

*Monitoring the Spatially and
Temporally Variable Great Lakes
Nearshore Using Continuously
Towed Instrumentation*

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Overview

- Great Lakes 101
- GLNPO Open Lake Monitoring Program
- Nearshore Issues/Needs
- Triaxus and Sensors in Houses
- Preliminary Data for Spring 2009
- First Lake Michigan Nearshore Survey

GLNPO Mission

- Protect and restore the physical, chemical, and biological integrity of the Great Lakes
- Monitor water, aquatic life, sediments and air to assess the health of the Great Lakes
- Sample the Great Lakes with the *R/V Lake Guardian*





The Great Lakes Basin

		Superior	Michigan	Huron	Erie	Ontario	Totals
Length	(km)	563	494	332	388	311	
Breadth	(km)	257	190	245	92	85	
Average Depth	(m)	147	85	59	19	86	
Maximum Depth	(m)	406	282	229	64	244	
Volume	(km ³)	12,100	4,920	3,540	484	1,640	22,684
Water Area	(km ²)	82,100	57,800	59,600	25,700	18,960	244,160
Land Drainage Area	(km ²)	127,700	118,000	134,100	78,000	64,030	521,830
Total Area	(km ²)	209,800	175,800	193,700	103,700	82,990	765,990
Shoreline Length	(km)	4,385	2,633	6,157	1,402	1,146	17,017
Retention Time	(years)	191	99	22	2.6	6	

Open Lake Sampling Stations

GLNPO'S Water Quality Survey Sampling Stations



Long-Term Water Quality Monitoring, Offshore – consistent sampling and analyses.

- Lakes Michigan, Huron and Erie started in 1983
- Ontario began in 1986
- Lake Superior began in 1992



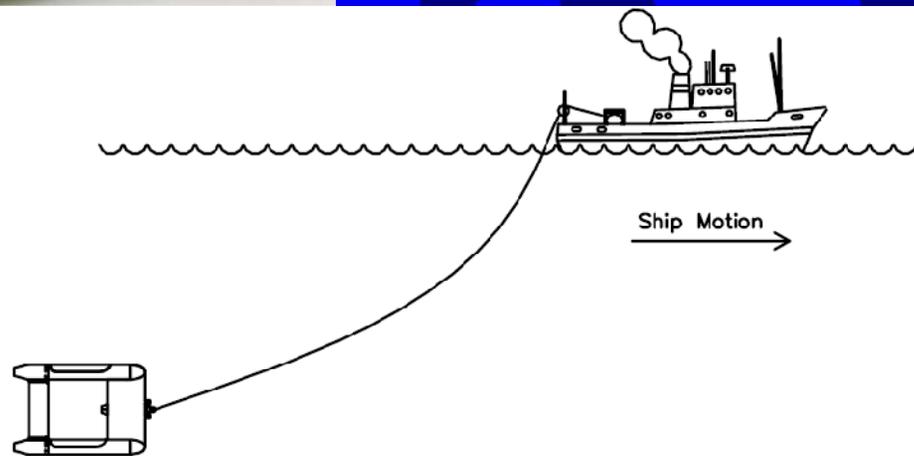
GLNPO's Nearshore Monitoring Program

- Nearshore monitoring challenge: limited availability of research vessels and resources to survey the extensive (>10,000 miles) shoreline
- Importance of nearshore surveys- nearshore waters are highly variable, high human interaction, can help inform federal/state/local monitoring programs and Great Lakes observing system

GLNPO's solution

- Incorporate real-time, nearshore data collected over a large shoreline distance
- Will supplement the GLNPO Open Water surveys
- Nearshore waters (defined as ~20 m contour) will be sampled in all five Great Lakes
- Use the *R/V Lake Guardian* and newly-acquired Triaxus platform

TRIAXUS 3D Towed Undulating Vehicle



Specifications

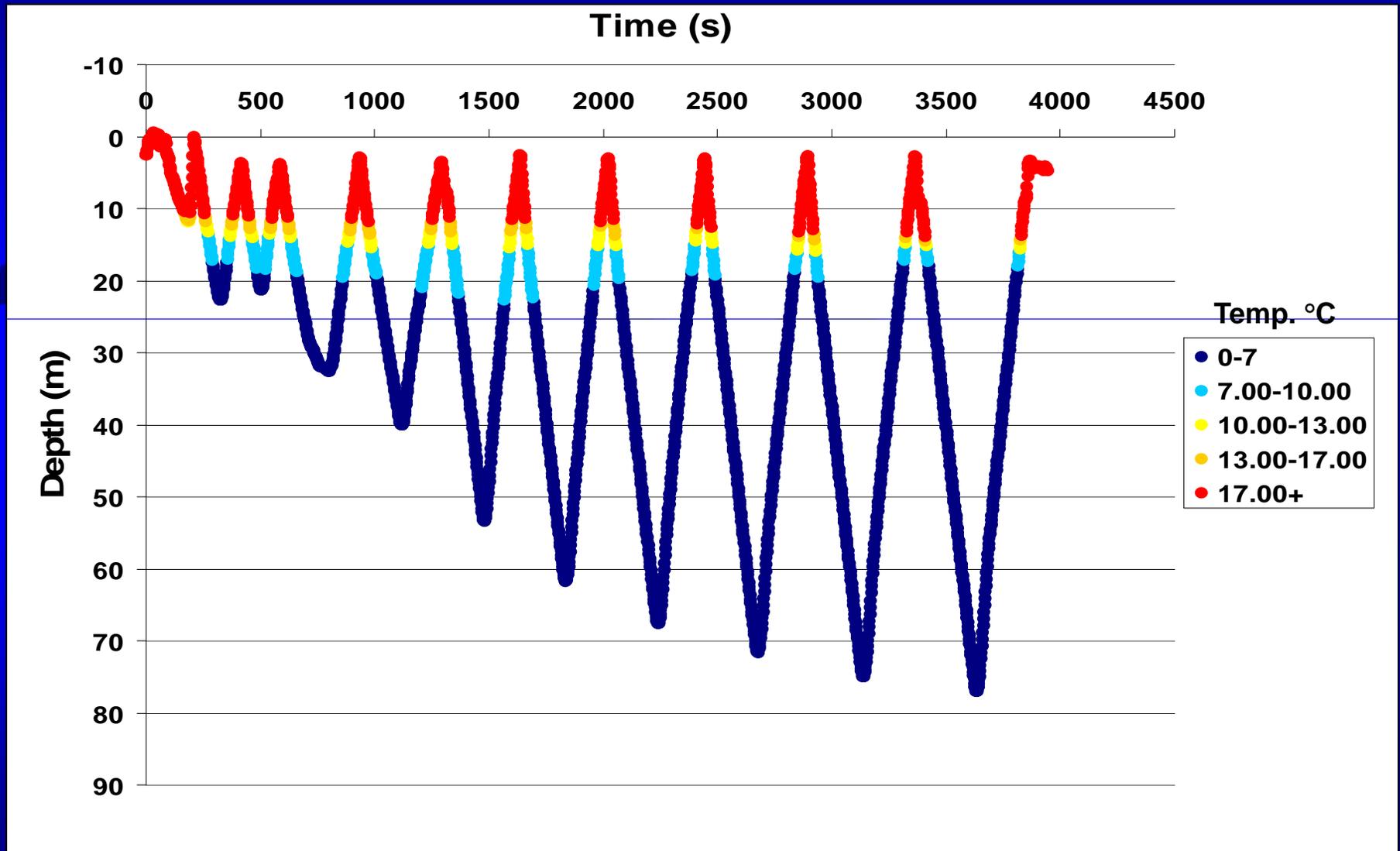
- Triaxus is a towed instrument platform that houses several sensors:
 - SeaBird CTD & D.O. probe
 - Active Fluorometer
 - Laser Optical Plankton Counter (LOPC)
 - Nitrate Analyzer
 - Side-Scan Sonar
 - Fluoroprobe
 - Transmissometer
- Towed behind the R/V Lake Guardian

