How we view CSMI

The recently updated Great Lakes Water Quality Agreement commits the United States and Canada to deliver a binational Cooperative Science and Monitoring Initiative (CSMI) for each lake on a five-year rotational basis to support Lakewide Action and Management Plans (LAMP) information needs. The 2013 Lake Ontario CSMI effort was collaboratively planned to meet management needs and science questions. The 2013 approach was developed through discussion among a broad spectrum of binational partner agencies and institutions with interest in Lake Ontario. Wherever possible we coordinated 2013 efforts to take advantage of the many long-term agency sampling efforts already in place and projects funded outside the CSMI-framework. This resulted in an unprecedented lake wide, multi-trophic level, seasonal sampling effort of watershed, nearshore, and offshore habitats. The work could be broadly categorized under four themes: nutrient loading and fate; spatial distribution of primary and secondary production; fish abundance and behavior; and food web mass balance modelling. The design sampled nutrient loading, water quality, biodiversity, contaminants, lower trophic levels, invasive species, and fisheries to develop a mechanistic understanding of Lake Ontario ecology that informs the diverse interests of decision makers, the public, and scientists.

SUNY-Brockport and Canadian agencies continued research understanding how nutrients levels vary over the season in near shore habitats. This image, just north of Rochester, NY, illustrates how turbid river inputs remain close to shore, including the Genesee River plume (right side).

Herein we build on our first report (http://www.dec.ny.gov/docs/water_pdf/csmi2013progrpt.pdf), recognize our initial products, highlight select research, describe our path forward, and discuss future improvements. This effort is not possible without the collaborative effort and funding of the 25+ agencies and institutions involved.

Products to Date

Lake Ont. Tech. Committee (LOC), Pulaski, NY	Jan 2014	2 presentations
New York Chapter American Fisheries Meeting, Geneva, NY	Feb 2014	5 presentations
2014 Great Lakes AOC RAP Implementation Workshop	Feb 2014	2 presentations
OMNR Food for Thought, Peterborough, ON	Mar 2014	1 presentation
COA 2013 Follow-up sampling, $141.9k, Johnson & Stewart	Mar 2014	Funded
Int. Assoc. for Great Lakes Res. Annual Meeting, Hamilton, ON	May 2014	16 presentations
Lake Ontario Committee, Gr. Lks. Fishery Comm., Windsor, ON	Mar 2014	2 presentations
GLFC, Why Ontario alewife haven't collapsed, Stewart $121k	June 2014	Full proposal
GLOS Data Management Proposal, $100k, Rudstam, et al.	Aug 2014	Full proposal

Research Focus

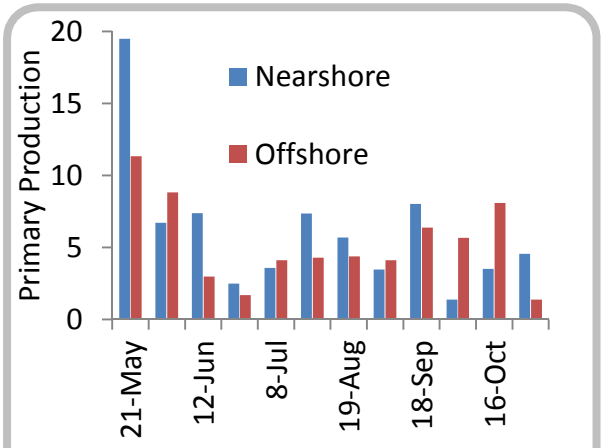
IAGLR 2014 Synthesis

More than 16 Lake Ontario 2013 CSMI papers were presented at the Int. Assoc. of Great Lakes Research (IAGLR) conference. Common themes included the role of the deep chlorophyll layer (DCL), zooplankton community changes, and new technologies that more completely illustrate this complex ecosystem. Maximum phytoplankton production has slowly shifted to deeper depths from ~5 m in the 1970s to more than 15 m in 2013. As primary production has shifted so has the behavior of zooplankton, mysids, and fish. The DCL commonly forms in summer below the thermocline. Sampling must consider such physical and behavioral changes to accurately quantify various trophic levels. Predation by invasive *Cercopagis* and *Bythotrephes* is likely influencing the zooplankton community and the planktonic stage of quagga mussels is at times an important part of total zooplankton biomass. Satellite remote sensing, underwater vehicles, and autonomous sensors are collecting large amounts of data at considerable cost savings as they are mostly independent of traditional vessels. Beyond describing current conditions, these data sources tune mechanism-based hydrodynamic and bioenergetics models that predict lake and food web dynamics. There is evidence that quagga mussel populations are decreasing at some depth zones, matching observations on some of the other Great Lakes. Population dynamics of these mussels are complex and they appear to grow differently depending on depth and location. Alewife continue to dominate prey fish while Round Goby are the most abundant benthic prey fish. Predator fish diets have responded to prey fish changes, but alewife continue to dominate all salmonid diets. Full abstracts of IAGLR papers are at iaglr.com. We summarize four of the many excellent presentations.

