CSMI Supports Management Needs

The Cooperative Science and Monitoring Initiative (CSMI) is a binational effort that rotates through the Great Lakes on a 5-year cycle coordinating scientific monitoring and research to better understand the Great Lakes ecosystem. CSMI informs Great Lakes management programs such as Lakewide Action and Management Plans (LAMPs) and Great Lakes Fishery Commission's Lake Committees as well as provinces, states, tribes and Metis in support of US & Canadian Great Lakes Water Quality Agreement commitments. In 2013, the Lake Ontario effort took a collaborative approach to determine the source and fate of nutrients and food web production across trophic levels. Five research themes included:

- Nutrient loading and fate
- Nearshore and offshore linkages
- Dynamics of primary & secondary production
- Fish production, distribution & diet
- Trophic transfer & food web mass-balance

This research will address management and research priorities including nutrient loading and management, the role of invasive species, identifying energy pathways between offshore-and nearshore habitats, and the ability of the lake to sustain fisheries. **This progress report presents preliminary information; it should not be referenced and does not provide a complete representation of all CSMI or Lake Ontario related research.**

Collaboration Is Key

This 2013 CSMI, system-wide investigation of Lake Ontario would not be possible without the direct and in-kind support contributed to CSMI 2013 from US Environmental Protection Agency (EPA), Canada Ontario Agreement (COA), Environment Canada (EC), New York State Department of Environmental Conservation (NYSDEC), US Geological Survey (USGS), US Fish and Wildlife Service (USFWS), Ontario Ministry of Natural Resources (OMNR), Fisheries and Oceans Canada (DFO), National Oceanic and Atmospheric Administration (NOAA), and academics from Cornell, University of Windsor, Buffalo State, University of Michigan, University of Buffalo, SUNY Brockport, Syracuse, SUNY ESF, Bowling Green, Clarkson, and Notre Dame.

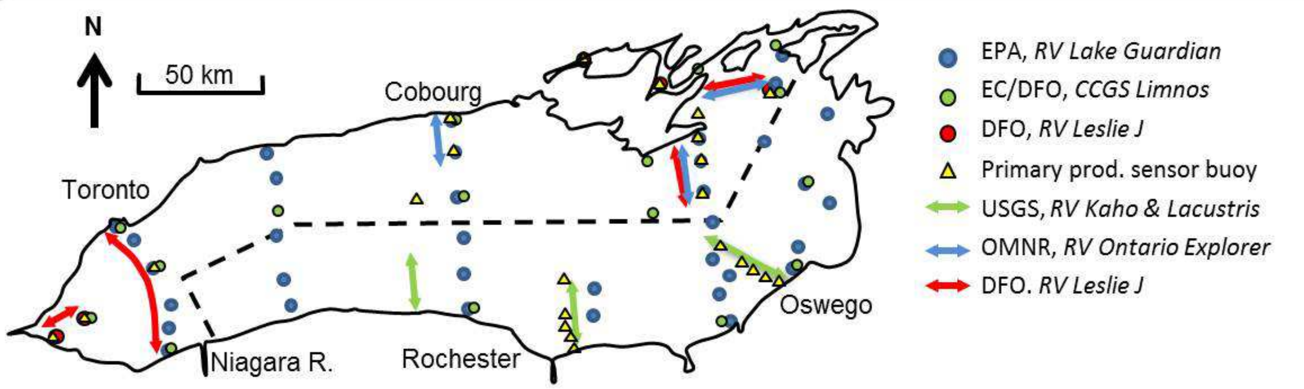
Thanks For Your Support

The tireless efforts of vessel crews, administrative, and technical operations staff were critical for ensuring a safe and productive work environment during 2013 in both laboratory and vessel settings. The EPA's *Lake Guardian* & Canadian Coast Guard research vessel *Limnos* and *Kelso* provided wide spatial sampling while the new vessels in the fleet, including the OMNR *RV Ontario Explorer* and USGS *RV Kaho*, sampled monthly along transects extending from nearshore to deep-water habitats. Smaller research vessels, such as the USGS *RV Lacustris* and DFO's *RV Leslie J*. played important roles collecting nearshore samples and filling in for offshore sampling when large vessels were unavailable.

A photo from the International Space Station highlights a late-summer "whiting event" in Lake Ontario Aug 24, 2013. These events occur at certain temperature and water acidity levels that cause fine particles of calcium carbonate to precipitate.