SeaBird CTD

- Monitors multiple parameters:
 - Temperature
 - pH
 - Conductivity
 - Dissolved oxygen
 - Fluorescence



Temperature vs Depth over Time



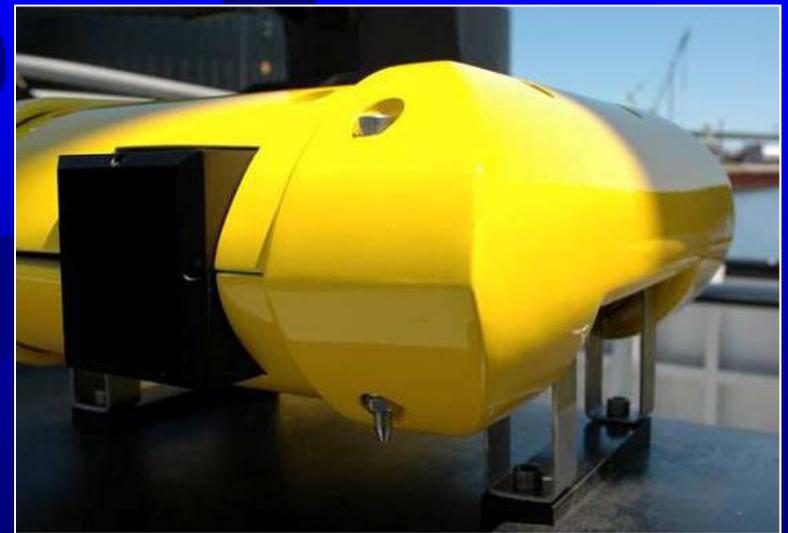
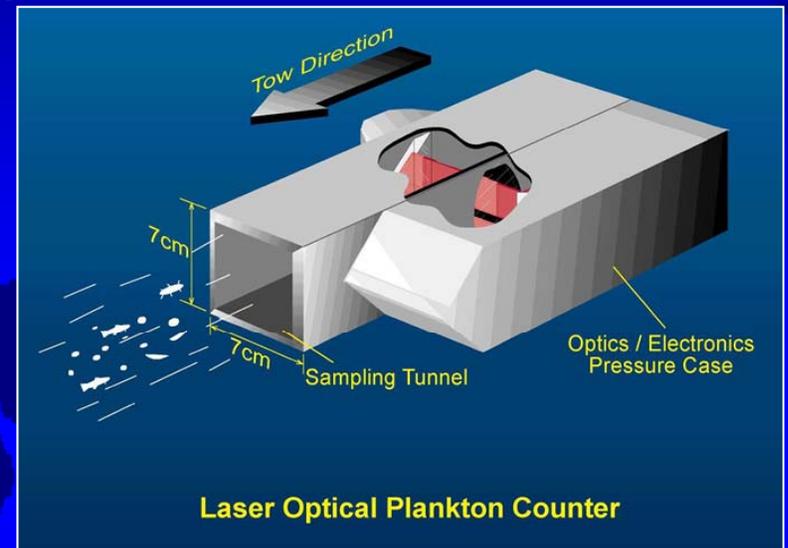
Active Fluorometer

- Used to determine the photosynthetic efficiency of phytoplankton in both oligotrophic and mesotrophic environments
- Utilize the relationship between chlorophyll fluorescence and photosynthesis to characterize phytoplankton 'health'

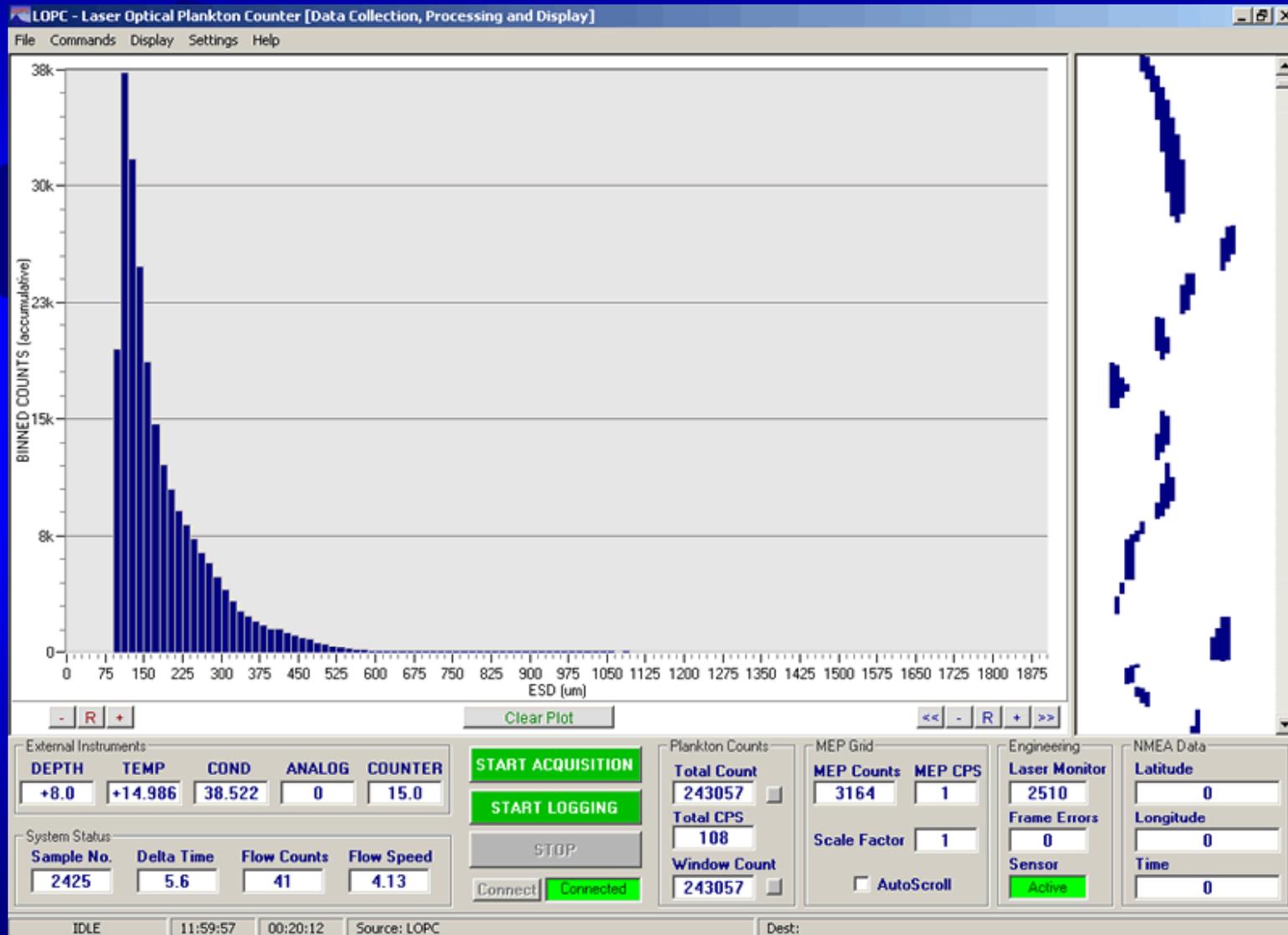


Laser-Optical Plankton Counter (LOPC)