Ecology and Dynamics of Planktonic Communities in Western Lake Ontario: 2013 Intensive Studies.

Niblock, H., M. Munawar, M. Fitzpatrick Fisheries & Oceans Canada, IAGLR 2014

Biweekly sampling at a nearshore (7m) and offshore (60m) station in western Lake Ontario were oligotrophic with an average chlorophyll a concentration of 3.1 µg/l (nearshore) and 2.4 µg/l (offshore). Integrated epilimnetic phytoplankton biomass was higher and more variable in the nearshore compared to the offshore. Primary productivity was generally low, on average 5 - 6 mg C/m3/h at both locations. Chlorophyll a profiles exhibited deep chlorophyll maxima during the spring and summer. DCL plankton were primarily Diatoms while epilimnion communities were mainly Cryptophyceae. In the hypolimnion Diatoms identified microscopically were not detected using in situ fluorometric measures and may represent an important deep food source for zooplankton.



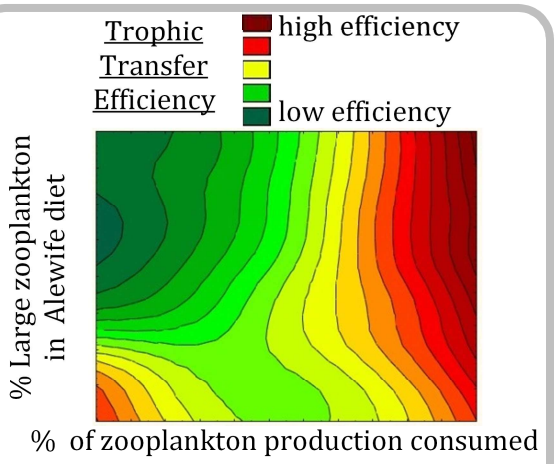
Primary productivity rate (mg C·m^{-3} · hr^{-1}) from nearshore and offshore sites in western Lake Ontario, measured by Fisheries and Oceans Canada

Linear Inverse Modelling: A New Tool To Examine Food Web Scale Questions In The Great Lakes.

Hossain, M. and T. Stewart
Ontario Ministry of Nat. Res, IAGLR 2014

Food web models that link changes in water quality, lower trophic levels, invasive species and fisheries can provide mechanistic understanding useful to policy. We "translate" a published Lake Ontario ECOPATH model into a linear inverse model (LIM) allowing more flexibility and better use of available data. We show how this new approach solves multiple mass balances simultaneously and retains solutions to account for

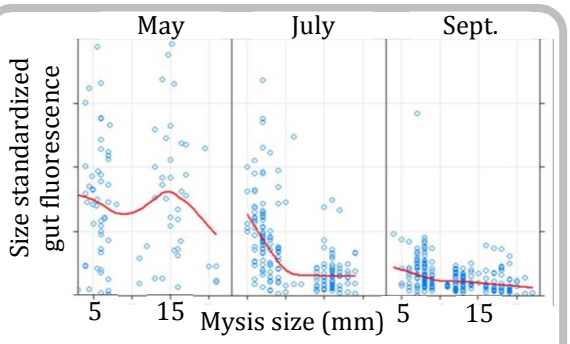
uncertainty in model inputs, the ability to statistically examine model parameter interactions, and the ability to formulate and test hypotheses. Applications include comparative food web studies, examining spatially-explicit trophic exchanges, or evaluating food web consequences of potential new invaders.



Models illustrate energy transfer efficiency from zooplankton to alewife is influenced by how much **AND** what zooplankton alewife are eating.