Save the Date!

CSMI researchers will present more thorough assessments of Lake Ontario's changing ecosystem at the upcoming International Association of Great Lakes Research annual conference at Hamilton, Ontario on May 26-30, 2014. For more information visit www.iaglr.org.



The 2013 Lake Ontario CSMI sampling included point samples (circles) and transects (arrows). Triangles mark sensor buoys that estimate primary production throughout the water column. NOT PICTURED: Nutrient, nutrient loading, contaminant, and harmful algal bloom sampling occurred throughout nearshore habitats.

Thousands of Samples & Initial Results

CSMI 2013 yielded impressive numbers of samples to characterize Lake Ontario's aquatic food web, hydrodynamics, and water chemistry. In addition to new monitoring efforts, CSMI work augments long term federal, provincial, state, and academic monitoring programs. Including these data with the CSMI sampling data will develop a more complete understanding of Lake Ontario's status. A web-based interactive map illustrating sampling locations for many of these samples is available: http://wim.usgs.gov/wimMappersBeta/index.html?m=DataVerificationMapper

Sample Type	DFO & EC	EPA	NYSDEC	OMNR	USGS
Data Loggers	111		5	64	48
Sensor Buoys	15			9	10
Water Chemistry	514	600	180	15	398
Water Col. Prof.	393	90	80	58	160
14C Pri. Prod.	102				
Chlorophyll	868	1476	80	58	995
Partic.Org.Carbon	388	167		66	236
Phytoplankton	102	120		15	115
Secchi	232	45	90	15	17
Benthic invert.	18	191		106	122
Microbial	137			15	
Rotifers	103	200		58	36
Zooplankton	372	487	68	421	253
LOPC/TriAxus	850	720			
Fish Diets				3751	3400
Fish Trawls	106		121	116	189
Hydroacoustics		21	5	27	16
Vertical Gillnets	14			44	13
Fish Caught	2049		614902	20171	263710
Horizontal Gillnet			65	301	45

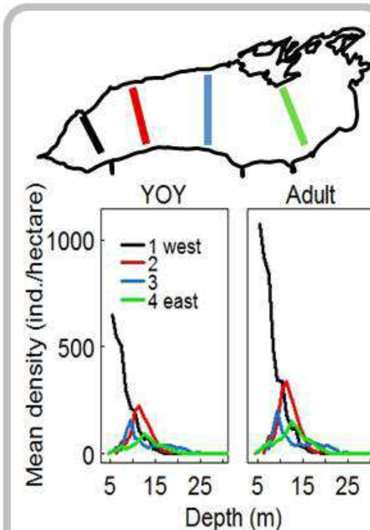
Main-lake samples collected in 2013 CSMI efforts. Does not include samples collected in nearshore and tributary research projects. In addition, thousands of algae, zooplankton, and fish tissue samples were collected to quantify food web pathways and energy sources.

Diporeia rare

Lake bottom samples revealed that Lake Ontario's benthic invertebrate community continues to be dominated by invasive Quagga mussels. In over 125 samples collected from 8 to 200m along the southern shore, USGS technicians only identified 6 *Diporeia*, the native amphipod that historically was an important source of food for fish. EPA/NOAA samples, which covered other portions of the lake, will help in understanding the remaining distribution of this native invertebrate.

Pelagic Prey Fish Gradient West to East

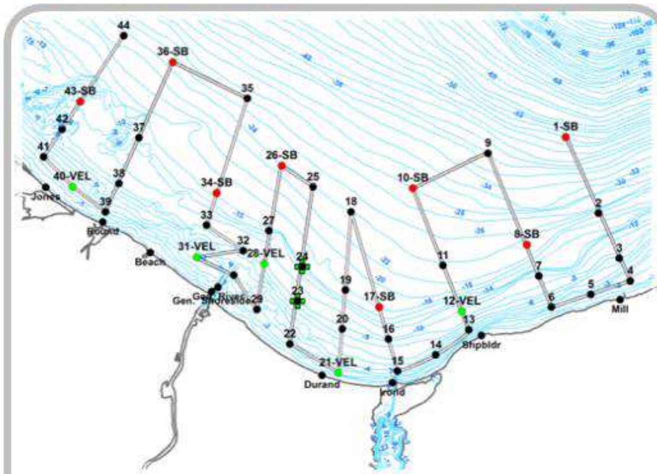
Hydroacoustics were used aboard the *RV Lake Guardian* and other vessels to study lake-wide patterns of fish distribution. Pelagic prey fish such as alewife and rainbow smelt were found to be most abundant in the western basin. Research will explore how zooplankton and temperature may influence observed patterns, while fish managers use such data to balance predator-prey levels.



