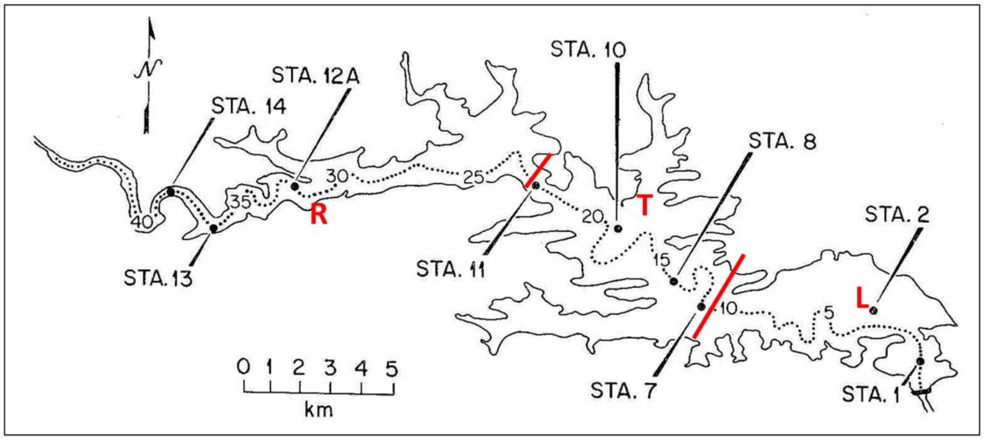
Lab 5 – Analysis of the Nutrient Status of DeGray Lake, Arkansas

DeGray Lake is a reservoir on the Caddo River, in the foothills of the Ouachita Mountains of Arkansas. The lake offers a huge span of recreational area and spectacular views. Construction on the dam began in 1962 and was completed in 1972. (*Taken in part from Wikipedia and the US COE*.)

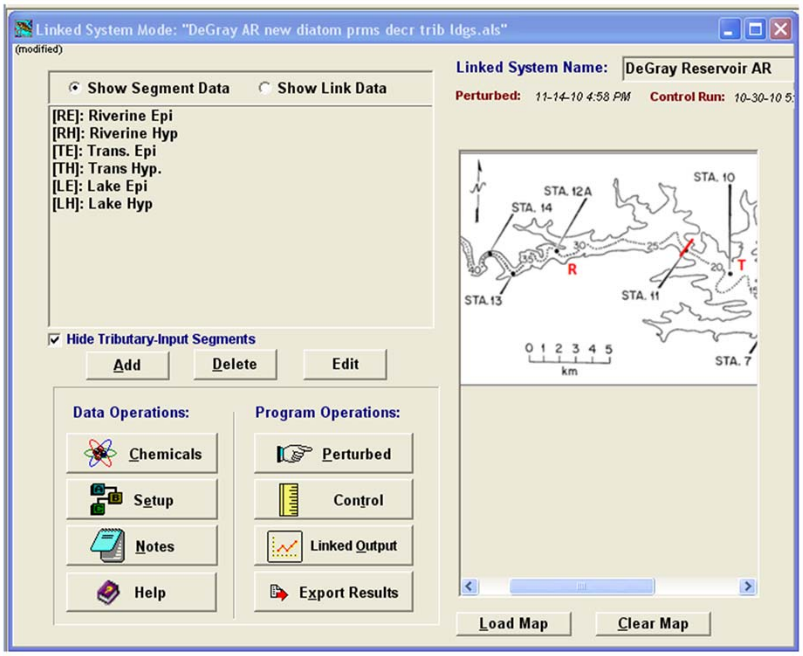
The lake was studied extensively by the Corps of Engineers in the development and verification of the CE-QUAL model. We will model the transient period following impoundment.

The long, narrow, dendritic reservoir was formed by damming the canyon of the whitewater Caddo River in the foothills of the Ouachita Mountains



The reservoir can be divided into an upstream riverine zone (R), followed by a transition zone (T), and then a lacustrine zone (L) near the dam.

We will investigate the productivity gradient from the riverine to the transition and lacustrine zones



What happens if you change the nutrient loadings from the Caddo River, such as doubling N, P, and detrital loadings?

