Relationships Between Dreissend's Distribution and the Vertical Structure of Plankton Communities in Lake Erie

[1]Ghadouani, Anas, [2]Barton, David R., [2]Guildford, Stephanie J., [2]Hecky, Robert E., [2]Smith, Ralph E. H.
1)- Centre for Water Research, The University of Western Australia, 35 Stirling Highway, M015, Crawley, Western Australia, Australia 6009
2)- Department of Biology, University of Waterloo, 200, University Avenue West, Waterloo, Ontario, N2L 3G1, Canada

ABSTRACT

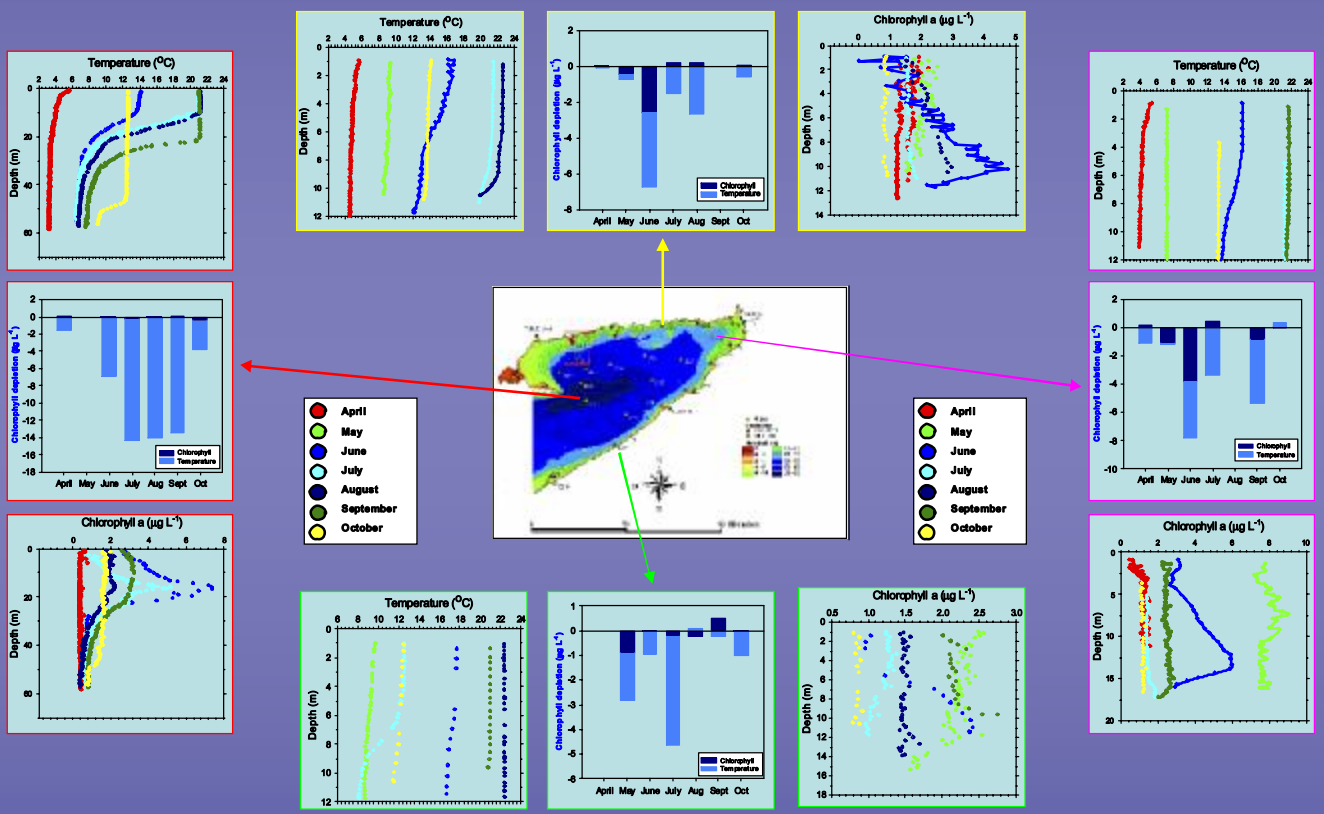
It is widely believed that the arrival of dreissenid mussels has caused important changes in the overall functioning of Lake Erie. It has been shown that dreissenids may have increased nutrients availability through a faster cycling of key elements promoting cyanobacterial blooms. Since then, the occurrence of cyanobacterial blooms have been reported to have increased and were always related to either direct or indirect changes to the system caused by dreissenids invasions. However, these hypotheses have not been formally tested at a larger scale. In the present study, we report results from a total of 10 cruises where detailed measurement were taken across the whole lake and more intensively the eastern basin of lake Erie. A new spectrofluorometric method was used to determine the vertical structure of phytoplankton communities at a total of 40 carefully chosen stations. The main objective of this study was to relate the changes phytoplankton community structure and their vertical distribution. Although quite variable, total phytoplankton biomass seem to be inversely related to dreissenid's densities. Chlorophyll concentrations averaged over the water column declined consistently with depth from offshore to nearshore. These patterns are even more consistent when only the top mixed layer of the epilimnion is considered. Evidence for Sharpe near-bottom depletion in chlorophyll concentrations was observed at several nearshore stations after stratification had taken place.

