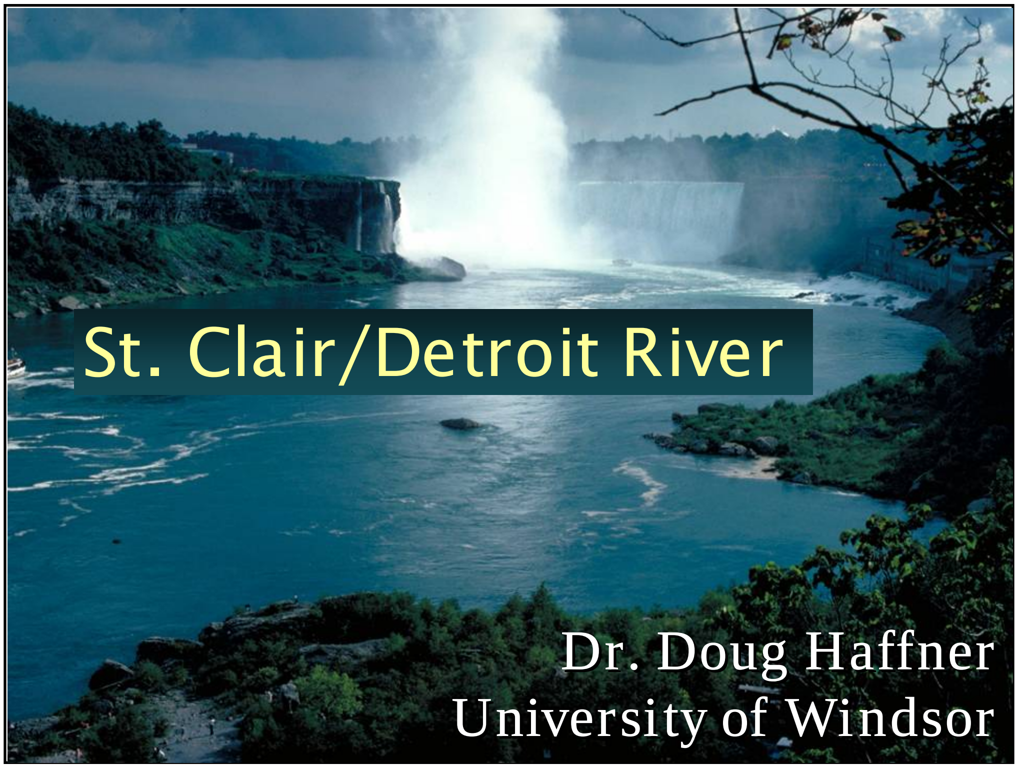

St. Clair/Detroit River
Dr. Doug Haffner
University of Windsor

St. Clair – Detroit Corridor

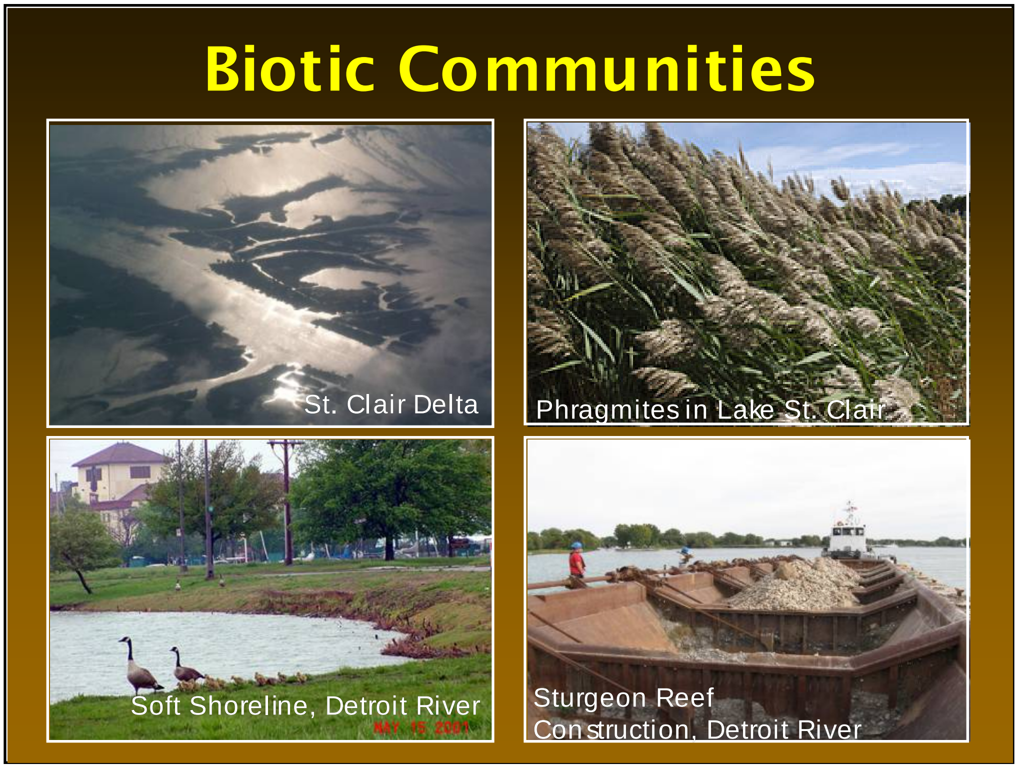
St. Clair River	
Maximum Depth	25 feet 7.6 meters
Land Drainage Area	6,520 sq. mi. 16,886.7 sq. km.
Shoreline Length	55.92 miles 89.9 km
Retention Time	21 hours

Lake St. Clair	
Maximum Depth	27 feet 8.2 meters
Land Drainage Area	4,890 sq. mi. 12,665 sq. km.
Shoreline Length	130 miles 209.2 km
Retention Time	9 days

Detroit River	
Maximum Depth	50 feet 15.24 meters
Land Drainage Area	807 sq. mi. 2,090.1 sq. km.
Shoreline Length	58.35 miles 93.9 km
Retention Time	20 hours

The St Clair-Detroit corridor is a channel that connects Lake Huron to Lake Erie. Although the Corridor is one continuous channel it is broken into three distinct sections: the St. Clair River; Lake St. Clair; and, the Detroit River. Water from Lake Huron enters Lake Erie within 48 hours with a discharge of approximately 5240 cubic metres per second. This huge flow from Lake Huron dominates all other inputs tributary, industrial or municipal.

