



Lake Michigan Eutrophication Modeling: Results and Application

**Large Lakes Research Station
(U.S. EPA/ORD/NHEERL/MED)
with
U.S. EPA Great Lakes National Program Office**

Goals

Determine the present status of phosphorus loads and concentrations compared to GLWQA and IJC targets

Provide the modeled Lake Michigan mass balance for phosphorus

Forecast lake phytoplankton (chl-a) and phosphorus concentrations under different phosphorus loads

Calculate carbon production for the PCB transport and fate model (LM2-Toxic)

Major Findings

Lake Michigan phosphorus loads and concentrations are low and below GLWQA and IJC targets

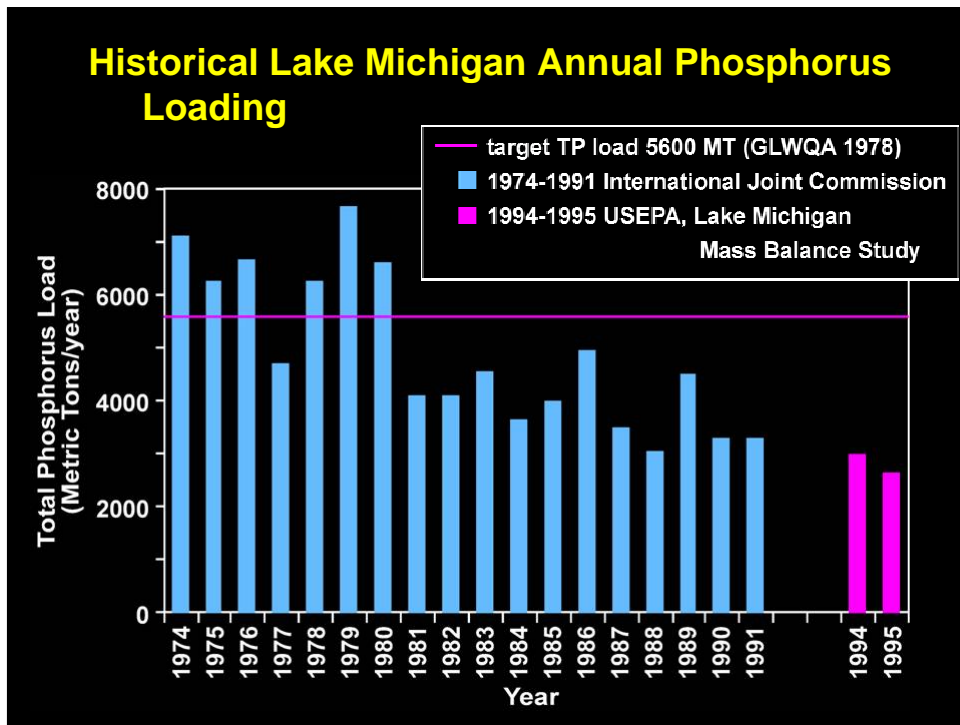
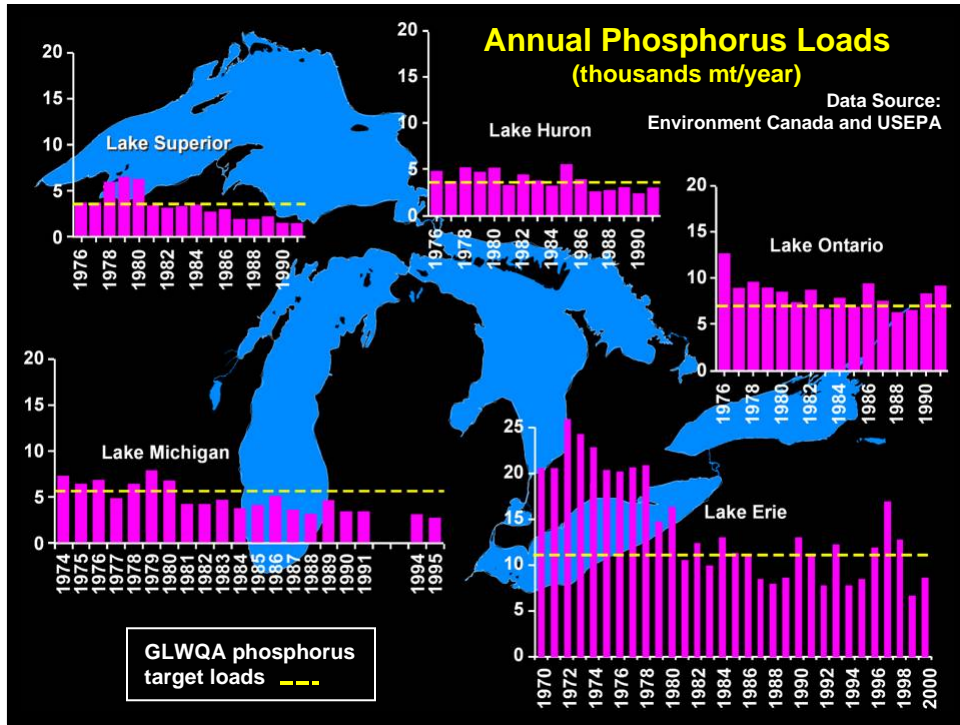
Tributaries are the major source of phosphorus to Lake Michigan

Highest concentrations can be observed in selected nearshore zones near tributary mouths and in Green Bay

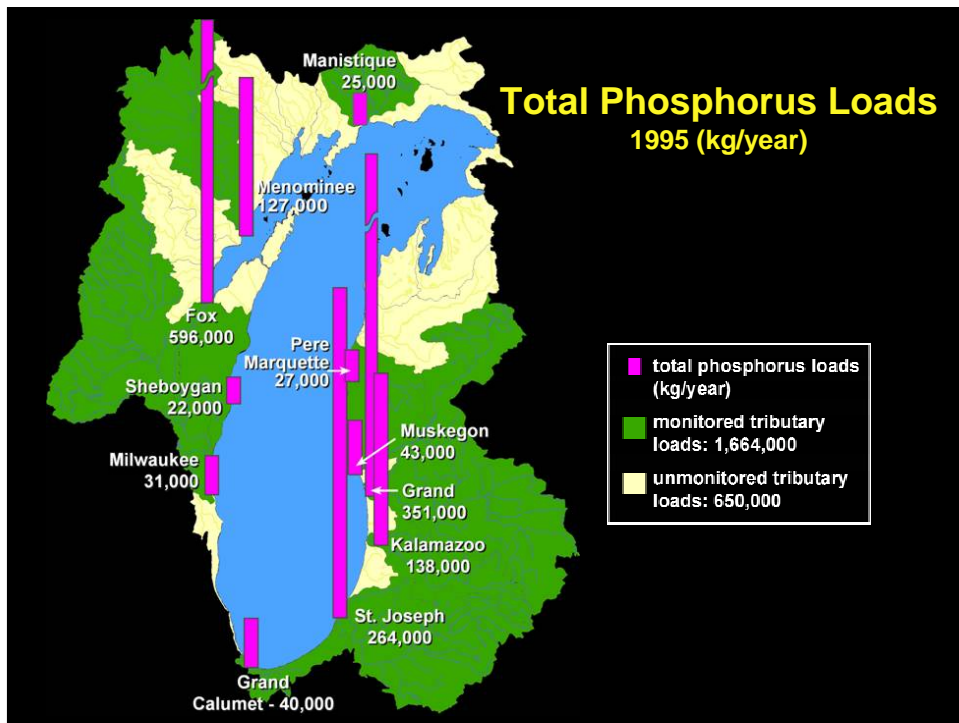
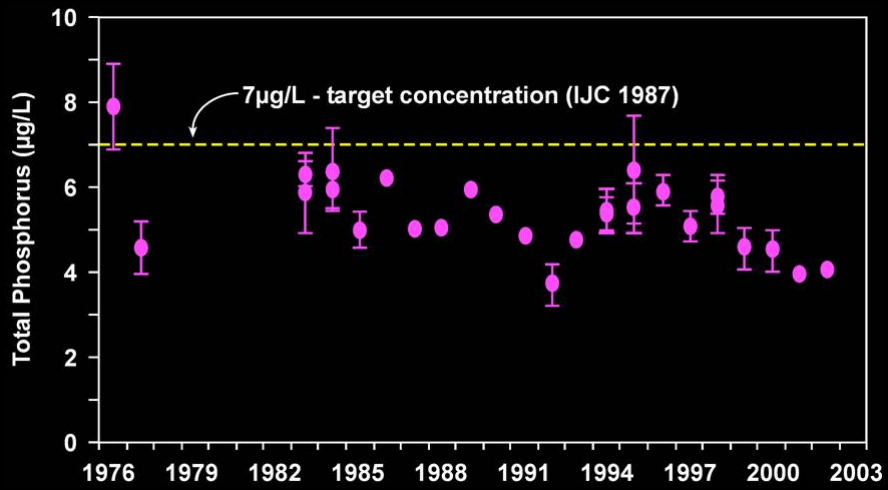
There is no evidence of increasing loads or increasing concentrations in the open-water through 2002; forecasts indicate relatively stable phosphorus and chlorophyll-a concentrations into the future

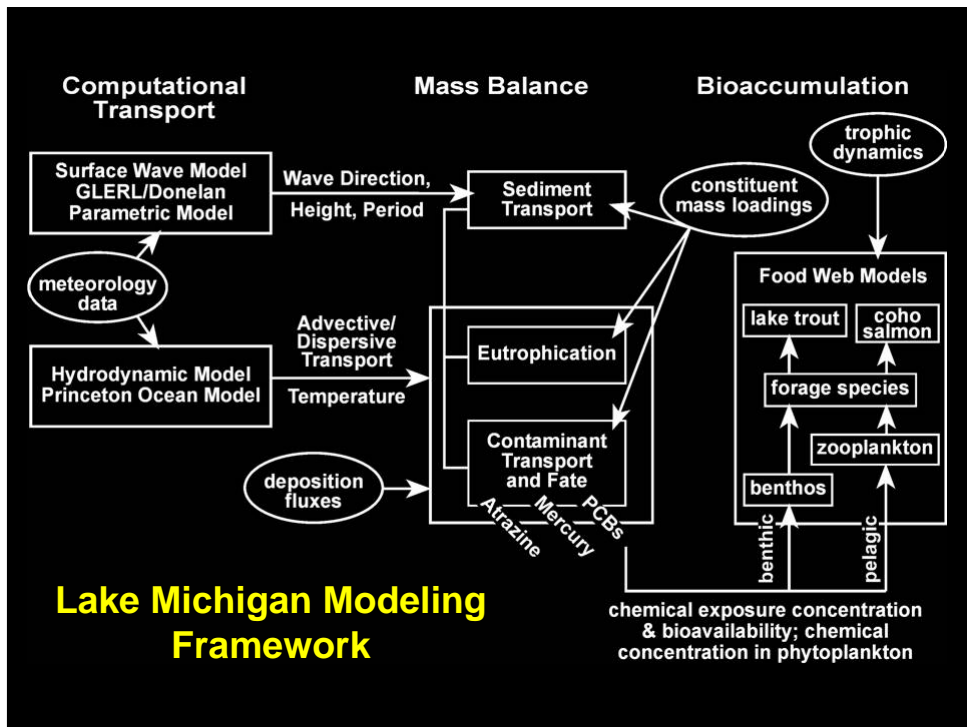
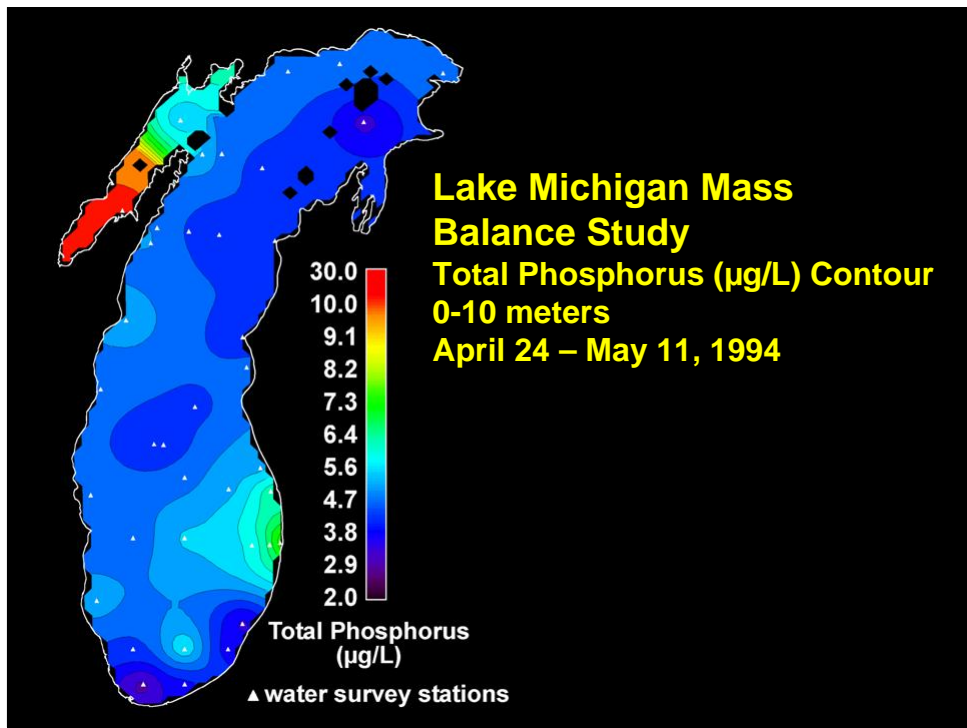
Eutrophication Issues / Symptoms

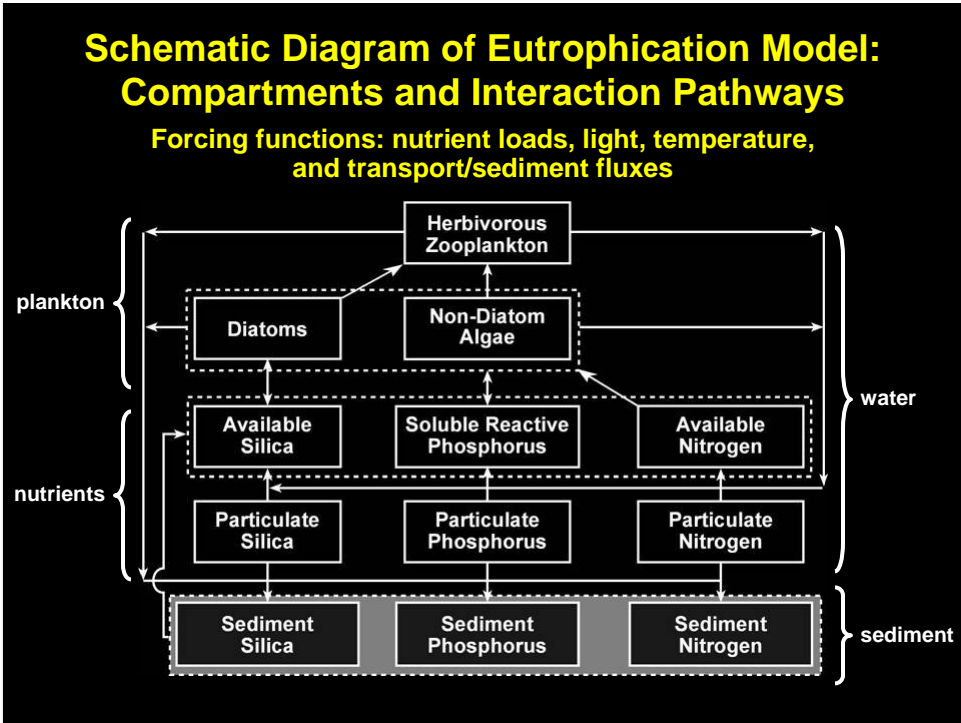
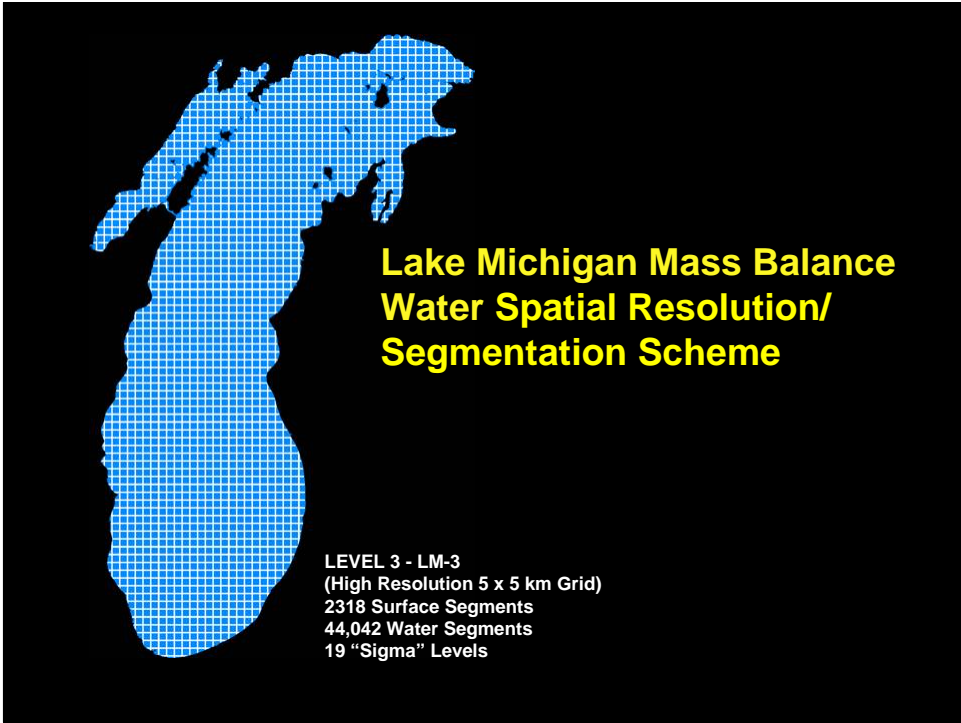
- Increased phosphorus loads and concentrations (Phosphorus the primary limiting nutrient)
- Excessive algal growth
- Nitrogen and silica become secondarily limiting
- N:P ratios are altered; phytoplankton species composition changes
- Heterocystaceous blue-green algal blooms
- Aesthetics
- Taste and odor problems at drinking water intakes
- Filter-clogging algae at water intakes
- Excessive Cladophora growth
- Beach fouling