If the following slides, the significance of Tributary inputs and water routing will be explained. You will also learn how to change the loadings to answer the question above.

Because of execution time, *you may wish to set up and start a perturbation run, and then examine the control output.*

Explore the output of the control simulation (**DeGray Lake AR_results.als**) . You can plot the linked segments together or separately. There are lots of graphs because the calibration is a work in progress. The final calibration is likely to be somewhat different. (At issue are the boundary conditions, some of which are not well defined by available data.)

What is the trophic status of the lake? How does the TSI (Trophic State Index) vary from the riverine to the lacustrine segments?

Hint: Table 8 (page 131) of the Technical Documentation gives the trophic states according to the TSI(chl), which you can compute in AQUATOX.

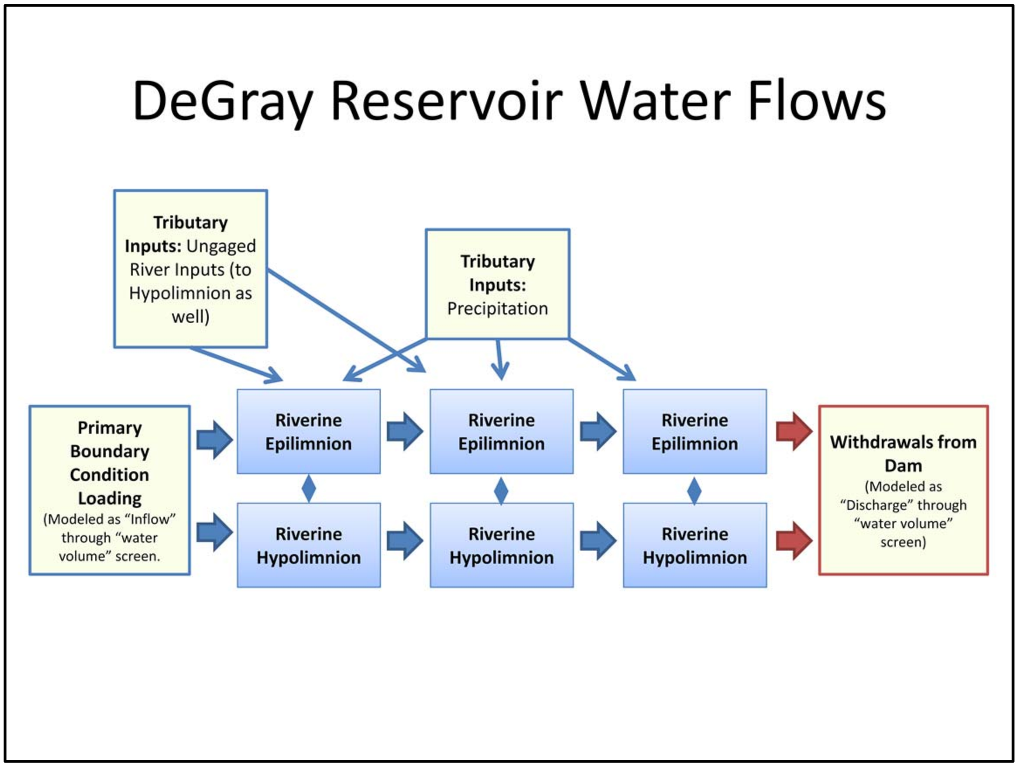
Tributary Inputs

- Allow a user to enter a set of nutrient, organic matter, toxicant, and/or biotic loadings
- Water flows are entered as linkages from the tributary input segments into the modeled segment
- Output from these segments are not included in the linked output screen
- Can be hidden from view by clicking the "Hide Tributary-Input Segments" box at the bottom of the study window

In the single-segment formulation, point sources and non-point source loadings have no water associated with them, and loadings are given in grams per day. The tributary input segment allows a user to enter a set of nutrient, organics, toxicants, and/or biotic loadings as concentrations in water that are associated with a water flow. The loadings are entered ***as loadings to the tributary input segment itself.*** The water flows that those loadings are associated with are entered ***as linkages*** from the tributary input segments into the modeled segment.