Lake-wide chlorophyll usage by *Mysis* in Lake Ontario: The gut fluorescence technique.
O'Malley, B, J. Watkins, L. Rudstam, T. Holda, B. Weidel, Cornell Univ. IAGLR 2014

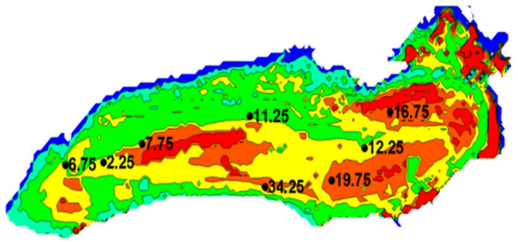
Quantifying *Mysis* consumption of phytoplankton in the field is difficult but important for Great Lake food webs. Gut fluorescence may provide an estimate of grazing by omnivorous *Mysis diluviana* and we tested this method in 2013 in Lake Ontario. We hypothesized that mysids in Lake Ontario graze on diatoms and other phytoplankton even after the onset of thermal stratification by utilizing the deep chlorophyll layer. Chlorophyll was most abundant in stomachs during May for both adults and juveniles, suggesting heavy grazing, whereas in July and September mysids fed more on zooplankton. Future studies should use gut fluorescence with stomach content analysis to estimate invertebrate grazing.



Gut fluorescence, an index of algae in Lake Ontario *Mysis diluviana* diets declines strongly with season and *Mysis* size.

Thermocline modeling for the deep chlorophyll layer in Lake Ontario.
Ghaneeizad, S, Atkinson,J. , Scofield, A., Watkins, J. Rudstam, L, Feng, Y.,Univ. at Buffalo, IAGLR 2014

Thermocline distribution and dynamics in Lake Ontario is critical to predict the formation and location of the DCL. Thermocline predictions were extracted from modeling results for 2012 and 2013 using the hydrodynamic Princeton Ocean Model for the Great Lakes (POMGL2007), and are compared with temperature profiles from April, May, July, August, and September. Model predictions agree well with the measurements in the deeper water regions, but agreement is poorer in shallower, nearshore regions. Distributions of the thermocline depth also show typical domed behavior under certain conditions. This comparison confirms the ability of the POMGL as a tool to predict the thermocline depth and identifies nearshore regions where the model can be improved, potentially by including data on waves.



The POMGL uses meteorological data to predict August thermocline depth in Lake Ontario. Blue represents shallow thermocline and red illustrates deep thermocline depths.

Moving Forward

Moving the momentous 2013 field and analysis effort forward has brought new challenges. Follow-up CSMI meetings have used other gatherings such as the GLFC's Lake Committee meetings and IAGLR to reduce travel costs. Additionally, the group uses a series of products (listed below) that promote communication and reduce redundancy.

The ***Sample Inventory*** provides basic sample information (what, where, how, how often, and who to contact). For instance, we have identified 14 different groups that collected 2013 lake and tributary nutrient data. This list ensures researchers are aware of potential data, promoting whole-lake perspectives in analyses.

Project List outlines scientific papers and identifies researchers leading or contributing to project. This document promotes whole–lake collaboration within our geographically diverse group and contains approximately 40 papers.

Final Report – End users of CSMI results asked for faster and more frequent reporting to advise policy and assist planning. In addition to frequent progress reports, we propose a short-format (15pg) 2013 final report, to be drafted by the fall 2014 and finalized by spring 2015. This non-technical report will illustrate trends, provide synthesis, and reference where data contribute to management indicators such as those in the LAMP or the Fish Community Objectives. Additional results incorporated into analytical products (ie. decision support tools, mass balance models), will be disseminated through the peer reviewed literature. To be fully effective these products will be developed in consultation with the end users.

Nearshore to offshore energy paths were a pivotal part of 2013 research. Here OMNR technicians seine nearshore fish for stable isotope and fatty acid analysis.

Improvements

Throughout the 2013 process the group has been cognizant of how we might improve in 2018. Common themes include data access, funding timelines, and disseminating results.

Data Access: To improve 2013 data access we are (1) addressing questions using multiple agency databases providing broad spatial perspective and (2) seeking outside data management funding. A preproposal (successfully advanced to full proposal) to GLOS will coalesce parts of the 2013 and historic data to be hosted online in a variety of portals/catalogs.

Examples of Online Data Catalogs & Portals

Science Base, USGS
https://www.sciencebase.gov/catalog/
Great Lakes Inform. Mgmt. & Delivery Sys.
http://imds.greenlitestaging.com/
Global Great Lakes
http://www.globalgreatlakes.org/
Global Lakes Ecological Observ. Network
http://www.gleon.org/
Great.Lakes Monitoring, IL - IN Sea Grant
http://greatlakesmonitoring.org

Stretch out funding: 2018 CSMI participants and funders should consider alternative funding periods that provide for analysis and writing multiple years after the field sampling.

Disseminating results –We are actively identifying end user groups and attempting to communicate with these groups throughout the process. For example, websites are centralizing information and science about Lake Ontario and the management processes. (http://www.lakeontarioforum.org/)

More Information

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