

## **Lab 7: Risk Assessment of Insecticide in Ohio Stream**

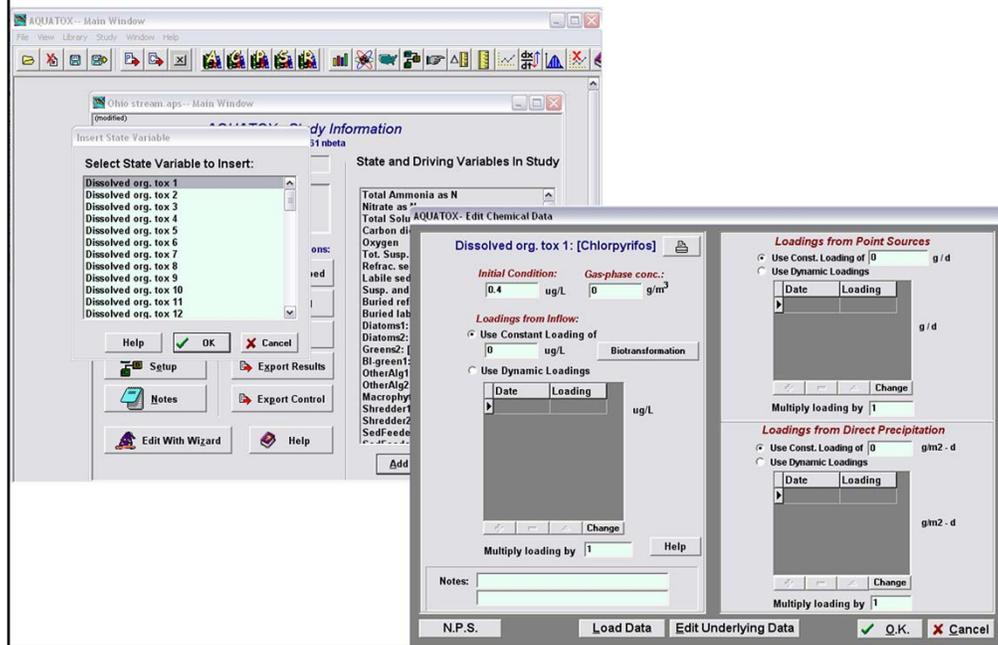
Objective: analyze direct and indirect ecotoxicological effects with model

- Assessment of chlorpyrifos in a generic stream
  - small stream in corn belt
  - drain tiles
- Open Ohio Stream.aps,
- Add chlorpyrifos, save as Ohio Stream chlor.aps
- Run, plot, analyze control/perturbed/ %difference
- Compare constant exposure vs. single dose

We will use a constant level of 0.4 ug/L chlorpyrifos in a generic small stream for purposes of risk assessment. This concentration is based on the worst-case value chosen by US EPA for risk assessment of chlorpyrifos. We will start the simulation on May 1, the start of the growing season.

The second simulation will compare a constant dose against a single, initial dose of the same magnitude.