There are many environmental issues in the Corridor, indeed the very first IJC Great Lakes Reference was the study of Bacteria in the Detroit River. Contaminants such as mercury resulted in the first ever closing of a commercial fishery in the Great Lakes, and major PCB sources in the corridor contribute significantly to problems in the lower lakes and St. Lawrence.



Another major issue in the corridor is habitat. The St. Clair delta is the largest wetland in the Great Lakes at 13,000 ha (32, 000 acres). Loss of wetlands has been a critical issue throughout the Great Lakes, especially along the Detroit River where several new programs have been established to protect and rehabilitate natural habitats.

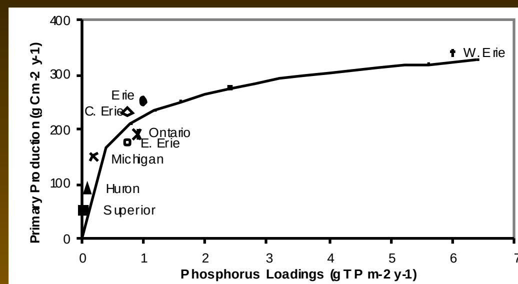
Human health issues, air quality, land use and economic development are also critical issues in the corridor, thus to talk about the ‘State of the Corridor’ is a huge topic, well beyond a simple presentation. In a day when we know multiple stressors need to be our focus to understand the state of the environment, we continue to address single issues, pretending these issues are NOT independent and interactive. Today I will continue that trend by discussing eutrophication (nutrient enrichment issues) in the Corridor and the Western Basin of Lake Erie.

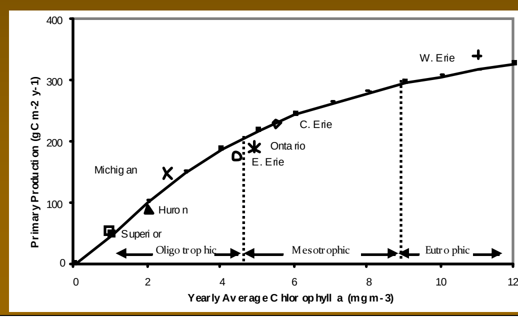
Huron-Erie Corridor and Eutrophication

- Lake Erie "Dead" from eutrophication and P identified as the limiting nutrient.
- Detroit River is the largest single P source to Lake Erie.
- Lake Erie target load set at 11 tonnes/year based on Vollenweider model.
- Model predicts primary production and algal biomass will decline to mesotrophic conditions with decreased P loads.

The 'death' of Lake Erie spurred the signing of the Great Lakes Water Quality Agreement in 1972 with the primary aim to address eutrophication. In the same time frame, the governments of Canada and the United States assigned the International Joint Commission a study to determine how land use was affecting water quality (PLUARG). Both activities resulted in major efforts to control municipal, industrial and agricultural inputs of phosphorus, thought to the nutrient most limiting eutrophication in the Great Lakes.

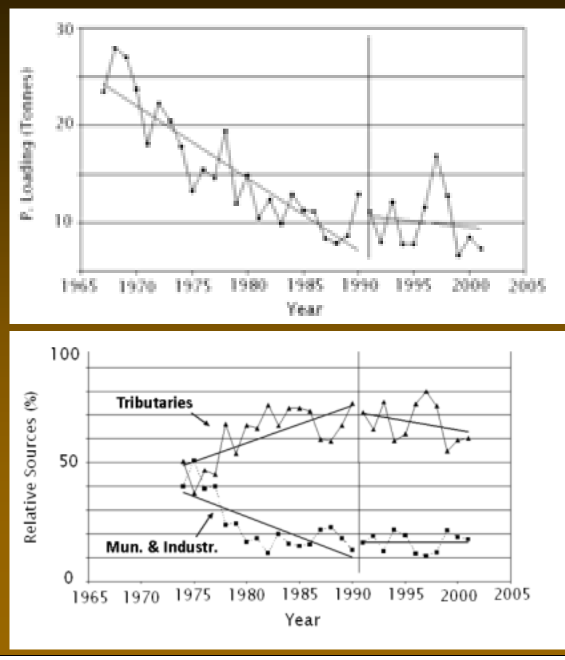
Eutrophication Models Vollenweider, Munawar and Stadelmann (1974)