INTRODUCTION

In Lake Erie, nutrient controls led to significantly diminished phytoplankton biomass in the 1980's compared to the 1960's and 70's, and cyanobacterial blooms were no longer observed. The arrival of *Dreissena* in the late 1980's was associated with further decreases of phytoplankton biomass in nearshore areas and the shallow west basin.

In the deeper offshore waters of the central and east basin, impacts of *Dreissena* colonization on total phytoplankton biomass were not as clear. In 1998, phytoplankton biomass in offshore waters was low compared to the 1980's and previous decades, although species considered typical of eutrophic waters were still prominent. Potentially toxic *Microcystis spp.* comprised the majority of the substantial cyanobacterial biomass reported at some stations in all three basins. The spectrofluorometer (Fluoroprobe) was deployed in three lake-wide surveys intended to address recent concerns that symptoms of eutrophication, including elevated phosphorus and phytoplankton biomass concentrations, are returning to Lake Erie. Although phytoplankton biomass was reported to be low in 1998, there is evidence of increasing phosphorus and chlorophyll-*a* (chl-*a*) concentrations in the central basin in subsequent years (D. Culver, D. Rockwell, pers. comm.).

Our goal was to characterize the lake-wide distribution of major phytoplankton groups for comparison with previous surveys, assess the reliability of the fluorescence method for inferring chlorophyll *a* and potentially toxic cyanobacterial occurrence, and document the effects of dreissenids filtering activity in nearshore area through near bottom depletion of chlorophyll concentrations explore the scales of variability as evidenced by the new spectrofluorometric technology.



METHODS

In summer 2002, samples were taken from Lake Erie aboard Environment Canada R/V Limnos during 7 consecutive cruises from April throughout October. A total of 14 stations were sampled across the Eastern basin of Lake Erie. At each station, the fluoroprobe was deployed, three times, at a rate of approximately 0.1 m s-1 taking a measurement each second to allow for high resolution profiling of the water column. Detailed descriptions of the fluoroprobe can be found elsewhere (Beutler et al. 2002, 2003). Essentially, this instrument measures chlorophyll *a* (chl-*a*) fluorescence after a 0.1 ms excitation by 5 light emitting diodes (450, 525, 570, 590 and 610 nm). The fluorescence is then transformed through an algorithm and total biomass of phytoplankton expressed in equivalent µg chl-*a*/L.

The fluoroprobe is also equipped with a thermistor for measuring temperature with an accuracy of 0.05°C according to the manufacturer. This instrument is manufactured by a German company BBE-Moldaenke, Kiel, Germany.

RESULTS & DISCUSSION

Our results indicated existence of near bottom depletion of chlorophyll is some of the stations samples. There was high variability in this feature between stations and dates. The maximum near bottom depletions were observed in stations from northern shore of the lake, while little or no differences were present in deep offshore station and similarly in the southern shore of the lake.

Preliminary results from a lake wide survey of dreissenid mussel indicated differences in mussel densities between the north and south coasts of the east basin. The mean densities were greater on the north side. While formal relationships between the occurrences of near bottom depletion of chlorophyll and density of dreissenid mussels is yet to be determined, and it is not possible to attribute these features to intensive filtering activities by the mussels. The difference between northshore and southshore in near bottom depletion of chlorophyll may however be explained by the marked difference in mussels density. Northern shore bedrock is known to have higher mussel density then the southern shore known for much steeper slopes. However, little quantitative information is available from the southern shore. Near bottom chlorophyll depletion was also associated with thermal stratification and was maximal in June. One possible explanation for the pattern observed in June could be explored by looking at the seasonal variability in the physiological activities with the mussels mainly driven by temperature. Formal testing of these hypotheses will be conducted following results on the physiology of the mussels driven from laboratory and in situ experiment conducted by other participant in the project from the University of Waterloo.

Acknowledgements: