St. Lawrence River Study Board of the US-Canadian International Joint Commission as well as the Town of Brighton Planning Board. He has served as past Chairman of the Monroe County Environmental Management Council and as past Chairman of the Town of Brighton Conservation Board.

Dr. Sciremammano specializes in the areas of hydrology, oceanography, and environmental analysis and management. His activities have ranged from fundamental research in ocean dynamics to applied problem solving in support of specific industrial needs. Funding for these activities has been obtained from the National Science Foundation, the National Oceanic and Atmospheric Administration, the National Aeronautics and Space Administration, the States of New York and New Jersey, and many private industrial entities.

Charles Knauf, Monroe County Department of Health

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Charles Knauf currently serves as an Environmental Health Program Analyst with the Bureau of Environmental Quality in the Monroe County Health Department's Division of Environmental Health. Formerly a Senior Public Health Chemist for the Monroe County Environmental Health Laboratory, Mr. Knauf has a Bachelor of Arts Degree from SUNY at Binghamton, and has supplemental coursework in chemistry and mathematics. Since starting work with Monroe County in 1985, Mr. Knauf has worked on a number of projects, including the cooperative monitoring program with the United States Geological Survey, the Irondequoit Creek Wetlands Project, and as staff support for the Irondequoit Watershed Collaborative modeling effort. Mr. Knauf has also represented the Health Department on the Monroe County Water Quality Coordinating Committee, the Irondequoit Bay Coordinating Committee Technical Group, the Oatka Watershed Collaborative, and the Finger Lakes Lake Ontario Watershed Protection Alliance. Prior to his employment with Monroe County, Mr. Knauf served as secretary of the Monroe County Conservation Council. Mr. Knauf has also served as a member of the Monroe Community College Chemical Technology Advisory Committee 1996-1999; as a facilitator for the New York State Department of Environmental Conservation Fisheries Congress, 1996-97; as group facilitator for the Oatka Creek Watershed for Caring for Creeks Conference, 1998; and was a presenter on Applications of Statistics in Laboratory Quality Assurance and Quality Control for the Monroe Community College Mathematics Department Statistics Conference, Spring 1997.

Helen Domske, New York Sea Grant

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(716) 645-3610

Helen Domske is a Coastal Education Specialist for New York Sea Grant and the Associate Director of the Great Lakes Program at the University at Buffalo. She serves as editor for the Great Lakes Research Review and other publications that are produced by the Great Lakes Program. Helen is involved in Great Lakes issues such as exotic species, botulism in Lake Erie, and the Lakewide Management programs for the lower lakes. She is a member of the Lake Erie Binational Forum and has developed educational programs for both the Lake Ontario and Lake Erie LaMPs. For over 20 years, Helen has been actively involved in education and outreach on the Great Lakes, providing programs to thousands of teachers, students and stakeholders around the basin.

**Lake Ontario Algae Cause and Solution Workshop
May 30, 2002
Attendees List**

First Name	Last Name	Organization Name
Donna	Alder	Roberts Wesleyan College
Laura	Arney	Friends of the Genesee
Dr. Joseph	Atkinson	Great Lakes Program
Mark	Ballerstein	Monroe County Dept. of Environmental Services
Robert	Barbiero	NYS Parks and Recreation
Ashley	Barrie	Regional Municipality of Peel
Carole	Beal	Monroe County Health Department
Rochelle	Bell	Monroe County Planning & Development Department
David J	Bell	
Nichelle	Billhardt	Orleans County SWCD
Tiffany	Boas	Wayne County Soil & Water Conservation District
Greg	Boyer	Faculty of Chemistry, SUNY ESF
Margit	Brazda Poirier	Water Education Collaborative
Dr. Beverly	Brown	Biology Department
Gary	Brown	Monroe County Health Department
Kristen	Bud	Monroe County Soil & Water Conservation District
Don	Burton	NYS Lawn Care Association
Steve	Cantatore	Town of Greece
Matt	Chapman	Town of Greece
Murray N	Charlton	Environment Canada
Margaret	Cleary	Monroe County Health Department
Ralph	Condit	Monroe County Health Department
Peter	D'Aiuto	SUNY Brockport
Richard	Davin	Livingston County Health Department
John D	Devlin	Wilson Tuscarora State Park
Wayne	Dickinson PHS	Orleans County Health Department
Paul	Dicky	Niagara County Health Department
Hon. Doug	Dobson	Monroe County Legislature 07th District
Helen	Domske	New York Sea Grant
Becky	Doyle	Cornell University
Jack	Doyle	(c/o Kevin Crerand)
Anthony	Friona	U.S. Army Corps of Engineers
Barry	Fry	Columbia Analytical
Tom	Galetto	Town of Greece Environmental Board
Mike	Garland	County Executive's Office
John	Gauthier	Town of Greece
Jake	Gillette	Cornell University
Tom	Goodwin	Monroe County Planning & Development Department