# Add chlorpyrifos



**Add Dissolved org. tox 1** as statevariable

Choose **chlorpyrifos**

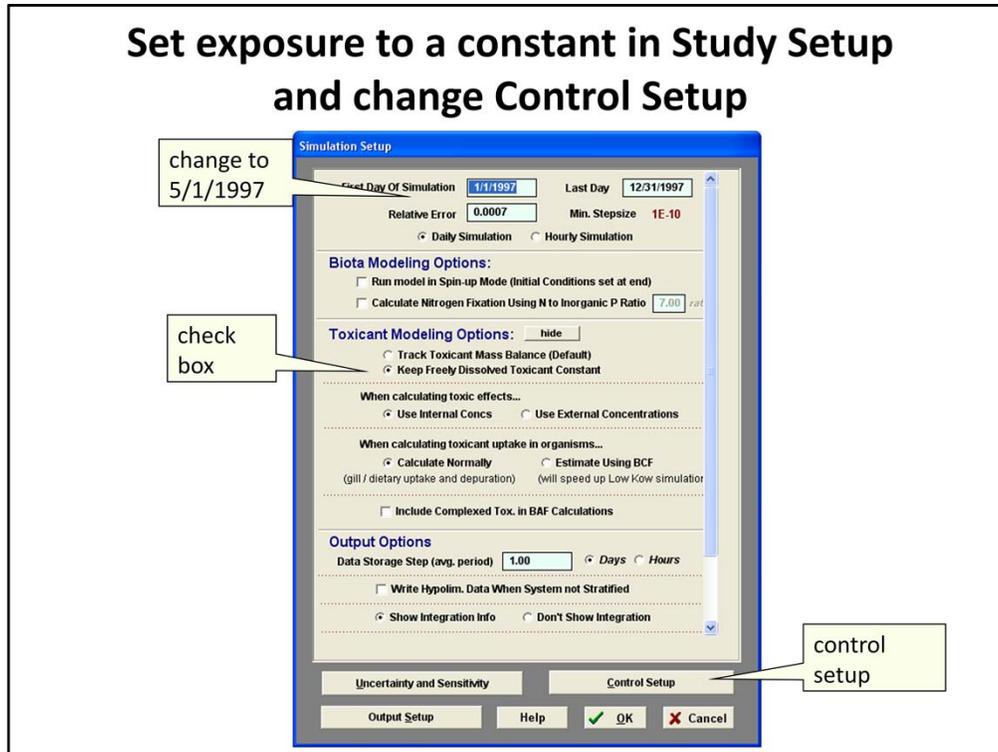
Double-click on **Dissolved org. tox 1 [chlorpyrifos]** in the state variable list

Set the initial condition to 0.4 ug/L

Click on **OK** to exit

Save as **Ohio stream chlorpyrifos.ap**s

## Set exposure to a constant in Study Setup and change Control Setup



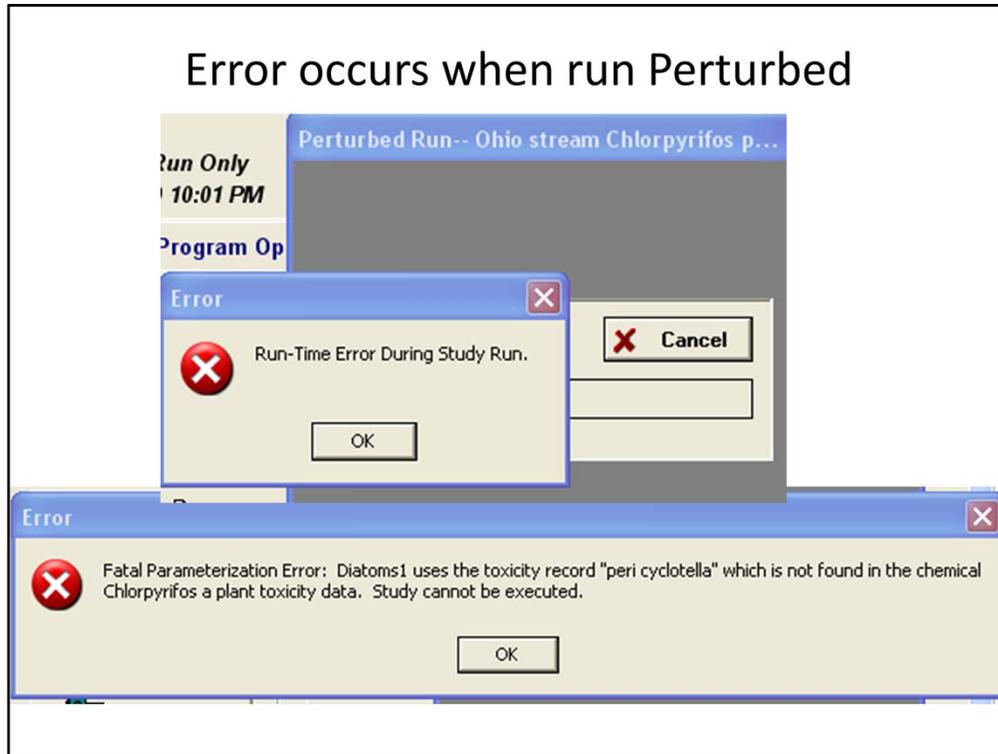
In Main Screen click on **Study Setup**

Check box **Keep Freely Dissolved Contaminant Constant**

Change start date to **5/1/1997** (to speed up simulation)