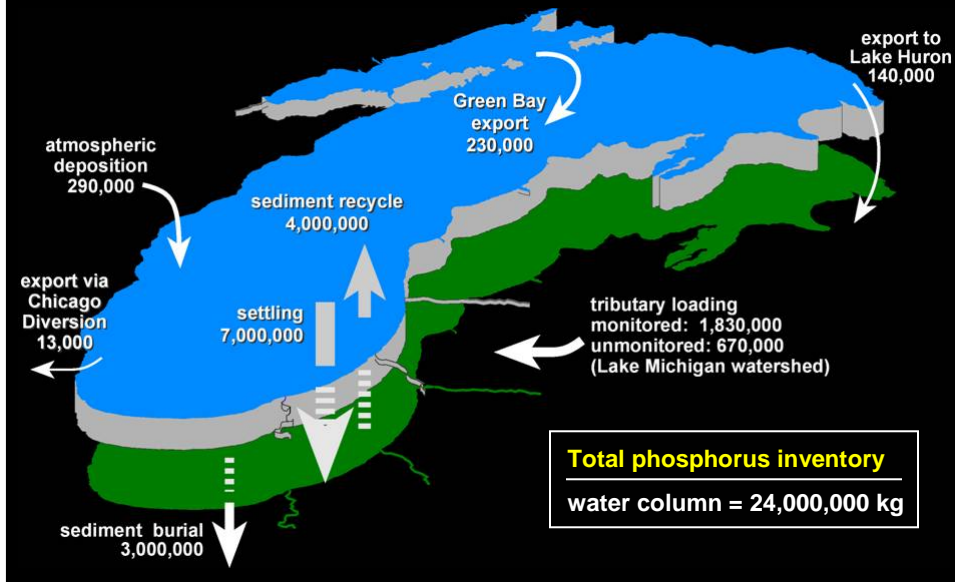
Lake Michigan Whole Lake Total Phosphorus USEPA Great Lakes National Program Office (1976-2002)



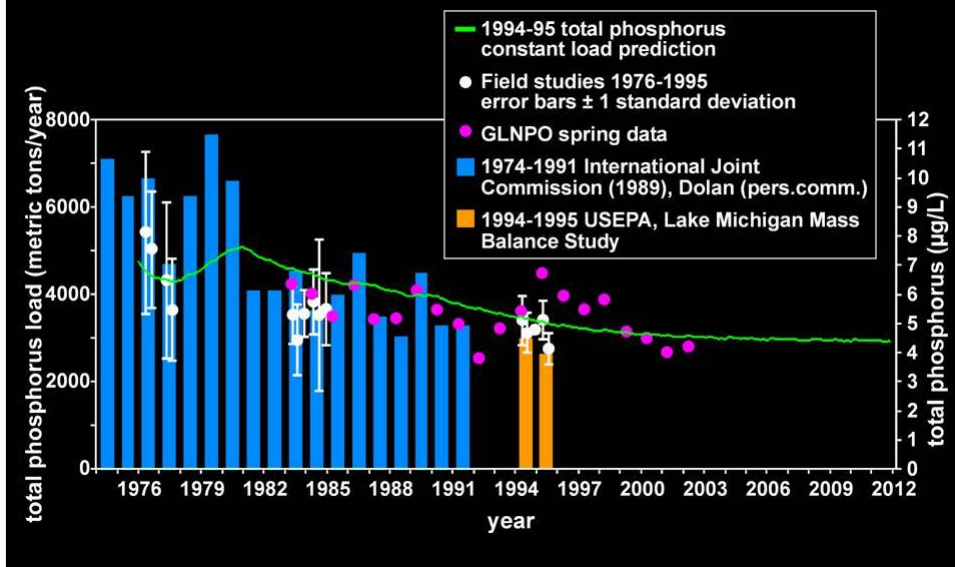




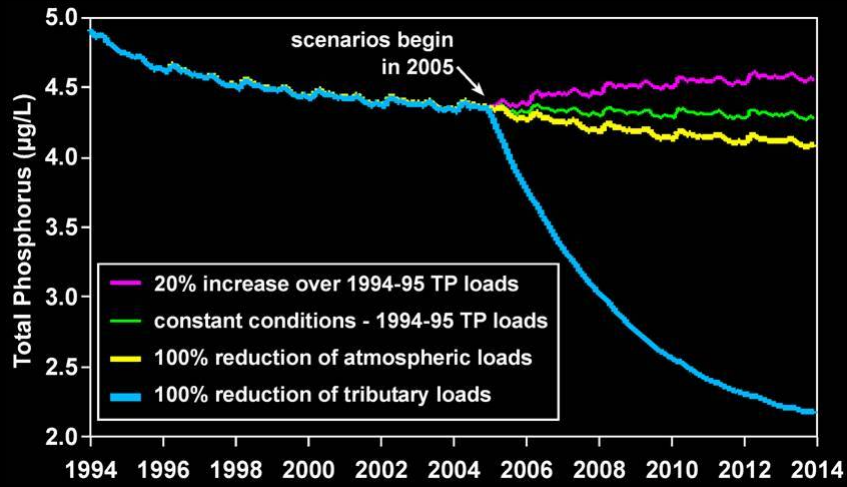
1994-1995 Lake Michigan Total Phosphorus Mass Balance (kg/year)



Total Phosphorus Model Prediction 1976-2011 and Annual Lake Michigan Phosphorus Loads 1974-1995