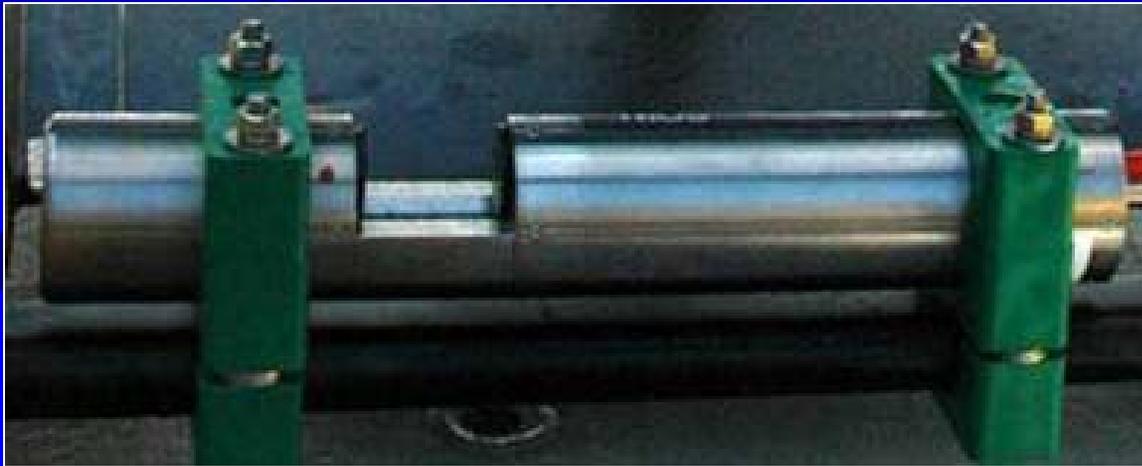
- The LOPC is an optical plankton counter with an imaging capability.
- Particles pass through a laser light beam and block the light falling on an array of sensors oriented perpendicularly to the flow direction.
- Particles as small as $100\ \mu\text{m}$ can be detected, sized, and counted.
- Concentration densities as high as 1,000,000 particles per cubic meter can be quantified.
- Can be towed at speeds up to 12 knots



LOPC Continued

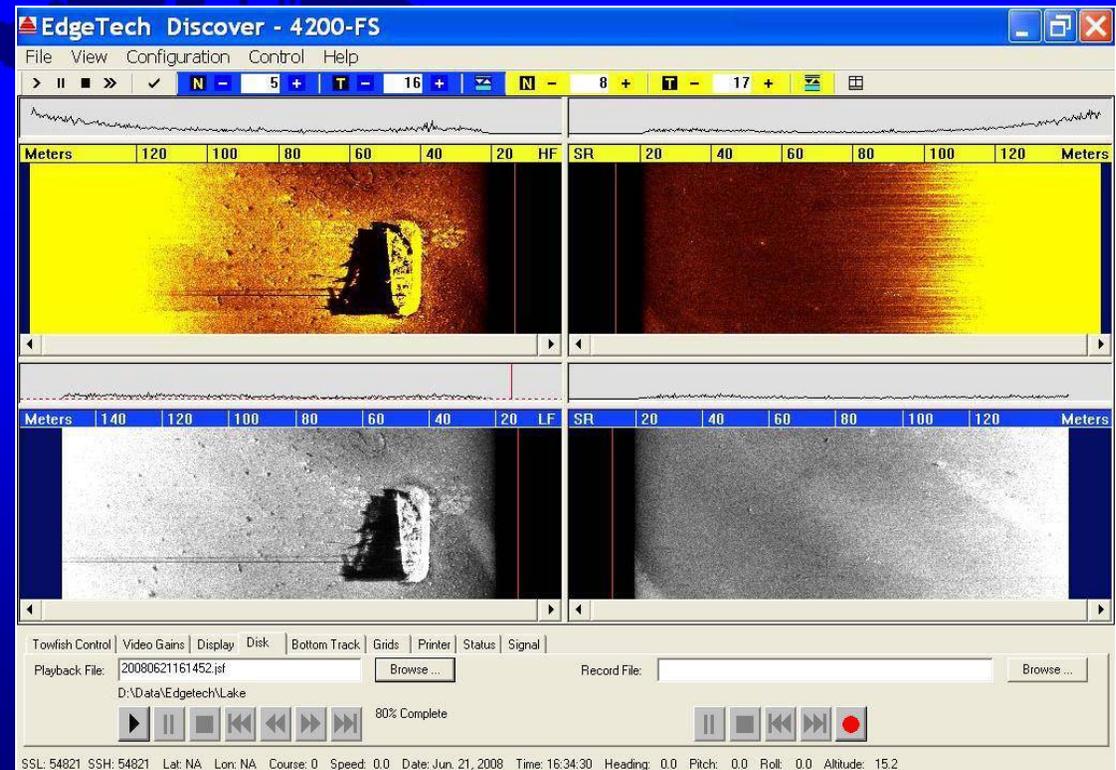


Nitrate Analyzer



Side-Scan Sonar

- Used for mapping the bottom of the lake and creating habitat maps.