In **Control Setup** check **All Organic Toxicants** boxes (so Control will not have chlorpyrifos)

## Error occurs when run Perturbed



**Run** the perturbed simulation. We have purposefully included an error! Organisms must be linked to a valid toxicity record for the toxicant being modeled. The disconnect occurs when organisms are parameterized for one toxicant and then used for another toxicant with different available toxicity data.

## Change the linkage to toxicity record

The screenshot shows the AQUATOX- Edit Plant interface. The title bar reads "AQUATOX- Edit Plant". Below the title bar are buttons for "Load from Library", "Save to Library", "OK", "Print", "Help", and "Peri High-Nut Diatom". The main area is titled "Plant Data:" and includes a "Periphyton Linkage" button and an "Edit All" button. The "Plant" field is set to "Peri High-Nut Diatom". The "Scientific Name" field is empty. The "Plant Type" dropdown is set to "Periphyton". The "Toxicity Record" dropdown is set to "Peri, Cyclotell". The "Taxonomic Type" dropdown is set to "Diatoms". A yellow callout box labeled "Note" points to the "Toxicity Record" dropdown. Another yellow callout box labeled "change to Diatoms using pull-down menu" points to the "Taxonomic Type" dropdown. Below the "References:" section, there is a table of parameters and their values:

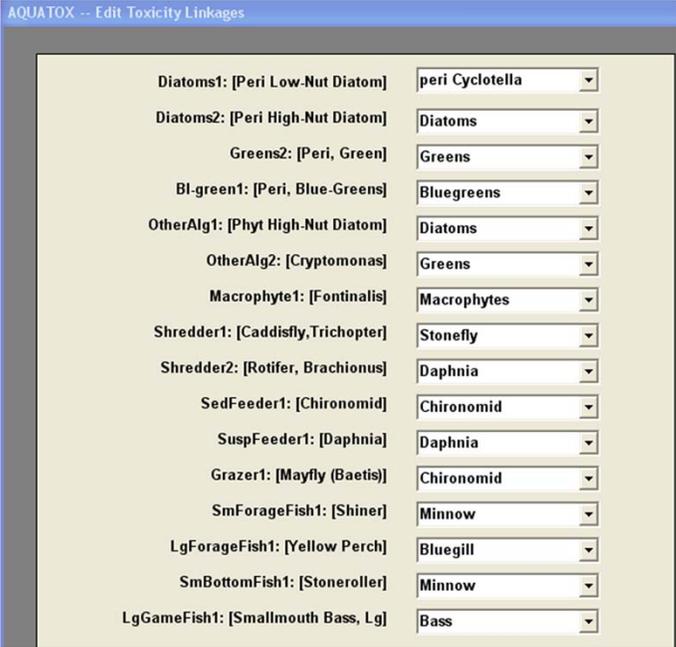
Parameter	Value	Unit	Reference
Saturating Light	22.5	Ly/d	Hill, 1996 64 (22.5)
Use Adaptive Light	<input type="checkbox"/>		
Max. Saturating Light	300	Ly/d	Default
Min. Saturating Light	80	Ly/d	Default
P Half-saturation	0.1	mg/L	Borchard;Collins & Wlosinski '83, p. 33 0.055
N Half-saturation	0.2	mg/L	Collins & Wlosinski '83, p. 36, EcoTox=0.007
Inorg. C Half-saturation	0.054	mg/L	C & W '83, p. 39 (greens) = 0.054
Temp. Response Slope	1.8		
Optimum Temperature	20	°C	Collins & Wlosinski '83, p. 43 = 20
Maximum Temperature	35	°C	
Min Adaptation Temp.	2	°C	2
Max. Photosynthetic Rate	2.06	1/d	Collins & Wlosinski '83; EcoTox 1.96 = 2.06
Photorespiration Coefficient	0.026	1/d	" 0.026
Resp Rate at 20 deg. C	0.08	g/g-d	Riley and von Aux, 1949, cited in C.&W.1983