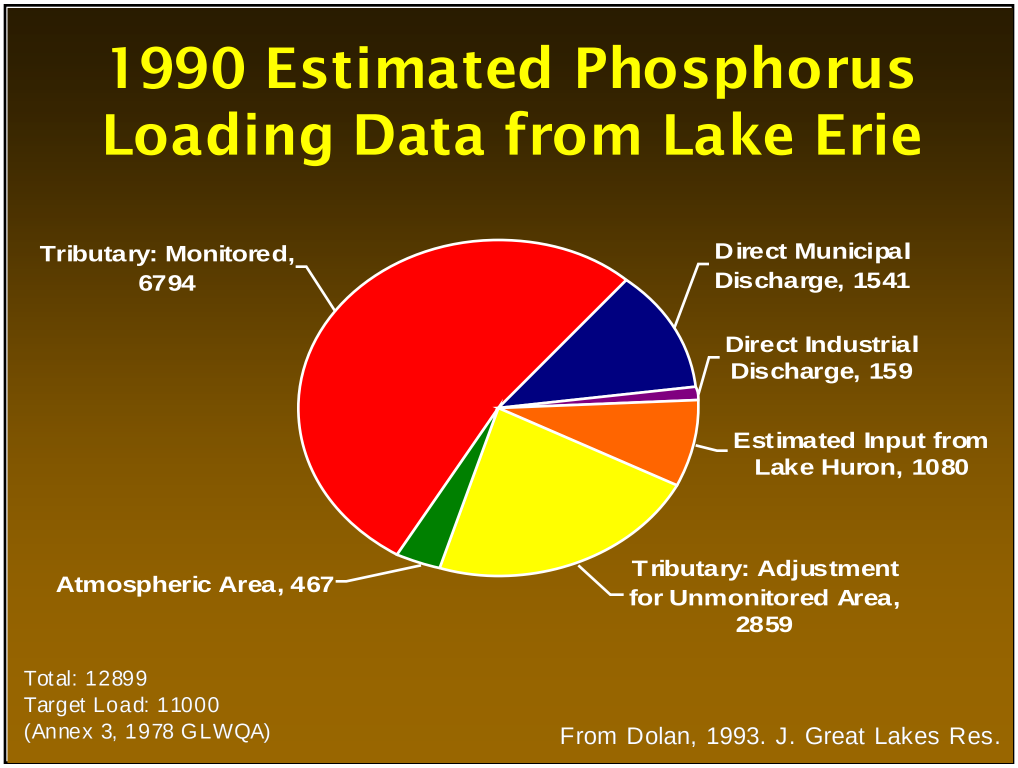


Target Loads of Phosphorus were set for each lake using simple models that related phosphorus inputs to primary production and algal biomass (usually measured as Chlorophyll a).

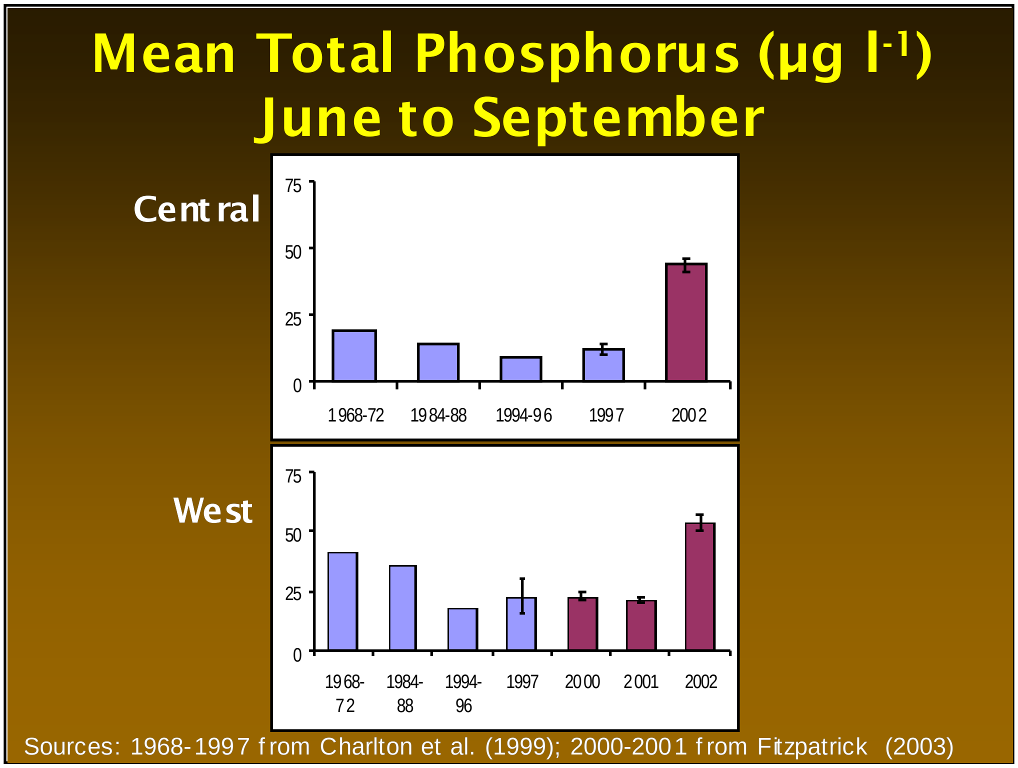
Dolan and McGunagle (2005)



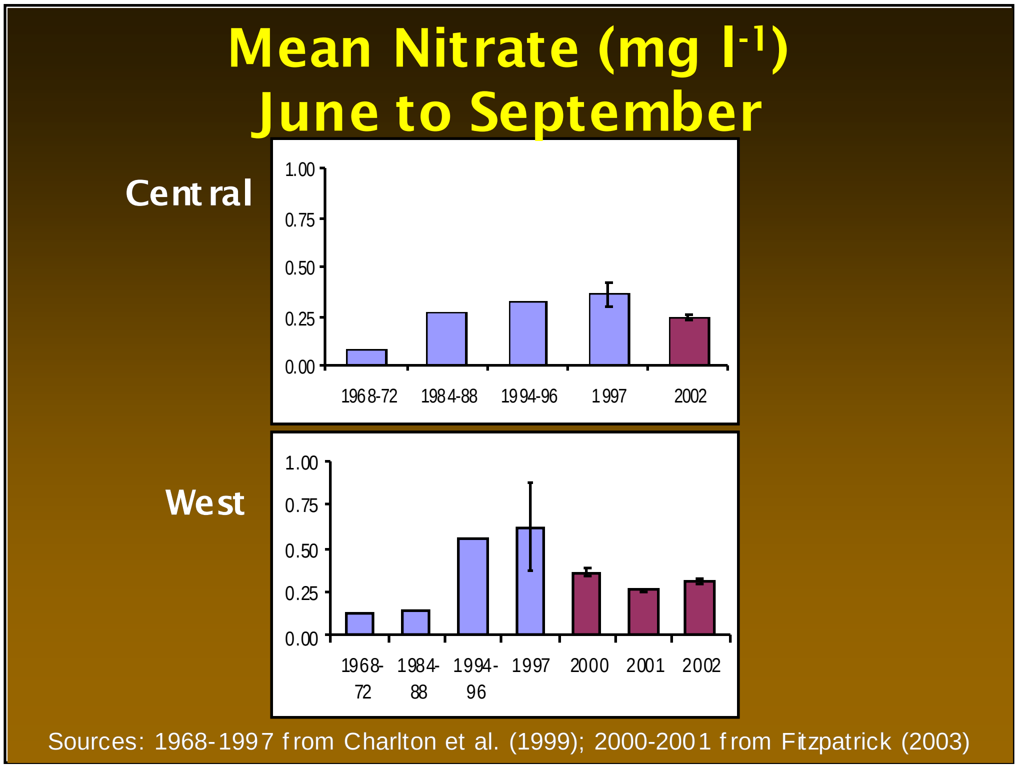
Efforts to control P inputs were mostly successful with Lake Erie achieving its target load of 11 tonnes P per year in the mid 1980s. Most of this was achieved through reduction of municipal and industrial loadings, agricultural or non-point source controls were less successful, and new management practices are still required.