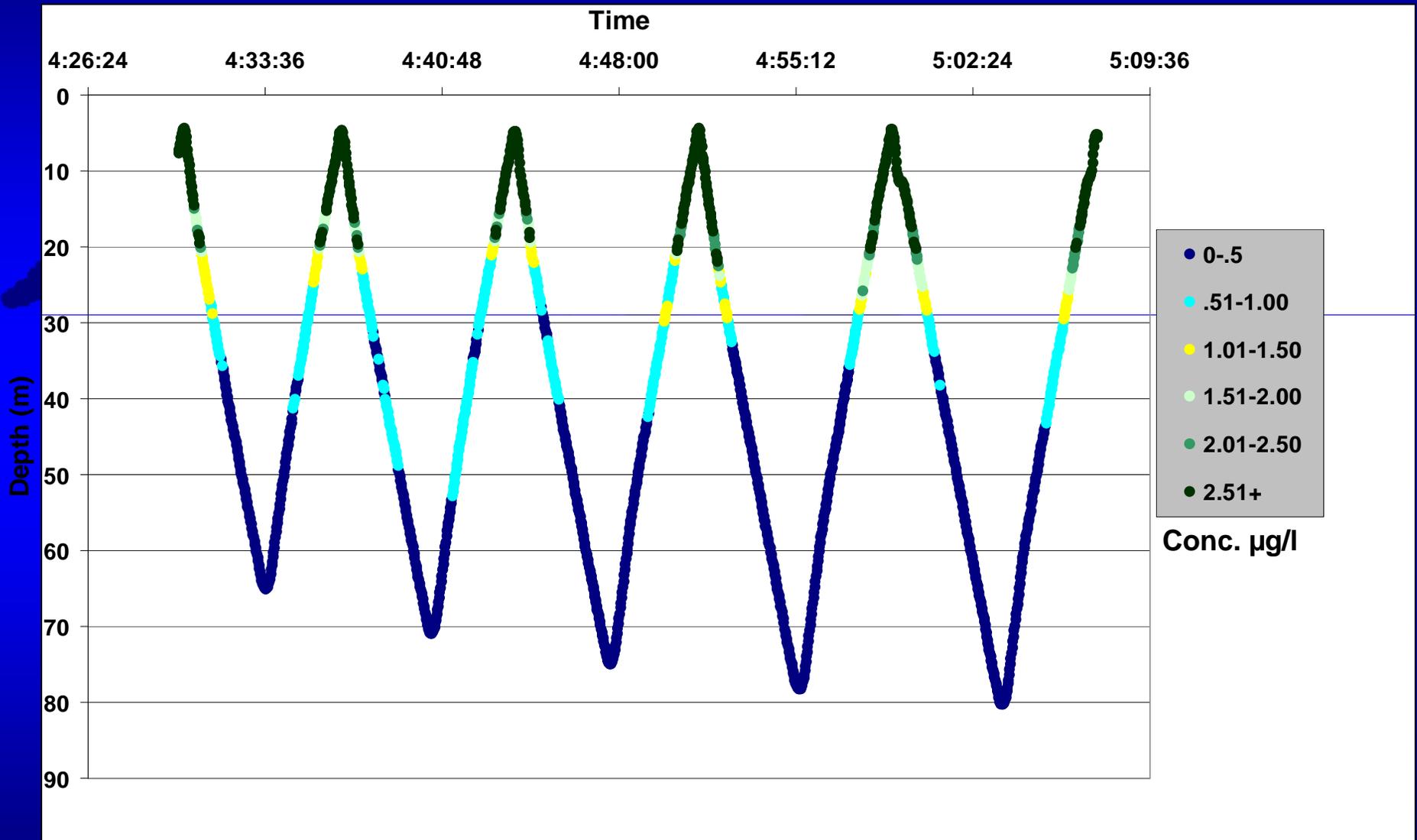


Fluoroprobe

- Measures *in situ* chlorophyll content
- Uses several excitation/emission wavelengths to separate algal groups:
 - cyanobacteria
 - green algae
 - (diatoms /dinoflagellates/ chrysophyta)
 - cryptophyta



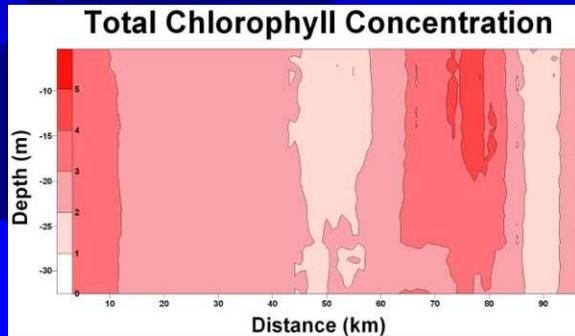
Algae Concentration vs Depth over Time



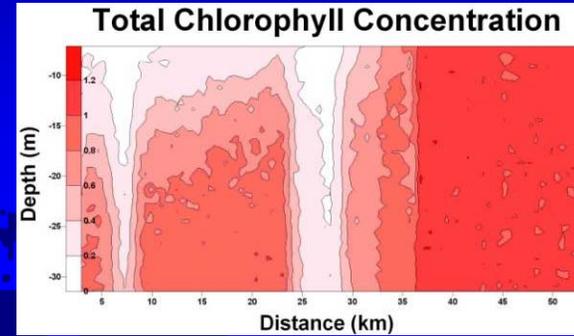
Spring 2009 Survey Tows



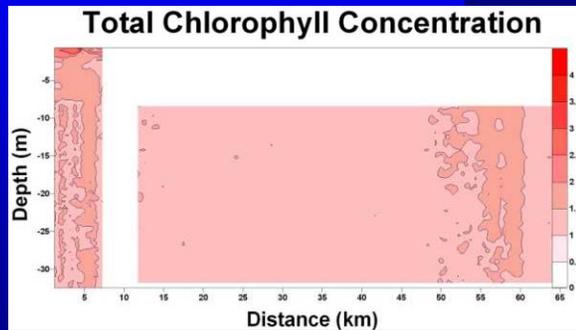
Fluoroprobe ($\mu\text{g/L}$)



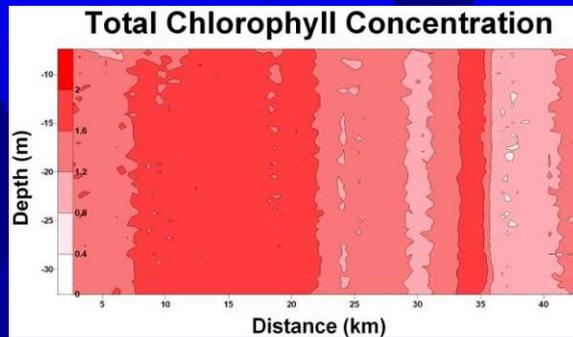
Erie



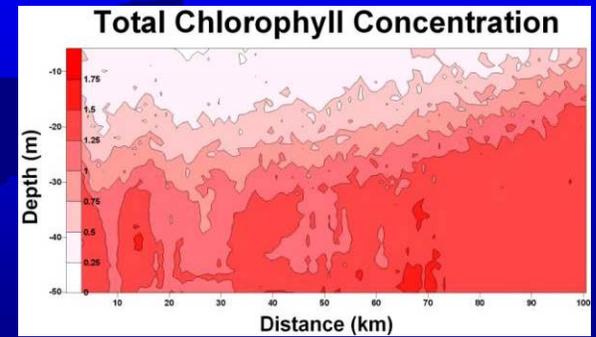
Huron



Michigan

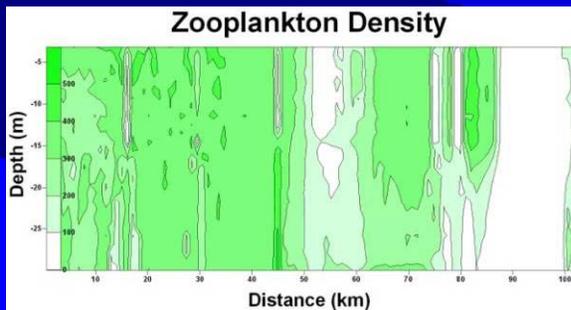


Ontario

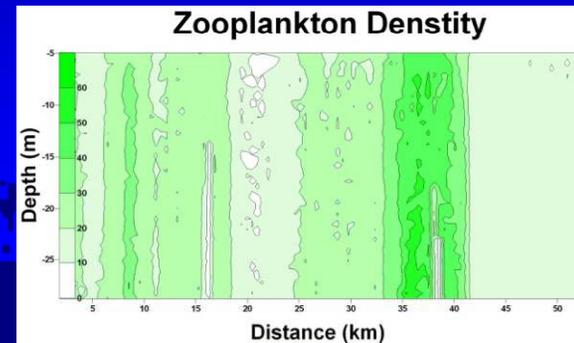


Superior

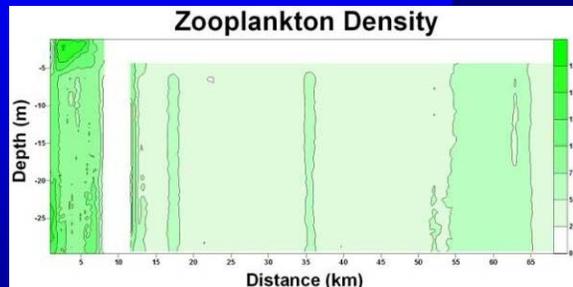
Laser Optical Plankton Counter ($\mu\text{m}/\text{km}$)