Hydroacoustic transects from west (black) to east (green) show density & depth of pelagic prey fish in 2013 spring surveys. Data: Milan Riha, Lars Rudstam.

Nearshore Nutrients & Thermal Bar

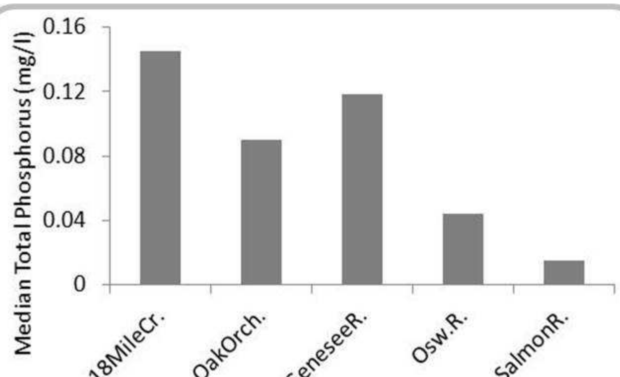
In 2008, SUNY Brockport and Ontario Ministry of the Environment coordinated an assessment of nearshore nutrient conditions and found that tributary-based nutrients were linked to local eutrophication problems in the lake's nearshore. In 2013, these institutions built on this work, with monthly sampling in nearshore habitats and transects extending into the lake. Special attention was focused on quantifying the timing of nearshore warming and how that warm water moved offshore. This "thermal bar" of nearshore warm water presses against colder offshore water, prevents mixing, and keeps spring time nutrients from tributaries close to shore.



Nearshore nutrient research by SUNY Brockport used intensive sampling grids, such as this one in the Rochester area, to determine how nutrients entering from tributaries move in the lake.

Nutrient Inputs From South Shore Tributaries

USGS Water Science Center researchers out of Ithaca, NY, estimated the nutrient inputs to Lake Ontario from six tributaries across the southern shore. Such studies require both constant monitoring of stream water levels and nutrient concentrations. These data will help estimate the total amount and spatial arrangements of nutrients entering the lake - critical information for biophysical models describing spatial algal patterns.



Mean total phosphorus concentrations at six tributaries across Lake Ontario's south shore. Preliminary data, do not use or cite.

Novel Sampling Techniques

Field sampling used new techniques and advanced technologies to address both current and historic research questions.

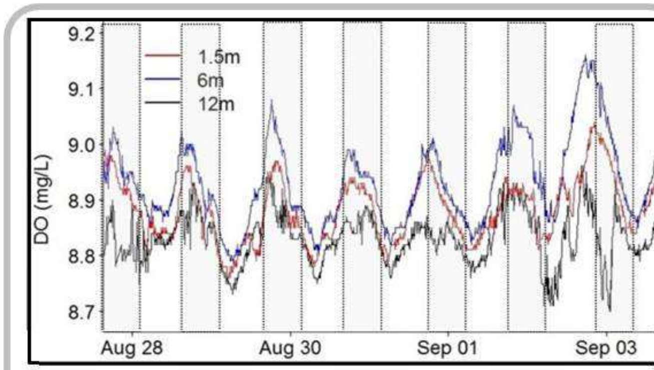
Glider Traces Deep Chlorophyll Layers

Layers of algae that grow in deep regions of Lake Ontario may fuel the food web, but the spatial extent of this habitat is unknown. NOAA, USGS and Cornell scientists mapped this deep primary production using an autonomous glider that traversed Lake Ontario during August 2013. The glider changes its buoyancy to move up and down in the water column while fins guide it over a zig-zag path that started near Oswego, NY and ended 30 days later near in Olcott, NY, more than 100 miles away.