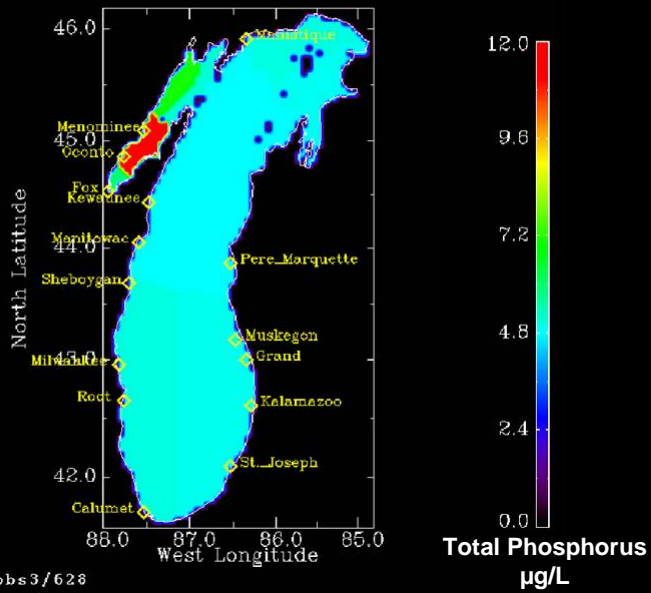


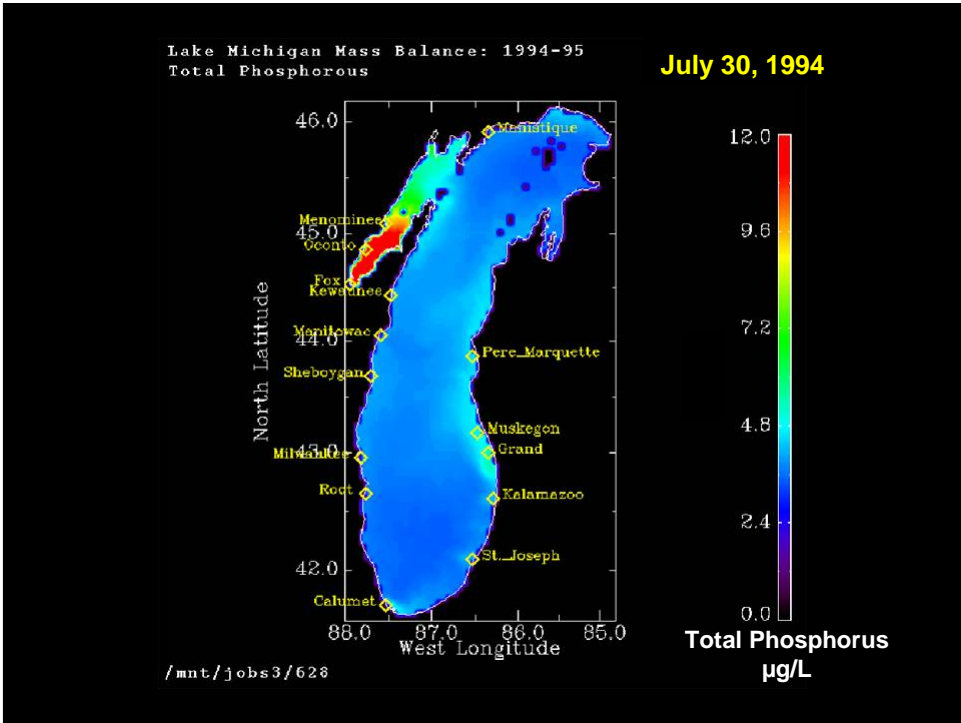
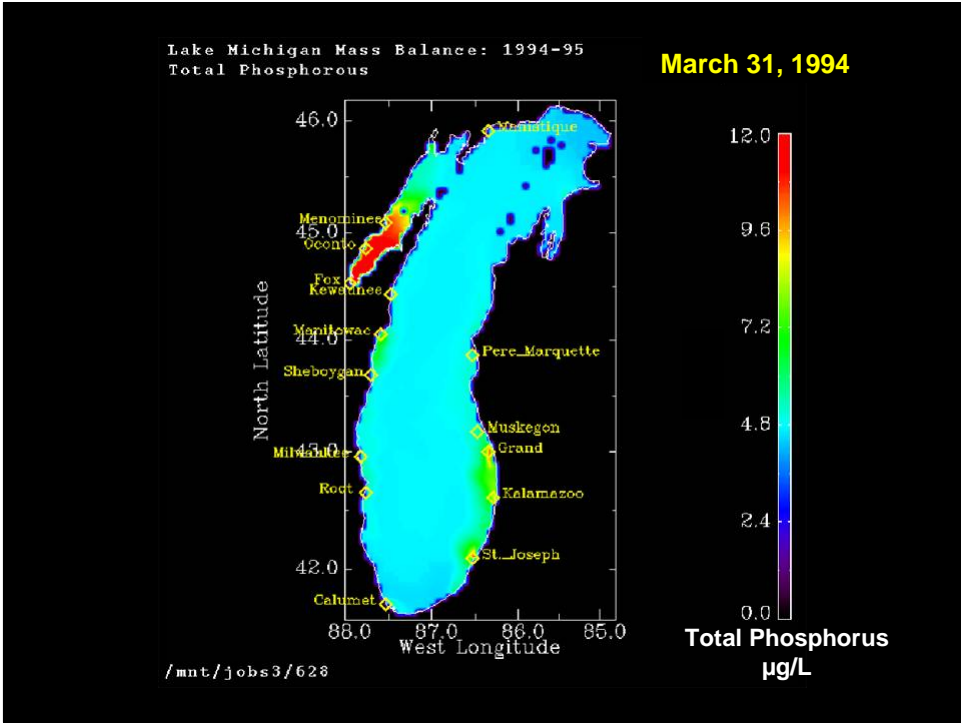
Lake Michigan Total Phosphorus Forecasts

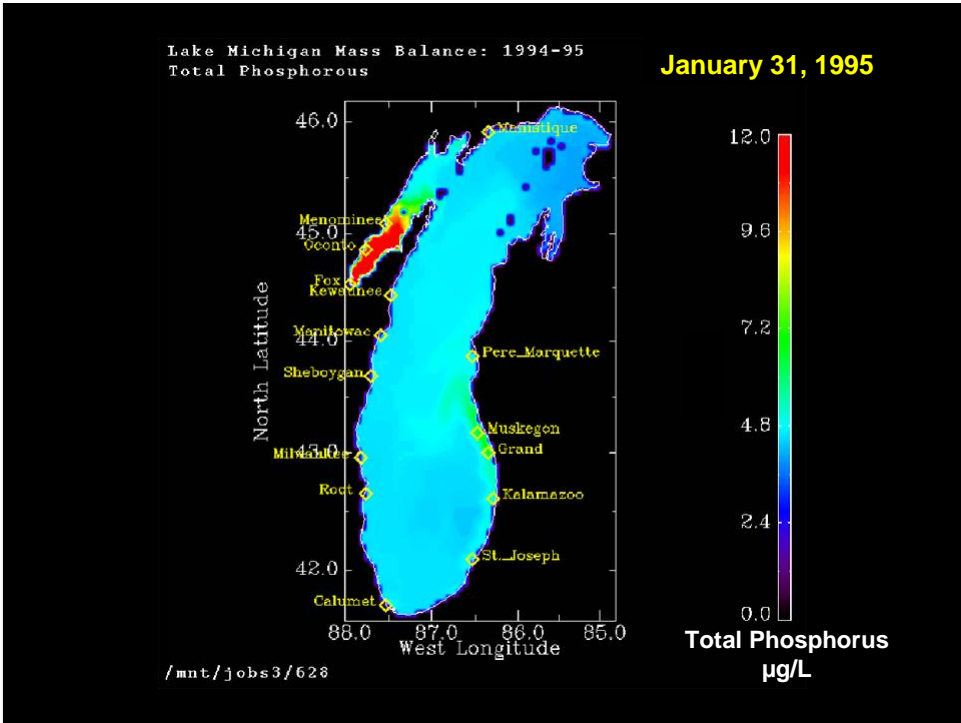
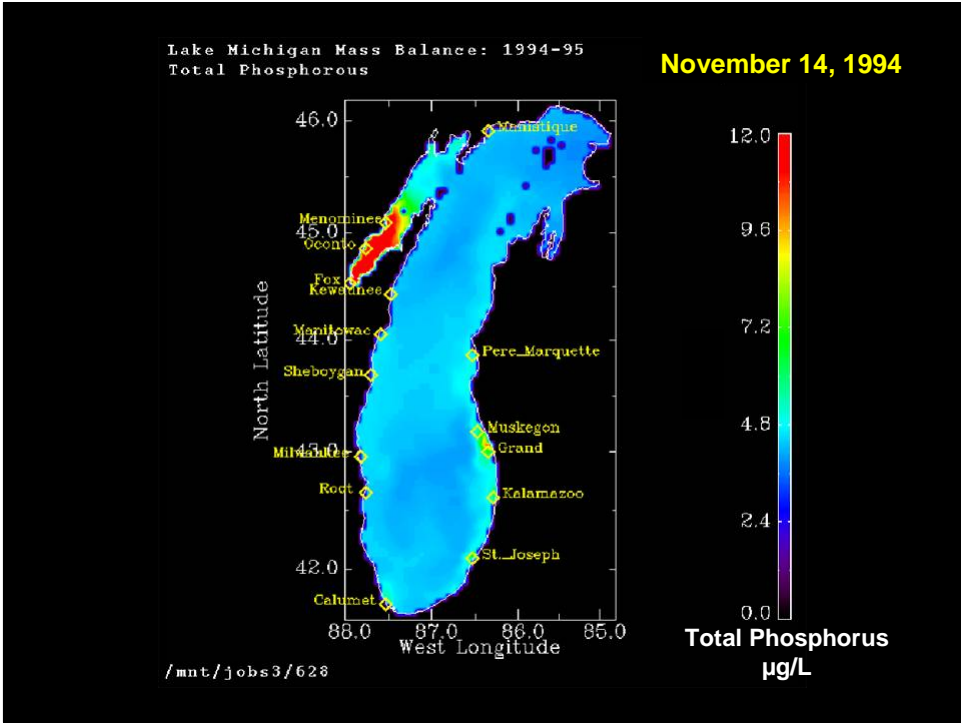


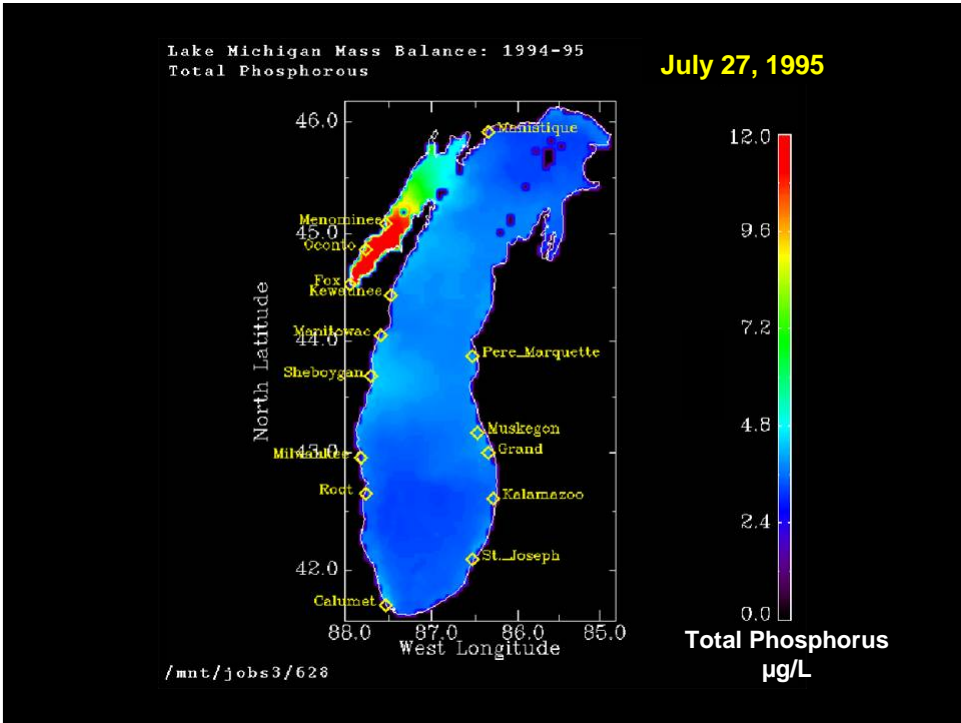
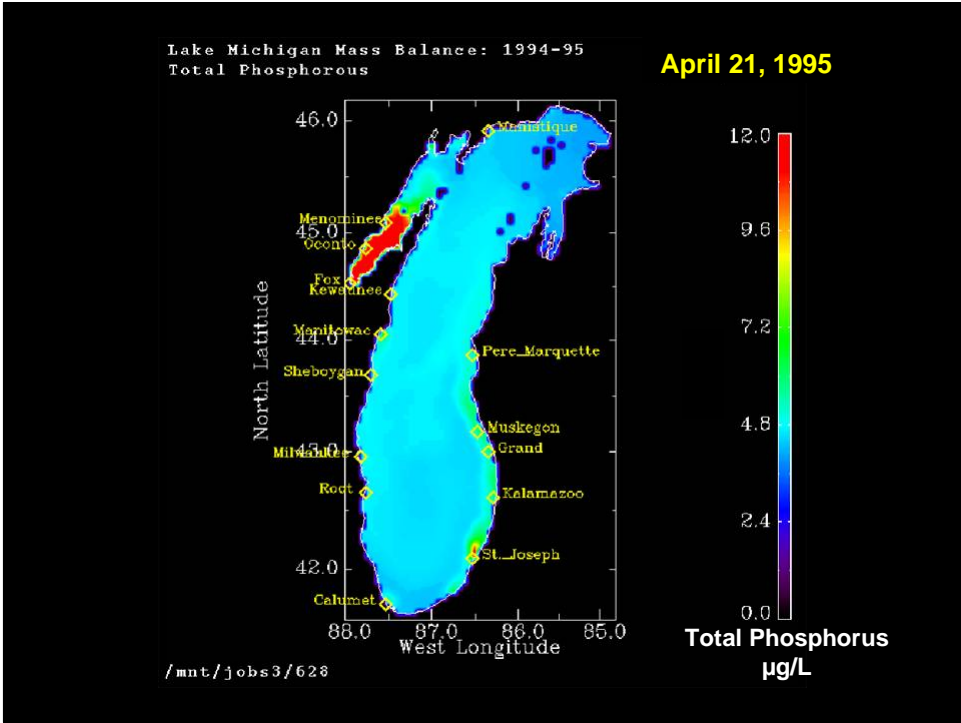
Lake Michigan Mass Balance: 1994-95
Total Phosphorous