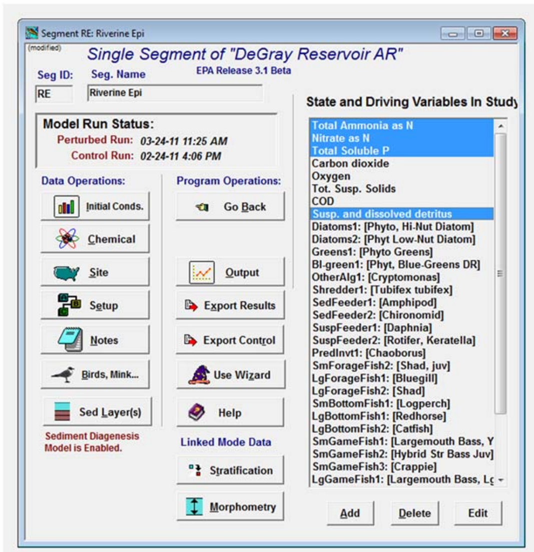
Tributary inputs may be used to model tributaries, point sources, non-point sources, and even groundwater inputs into the modeled system.
Because tributary input segments are "dummy" segments, output from these segments are not included in the linked output screen, or when linked results are exported.

Tributary input segments provide the user with considerable flexibility for playing "what-if" games regarding a given source of loadings. For example, if a management practice could conceivably reduce both the amount of water released and the concentrations of pollutants within that water from a point-source, the effects of this change can be directly modeled.

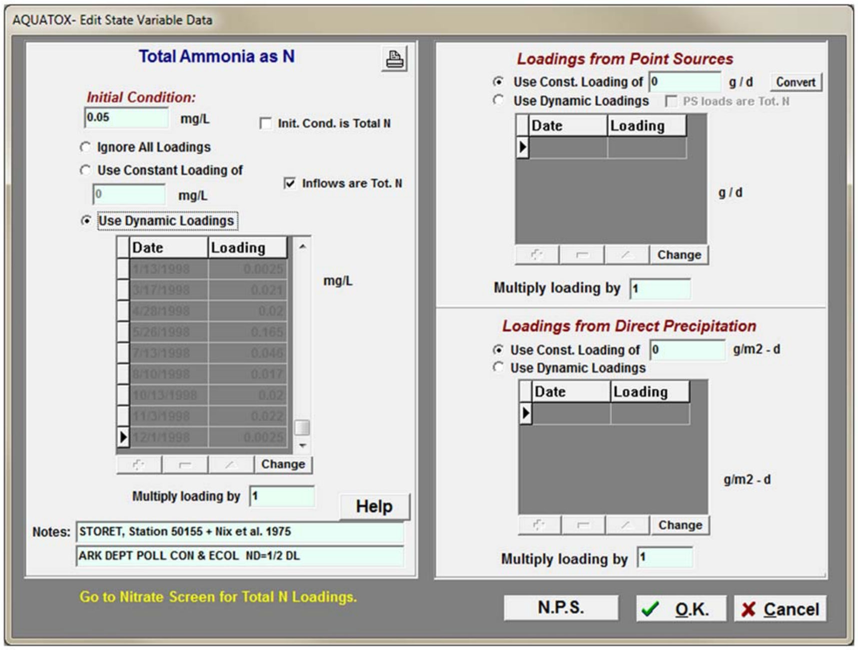


There are six segments within the model domain fed by seven "tributary inputs" representing smaller (ungaged) river loadings and precipitation.