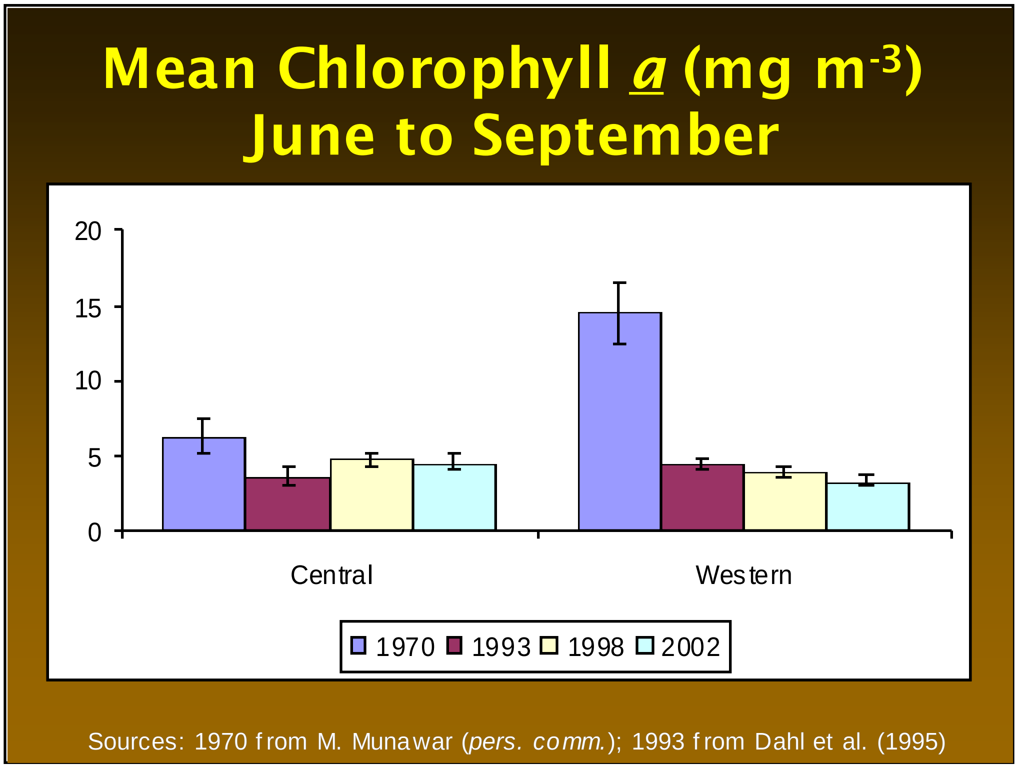
Today, the largest single source of P loading to Lake Erie remains the St.Clair – Detroit River Connecting Channel, although this is relatively small compared with total runoff from non-point sources. The question remains, however, is eutrophication within the connecting channel an issue, and do these phosphorus inputs regulate eutrophication in Lake Erie, especially the Western Basin?



Long term trends of Total Phosphorus concentrations in the Central and Western Basin of Lake Erie reveal some declines in concentrations between 1968 and 1997, but it can also be noted that storm events (likely to be more frequent and more intense with climate change) can also strongly determine P concentrations in the lake as observed in 2002.

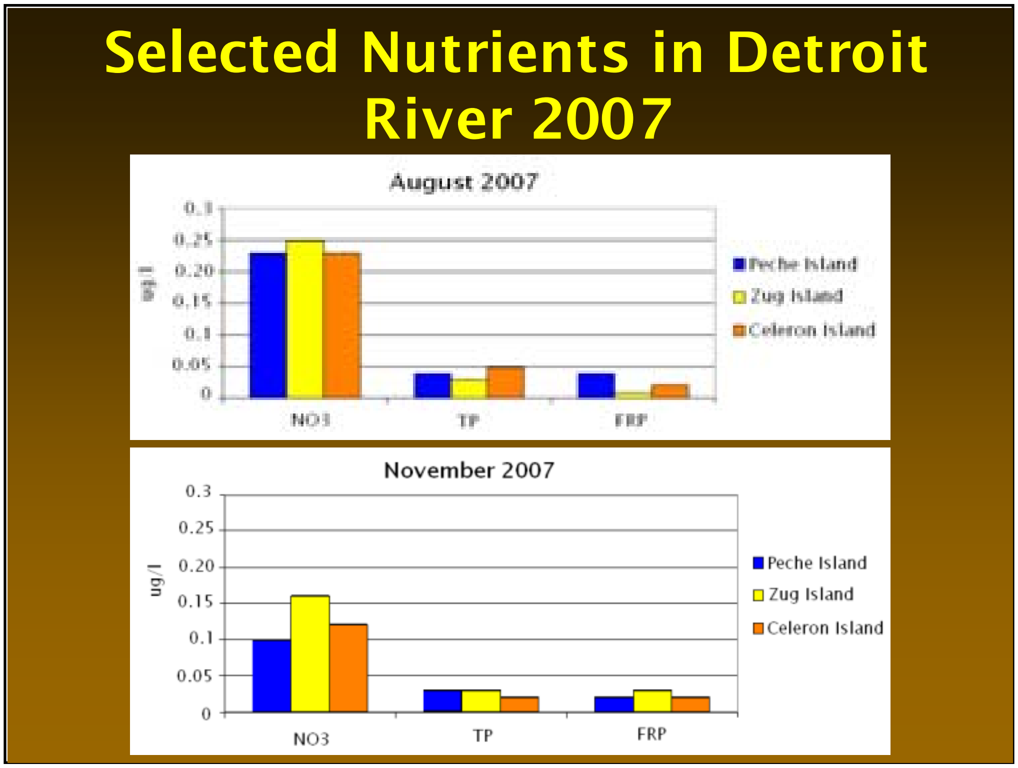


Nitrogen is often limiting primary production as well, but as there a few or no controls on N loadings, nitrate concentrations have continued to increase over time. These levels are not a concern to human health, but certainly are sufficient to start affecting community composition of primary producers.