The pull-down menu for the Toxicity Record lists the available state-variable linkages for the toxicant. As you have seen, if you miss an assignment the program will return an error and tell you which state variable is unassigned.

If you need to make more than one toxicity assignment, click on **Edit All** next to the pull-down menu.

**In order to fix this simulation, double-click on Diatoms1:[Peri Low-Nut Diatom], click on Edit Underlying Data, and click Edit All...**

## Can edit all toxicity linkages



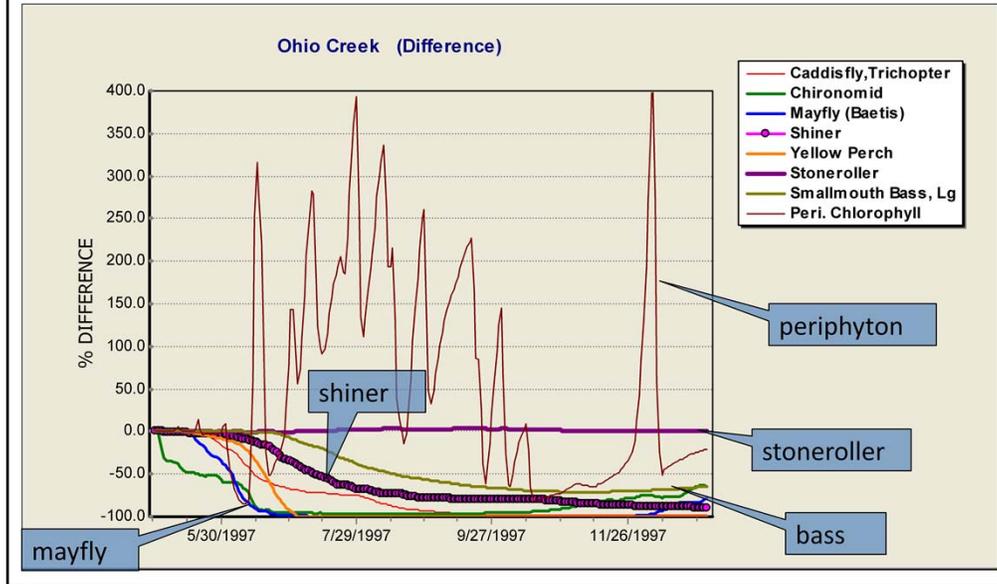
Toxicity Linkage	Assigned Organism
Diatoms1: [Peri Low-Nut Diatom]	peri Cyclotella
Diatoms2: [Peri High-Nut Diatom]	Diatoms
Greens2: [Peri, Green]	Greens
Bl-green1: [Peri, Blue-Greens]	Bluegreens
OtherAlg1: [Phyt High-Nut Diatom]	Diatoms
OtherAlg2: [Cryptomonas]	Greens
Macrophyte1: [Fontinalis]	Macrophytes
Shredder1: [Caddisfly, Trichopter]	Stonefly
Shredder2: [Rotifer, Brachionus]	Daphnia
SedFeeder1: [Chironomid]	Chironomid
SuspFeeder1: [Daphnia]	Daphnia
Grazer1: [Mayfly (Baetis)]	Chironomid
SmForageFish1: [Shiner]	Minnow
LgForageFish1: [Yellow Perch]	Bluegill
SmBottomFish1: [Stoneroller]	Minnow
LgGameFish1: [Smallmouth Bass, Lg]	Bass

By clicking on **Edit All** next to the toxicity assignment you can assign all linkages in one screen.