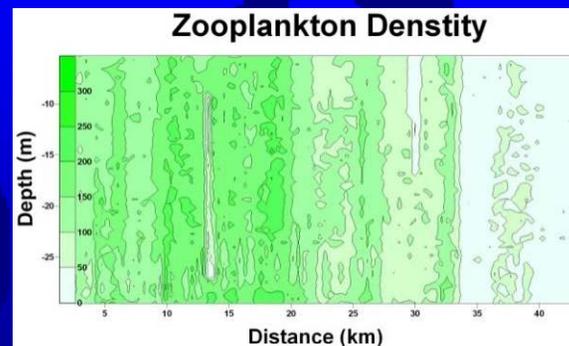
Erie



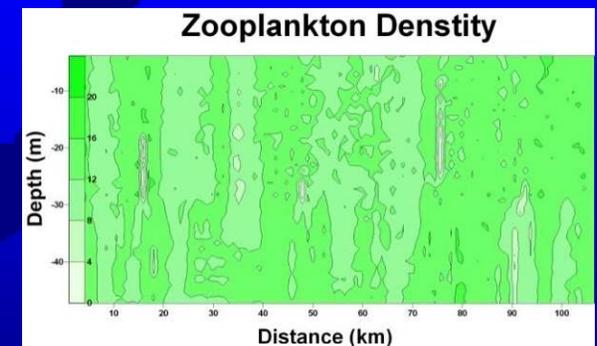
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Michigan

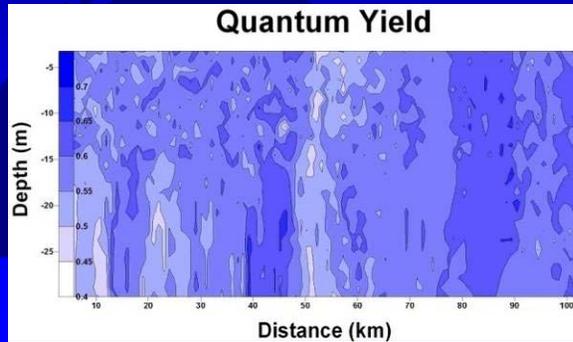


Ontario

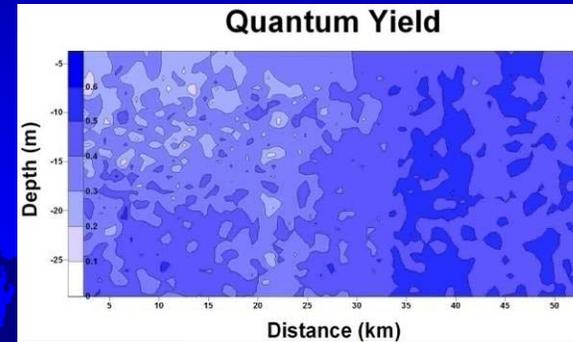


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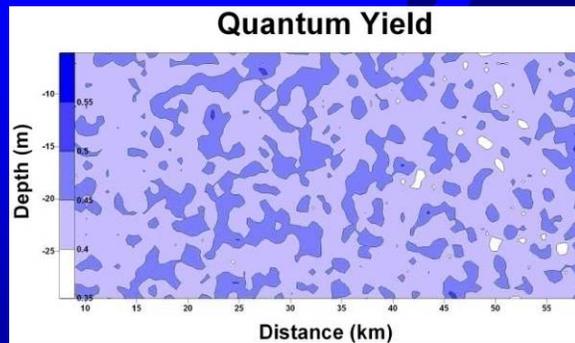
Phytoflash