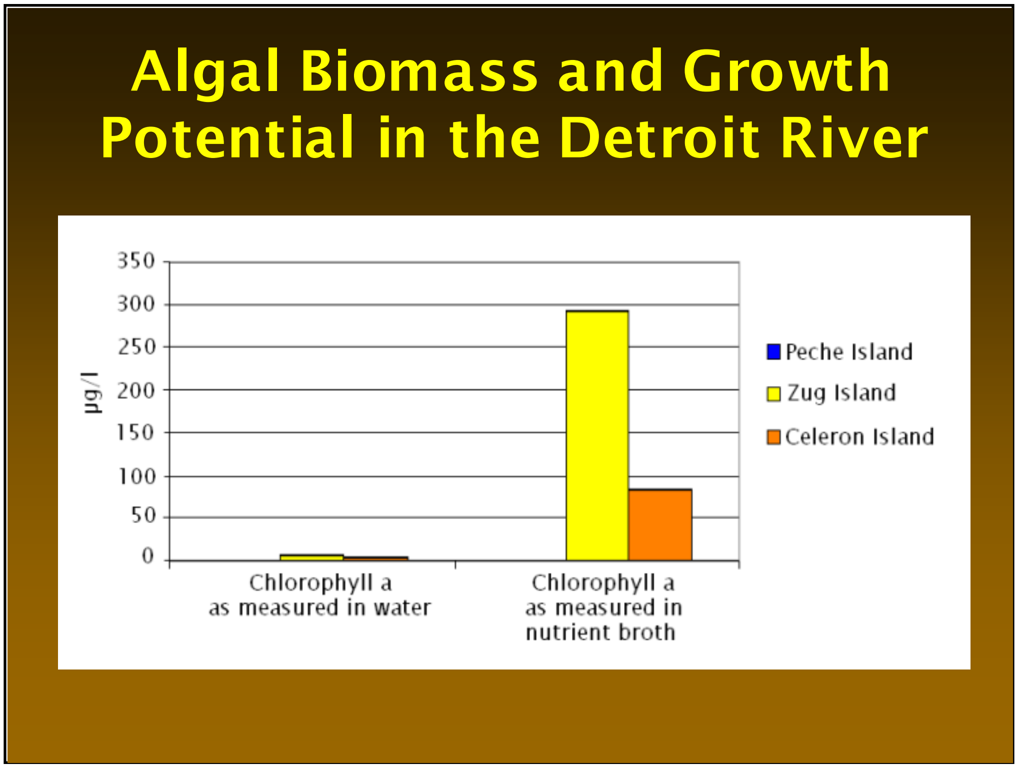
P controls are thought to have reduced algal biomass in the western basin of Lake Erie since 1970, but there remains a question as to how much the biomass is regulated by eutrophication programs vs zebra/quaga mussels. Indeed, about a decade ago there was a debate to increase P inputs to Lake Erie to protect the fisheries.

Unfortunately, corridor wide studies seem to be bureaucratically unpopular with independent studies being implemented in the St. Clair River RAP, the Lake St. Clair Study and the Detroit River RAP. Such a management approach makes it impossible to discuss the overall state of the corridor with respect to eutrophication or any other issue. In the following few slides I will discuss the results of the Detroit River Eutrophication Study. Being the final discharge to Lake Erie, this study focuses on the quality of water after passing through the corridor. Three ranges were sampled in the Detroit River, each range consisting of a Canadian nearshore station, a mid-river site and a US nearshore site. **[click add animation]** Water samples were collected at 1 and 5 m depth and analyzed for nutrients, phytoplankton and zooplankton.



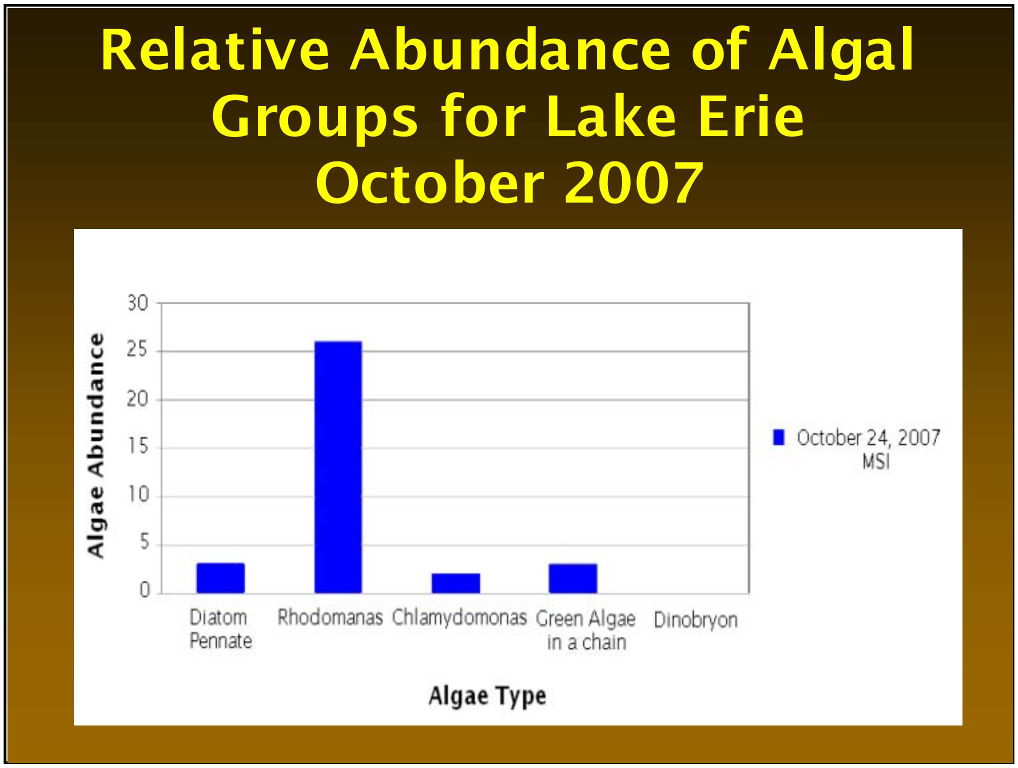
As noted in August, and on all sampling occasions there was no evidence of an upstream-downstream gradient of nutrients, despite the rather large discharges from Detroit and Windsor. P removal programs have been effective, and remain completely swamped by the huge dilution factor associated with the flow of the river.