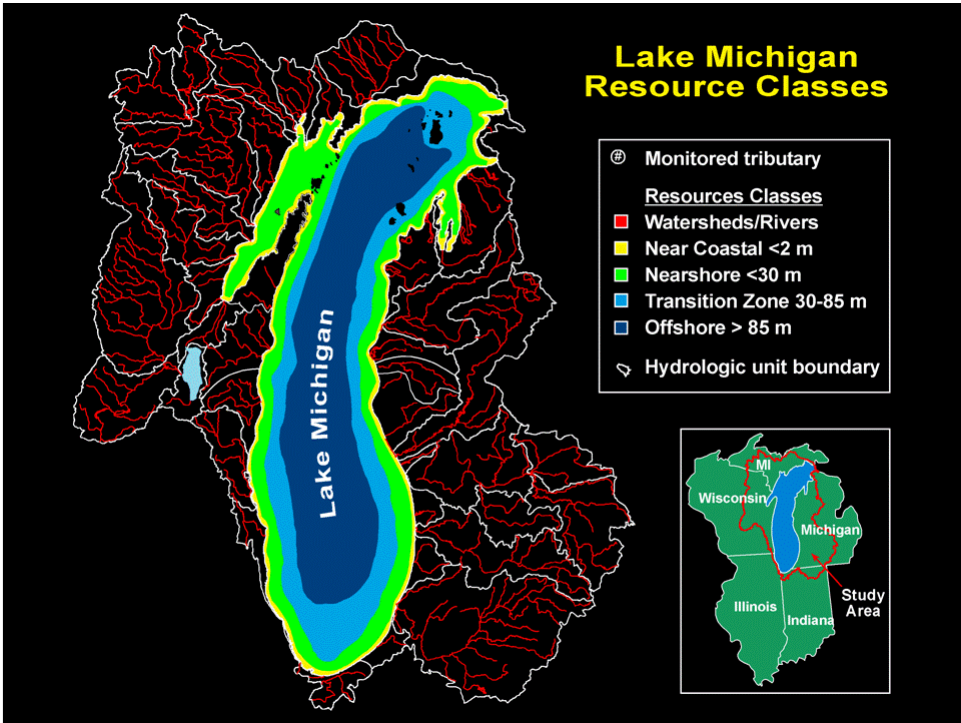
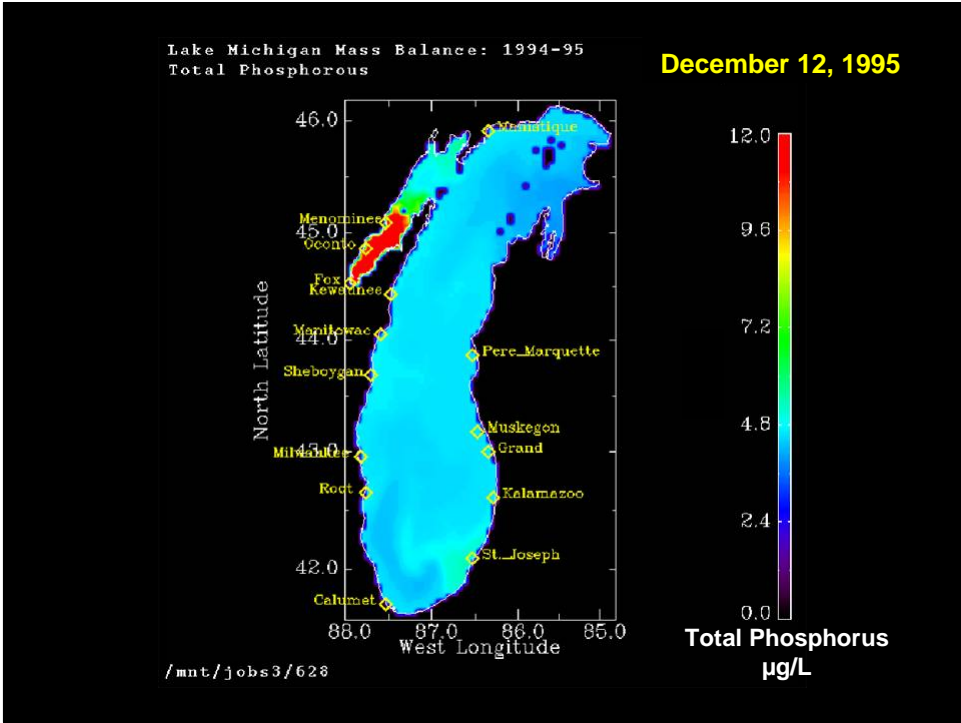
January 1, 1994

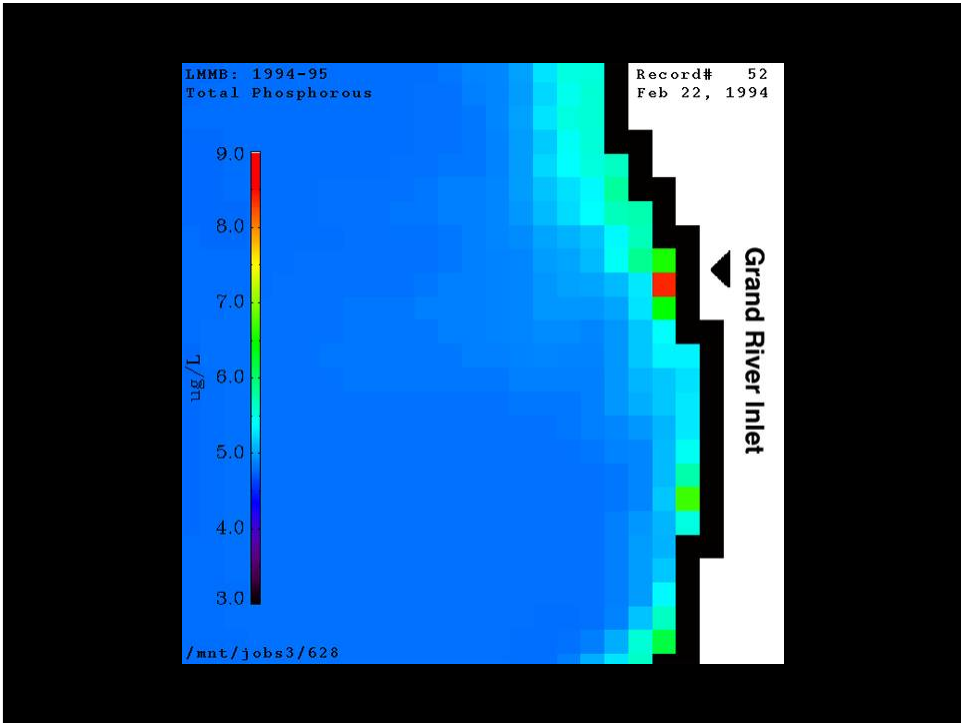
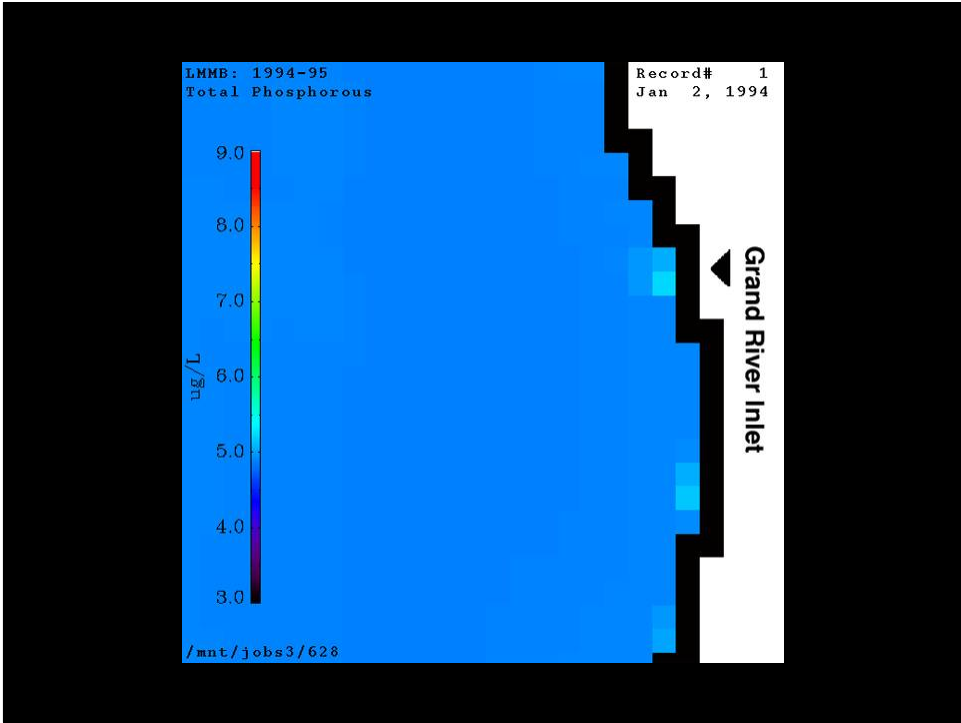