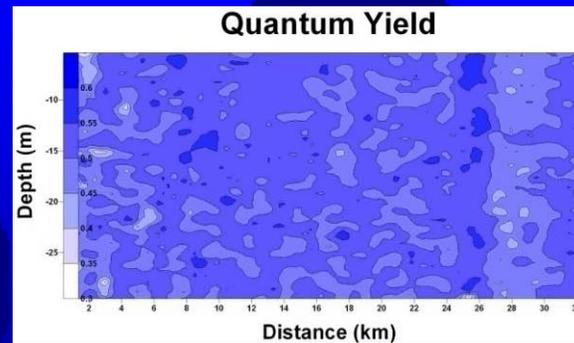
Erie



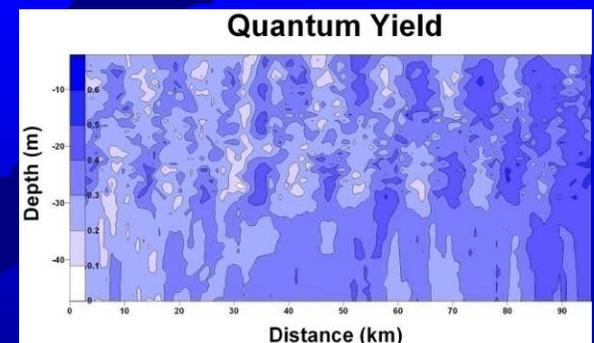
Huron



Michigan

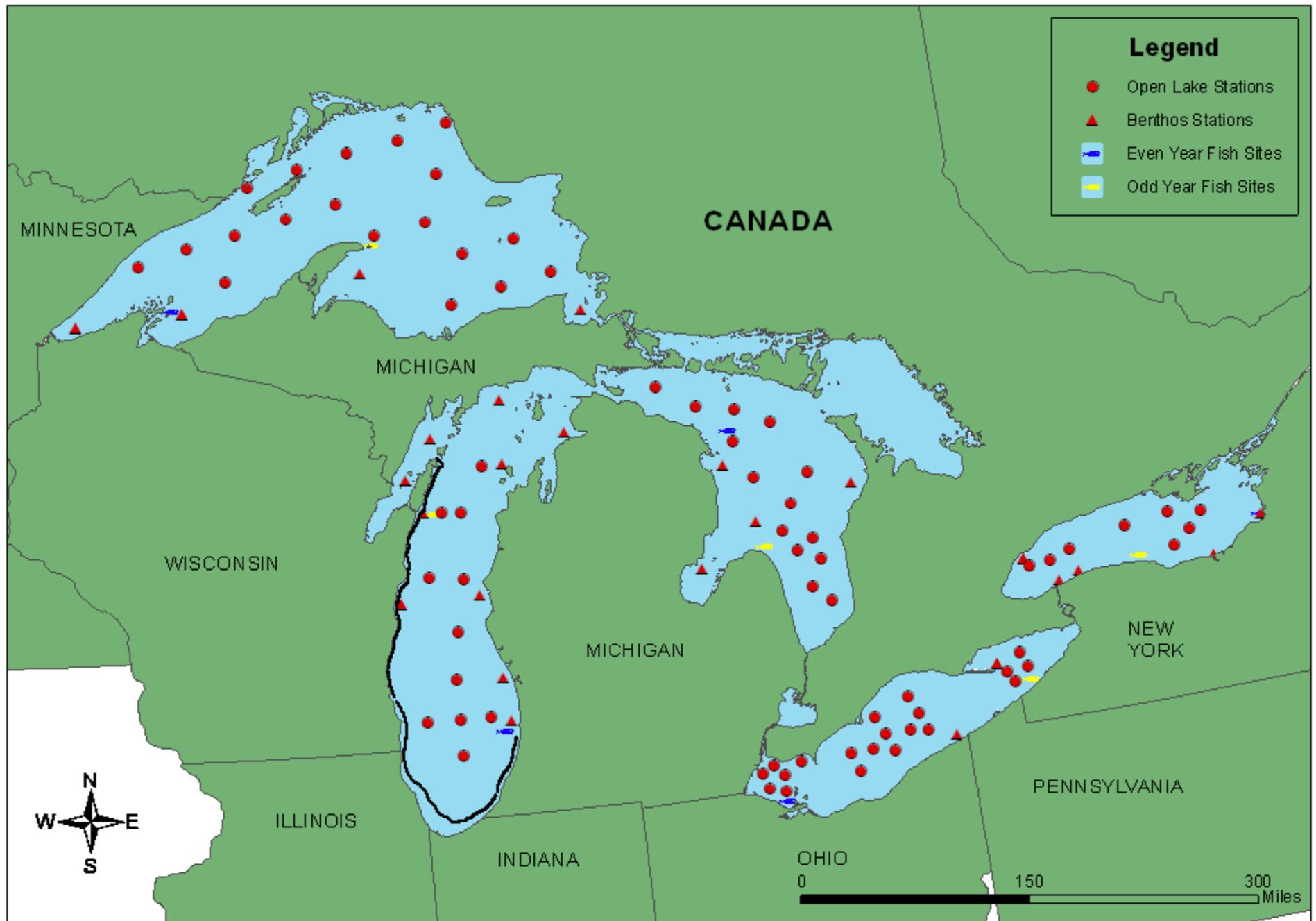


Ontario

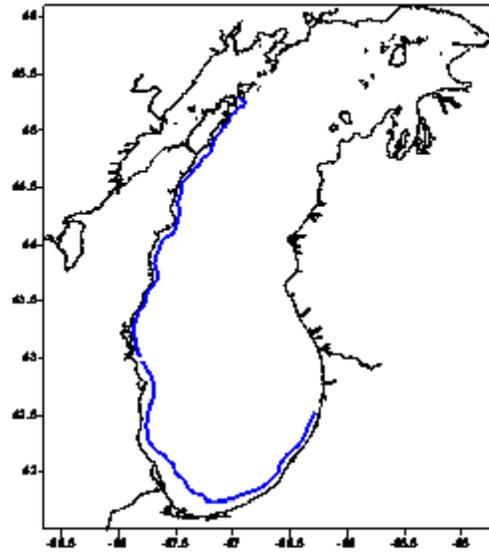


Superior

2009 Lake Michigan Nearshore Tow



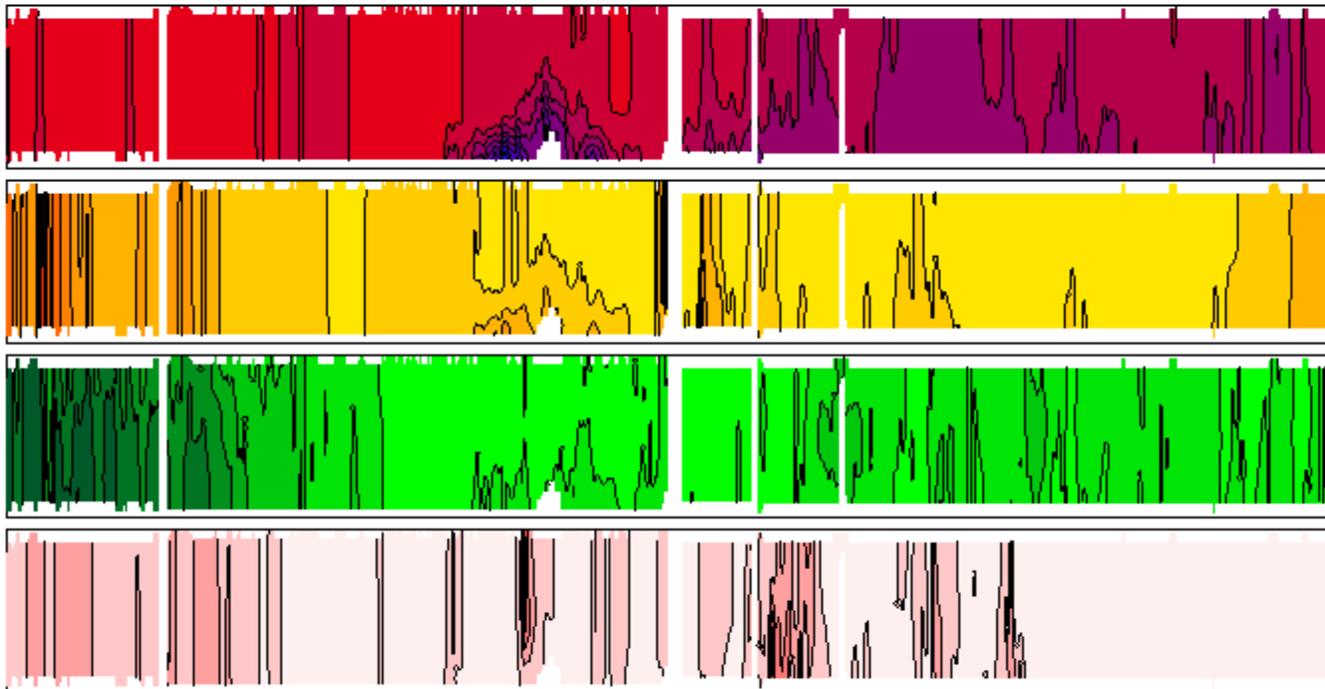