November data are presented to confirm the lack of an upstream-downstream gradient on the different sampling occasions.

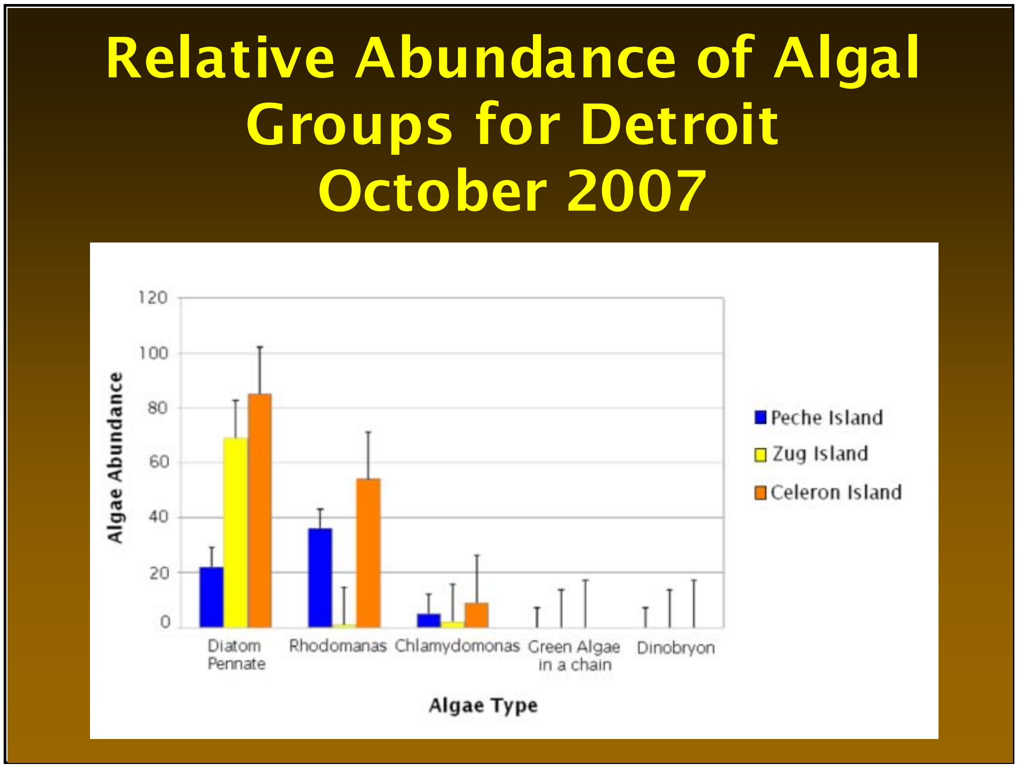


Chorophyll a was used a measure of phytoplankton biomass and was mostly below or just above detection levels. Again there was no evidence of an upstream-downstream gradient. Samples of water were placed in a nutrient broth as a ‘positive control’ to make sure there was not something in the water that prevented phytoplankton from using the available nutrients in the corridor waters. When placed in a nutrient broth, the phytoplankton of the Detroit River produced large populations. Essentially, the waters of the corridor are healthy, and phytoplankton growth is nutrient limited.

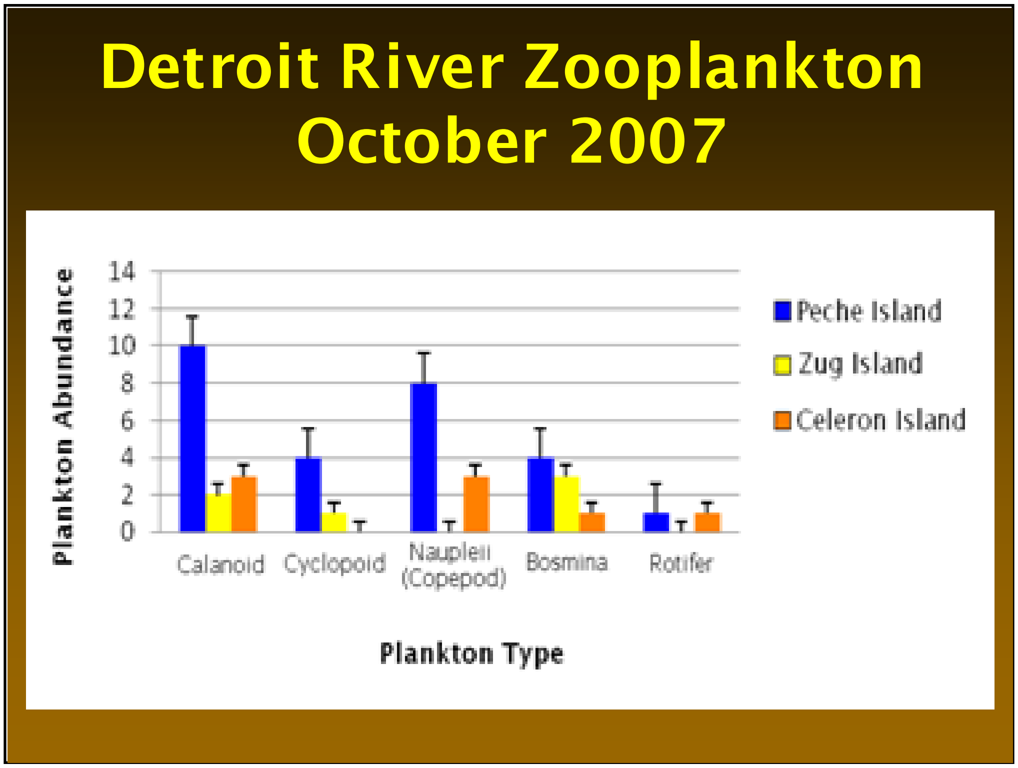
(Detroit River Nov 2007)