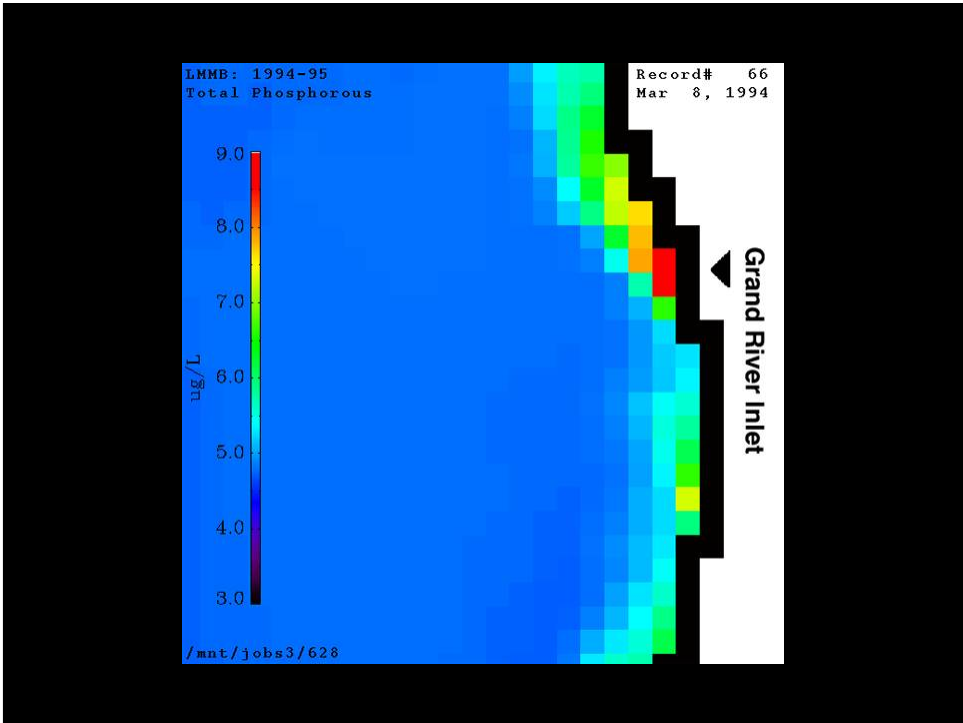
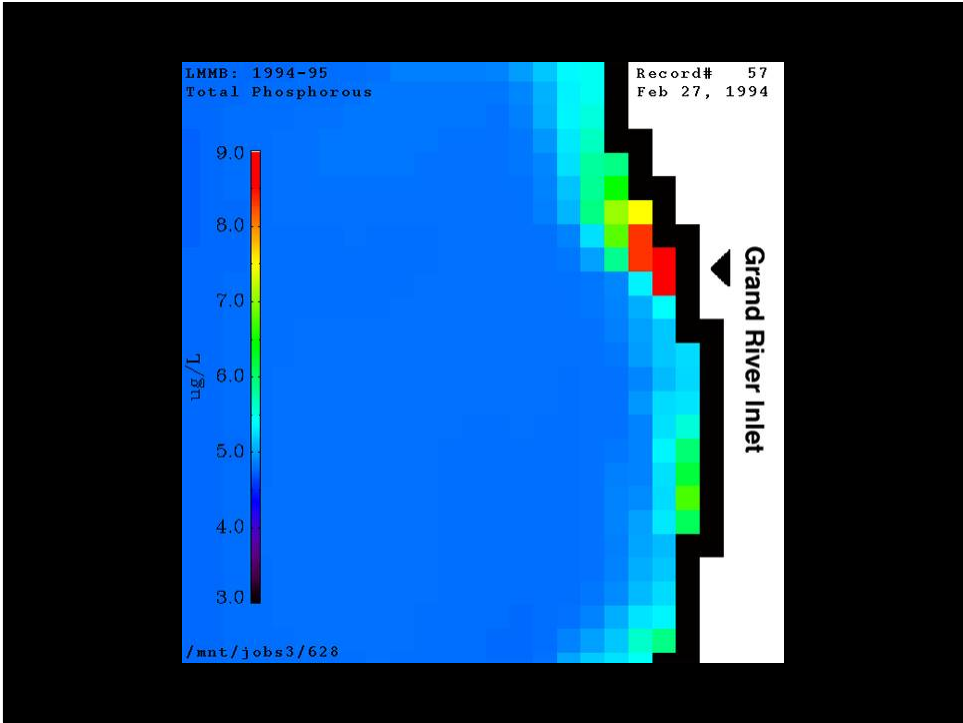


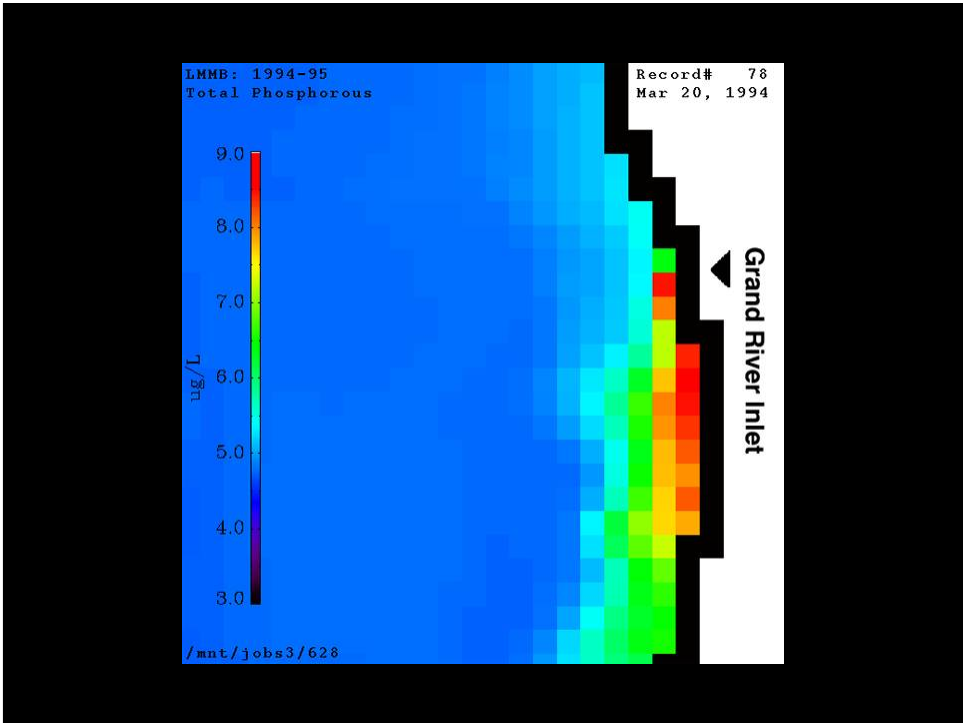
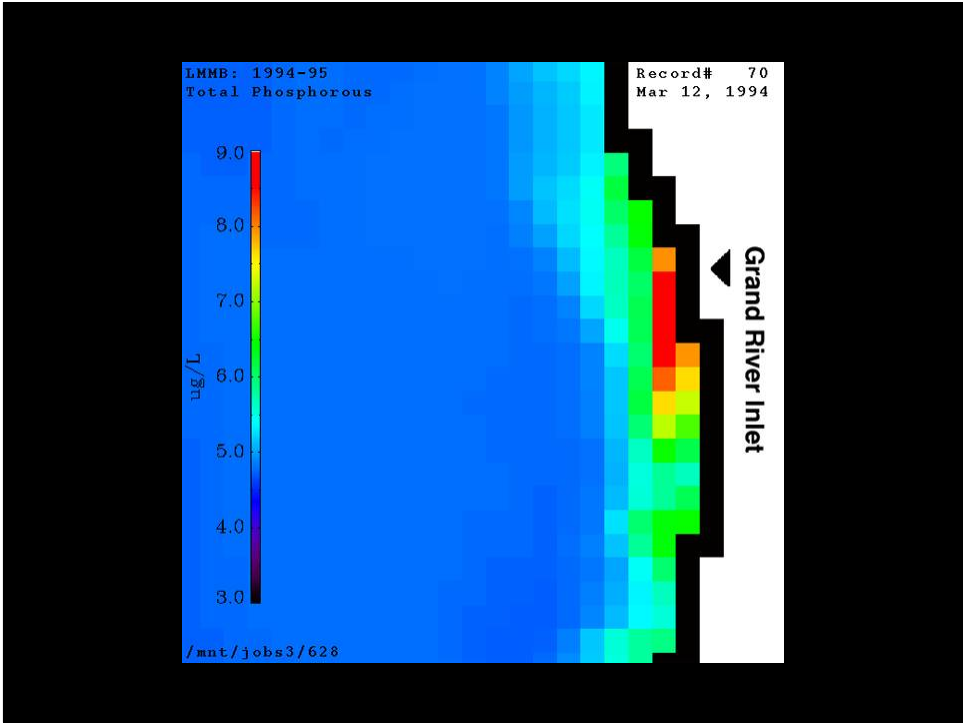