2009 Lake Michigan Nearshore Tow



St. Joseph, MI

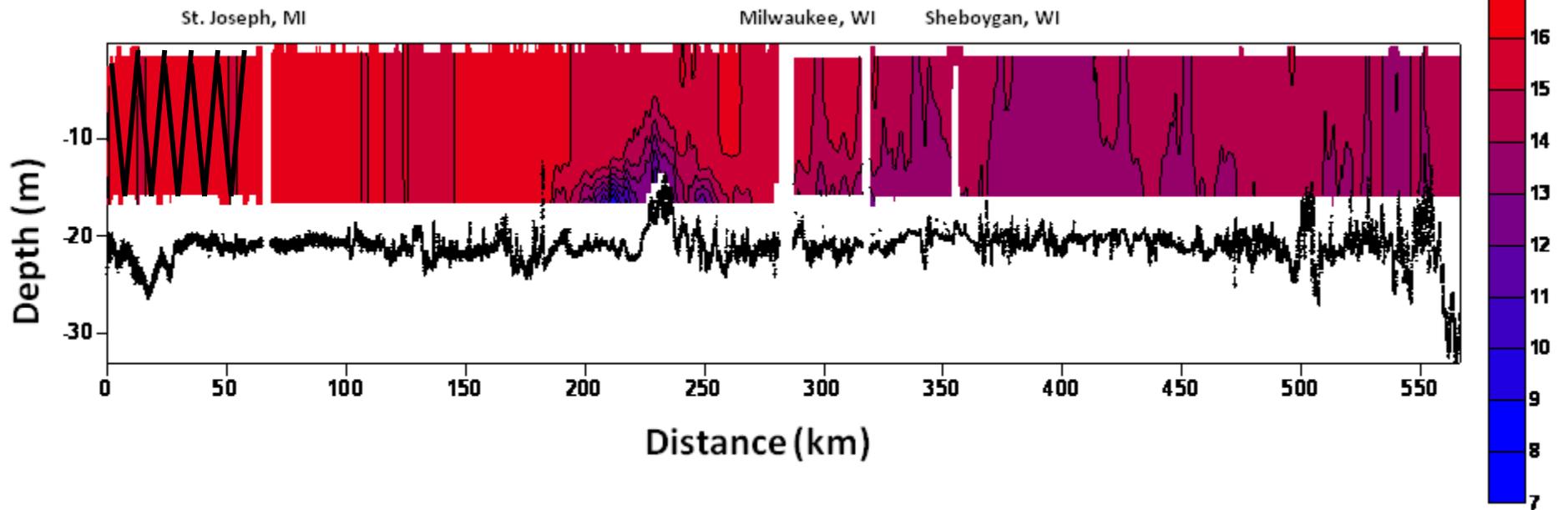
Milwaukee, WI

Green Bay



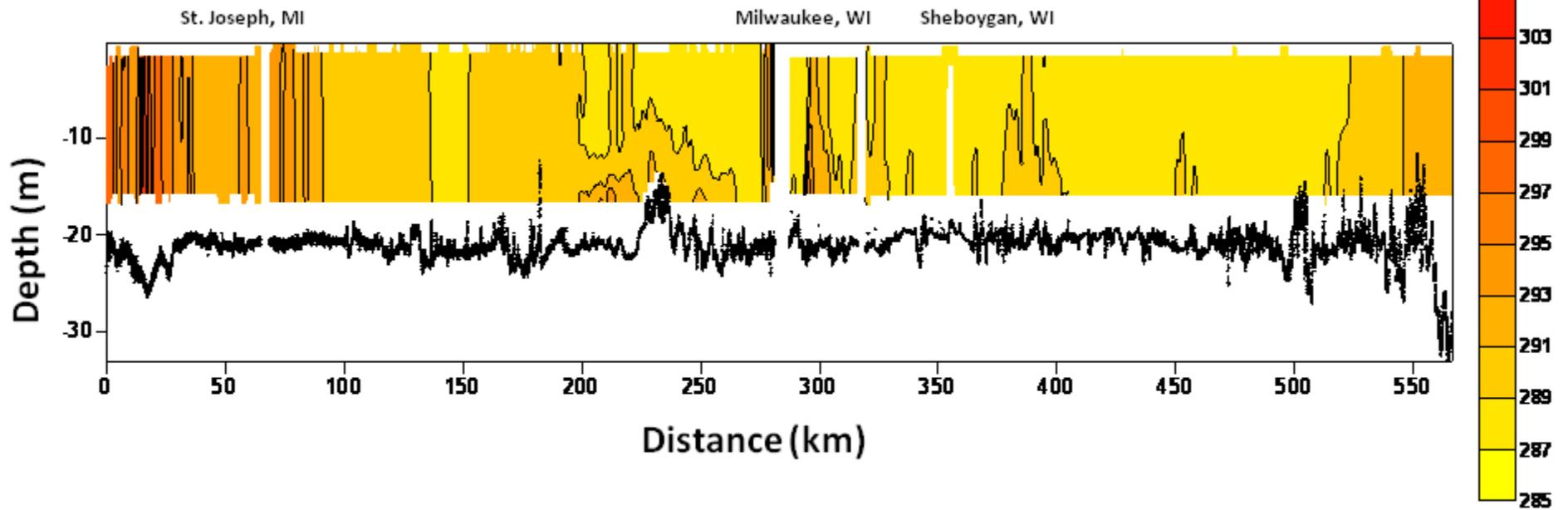
2009 Lake Michigan Nearshore Tow

Temperature (°C)



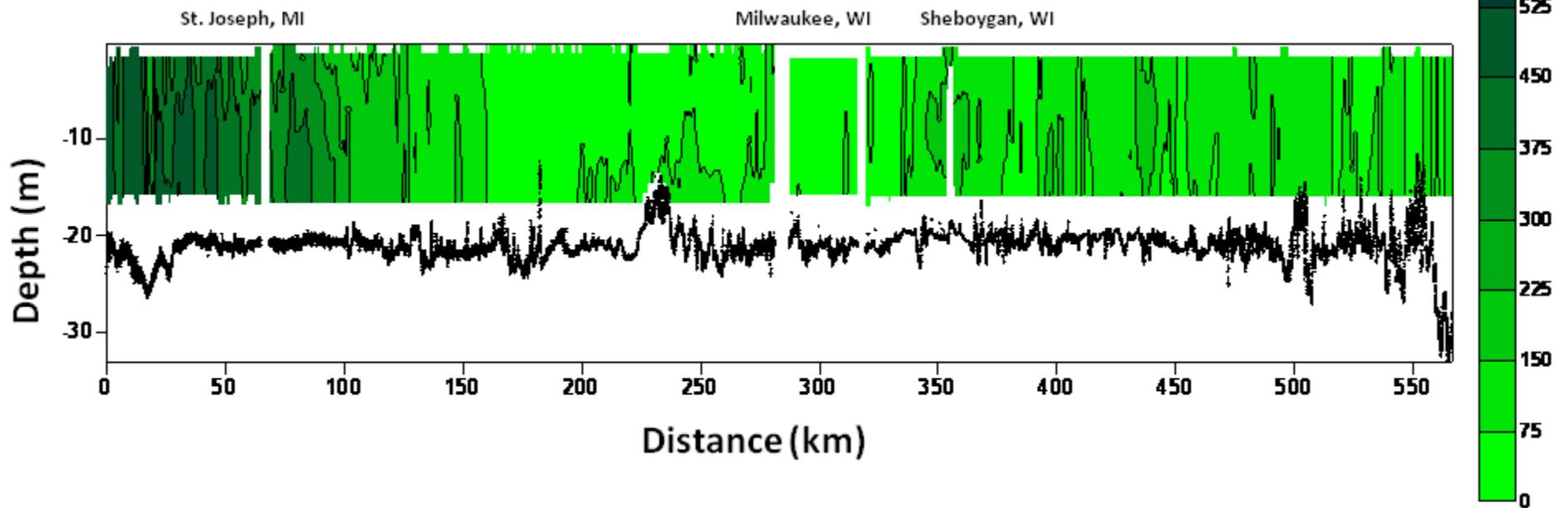
2009 Lake Michigan Nearshore Tow

Specific Conductance (uS/cm)