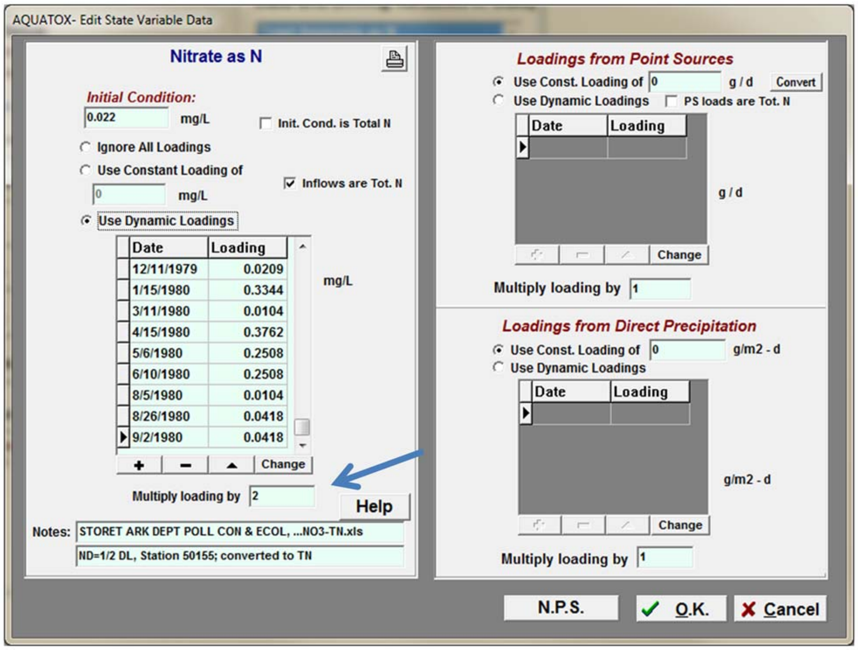
Change Loading from the Caddo River



- Select Riverine Epilimnion (RE)
- Select:
  - Total Ammonia as N
  - Nitrate as N
  - Total Soluble P
  - Susp. And dissolved detritus
- Click Edit



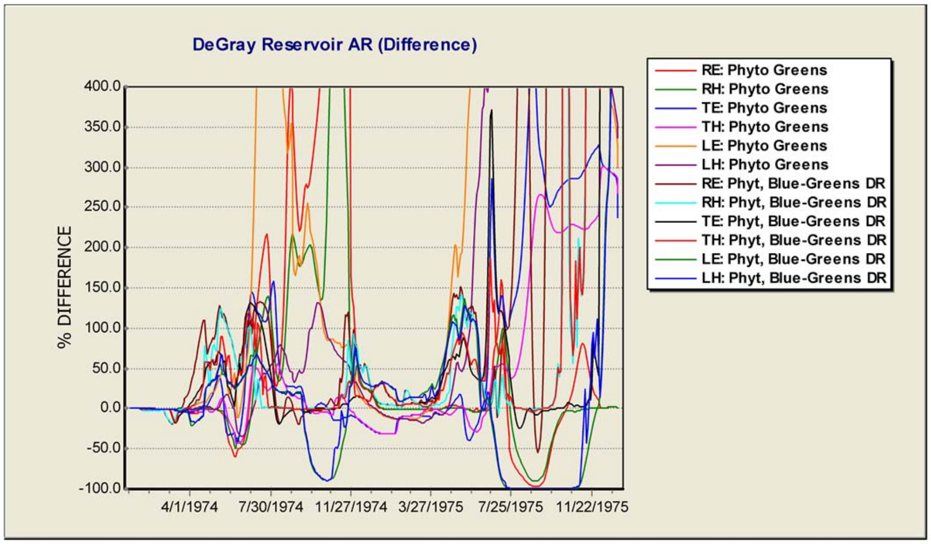
Here we are using “Inflows are Tot. N” , so we will specify the change in loading on the Nitrate Screen.



In the Nitrate, Total Soluble P, and Susp. and dissolved detritus screens, simply change the multiplier in the “Multiply loading by” box to 2 in order to double the inputs from the Caddo River.

Follow the same steps to increase the loadings in the Riverine Hypolimnion (RH)

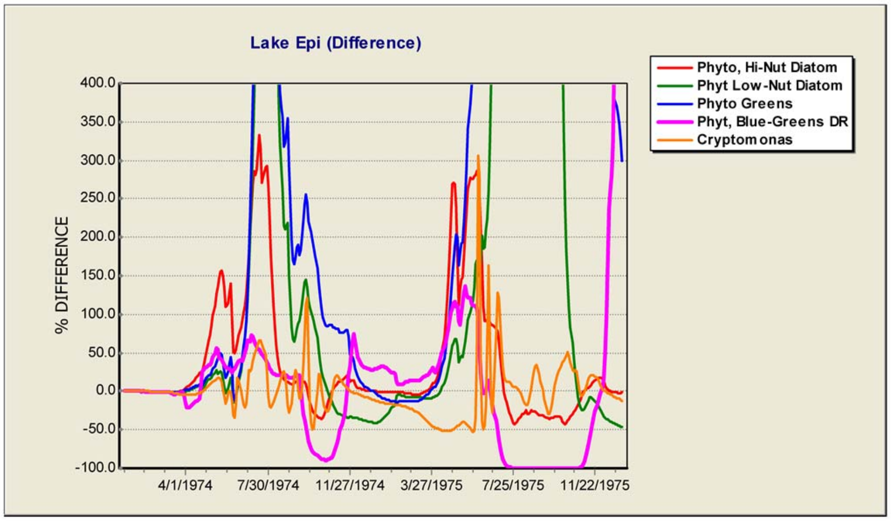
Effect of Doubling Nutrient Loadings on Greens Across Reaches