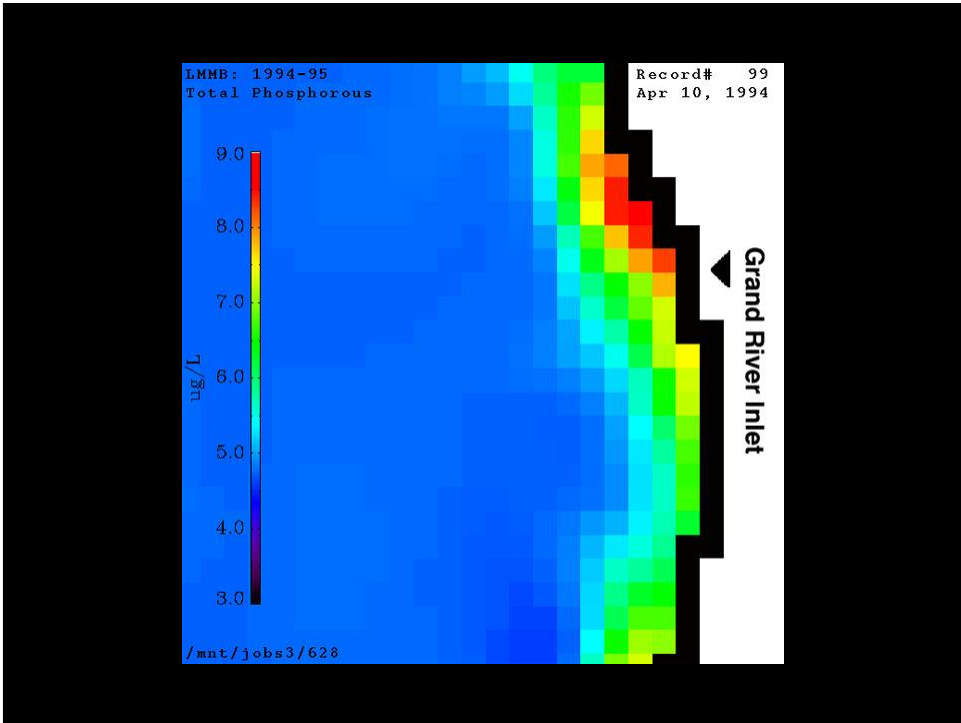
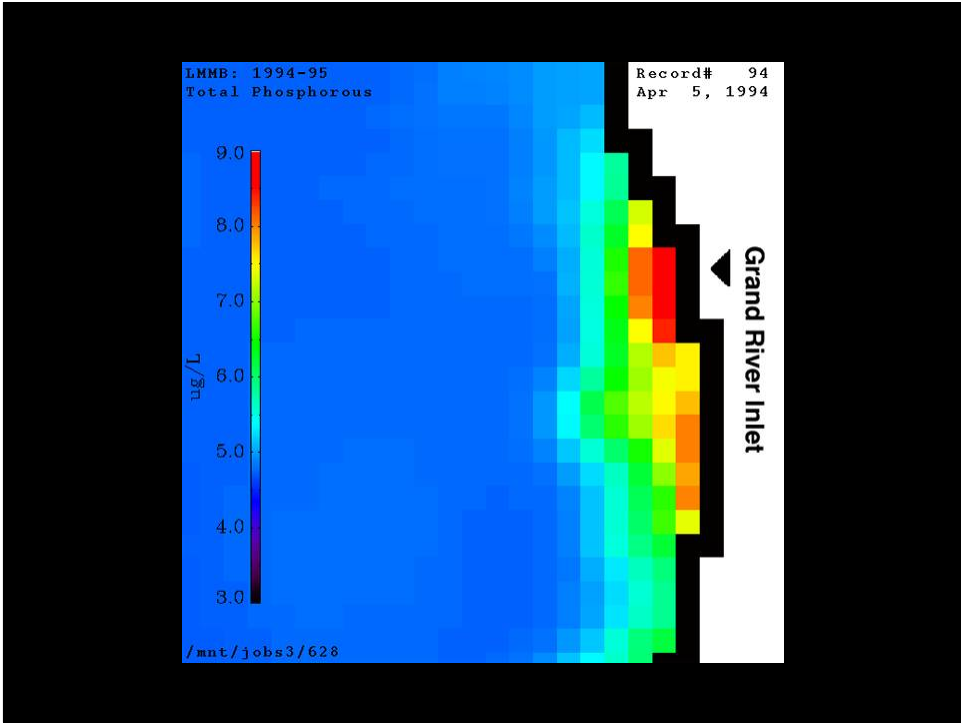


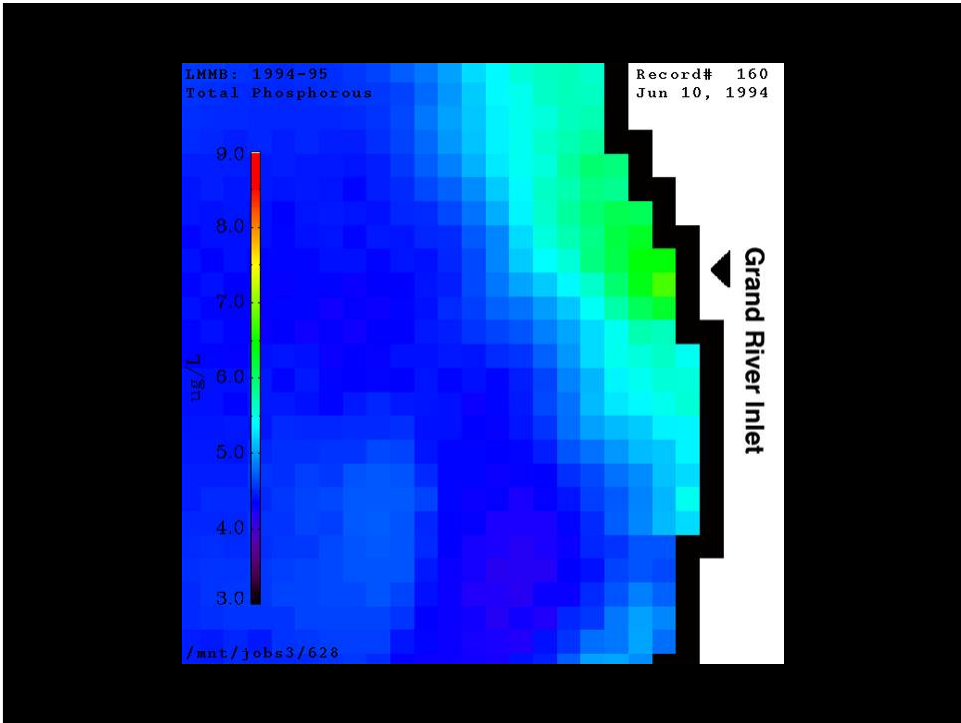
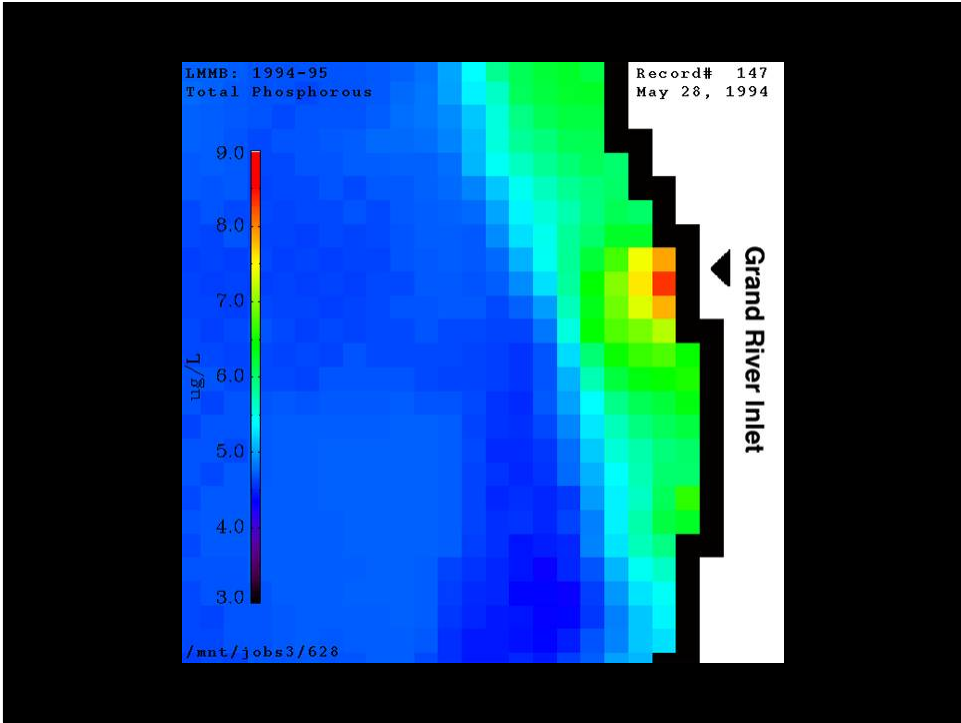