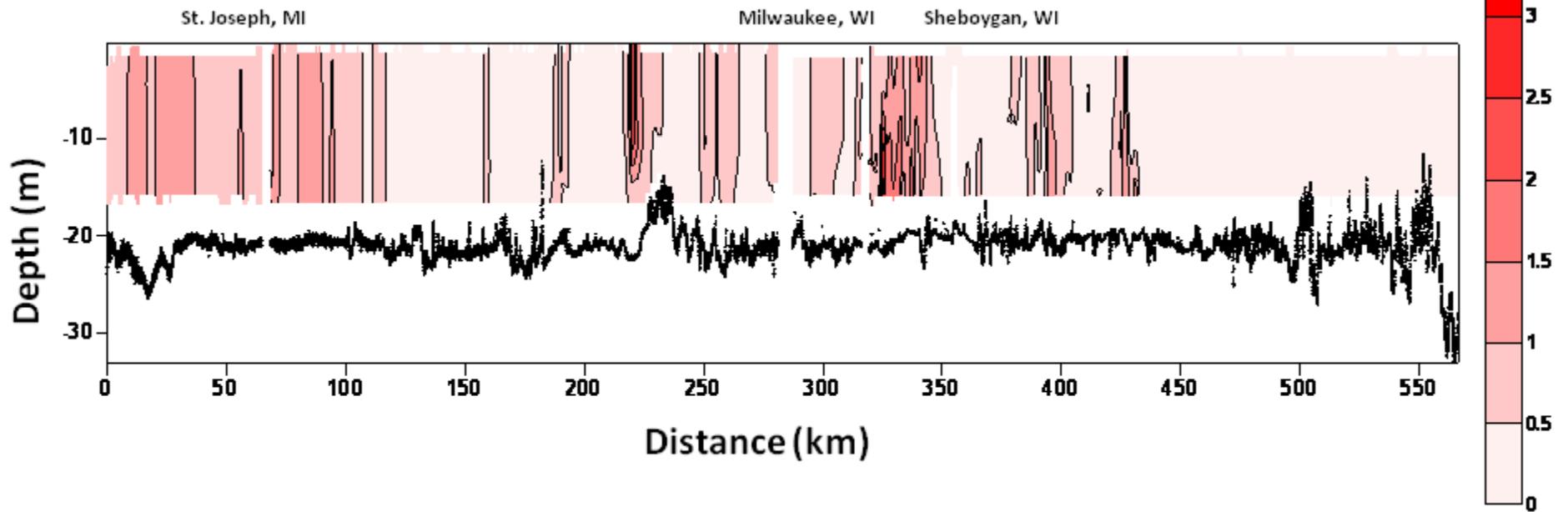
2009 Lake Michigan Nearshore Tow

Zooplankton Density

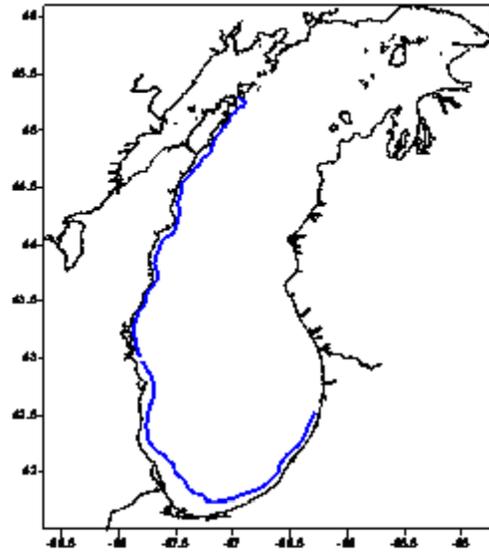


2009 Lake Michigan Nearshore Tow

Beam Attenuation (1/m)



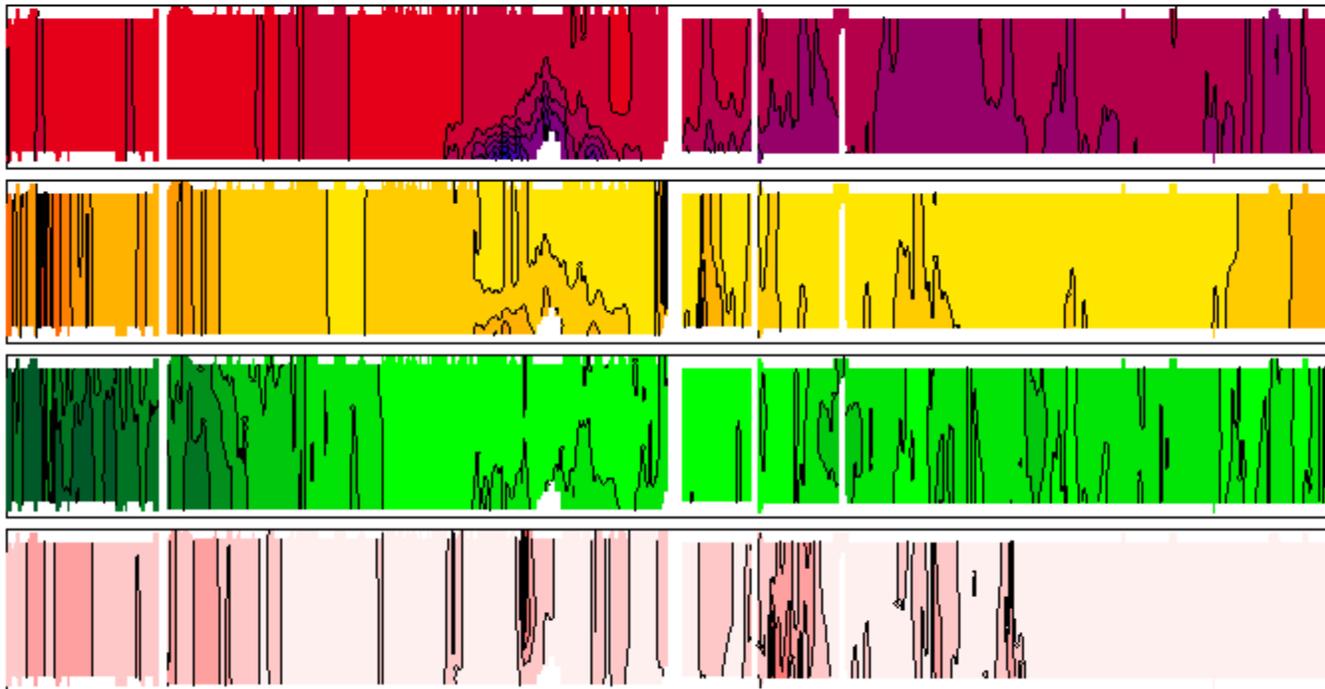
2009 Lake Michigan Nearshore Tow



St. Joseph, MI

Milwaukee, WI

Green Bay



Where next?

- Build on U.S. EPA, Office of Research and Development work in towed sensors.
- Develop nearshore indicators utilizing sensor data
- Establish nearshore transects to be sampled on a 5 year rotation.



For More Information

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- www.epa.gov/glnpo