**Change the toxicity linkage for Diatoms1:[Peri Low-Nut Diatom] from peri Cyclotella to Diatoms.**

**Run** both the control and perturbed simulations.

## Impacts of constant chlorpyrifos on animals are dramatic, algae increase

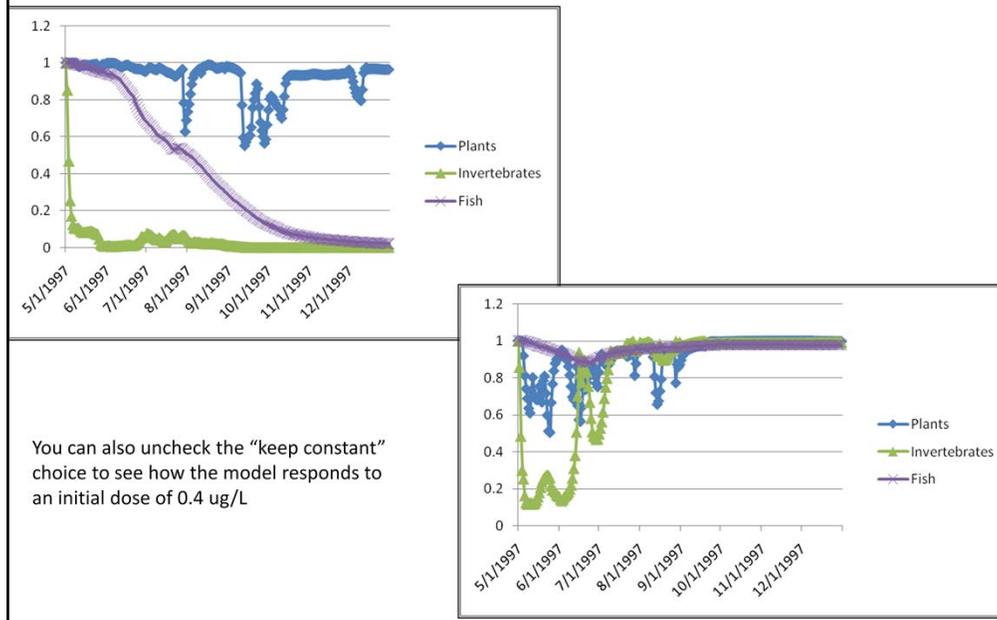


The best indication of the impacts are to be seen in a **Difference** graph that compares the perturbed with the control. To get this you have to run the simulations for the same period. Note that most of the invertebrates disappear quickly, followed by the fish. Shiners and stonerollers share the same toxicity record (Minnow), so the relative decline of shinners is due to loss of invertebrate food base and not direct toxicity whereas stonerollers, which graze periphyton, are unaffected.

What is the impact of an initial (rather than constant) exposure to 0.4  $\mu\text{g}/\text{L}$  chlorpyrifos on May 1?

Within a week the chironomids are reduced by > 99%, in 2 weeks Mayfly numbers are reduced by more than 95%, in one month Caddisflies are reduced by almost 94%. In about 2 months the yellow perch population is < 1% its starting amount and in 3 months the Smallmouth Bass population is reduced to half its original number. By the end of 1997, the Shiner population is >99% lost. Conversely, the stoneroller population decreases by no more than 10% before rebounding and periphyton experience some blooms and smaller die-offs.

## Plot of Steinhaus indices shows community impacts predicted by the model



The chronic exposure to 0.4 ug/L chlorpyrifos is predicted to lead to the rapid disappearance of invertebrates followed by fish. Periphyton are also affected due to release of herbivory.

An acute exposure of 0.4 ug/L is predicted to result in a significant change in the animals (about 80% dissimilarity for invertebrates compared to the control). However, complete recovery is predicted in about 5 months.

The output files with graphs are in the Data directory as **Ohio stream Chlorpyrifos constant\_Stein.xlsx** and **Ohio stream Chlorpyrifos pulse\_Stein.xls**.