Reinhard	Gsellmeier	Monroe County Dept. of Environmental Services
Ron	Gwozdek	Niagara County Health Department
Wayne	Hale	Orleans County Planning Department
David	Herring	NYS Office of Parks
Heather	Hogarty	Livingston County Planning Department
Marjorie	Horton	
Kenneth	Horton	
Lee Anne	Jones	Regional Municipality of Halton
Charlie	Knauf	Monroe County Health Department
Dr. Robert	Kremens	Town of Pittsford Environmental Board
Betsy	Landre	FL-LOWPA
Bill	Larsen	Rochester Institute of Technology
Margaret	Larsen	Monroe County Parks Department
Dr. Joseph	Makarewicz	SUNY Brockport
Dr. Joseph	Martin	Grand View Beach Association
Michael F	Masters	Orleans County
Christine	Maurer	Monroe County Health Department
Richard	Metzger	Monroe County Water Authority
Frank	Michaels	
Larry	Moore PhD	Ontario Clean Water Agency
Jim	Nugent	Shoremont Water Treatment Plant
Eileen	O'Connor	Cayuga County Health Department
Chuck	O'Neill	NYS Sea Grant Extension
Laura	Ortiz	U.S. Army Corps of Engineers
Karen	Paris Tuori	Monroe County Health Department
Mark	Passuite	Niagara County Dept. of Planning & Development
Webster	Pearsall	NYSDEC Region 8
Margy	Peet	Monroe County Health Department
Greg	Pien	Grand View Beach Association
Bob	Pierce	Orleans County Dept. of Planning & Research
Will	Poppe	G/FLRPC
Rolando	Raqueno	Rochester Institute of Technology
Robert	Remillard	USDA, NRCS, Lake Plain RC&D Program
Dave	Rinaldo	Monroe County Parks Department
Sharon	Rosenblum	Monroe County Cornell Cooperative Extension
Jay	Ross	
Dan	Rothman	URS Grenier, Inc.
Ed	Sander	Monroe County Fishery Advisory Board
Andy	Sansone	Monroe County Health Department
Paul	Sawyko	Rochester Gas & Electric
Leonard	Schantz	City of Rochester
James R	Schiebel	Hamlin Conservation Board
Kris	Scholl	Cayuga County Health Department
Dr. Frank	Sciremammano	Rochester Institute of Technology

David	Scudder	Wayne County WQCC
Mark	Seider	Niagara County Soil & Water Conservation District
Jerry	Senecal	Orleans County
Todd	Shervin	Orleans County Health Department
Timothy	Simon	Niagara Reservation State Park
Michael	Smith	US Army Corps of Engineers
Paula	Smith	Monroe County Soil & Water Conservation District
Rolfe	Steck	NYS Office of Parks and Recreation
Robert	Stevenson	Northwest District
Karen B.	Terbush	NYS Parks, Recreation & Historic Preservation
John	Terninko	Center for Environmental Information
John	Tofany	Greece Conservation Advisory Board
Dr. Anthony	Vodacek	Rochester Institute of Technology
Sharon N	Walker	
John R	Walker	
Dr. John	Waud	Allied Health Sciences
Dan	Weykman	Monroe County Soil & Water Conservation District
Robert	White	Pultneyville Yacht Club
David G	White	New York Sea Grant
Colleen	Wolfe	Stenographer
Don	Zelazny	NYSDEC Region 9
Hon. Wayne	Zyra	Monroe County Legislature, 02nd District