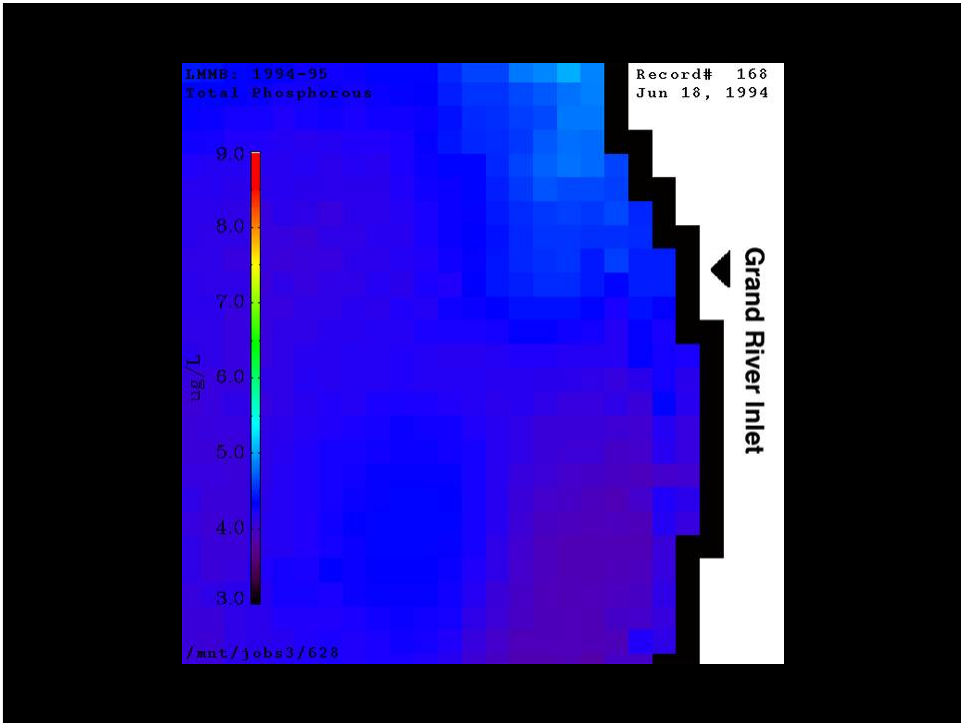
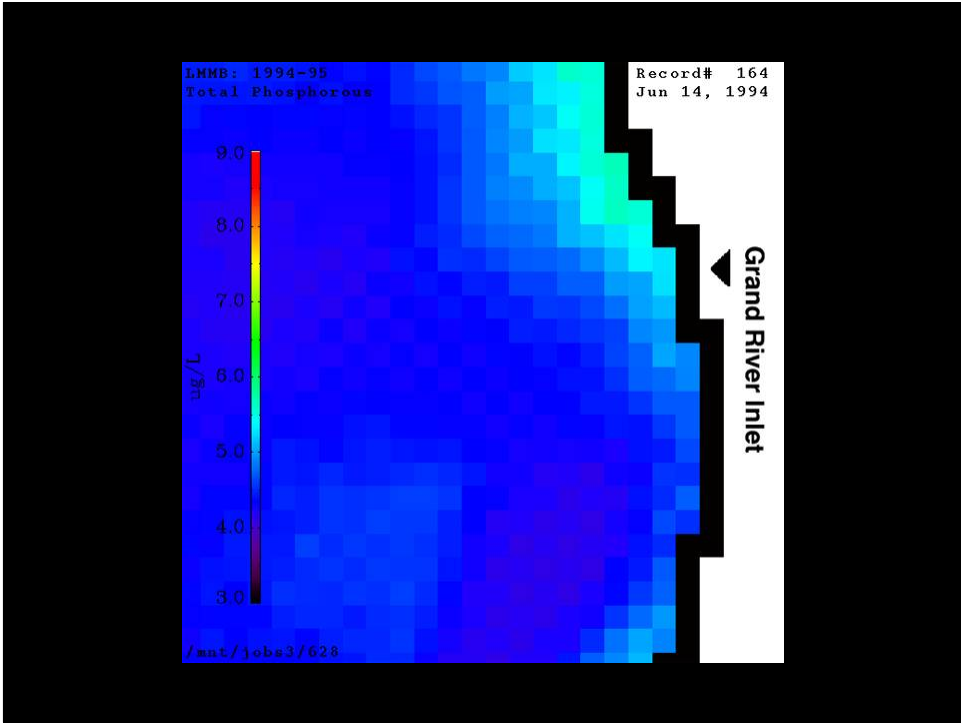


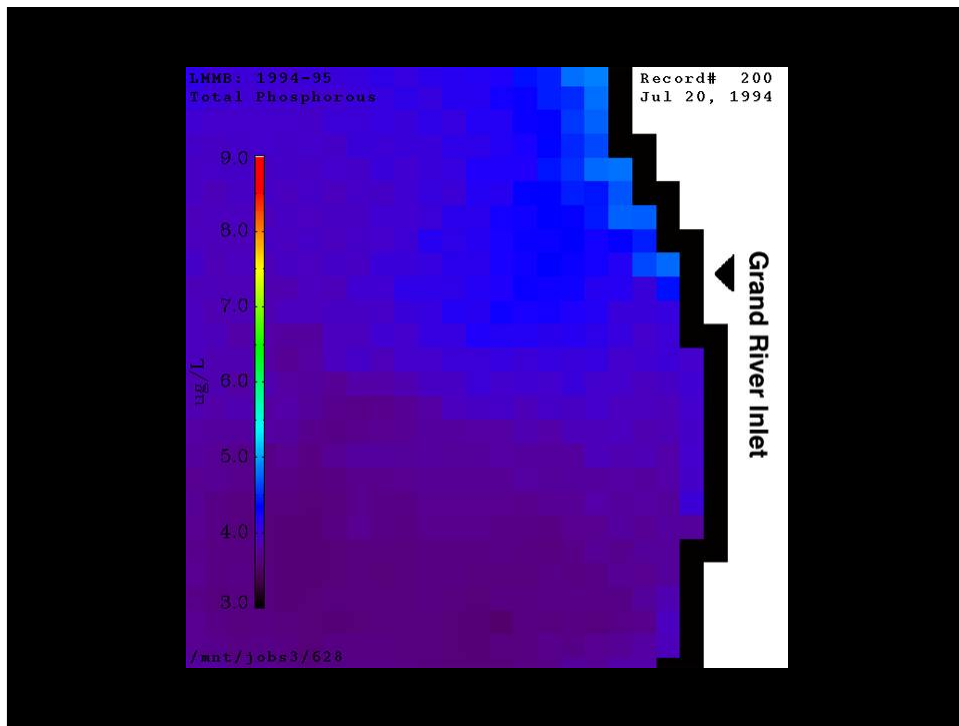












Summary

Lake Michigan phosphorus loads and concentrations are low and below GLWQA and IJC targets

The largest external loads of phosphorus to Lake Michigan are from tributaries

Highest concentrations can be observed in selected nearshore zones near tributary mouths and in Green Bay

There is no evidence of increasing loads or increasing concentrations in the open-water through 2002; forecasts indicate relatively stable phosphorus and chlorophyll-a concentrations into the future

Next Steps

Journal publications and EPA reports

Phosphorus loads should be calculated and updated from 1992 through the present

Additional forecasts?

State visits

Post-audit with 2005 sampling results

Pursue the integration of LM3 high resolution sediment model with the eutrophication model