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Recent Water Quality Trends in Lake Erie

The U.S. EPA Great Lakes National Program Office, based on disturbing trends observed in the GLNPO long-term monitoring data for the Central Basin of Lake Erie, provided funding to support the Lake Erie Trophic Study (LETS) from 2002-2003 for collaborative efforts with Environment Canada to understand the changes observed in Lake Erie. Some of the results from LETS are included in this report. Changes in the water chemistry during the 1990's were inconsistent with predictions and dynamics of models of internal lake function. Increases in spring open lake total phosphorus concentrations in the Central basin of Lake Erie starting in 1990 are observed to continue through 2005 and are approximately 15% higher in the central basin from the *Dreissena* period (1990-2004) than in the pre-*Dreissena* period (1983-1989). Total phosphorus calculations of measured external phosphorus loads thru 2003 shows no consistent increases in loading and do not fully explain the concentrations observed, but loads are very responsive to rainfall. Dissolved oxygen depletion rates are linked to total phosphorus loads of the previous year and environmental factors that determine the hypolimnion thickness. Lower phosphorus loadings result in lower dissolved oxygen depletion rates, but are not sufficient to restore year round oxygen conditions in the Central Basin. No dissolved oxygen rate changes due to the *Dreissena* invasion are found.

Continuing environmentally significant changes in chemical make of the lake are observed, coinciding with the massive invasion of the *Dreissena*. Alkalinity depletion due to calcium uptake in the shells of the *Dreissena* in the eastern basin is observed with some recovery beginning when *Dreissena* growth rates are stabilizing. Dissolved reactive silica increases in all basins appear to be in conjunction with the *Dreissena* grazing of phytoplankton which had reduced biovolume by 80% in 2000 and altered the silica uptake by the diatoms in the spring shifting silica utilization to latter in the year. Shifts in the diatom community from pennates with low silica requirements to centric diatoms with high silica requirement are observed.

Major changes in spring water chemistry concentrations were observed, primarily in the Central and Eastern basins, in the years immediately following the introduction of Dreissena. These major changes have persisted for over a decade. For example comparing the pre-*Dreissena* and *Dreissena* periods, chemical concentrations of total dissolved phosphorus in the Central ($p<0.001$, 46% increase from 3.9 to 5.7 ug P/L) and Eastern ($p=0.021$, 19% increase from 5.1 to 7.3 ug P/L) basins; silica in all basins, Western ($p<0.001$, 91% increase from 0.768 to 1.468 mg SiO_2/L), Central ($p<0.001$, 1002% increase from 0.0.045 to 0.451mg SiO_2/L) and Eastern ($p=0.042$, 398% increase from 0.176 to 0.700mg SiO_2/L), turbidity in the Eastern basin ($p=0.003$, decrease from 2.3 to 1.1 NTU) and Secchi in the Eastern basin (p=<0.001, increase from 3.2 to 7.9 M). Statistically significant changes that now appear to be transitory are alkalinity in the Central ($p<0.001$, 4.6% decrease from 93.7 to 89.3 mg $CaCO_3$/L) and Eastern ($p<0.001$, 6.2% decrease from 94.8 to 88.9 mg $CaCO_3$/L) basins and conductivity in the Central ($p=0.001$, 1.2 % decrease from 276.5 to 273.1 umho/cm) and Eastern ($p=0.006$, 1.7% decrease from 281.7 to 276.8 umho/cm) basins. Other statistically significant changes in the spring water chemistry concentrations are occurring but may not be related to the Dreissena invasion are Nitrate + Nitrite Nitrogen increases in the Central ($p=0.006$, 20% increase from 0.198 to 0.237 mg N/L) and Eastern ($p<0.001$, 14% increase from 0.244 to 0.279 mg N/L) basins, and chloride increases in the Central ($p=0.005$, 4% increase from 14.4 to 15.0 mg Cl/L) and Eastern ($p=0.007$, 3% increase from 15.2 to 15.6 mg Cl/L) basin, turbidity in the Central basin ($p=0.003$, increase from 2.0 to 3.5 NTU) and secchi in the Central basin ($p<0.001$, decrease from 4.1 to 2.9 M).

No significant changes in total phosphorus have been observed in any basin from the pre-*Dreissena* and the *Dreissena* periods with observed average concentrations for the three basins: Western Basin (19.7 increasing to 23.7 ug P/L), Central Basin (10.9 increasing to 12.5 ug P/L) and Eastern Basin (11.8 decreasing to 10.2 ug P/L). Expected water quality concentrations in each of these basins that would result if total phosphorus loading objectives were met would be 15 ug P/L in the Western Basin and 10 ug P/L in the Central and Eastern Basins. The Western and Central basin are above the expected water quality concentrations while the Eastern Basin appears to be at the expected water quality concentration.

Large percentage shifts in the composition of total phosphorus in each basin has occurred when comparing the pre-*Dreissena* and the *Dreissena* periods for the three basins: Western Basin (18% to 30%), Central Basin (36% to 46%), and Eastern Basin (44% to 72%)