This graph shows the effect of doubling the nutrient loadings from the Caddo River on Algae throughout the DeGray Reservoir system (note that “All Segments” is specified in the upper left).

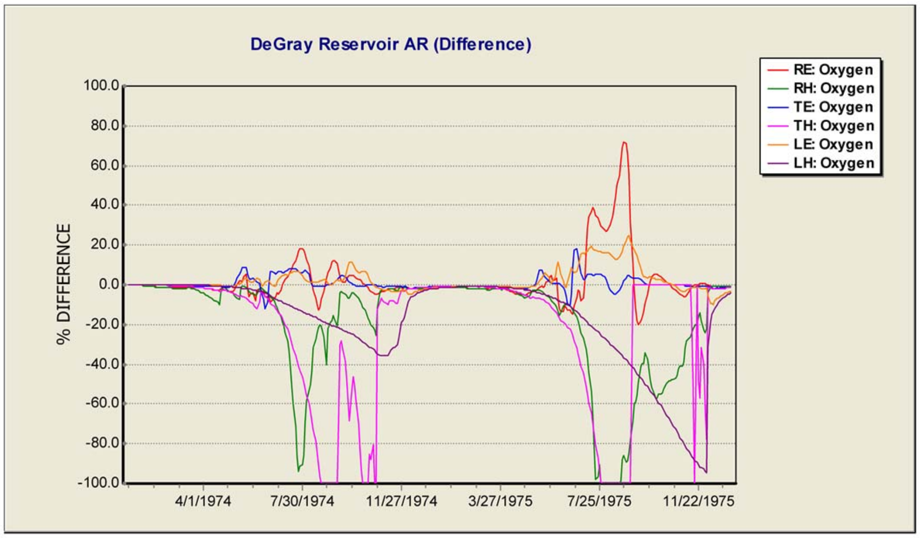
It appears this change leads to algal blooms in the summer, with a general increase in green and blue-green algae concentrations throughout the year (with intermittent population crashes)

Effect of Doubling Nutrient Loadings on Plants (Lake Epilimnion)



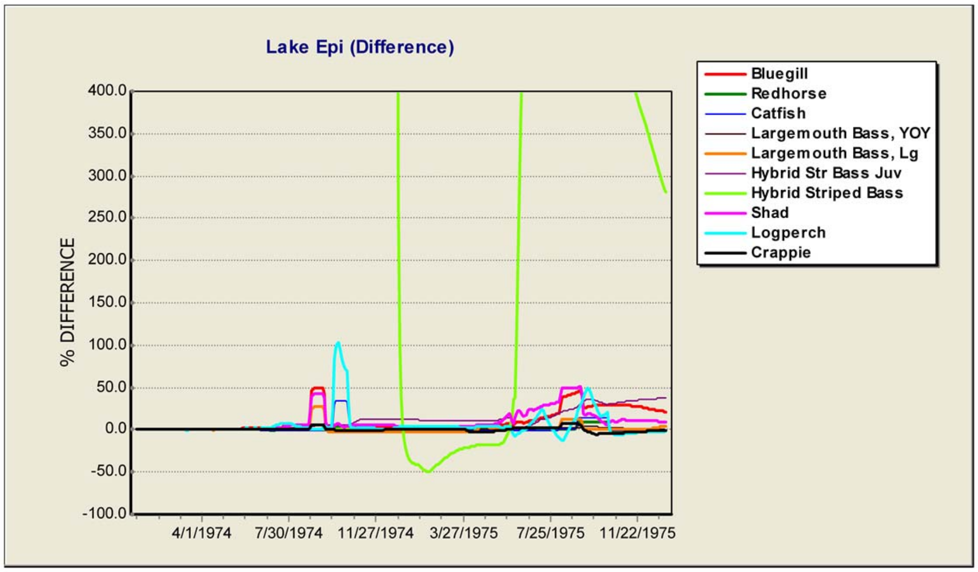
By examining all the plants in the the Epilimnion of the Lake segment, the difference graph shows that AQUATOX predicts several crashes/blooms of blue-green algae in the lake as a consequence of increased nutrient loading.