NOAA scientist explains how the autonomous glider dives and surfaces to study primary production to interested lake users in Olcott, NY. Photo: Brian Weidel

New Ways to Measure Algal Growth

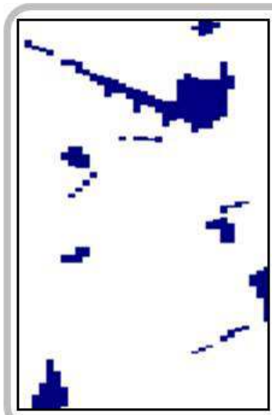
Algae, at the base of the food web, produce oxygen. Diel changes in dissolved oxygen levels can be used to estimate how much algae grows (primary production). Dissolved oxygen data loggers, attached to buoys in nearshore and offshore waters, measured the daily oxygen cycle and primary production in certain habitats and depths. More accurate estimates of primary production throughout different lake habitats will help parameterize food web models and understand how changes in nutrient loads may influence water clarity.

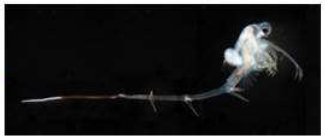


Sensors tracked daily oxygen cycles in Lake Ontario at three depths. Rising levels represent primary production while declining portions represent respiration. This high-frequency method was compared to traditional radioisotope techniques.

Lasers and Sound Measure Zooplankton

Underwater, high-frequency hydroacoustics and laser optical plankton counters were towed across sampling transects all over Lake Ontario and compared to more traditional net sampling to evaluate how these new technologies can improve our understanding of zooplankton distribution and behavior.

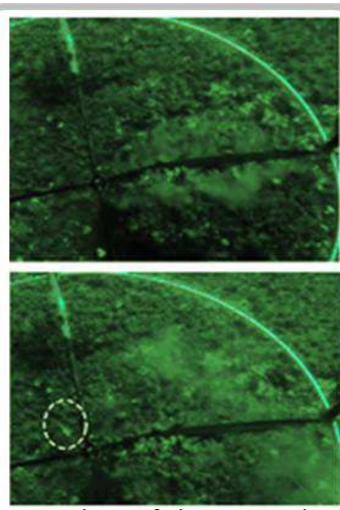




A laser optical plankton counter image (left) from Lake Ontario closely resembles an invasive *Bythotrephes* (above). LOPC image: Warren Currie, *Bytho.* image: Andrea Miehls.

Deepwater electrofishing counts gobies in rocks

The role of round gobies in Lake Ontario's food web is of great interest because they can be an important food source for salmonids. Measuring the number of gobies in rocky habitats is difficult, so OMNR scientists are evaluating new methods to quantify gobies using electrical current. The electrofishing grid temporarily stuns the gobies within a known area. Scientists then count the stunned gobies, which roll over, revealing their light colored undersides.



Top: electrofishing quadrat in mussel covered substrate, no electrical current. Bottom panel: with current, the white underside of a goby is evident (dashed circle). Photo: M.Yuille

Students Power 2013 Effort

Students completed and assisted on many of the sample collections and analyses collected in the 2013 effort. DFO field crews included four undergraduates and 2 recently graduated technicians. Vadim Karatayev, an undergad at Cornell, is studying *Dreissena* growth dynamics while James Mumby, a master's student at the University of Windsor, uses tissue samples to understand predatory fish feeding patterns. Cornell graduate students Annie Scofield and Toby Holda use data from across Lake Ontario and other Great Lakes on topics associated with the deep chlorophyll layer and the native fresh water shrimp, *Mysis diluviana.* Notre Dame graduate students Jake Zwart and Patrick Kelly are determining causes of variability (space, time, depth) in lake-wide primary production estimates and how important DCL algae are to zooplankton.

A native lake trout ahead of the USGS bottom trawl (35m, Rochester, NY). Video shows when trawls contact the lake bottom, yielding area swept and prey fish density estimates which are needed for mass balance food web models and cross-lake comparisons.

Technicians B. O'Malley, S. Burnett, and E. Jackson count and measure CSMI zooplankton and rotifer samples in the newly remodeled Great Lakes Lab at the Cornell Biological Field Station.

USGS scientists deploy a sensor-equipped buoy in 200 meters of water, northwest of Oswego NY. The buoy measures and records dissolved oxygen and weather data to predict algae production.

Contacts, Information, and Collaboration

Lake Ontario 2013 CSMI success depends on disseminating results and building collaboration. If you would like more information or are interested in collaborating on related research please contact :

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