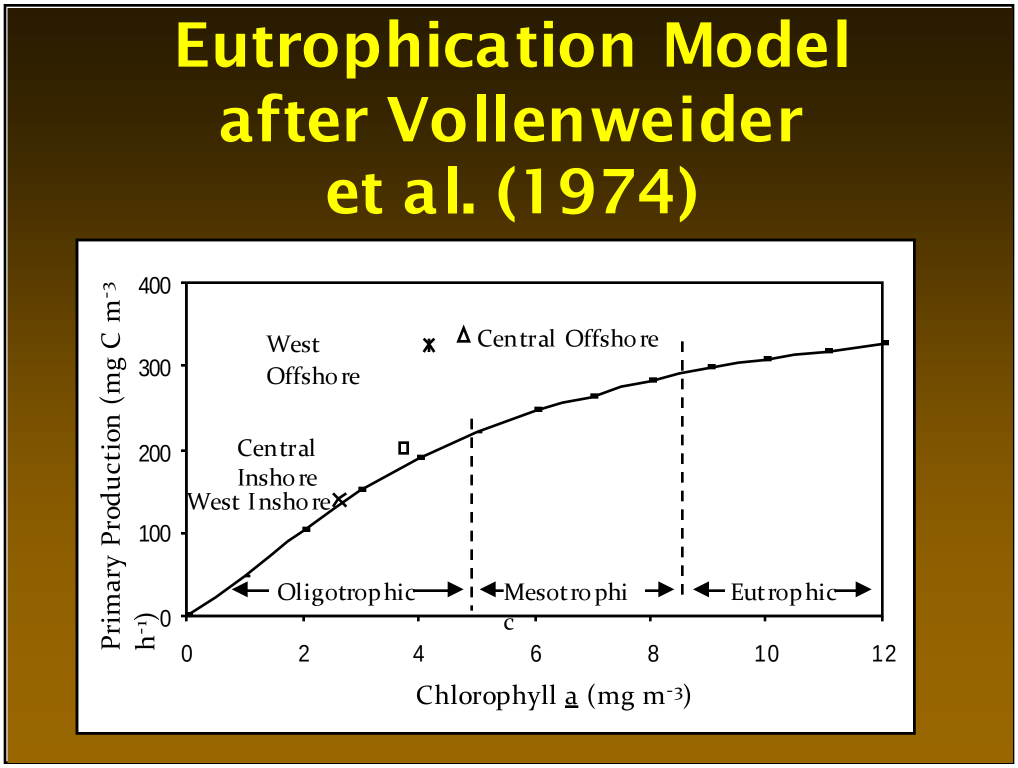
The phytoplankton of the Western Basin of Lake Erie is however very much influenced by the large advective inputs of phytoplankton via the St. Clair/Detroit Rivers. Because of the quick transfer of large volumes of Lake Huron water, the algal assemblage of the Western Basin contains a mixture of eutrophic, mesotrophic and eutrophic algae.



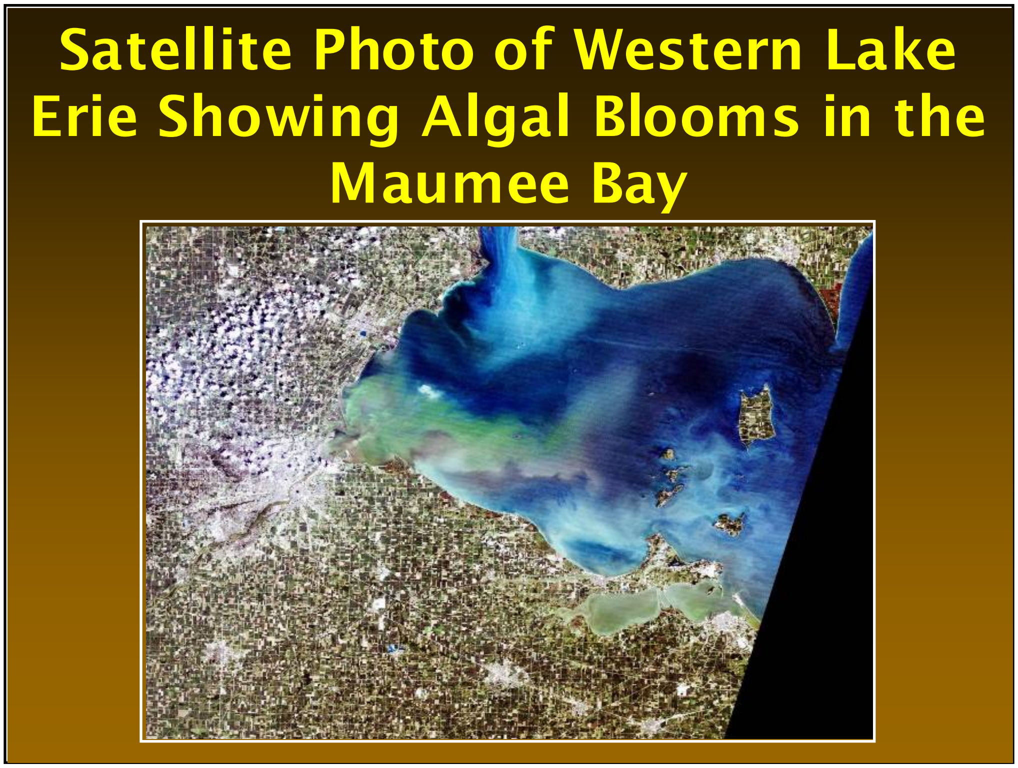
As noted in October, the phytoplankton of the corridor is very similar to the composition observed in Lake Erie, although the pennate diatoms such as Fragillaria have reached higher abundances in the lake waters. The maintainence of Dinobryon, a very oligtrophic genera, reveals an unique mixture of algae, primarily indicative of mesotrophic/oligotrophic conditions.