Effect of Doubling Nutrient Loadings on Oxygen Levels



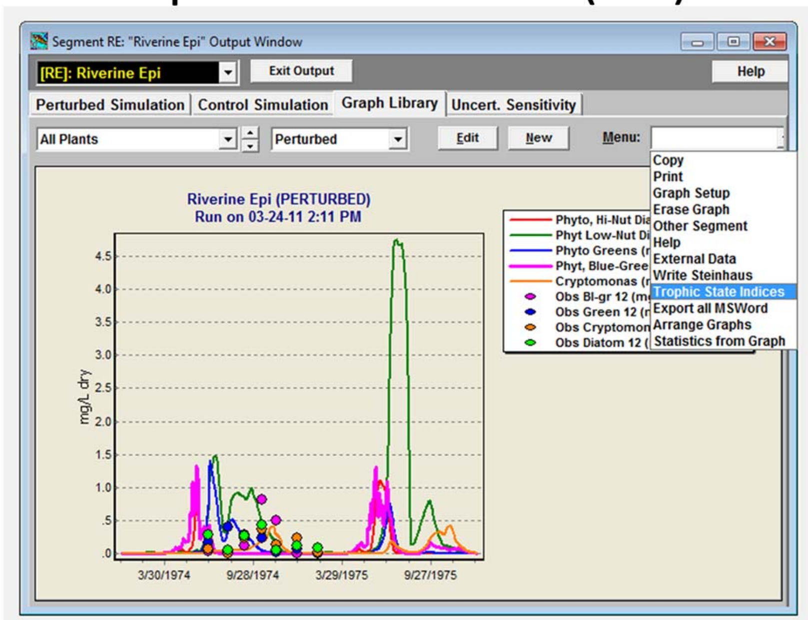
Doubling the Nutrient input from the river will reduce the oxygen levels in the majority of the reservoir

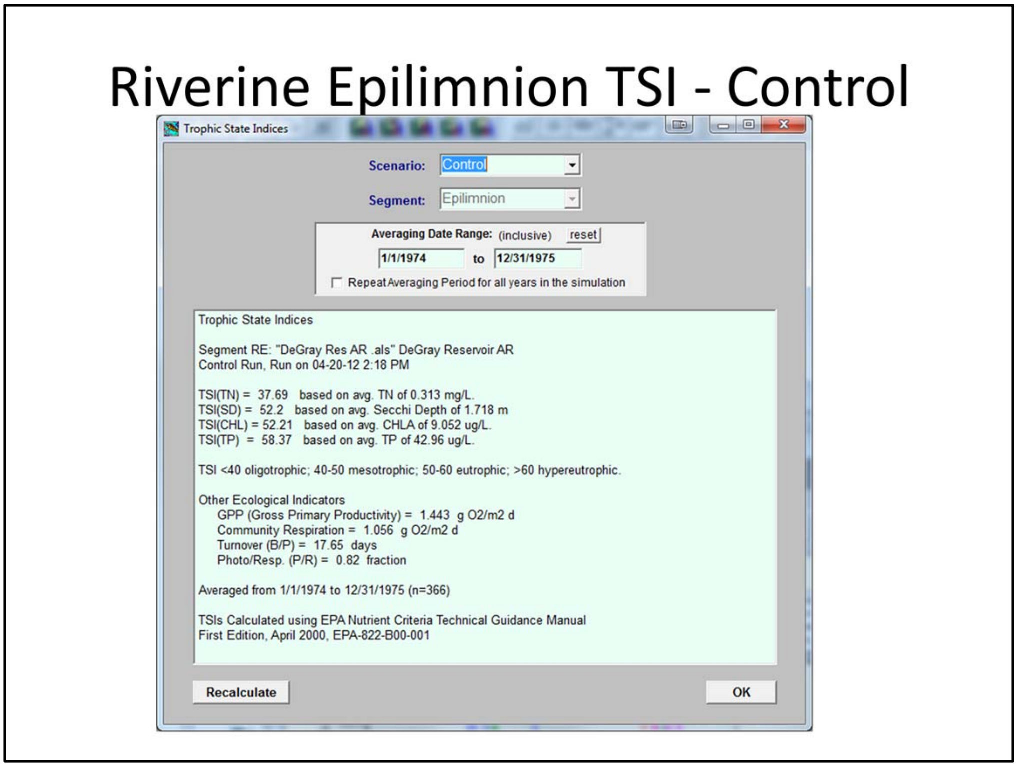
Effect of Doubling Nutrient Loadings on Fish Levels in the Lake Epilimnion