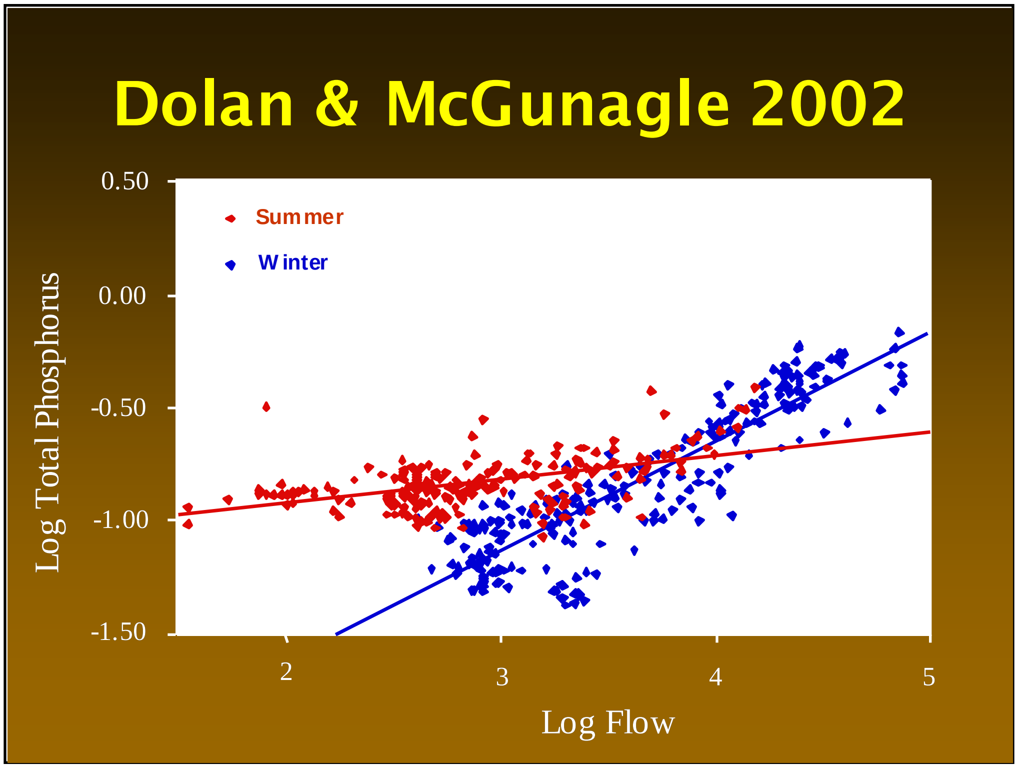
Confirming the mesotrophic/oligotrophic conditions of the St. Clair/Detroit River waters as they enter Lake Erie, the zooplankton community also primarily reflects that of Lake Huron. *In the less than 48 hours water travels from Lake Huron to Lake Erie, the waters do not change significantly in nutrient concentrations or in either the phytoplankton/zooplankton assemblages.*



Do we need to do more P controls for eutrophication? To some degree P controls are matched with a decline in Chlorophyll a, but the primary production of Lake Erie has remained similar to that before P controls were initiated. Other factors, other than simply phosphorus, regulate primary production, and we need to move towards managing the lakes with multiple stressor models that account for other stresses such as invading species, climate change and fisheries.



Indeed multiple stressor models are essential. Shown here is the plume of the Maumee River, which contributes much higher concentrations (330 ug/L) of phosphorus than the St. Clair/Detroit Rivers (20 ug/L), yet has lower loadings than the Corridor (1444 vs 3610 tonnes). It has been demonstrated by Ludsin that these late winter inputs from the Maumee are critical for walleye recruitment in the Western Basin. This is an excellent example of how interactive and interdependent environmental issues can be and why we need to develop new environmental management paradigms if we are to establish ecologically responsible target loads to manage eutrophication.



In this figure we can see the largest phosphorus inputs are in the winter to early spring, and these very loads are critical to fishery recruitment. Before pushing phosphorus controls any further we need to close the link between fisheries needs and eutrophication management.

Example Years of Fisheries and Primary Production

Year	Catch (10 000 kg)	Trophic Level	PPR (g C m^{-2})	% PPR
1950	1,657.20	4	67.7	27.1
1960	2,254.10	3.5	33.1	13.2
1970	1,774.70	3.6	28.7	11.5
1980	2,276.60	3.6	42.8	17.1
1990	2,094.00	3.6	40.4	16.2
2000	1,016.90	3.8	29.4	11.8

- 8% PPR Required for sustainable Fisheries
- 1950-2000 always greater than 8%

The last column reveals that our commercial fish catch is about 12% of the total Primary Production, slightly above the 8% recommended by the FAO for sustainable fisheries. Had we successfully reduced Primary Production as predicted by the original eutrophication models, Primary Production Required (PPR) would be 25%!! Single issue management models must be viewed with great trepidation!!

Eutrophication in the Huron-Erie Corridor

- Although an important single loading source to Lake Erie, the waters of the corridor maintain meso-trophic conditions in the Western Basin
- Questionable as to what factors regulate primary production and algal standing crops in the Western Basin of Lake Erie

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Eutrophication and Primary Production

- Further P control (if required) should focus on agricultural runoff
- Any management effort that can reduce primary production in Lake Erie will need to consider impact on fisheries
- Eutrophication is not a concern to remedial action programs in the Huron-Erie corridor, but lake management plans must address the eutrophication/fish production relationship

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Conclusion

- P and N concentrations in Detroit River dilute P and N in W. Basin of Lake Erie
- Do advective nutrient inputs maintain PP?
- Algal assemblage of DR effects composition in the Western Basin (advective inputs are ecologically very important)
- Nutrient control programs need to address agricultural run off

P and N concentrations in Detroit River dilute P and N in W. Basin of Lake Erie

Do advective nutrient inputs maintain PP?

Algal assemblage of DR effects composition in the Western Basin (advective inputs are ecologically very important)

Nutrient control programs need to address agricultural run off