By doubling nutrient inflows, the fish levels in the epilimnion of the lake are generally increased, with a very large change in the hybrid striped bass population.

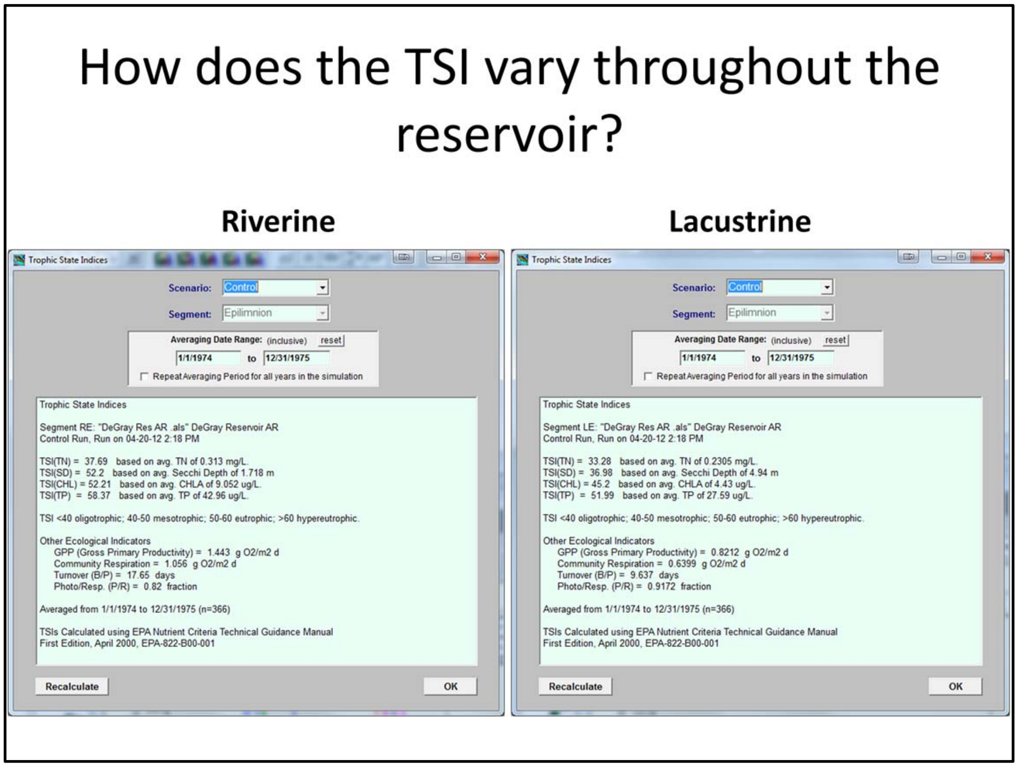
Trophic State Index (TSI)





Based on the range of the TSI (37.7 to 58.4) , the SD = 1.7, and TP = 43 ug/L, the riverine epilimnion can be characterized as Eutrophic.

The TSI(TP) >TSI(CHL) = TSI(SD), so zooplankton grazing or nitrogren (or some other factor other than P) is limiting biomass.



These values are for the control state (where nutrient loadings have not been doubled).